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Effects of Circadian Rhythm Phase Alteration on Physiological and Psychological Variables: Implications to Pilot Performance
(including a partially annotated bibliography)

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PREFACE

This report is the preliminary effort of the NASA Joint Research Interchange entitled "Effects of Circadian Rhythm Phase Alteration on Physiological and Psychological Variables: Implications to Pilot Performance" (NCA2-OR675-005) conducted under the direction of Dr. Daniel C. Holley, Department of Biological Sciences, San Jose State University, San Jose, California. The review narrative was compiled by several individuals. The limited time for carrying out this project (June 1, 1980 to July 15, 1980) precluded integrative editing of the review sections to effect a common style. As with any project of large scope and limited time, many people made special contributions without which we could not have completed this effort. We acknowledge the excellent support of the library staff of San Jose State University (Mrs. King Wah Moberg and Mrs. Kathleen Taylor). We are also appreciative of the superb technical assistance of Mrs. Bridget Falkenstein, Mr. Curt Zingheim, Mrs. Dora McCollister, and Ms. Rosemary Burnett. We thankfully acknowledge Dr. Leon Rosenblatt, Walnut Creek, California, for reviewing the manuscript and providing constructive criticism.

EFFECTS OF CIRCADIAN RHYTHM PHASE ALTERATION ON PHYSIOLOGICAL AND PSYCHOLOGICAL VARIABLES: IMPLICATIONS TO PILOT PERFORMANCE

(Including a partially annotated bibliography)

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SUMMARY

Selected recently published literature (1972 to 1980) was reviewed dealing with the physiologic and psychologic effects of altered circadian rhythm phase relationships in higher vertebrates. Major emphasis was placed on the effects of environmental synchronizers upon circadian rhythmic stability in man and the deleterious alterations in performance and well-being which result from changes in this stability. The review (66 pp) includes a partially annotated bibliography consisting of 2084 references relevant to pilot performance and circadian phase alteration. Review categories include: 1) human performance, with primary emphasis on the effects of sleep loss or disturbance and fatigue; 2) phase shift, in which ground based light/dark cycle alteration and transmeridian flight studies are discussed; 3) shiftwork; 4) internal desynchronization, which includes the effects of constant environments, isolation or other environmental factors on rhythmic stability, and the effects of rhythm disturbances on sleep and psychopathology; 5) chronotherapy, the application of methods to ameliorate desynchronosis symptomatology; and 6) biorhythm theory, in which a critical analysis is made of the birthdate based biorhythm method for predicting aviation accident susceptibility. There is a need for more integrative investigation in realistic operational environments to evaluate the effects of chronic time zone travel upon health and performance. Further work is necessary on the evaluation of chronotherapeutic measures and the development of appropriate educational programs for pilots based upon present knowledge of the influence of sleep and circadian rhythm disturbances upon performance.

I. INTRODUCTION

This annotated bibliography has been compiled to provide a data base of material in the scientific literature on which to address the following questions: 1) What, if any, are the pertinent issues of importance to the aeronautical community regarding circadian desynchronosis; and 2) Can these issues be resolved by current research techniques?

We have included a review of selected recently published literature dealing with the physiological and psychological effects of altered circadian rhythm phase relationships in higher vertebrate species, with major emphasis on the effects of alteration in environmental synchronizers upon circadian rhythmic stability in man, and the deleterious changes in performance and well-being which result from changes in such stability.

The report includes an annotated bibliography of materials relevant to pilot performance and circadian phase alterations and a series of review articles, each of which covers a major research area within the topic. A selected bibliography of citations (included within the master bibliography) pertaining to each review area can be found at the end of each section.

NASA previously funded a review of the literature dealing with factors in the aviation environment and their effects on performance (Beljan, J. R., L. S. Rosenblatt, N. W. Hetherington, J. L. Lyman, S. F. Flaim, G. T. Dale, and D. C. Holley, Human Performance in the Aviation Environment, NASA Contract No. NAS2-6657, 1972). This report included a review of circadian rhythm desynchronization in relation to performance. It concluded that rhythm desynchronization often results in a wide variety of physiological and psychological abnormalities resulting in the desynchronosis syndrome, which can have debilitating effects on individual performance.

The annotated bibliography in the present report includes all available literature since the time of the Beljan report (1972 to present). A few selected publications from the period prior to 1972 which were omitted from the Beljan report have been included in order to complete the literature review. Methods of retrieval included:

1. Computerized literature search of several data bases (Medlars, Recon, Dialog).

2. Direct search of literature indexes (Biological Abstracts, Bioresearch Index, Index Medicus, Excerpta Medica, International Aerospace Abstracts (IAA), Scientific and Technical Aerospace Reports (STAR), Science Citation Index, Psychological Abstracts, Reader's Guide to Periodical Literature).

3. Direct search of abstracting services covering foreign literature (Library of Congress Science & Technology (S & T) Alert items and USSR Life Sciences Digest).

4. Direct search of lists of literature currently in print (Bowker's Books in Print, British Books in Print, Canadian Books in Print, Medical Books and Serials in Print).

5. Cross reference of many of the bibliographies in published articles retrieved.

An attempt was made to obtain as many references as possible relevant to performance and circadian rhythm desynchronization within the time period of the consortium (June 1, 1980 to July 15, 1980) and any omissions should be considered unintentional. The annotations to the citations are either: 1) the author's abstract or summary; 2) an abstract from an indexing system or computer search; or 3) an abstract made by one of our group. A total of approximately 2000 references was obtained, including approximately 85% relating to humans, 5% to non-human primate, and 10% to animal studies. The non-human primate and animal references represent a select group of papers which were included in this report since they deal with important experimental studies of circadian rhythm desynchronization, rephasal dynamics and mechanisms, conducted under carefully controlled laboratory conditions to an extent which is usually not possible for human research. Some of these studies could not have been performed on human subjects.

A significant finding of this project was the tremendous increase in the sleep literature since the Beljan report in 1972. The role of sleep and the significance of the sleep-wake cycle in physiology and psychology cannot be overestimated. This subject is treated in several sections of this report since it is key to the discussion of many of the topic categories.

The literature obtained for this report was divided into six major categories:

Performance

This category includes those papers relevant to the topic of performance which do not fall into the categories of shift work, phase shift, internal desynchronization or chronotherapy. This discussion, therefore, focuses on variables which adversely affect performance, primarily those factors which affect human performance in the aviation environment. Primary attention has been directed to the effects of sleep loss or disturbance and fatigue. Other variables affecting performance such as motivation, arousal, hypoglycemia and drugs are also discussed. This category is important to the topic of performance and circadian rhythm desynchronization since the relative effect on pilot performance of circadian rhythm desynchronosis-induced performance deterioration will be a function of the existing level of performance deterioration resulting from the effects of one or more of the variables discussed in this section.

Phase-Shift

This category includes studies involving rhythm desynchronization resulting from altered rhythm synchronizer phases (light-dark cycles, social interaction and meal timing). Primary emphasis will be placed upon the effects of transmeridian flight upon circadian rhythm desynchronization and readaptation, performance and physical and psychological well-being. This category will also include discussion of ground-based experimental studies on circadian rhythm phase-shifts, inverted schedules, unusual work-rest schedules, and rhythm desynchronization, which have implications to pilot performance on transmeridian routes.

Shift-Work

This category includes papers involving circadian phase-shifts in the work environment, i.e., the effects of various kinds of rotating work shift schedules or night work on rhythm stability and their effects upon performance and well-being. This topic is important in that rhythm desynchronization resulting from shift-work is often manifested by performance deterioration and health problems and therefore has implications to pilot and air traffic controller performance. The effect of circadian desynchronization upon homeostatic regulation of physiological processes and subsequent long term effects upon health and longevity is discussed.

Internal Desynchronization

This category includes all studies involving circadian rhythm desynchronization or rhythm instability which do not fall under the categories of shift-work or phase-shift. It includes the effects of constant environments (e.g., continuous light or darkness) and isolation on rhythmicity, the effects of rhythm disturbance on sleep and psychopathology, and the effects of other environmental agents (electromagnetic fields, hypokinesis, space flight) on the maintenance of circadian rhythmic stability. This section provides a basic experimental background into the nature of circadian rhythmic desynchronization by examining studies of circadian pacemaker or coupled oscillating mechanisms. This topic is important in providing an experimental background for understanding the mechanisms involved in circadian rhythm desynchronization and their relationship to the kinds of sleep disturbances and deterioration in well-being commonly observed in humans who have become rhythmically desynchronized following transmeridian flight.

Chronotherapy

This section specifically deals with methods or suggestions for ameliorating or counteracting the effects of rhythm desynchronization. Included is a discussion of experimental approaches to the facilitation of readaptation following phase-shifts or transmeridian flights by effecting alterations in circadian rhythmicity (chronotherapy). These treatments include synchronizer control (e.g., light-dark cycles, meal timing, social interaction effects) and chronobiotics (drugs affecting circadian oscillatory mechanisms). In addition, methods or recommendations for alleviation of desynchronosis symptomatology have been included (sedative drugs, preadaptation, relaxation techniques, etc.). These treatments are discussed with respect to their relative effectiveness in treating desynchronosis and their suitability for future research.

The Biorhythm Theory

A separate section will provide a critical analysis of the so-called "biorhythm theory," which postulates that 23, 28, and 33 day cycles have significant influences upon performance levels and that aviation accident occurrences significantly above chance levels occur on days upon which these cycles cross the transition from high to low phases (critical days). The theory's many proponents, including some from the scientific community, have reported that a statistically significant number of aviation accidents occur on biorhythm critical days, that airlines have employed safety awareness programs using biorhythm charting to achieve substantial reductions in accidents and that certain airlines already use, or should use, biorhythm charting for work scheduling and safety meetings.

Although the scientific community has characterized the theory as fraudulent or invalid, the theory enjoys considerable popularity and it was deemed important to include in this report a critical analysis of the theory because of the theory's implications for pilot performance and aviation safety, based upon these reputed cyclical phenomena. This review will show that the original theory is mathematically and theoretically unsound, that studies in support of the theory mostly reflect improper methodology, lack of documentation, faulty interpretation of results and that the theory's predictions are contradicted by the entire literature on infradian biological rhythm research.

For the purpose of this report it is necessary to define terminology related to circadian rhythm synchronization, desynchronization and transmeridian flight.

- An environmental agent is termed a synchronizer (entraining agent, Zeitgeber) if it is capable of forcing another cycle to assume its frequency with a characteristic phase relationship. Examples of synchronizers are light-dark cycles, social interaction and restricted meal times.

- Circadian rhythms are said to be desynchronized from entrainment or synchronization when two or more previously synchronized rhythmic variables cease to exhibit the same frequency or phase relationship to the synchronizer.[722]

- Rhythm desynchronization from an environmental cycle is termed external desynchronization.

- If external desynchronization results in the continuance of periodicity with a natural frequency at least slightly different from the period of any known environmental factor, the resultant circadian rhythms are termed "free-running." Free-running often occurs in constant conditions (constant light or darkness in a controlled isolated environment).

- Internal desynchronization refers to desynchronization of two or more rhythmic variables from each other, manifested by the appearance of a previously absent difference in frequency or a change in the timing of rhythmic phase positions with respect to each other.

- A phase-shift refers to a change in timing of environmental synchronizer events with respect to phase position of rhythmic variables (i.e., timing of stabilized rhythmic peak and trough times).

- The circadian system responds to phase-shift induced by temporal alteration in synchronizers or transmeridian flight by exhibiting both external and internal desynchronization, followed by a period of adaptation (rephasal, resynchronization, re-entrainment) in which the previous phase relationship between the synchronizer and the rhythmic variable becomes reestablished.

- Rhythm desynchronization in which there is a deficit in physical, physiological or mental performance, or with increased risk of disease or overt illness is termed dyschrony or desynchronosis.[722] Although objections have been raised to the term desynchronosis,[722] as implying a degenerative condition, the term is widely used and, therefore, the terms desynchronosis and dyschrony will be used synonymously in this report.

- Rhythm alteration associated with malaise and/or performance decrement in association with transmeridian travel will be termed transmeridian desynchronosis or dyschrony (TMD). The term "jet lag" is deemed inappropriate since TMD may occur following the crossing of time zones by means other than jets and it may be absent in the case of rapid round trips by jet.[722]

- Excessively delayed rhythm resynchronization or readaptation following transmeridian travel, due to climatic, cultural or other environmental differences between origin and destination, is referred to as latent desynchronosis.

Confusion exists in the literature between the terms biorhythm and biorhythmic and biological rhythm, as they refer to the popular biorhythm theory of 23, 28, and 33 day cycles or to empirically-based investigation of periodicity in various physiological or performance variables. For example, one reference in this bibliography[1156] entitled "Relationship of Selected Biological Rhythms to Performance of Competitive Swimmers" is actually an investigation in biorhythmic-cycle theory. However, another paper entitled "Biorhythm and Watch Rhythms"[299] is an investigation of circadian rhythmicity. Therefore, in this report, the term "biorhythm" or "biorhythmic" will refer exclusively to biorhythm theory cycles and the term "biological rhythm" will refer to empirically-based studies of periodicity in physiological or performance data. As a further distinction, the 23, 28, and 33 day cycles of biorhythm theory will be referred to as biorhythm cycles. Periodicities in the biorhythm cycle time domain, which were obtained by time series analysis of physiological or performance data will be referred to as low-frequency or infradian rhythms.

II. PERFORMANCE

A. Introduction

This section is an update of the report by Beljan et al.[177] with regard to certain variables which adversely affect performance in the aviation environment. No attempt at completeness is intended. Instead, the discussion focuses on three primary areas of research: fatigue, performance rhythms, and sleep loss and disruption. A fourth area on alcohol, drugs, and hypoglycemia, and the physiology of sleep deprivation is briefly covered.

Together with sleep loss, a common complaint of aircrew personnel is fatigue. Research on fatigue has been beset with considerable problems of definition, measurement, and interpretation. More recent work has emphasized the redefinition of fatigue as a generalized reaction to stress. Of more importance, however, is the growing recognition that the symptoms usually used to describe fatigue can equally well be assigned to a simple inhibition effect known to occur with extended activity, an emotional variable similar to fear or anxiety, or to sleep deficit or disruption. The usefulness of the fatigue concept is discussed.

Studies on performance rhythms have come to recognize a distinction between those tasks involving memory storage and those involving only immediate information processing. Whereas performance on the latter is roughly in phase with body temperature rhythm (perhaps coincidentally), performance involving memory storage is out of phase with this function. There is also a need for closer attention to be paid to the differences in the basic processes underlying different tasks, and the choice of performance tasks which are more meaningful and relevant to those actually performed by workers.

Recent reviews, as well as research conducted during continuous operations in the field have seriously questioned laboratory conclusions that total (or partial) sleep deprivation results in significant performance decrements. Criticisms addressed to the experimental methodology of previous, sleep-loss research are discussed. Developments of recent research relating REM and Stage 4 sleep deprivation to performance are reported. The effects of napping on performance, mood states, and sleep stages are covered briefly.

A final discussion of recent works on the effects of alcohol and drugs on pilot performance is included. The high incidence of potential functional (reactive) hypoglycemia in airline pilots and the implications for flight safety are presented as a further example of factors which adversely affect performance in the aviation environment.

B. Fatigue

Research on fatigue has been plagued by problems of definition, measurement, and interpretation. Early studies on fatigue in industry concentrated on changes in production output following prolonged periods of work. Later research developed methods of measurement more applicable to tasks involving little physical effort and more sensitive to time-correlated variations in performance. Difficulties in interpreting many studies have resulted from a failure to consider fatigue in terms appropriate for dealing with a complex biological process. Conceptualizations of fatigue in simple energistic terms have led to a variety of methods of measurement which are difficult to interpret and which often result in paradoxical conclusions.

More recent research reflects a change in emphasis towards the chronic and cumulative effects of fatigue and concern for the long-term well-being of workers and aircrew members. Both in aviation and road transport studies it has become clear that fatigue effects cannot be easily distinguished from the effects of inadequate or disturbed sleep.[302] Many experimental studies have considered fatigue effects over a period of some hours and found slight to moderate performance deficits. It is often concluded that motivational factors can overcome such deficits. Hartman[760] reported moderate inflight fatigue and stress, aggravated by physical discomfort, in aircrew members in 15 separate 8 hour missions. It was also reported that recovery from these symptoms generally followed after one night of sleep. However, the validity of such conclusions may be restricted to experimental studies involving only relatively short periods of sleep deprivation. It has become clear that the fatigue problem is embedded in the whole life pattern of those who chronically suffer from it.[303]

Fatigue is often defined as a generalized response to stress (or a defense reaction to stress) over a period of time, which may be either acute or chronic (or both) and is measured by performance changes and by reports of subjective feelings. Anxiety appears to be a factor in both acute and chronic fatigue. Many of the performance decrements reported in fatigue studies are consistent with a high level of arousal, which is also found in studies of sleep deprivation.

Grandjean[692] has proposed a neurological concept of fatigue to account for these findings. This concept considers fatigue as a state of the central nervous system controlled by the antagonistic activity of the inhibitory and activating systems of the brain stem. If the inhibitory system dominates, the organism is in a state of fatigue. If the activating system prevails, the organism is in a state of wakefulness and ready for physical or mental activity. A boring or repetitive task would provide little stimulation and favor the onset of fatigue.[303] This would be accomplished by a decrease in motivation and physical and mental performance, and by the occurrence of subjective feelings of fatigue. Unfortunately, though the theory points to arousal as an important factor in fatigue studies, it does little to elucidate the nature of fatigue itself.

Long-term psychosomatic effects, sleep disturbance and the paradoxical results in fatigue studies are associated with performance changes resembling those found with elevated levels of arousal. All the behavioral features which distinguish the fatigued subject, including performance decrements, irritability, restlessness, and inability to sleep are actually non-specific as are the biochemical changes reported. These symptoms may also be found in individuals suffering from chronic anxiety.

The most common symptoms of fatigue reported are decrease of attention, slowed and impaired perception, impairment of thinking, and decrease of motivation and physical performance.[692] These various fatigue phenomena, as well as reported feelings of discomfort, irritability and restlessness can be reasonably assigned to an emotional variable similar to anxiety or fear, to sleep deficit or disruption, or to a simple inhibition effect known to occur with extended activity. Thus, the term "fatigue" seems unnecessary except as a label for a generalized response to stress over a period of time. This use of the fatigue concept seems even more inappropriate since it merely shifts attention to the equally vague notion of stress.

C. Performance Rhythms (Memory and Immediate Process Tasks)

Daily variations in the efficiency of performance have long been recognized. Klein et al.[972] reported circadian cycles of performance in psychomotor, symbol cancellation, reaction time, and digit summation tasks in human subjects. These variations tended to correspond with rhythmic changes in body temperature. Fort et al.[578] found this relationship was present whether the temperature changes were part of the natural circadian rhythm or were artificially induced. Behavioral performance rhythms can be modified by a number of factors such as disposition, practice, motivation, personality (introverts versus extroverts), sleep deprivation and work shifts.[972]

Folkard[555] found that speed in performing two logical reasoning tasks improved markedly from 0800 to 1400 hours and fell off fairly rapidly thereafter. Accuracy decreased linearly over the day. It was concluded that previous work relating performance to time of day actually found functions resulting from differences in task demands rather than from individual differences. The suggestion was made that the higher the memory or articulatory component of a task, the earlier in the day performance on such a task peaks. It was assumed that the logical tasks employed involved both short-term memory and immediate processing.

Buck[287] conducted a study utilizing a step-input pursuit tracking task which confirmed Folkard's results. Performance varied with time of day in a manner and to an extent dependent on the choice of index so that circadian rhythms for speed scores were in inverse phase with those for accuracy scores.[287] Increased short-term memory demands disrupted the movement-time rhythm, indicating that psychomotor and short-term memory functions vary in inverse phase with the time of day.

Rutenfranz and Colquhoun[1589] suggested that performance rhythms are closely connected to the cycle of "sleep need." Blake[1589] found circadian performance variations in vigilance, card sorting, reaction time, serial reaction, letter cancellation, and calculations tests. All exhibited the "late peaking" phenomenon which may be due to a final surge of motivation or an interaction between practice effect and time of day. A seventh test on digit span did not display the "late peak." Further, digit span performance was out of phase with performance on the other tests.

Rutenfranz and Colquhoun[1589] also proposed that there are two types of tasks, immediate information-processing tasks and storage-of-information tasks. The former are roughly in phase with body temperature rhythm (perhaps coincidentally) and the latter are out of phase with this rhythm. Monk et al.[1256] found that the memory load of a particular task can influence not only the phase of its circadian rhythm, but also the rate at which the phase of the rhythm adjusts to a new schedule. It was concluded that these results are inconsistent with the notion that mental performance can be considered to have a single rhythm with a particular phase and rate of adaptation.

It is clear that future studies need to direct closer attention to differences in the basic processes underlying different performances. Rutenfranz and Colquhoun[1589] propose a taxonomic approach to be used in future performance rhythm research which may help clarify the parameters under study. It is also imperative that studies of performance rhythms in shift work and rapid time zone changes utilize tests which represent a meaningful simulation of certain aspects of the task which the worker actually performs.

D. Sleep and Performance

Horne,[860] after a lengthy review of studies concerning the biological effects of total sleep deprivation (TSD, defined as deprivation of sleep exceeding 24 hours), concluded that TSD does not appear to produce any major changes in biochemical and physiological measures of somatic functioning. This would imply, in addition, that there is little support for the theory that body restitution plays a significant role in the functions of sleep. Horne has offered six major criticisms of the experimental methodology employed in TSD research: 1) apart from TSD itself, most studies utilized unnatural and unrealistic environments; 2) many studies may have been of insufficient length to detect any major disruption of somatic functioning; 3) the somatic functions measured were often of limited range and were inadequately analyzed; 4) subjects were constitutionally stereotyped, being primarily fit, young, intelligent male adults; 5) reported statistical differences may have been of no physiological significance, while changes of possible statistical significance could have been obscured by analytical procedures; and 6) behavioral variables, such as novelty and anticipation, may have been confounding real effects of TSD. These criticisms may help account for the confusion and contradiction prevalent in the study of effects of sleep loss on human performance.

Compared to TSD, there are only a few studies on partial sleep loss (PSL). Johnson and Naitoh[905] reported difficulty in finding studies demonstrating a consistent performance deficit during short periods of sleep deprivation. As with TSD, an important source of variance in PSL studies is the circadian effect. Whether sleep is shortened by going to bed later, getting up later, or by fragmentation of sleep, there is an alteration in the timing of the sleep-wake cycle.[905] Because of this alteration it is difficult to determine if the changes observed following PSL were due to short sleep, or simply to the imposition of sleep (or wakefulness) on an unaccustomed portion of the circadian cycle. Subsequent to changes in both sleep times and sleep/waking cycles, disruption of the circadian cycle may be more relevant to waking behavior (performance and subjective mood) than PSL per se.[906]

The effects of PSL on performance are also confounded by the inherent organization of sleep stage patterns, since shortening of sleep changes the type of sleep obtained.[905] Despite considerable research, the function of Stage 4 and REM sleep remain a mystery. Moses et al.[1302] and others have verified the ultradian character of the REM sleep cycle, but whether REM sleep represents a sleep-dependent rhythm or Kleitman's Basic Rest-Activity Cycle is still in controversy.

Taub[1808] and other researchers have investigated napping behavior and its relationships to performance, mood states and sleep physiology. Napping appears to serve different but important functions for different types of individuals.[524] Aside from those who deliberately don't nap, there are habitual appetitive nappers (who nap lightly for psychological reasons apparently unrelated to reported sleep needs) and replacement nappers (who seem to nap regularly in response to temporary sleep deficits).

D.1 Total sleep deprivation- A number of recent laboratory studies[284,288,291,402,535,598,858,952,1083,1084,1119,1281,1284,1287,1508,1841,1923] reported decrements in human performance and/or changes in mood states resulting from TSD. A considerable variety of different tasks were employed including vigilance, interrogation rate, motor and visual response time, continuous or sustained work, immediate recall of word lists, vision accommodation, letter cancellation, logical-reasoning, coding, tracking or monitoring, and pursuit rotor. The durations of TSD in these studies ranged from 24 to 100 hours. Deficits in performance were also found to vary with personality types. Lester et al.[1084] reported the combination of high ego strength and low impulsiveness to be associated with better vigilance task performance.

In contrast with many laboratory studies, reports on research conducted during continuous operations tend to play down the role of TSD in producing any significant decrements in performance. Morgan et al.[1287] investigated the effects of continuous work and sleep loss on sustained performance and recovery during continuous operations. It was concluded that appropriately motivated and scheduled individuals should be able to follow a 36 hour continuous work, 12 hour recovery schedule with minimum decrements in performance.

Johnson and Naitoh[905] reported that within the 36-48 hour range of TSD likely to be experienced by aircrew personnel, no consistent or uniform performance decrement has been found in operational studies despite laboratory reports of decrements on certain tasks. These investigators pointed to the major importance of type of task, the environment in which the task is performed, and individual differences. It appears that the problem of relating laboratory studies, operational studies, and the tasks actually required of specific populations of workers (such as commercial-aviation pilots) has not yet been resolved.

D.2 Partial sleep deprivations- Webb and Agnew[1915] conducted a study on the effects of a chronic limitation of sleep length (5-1/2 hours of sleep a night for 60 days) and found that only the Wilkinson Vigilance Task showed a decline in performance with this schedule of restricted sleep. Initial difficulties in arousal from sleep in the morning and feelings of drowsiness during the day did not remain throughout the experiment. In addition, mood states showed no changes on this schedule.

Johnson[905] reported that PSL appears to be a part of most aircrew operations, especially those involving time zone changes. Of far more significance than the actual amount of sleep loss is the disruption of the circadian sleep-wake cycle.[905] During flight operations sleep appears to be fragmented and is often scheduled at unusual hours. Flights during the usual sleep periods are accompanied by greater accumulated sleep deficits.[905] Subjective feelings of fatigue are major findings in both the laboratory and operational setting. Subjective attitudes (mood, appearance, and behavior) as well as individual susceptibility or tolerance to effects of PSL are also felt to be important factors in crew performance.[905]

D.3 REM sleep- Kripke[1031] demonstrated an ultradian biological rhythm of 10 to 20 cycles/day associated with perceptual deprivation and REM sleep. These findings supported the concept of a discrete oscillatory mechanism modulating physiologic systems and behavior.

Salamy[1608] suggested that REM sleep deprivation in an instrumental performance study possessed motivational properties analogous to other physiological motives (such as hunger and thirst). However, Costello and Ogilvie[390] concluded that selective REM sleep deprivation can produce performance deficits similar to those of TSD. Such decrements can only be shown when the tasks are long in duration, repetitive in value, low in interest and incentive, and high in complexity.[390]

Johnson et al.[906] conducted research on the relation of stages of sleep to performance and concluded that the view of sleep stages as unique need states is probably too simple. The disruption of the sleep-waking cycle and, during sleep, the disruption of the REM-NREM sleep cycle are probably more relevant to waking performance than the total amount of time spent in specific sleep stages.[906] In a later study, Johnson and Naitoh[905] concluded that deprivation of REM sleep or Stage 4 sleep produces no behavioral changes supportive of earlier beliefs that the two sleep stages (especially REM sleep) were necessary for effective waking behavior.

D.4 Naps- Taub et al.[1805] found significant improvements in reaction time and alteration of subjective arousal after daytime naps. Taub et al.[1822] reported that the relative amounts of REM sleep and Stage 4 sleep in naps occurring after a regular 7-8 hours of night sleep changed progressively as napping transpired later in the day. Morning naps closely resembled the terminal portion of nocturnal sleep containing much REM sleep time but virtually no Stage 4 sleep. In contrast, evening naps were heavily concentrated in Stage 4 sleep but contained only limited REM sleep.[1822] Naps late at night appear to be compensatory in nature, while morning naps seem to occur independently of obvious physiological sleep requirements.

Taub and Tanguay[1819] found enhanced performance on an auditory reaction time task following afternoon naps. Lubin et al.[1118] reported that while exercise increased impairment in performance due to sleep loss, naps reduced or removed this impairment. The importance of napping in possibly alleviating performance decrements in individuals chronically sleep deprived or desynchronized has as yet received little attention, however.

D.5 Conclusions- The paucity of data indicating a clear performance decrement following sleep loss does not diminish the importance of adequate sleep in alleviating the problems caused by repeated time zone crossings, or as a means of reducing the physiological cost of air operations. What is needed is a statistically reliable method of measuring performance decrements in the actual operating situation. In the meantime, operational planning involving aircrew personnel might use the time taken to return to pre-mission sleep patterns (sleep stabilization) as a measure of minimum recoverability time, and at least avoid the obvious performance problems resulting from cumulative build-up of sleep loss and disruption.

E. Other Factors and Performance

E.1 Drugs and hypoglycemia- Billings et al.[214] recorded in-flight performance of pilots who were under the influence of alcohol at one of three blood-level concentrations. Procedural errors increased significantly in frequency and potential seriousness with each increase in blood-alcohol level. At the highest level, the subjects lost control of the aircraft 16 times in 30 flights.[214] Tracking error and variability also increased with alcohol level.

In another study, Billings et al.[215] found results indicating that alcohol-induced pilot-performance degradation may occur first in secondary tasks rather than in the primary flying task. Apparently even highly skilled aviators exhibited potentially dangerous deterioration in performance at blood-alcohol levels as low as 0.04%.

Gerke et al.[646] reported some decremental effects on pilot performance under all levels of diazepam studied. Nicholson[1355] investigated the residual effects of hypnotics on performance, finding that while methaqualone hydrochloride (400 mg) and diazepam (10 mg) had limited performance effects, barbiturates and benzodiazepines appeared to lead to performance deficits lasting well into the next day.

Harper and Kidera[754] reported on the incidence of chemical and clinical hypoglycemia in 175 airline pilots. A high incidence of functional hypoglycemia was detected. The incidence of potential hypoglycemic pilots over age 40 was found to be 25%.[754] Cases involving compromises in flight safety of hypoglycemic etiology were presented.

The hazards of pre-flight drug use and hypoglycemia in pilots is illustrated by an NTSB report of a fatal aircraft accident.[104] The investigation concluded that performance errors which led to the fatal crash at 2248 hours (EDT) were due (in part) to the degraded physiological condition of the captain which seriously impaired his performance. The captain was taking polythiazide (a hypertensive medication) and allopurinal (a medication for gout). In addition, the captain's only known food intake occurred in the late afternoon, several hours before the crash.[104]

E.2 Physiology and performance- Only a small percentage of recent studies investigated the physiological aspects of fatigue and sleep deprivation in relation to performance rhythms. The importance of circadian variations in biochemical changes with respect to fatigue and performance was described in two 75-hour sleep deprivation studies.[600] Because catecholamine excretion, psychomotor performance, and psychological ratings were all measured (every 3 hours), this work represents one of the few integrated studies of its kind. All biochemical variables, as well as fatigue and distress ratings, exhibited circadian rhythms. Adrenalin had maximum values in the afternoon and minimal values in the early morning, while noradrenalin and urine flow peaked during morning hours.[600] Fatigue ratings were lowest about the time of maximum adrenalin. Adrenalin secretion was thus highly positively correlated with performance and negatively correlated with fatigue ratings.[600] The reverse was true of noradrenalin excretion. There were no marked changes over days in catecholamine excretion or diuresis. Further study revealed that the correlation between adrenalin and fatigue rates was not due to sleep loss, per se, while sleep loss was found to be an important factor in the positive relationship of noradrenalin to performance and fatigue.[600]

In general, the physiology of sleep deprivation is unclear. One study found that the ability to regulate body temperature was not reduced by sleep loss, and concluded that despite considerable psychomotor impairment during sleep deprivation, physiological regulatory mechanisms were relatively unaffected by sleep loss.[545]

F. Environmental Factors and Performance

The conflicting reports and conclusions presented in Beljan et al.[177] with regard to the detrimental effects of environmental factors on performance remain unsolved. Pierson[1436] reported no significant effects on psychomotor and decoding tasks of turboprop aircraft noise and an 8000 foot altitude in aircrews. Hawkins and Barber[791] found that negative ionization in the air was associated with a significant increment in psychomotor performance. Positive ionization appeared to have no effect.

G. Conclusions

A review of the recent literature revealed an enormous increase of sleep-related research during the last decade. Such research forms a major portion of the literature relevant to performance decrements and circadian rhythms. Studies on environmental factors such as noise, vibration, altitude, and air ions in relation to performance represented a much smaller percentage of the literature.

The need for studies integrating both psychological and physiological measures is quite apparent. The lack of coordinated measures on psychomotor and higher brain function tasks as well as on physiological parameters in the specific environmental setting under study has resulted in the production of isolated experimental results which cannot be meaningfully integrated. There is even serious question whether the results found in military aircrew operational studies are applicable to pilots in commercial aviation.

Further research integrating EEG sleep patterns, psychomotor and higher brain functioning measures, and physiological variables (especially from blood and urine samples) taken in both the laboratory and on board commerical aircraft are recommended. In addition, research into the simultaneous effects of sleep loss, environmental factors, drug use, diet and meal times, and rapid time zone crossings on commercial pilots might considerably clarify the possible additive or synergistic nature of these parameters on performance in flight. The possibility exists that the natural depression of arousal during certain times of the day may combine with other causes of performance decrement to form a crucial factor in commercial aviation accidents.

H. Selected Bibliography on Performance

4	107	210	289	388	508	592	686	770	859	926	1018	1103
5	110	211	290	390	509	593	687	771	860	937	1031	1104
6	111	212	291	395	510	594	690	772	861	938	1033	1105
7	112	213	302	396	512	595	692	773	863	939	1034	1106
8	120	214	305	398	515	597	693	774	864	940	1037	1107
15	132	215	312	402	519	598	699	777	865	949	1039	1110
18	146	217	313	409	521	599	700	783	870	950	1043	1112
19	154	218	315	414	524	600	701	784	873	952	1046	1118
23	160	223	316	417	525	601	708	786	874	953	1052	1119
24	165	226	327	420	528	602	722	787	875	954	1054	1120
25	168	227	329	425	530	603	731	788	876	955	1055	1125
27	171	229	332	427	535	604	734	791	877	956	1059	1126
28	172	230	335	430	538	605	743	796	881	957	1062	1127
29	177	231	338	431	545	615	744	801	883	958	1064	1128
30	182	235	340	432	547	635	745	802	893	959	1066	1129
31	184	242	342	433	548	642	747	807	894	962	1069	1130
35	186	243	344	434	555	643	748	808	898	963	1073	1149
36	189	244	348	439	557	644	749	809	899	964	1076	1165
40	190	256	350	440	559	646	752	810	900	965	1082	1166
42	191	258	351	441	561	647	753	811	901	967	1083	1170
45	192	259	352	442	565	648	754	813	902	968	1084	1173
47	193	264	359	445	570	649	756	815	903	970	1085	1174
73	194	265	360	455	571	651	757	818	904	971	1086	1178
74	195	266	361	456	572	652	758	822	905	972	1087	1182
78	196	267	362	461	577	655	759	826	906	975	1089	1183
79	200	268	363	466	578	660	760	827	907	986	1091	1186
81	201	279	366	470	579	661	761	828	908	993	1092	1189
86	204	282	367	474	580	670	762	832	911	996	1096	1194
91	205	284	371	479	583	672	764	833	912	1000	1097	1198
93	206	285	373	484	585	673	766	834	913	1001	1098	1199
96	207	286	374	497	586	674	767	856	918	1002	1100	1216
101	208	287	375	501	588	675	768	857	919	1011	1101	1220
104	209	288	387	507	589	676	769	858	925	1014	1102	1227

1238	1300	1356	1404	1479	1562	1639	1745	1816	1906	1951
1239	1301	1357	1421	1480	1563	1643	1747	1817	1907	1960
1241	1302	1359	1422	1481	1566	1645	1748	1818	1911	1965
1251	1309	1360	1425	1482	1567	1653	1749	1819	1914	1966
1253	1313	1361	1428	1483	1568	1656	1750	1820	1915	1967
1256	1322	1362	1431	1485	1571	1663	1751	1821	1918	1973
1268	1323	1364	1436	1486	1572	1664	1786	1822	1919	1974
1280	1324	1374	1437	1487	1575	1677	1795	1823	1920	1994
1281	1326	1375	1438	1488	1576	1691	1797	1824	1922	1996
1282	1327	1376	1457	1507	1577	1707	1804	1825	1923	2007
1283	1328	1377	1461	1508	1579	1708	1805	1834	1924	2008
1284	1346	1378	1465	1512	1588	1718	1806	1841	1925	2022
1285	1348	1379	1466	1514	1589	1719	1807	1854	1933	2026
1286	1349	1383	1467	1520	1591	1732	1808	1860	1937	2045
1287	1350	1387	1471	1522	1603	1735	1809	1867	1940	2054
1288	1351	1389	1472	1545	1608	1739	1810	1875	1944	2058
1295	1352	1390	1473	1548	1615	1740	1811	1879	1945	2066
1297	1353	1392	1474	1551	1622	1741	1812	1881	1949	2071
1298	1354	1393	1475	1554	1630	1743	1813	1905	1950	2084
1299	1355	1401	1478	1557	1634	1744	1815			

III. PHASE-SHIFT

A. Introduction

The continuous technical developments in air traffic make it possible for human beings to cover large distances in ever shorter periods of time. Until about the middle of the present century the greater part of travelling was dependent on such means of transportation as railroads, cars or ships, all of which require a relatively long time for long-distance journeys. Modern jet aircraft make it possible to cover these distances in just a few hours. Unlike flights in a north-south direction, trips in an easterly or westerly direction involve the crossing of time zones, with a time shift of one hour for every 15 meridians crossed (360°—24 hours).[460]

The extent to which such transmeridian trips can have a disturbing effect on the human organism will largely depend on the travelling speed and the number of time zones that are crossed. In the case of trips by ship or rail the body will not have any great difficulty in adapting its rhythmic functions to the slowly changing local time. In the case of air trips across several time zones, on the other hand, the traveller is abruptly transferred into an environment where the rhythm of the external time givers is displaced by several hours, forward or backward, with respect to that of the point of departure. This leads to a temporary desynchronization between the external Zeitgebers and the circadian rhythms of the human body.

This condition, or its symptoms, has been variously called "desynchronosis," "jet-lag," "time zone fatigue," "phase-shift syndrome," and a variety of other terms.[178] Upon deplaning, passengers and crew may experience states of irritability, disorientation, distortion in the sense of time and distance, aches of various types, digestive upsets, and disturbances in sleep habits. The effects of phase-shift and desynchronosis are of particular importance to the aviation and space environments in that they influence human performance rhythms and levels as well as physiological rhythms.

B. Effects of Sleep Disturbances on Performance

Tests carried out using a number of different tasks confirm that human performance varies to a daily rhythm.[787,973] Generally, performance rhythm rises during the day to a plateau between 1200-2100 hours, then declines to a minimum which is usually positioned at 0300-0600 hours at night. A post-lunch dip in performance occurs around 1300 hour regardless of when, or whether or not, lunch is eaten. A number of factors such as phase-shifted or displaced sleep, decreased motivation, and increased stress can negatively influence levels of performance.[972] In field studies, the rate of operational errors proved dependent on both time of day as well as on the length of the preceding duty period.[820]

If time zones are crossed, the sleep-wake period is phase-shifted with respect to the performance rhythm, because the performance rhythm is still tied to the Zeitgeber of the place of departure. Thus, waking activity is imposed on circadian sleep time. During the hours when tonic physiological levels are set for sleep rather than wakefulness, the "readiness" for mental performance is reduced.[972] The variance of amplitude of the performance rhythm (the difference between the maximum and minimum performance scores on a given test) within a circadian cycle is also task-dependent. This variation has been shown under laboratory conditions to be between 12-25% of the 24-hour mean performance level,[815] and was shown in certain cases to be as high as 30-50% of the daily mean in shift-workers. The amplitude of the cycle increases with more complex tasks, and is flatter with easier tasks.[45]

Both loss of sleep and the temporal displacement of the sleep-wake cycle as a result of time zone crossing adversely affect performance. Sleep disturbances are almost inevitable in long range aviation in which aircraft fly round-the-clock and irregular working periods break into the normal body "night." Similar problems occur in other occupations which involve rotation of shifts or extended or unusual work-rest schedules. When sleep is disturbed, it is probable that at times the subject is also experiencing some sleep deprivation. Pilots subjected to repeated transmeridian flights often complain of difficulties in falling asleep, spontaneous awakenings during the night and abbreviation of sleep by early duty hours.[787]

The occurrence of performance decrements following total sleep deprivation and other acute alterations in the amount of sleep is well documented.[188,600,1107] Taub and Berger[1806,1811] have shown that sleep extended beyond the normal 7-8 hour length also results in performance decrements. Additional studies by Taub and Berger have indicated that deficits of performance and mood occur following a 2-4 hour displacement of sleep, in either direction, within a 24 hour period when the total amount of sleep is held constant.[1813] These effects were shown to occur for habitual long sleepers (9.5-10.5 hours) as well as normal sleepers (7-8 hours).[1815]

The importance of the maintenance of an established temporal rhythm of the sleep-wake cycle is further indicated by Russian studies investigating the effects of temporal migrations of the sleep-wake cycle on performance. Even the gradual postponement, or phase-shifting, of sleep to progressively later times of the day over extended periods of time has profound, negative effects on performance, physical functions and sleep patterns of man.[89,1101,1105,1107]

It is clear that one of the main problems in aviation is sleep disturbance. Sleep deprivation and its resultant negative effects on performance is also important to consider in that sleep deprivation, superimposed on an altered sleep pattern, further aggravates performance.[1348]

A decrement in performance has been shown to occur and persist for some minutes immediately after awakening. The extent of this decrement is dependent upon two variables. One variable is task-complexity. The largest decrement occurred during the first 3 minutes for both reaction time and tasks involving higher mental functioning. For more difficult tasks, effects were shown to persist for up to 12 minutes. A second parameter influencing post-arousal performance is the stage of sleep from which the subject is aroused. Subjects arouse slowly from Stage 4 sleep and then perform well, while subjects awaken more rapidly from REM sleep but perform poorly.[710,2008]

Temporal relations of sleep and the effects of sleep deprivation on performance are important considerations in the design of duty schedules which involve rotating shifts and/or unusual work-rest cycles.[1358] Flight studies performed on aircrews working repeated 4/4, 10/10, and 16/16 hour duty-rest schedules indicated that these schedules disrupted normal sleep rhythms considerably, and led to sleep deficit with consequent subjective fatigue and reduced performance.[186] In addition, the decline in performance levels observed under these schedules was influenced by the time of mission departure. Performance decrements were found to be significantly larger (33% compared to 11%) and recovery was less complete for crews whose continued schedule began during the low point of the subjects' preflight circadian performance rhythms (crews beginning at 0400 hours) than in crews which began at 1600 hours.[352]

There is a close relationship between fatigue and sleep deprivation and phase-shift of the sleep-wake cycle.[787] Both stress and fatigue are important contributors to performance decrement. In his studies on the management of irregular rest and activity, Hartman[763] reported that fatigue levels in aircrews following a 4/4 or 16/16 work-rest schedule on extended missions increased rapidly during the first 18 hours, and stabilized thereafter at a level indicating moderate persistent fatigue. The fatigue effects observed were not relieved by on-board sleep. Decrements in vigilance observed after 10 hours of flight have been shown to be related to fatigue effects. These effects accumulated with prolonged and repeated flights.[1663] From a study in which subjects performed complex psychomotor tests under simulated conditions of an extended 2 hour work-rest schedule, Hale[747] reported that altitude effects (8000') intensified assessed fatigue levels, whereas low humidity was found to reduce fatigue. The extent to which fatigue and stress aggravated the desynchronosis syndrome has not been quantified. Part of the problem lies in the design of field experiments in which fatigue levels can be accurately and separately assessed.[674] The task of recreating all important variables on the ground regarding both time change and the new environment also presents considerable difficulty.

C. Effects of Transmeridian Flight on Circadian Rhythms

As stated previously, transmeridian flight involves a phase-shift between the body circadian rhythms which are synchronized to departure time, and the Zeitgebers at the place of destination. Thus, flights across time zones force a restructuring of the many circadian oscillating systems, resulting in external desynchronosis and its symptoms.

Some of the physiological rhythms affected by external desynchronization are: the sleep-wake cycle, body temperature, pulse rate, respiration, arterial pressure, diuresis, and excretion of K^+, Na^+, 17-hydroxycorticosteroids, and 17-ketosteroids in urine.[1723]

That transmeridian flight and the resulting external desynchronization also adversely affect performance has been well documented by Klein and his co-workers.[962,964,966,973] Using both pilot and student populations as subjects, and tests designed for occupational realism and circadian rhythmicity, his studies indicated that significant performance decrements occurred after crossing time zones. After crossing six time zones, 24 hour mean performance levels decreased 3-4% compared to preflight levels. Performance decrements in both simple tasks such as reaction time as well as complex sensorimotor skills required to operate flight simulators were more severe following easterly flights. Simpler tasks recovered to baseline levels after three days, but decrements in complex tasks persisted for up to five days post-flight. Rehme,[1506] testing pilot performance on flight simulators for several days before and after crossing nine time zones, reported a 5-15% performance decrement after a westerly flight, and an 18% decrement after an easterly flight, compared to preflight levels. Performance decrements following transmeridian flight have been observed in many other studies as well.[178,223,1723,1937,2067] Hauty and Adams[783] included north-south flights in addition to translongitudinal flights in order to determine whether fatigue or stress induced by the flight itself contributed to the performance degradation. Effects of north-south flight were found to be insignificant compared to those imposed by transmeridian flight.

Parallel studies on transmeridian flight and simulated transmeridian flight achieved by using an isolation unit which excluded local light, ambient temperature and sound, showed that comparable performance decrements and sleep disturbances resulted under both simulated and actual conditions. The performance decrement was also observed to be greater in the easterly flight and the simulated easterly flight.[579]

The symptoms of external desynchronization are commonly observed in time shifts exceeding 4 hours. Obvious impairment in sleep and digestion are detected when time shifts exceed 6-7 hours.[527] In the formula for computing the duration of post-flight rest proposed by ICAO (International Civil Aviation Organization), allowance is made for shifts equal to 4 hours or more.[767] It is evidently assumed that lesser shifts exert no appreciable negative effects. However, there is experimental evidence which indicates that adverse effects are observable on some parameters after shifts of only 2-3 hours. Studies by Gingst[664] indicated that 3-hour time shifts exerted a substantial influence on the functional state of the body which can have negative effects on the performance of athletes. Litsov[1102] reported that most crew members of the spaceships "Soyuz-3" — "Soyuz-8" suffered clear impairments in general well-being, a decrease in performance and deterioration of sleep, which persisted for several days, after experiencing only a 2 hour time shift.

Thus, it is quite apparent that the crossing of time zones and the resulting phase-shift of performance and physiological rhythms results in significant performance decrements. The reasons for the decrements may not be solely related to a shift in the circadian rhythm of performance, but may be the end result of many factors underlying or comprising the desynchronosis syndrome, e.g., sleep disturbances. Other factors include task complexity, increasing fatigue at the end of a work shift and individual variations.

D. Factors Influencing Rate of Re-entrainment After Phase-Shift of the Zeitgeber

The extent and duration of the dysrhythmic changes that occur after transmeridian flight depend on a number of factors, including flight direction (east versus west), angle of the phase-shift (related to the number of time zones crossed), flight conditions and the intensity of the Zeitgebers.

Phase adjustment of both physiological functions and performance take more time after an easterly flight, which involves a phase-advance, than a westerly flight, which involves a phase-delay.[650,1014,1723,1965] DeRoshia demonstrated the same effect in monkeys using altered light-dark conditions to simulate easterly and westerly flights. As in man, body temperature rephasal after a phase-delay was more rapid than after a phase-advance.[449] Other specific flight conditions concerning relative flight direction (homeward versus outgoing) and the time of flight departure (day versus night) have no effect on re-entrainment.[973,2023]

The "asymmetry effect" just described is opposite to that observed in humans under controlled conditions. Under simulated conditions, rephasal was observed to take longer after a phase-delay than after a phase-advance. It is not clear why this discrepancy exists. Differences between the two types of experiments involve isolation versus social contact, artificial versus natural Zeitgebers, and identity of Zeitgebers before and after flight. Finally, there is usually neither stress nor necessarily sleep deficit during simulation experiments as may occur during real flights.[127,137] Another factor which influences re-entrainment after a shift of Zeitgebers is the "preferred" period of the circadian system, as measured under constant conditions. Since human subjects tend to have a "preferred" period longer than 24 hours, the asymmetry effect observed after flights is less surprising than that seen in the isolation unit.[137]

There is considerable variation in the rate of resynchronization of individual rhythms in both humans and animals.[137,782,965,1723,1999] After a time shift, all rhythms are phase-shifted and the resynchronization process is not completed until each rhythm has rephased. Performance rhythms rephase fairly rapidly compared to physiological rhythms. For example, after a time shift of 5-6 hours (westerly direction) the performance returns to preflight levels after two days, whereas the sleep-wake cycle may require two to three days, the body temperature rhythm five days, and cortisol secretion up to eight days to rephase.[123]

The strength of new local Zeitgebers also influences rephasal of body rhythms after a phase shift has occurred.[139] Social contact has been shown to be a powerful Zeitgeber in humans, and one of particular importance in the field of aviation.[125,127,972,1721,1999] Klein[966,972] demonstrated that when subjects were restricted to indoor activity in the relative isolation of their accommodations after transmeridian flight, resynchronization of performance and physiological functions took significantly longer than when subjects were allowed outdoor activity and social contacts with the new environment. In animals, where the light-dark Zeitgeber is normally dominant,[139] only some evidence for social entrainment is known. Gwinner[706] has shown that species-specific song cycles from a tape recorder can synchronize circadian rhythms in birds within a small range. Studies by Rohles and Osbaldistron[1556] have shown social entrainment in Rhesus monkeys. Further evidence of the strength of social contact as a Zeitgeber is demonstrated in permanent shift-workers. Theoretically, the circadian rhythm of a person who is active at night should shift 180°, but this usually does not occur because social contact acts to keep the worker's rhythms entrained to the day-active cycle. As a compromise, rhythm functions often exhibit a reduced amplitude and deformation, rather than a complete shift.[123,872,1965]

The light-dark cycle has been shown to be only a weak Zeitgeber in humans.[137,1999] Experiments involving influence of the light-dark cycle alone and of light-dark cycles in conjunction with social Zeitgebers indicated that the influence of the light-dark cycle alone is small in comparison to the light-dark cycles which are augmented by social contact.[1999] Amplitude, phase position and waveform of the rhythms were the same for social Zeitgebers with and without the addition of light-dark influence.

A common complaint after crossing time zones is the feeling of hunger at odd hours of the day. Despite the fact that an upset eating schedule may be reflected in disturbances of the cycles of waste elimination, blood amino acid levels and other visceral activities, the timing of meals does not appear to act as a strong Zeitgeber in humans.[125,1056,1231] Circadian rhythms persist in humans virtually without alteration both in subjects who are completely starved and those who receive constant amounts of food at short intervals.[679] The same results were obtained in rat studies.[740] However, the actual timing of meals has effects on at least some rhythmic variables. The internal timing of rhythms in blood hormones concerning the fate of the meal (insulin, glucagon, somatotropin, and cortisol), as well as rhythms in blood pressure and pulse can differ on a regimen of breakfast only or dinner only. Also, the amplitudes of certain plasma-constituent rhythms are increased by timed daily access to feed.[740] Meal timing does act as a Zeitgeber in monkeys, but not as a classical Zeitgeber in rats.[10,1765] In monkeys, splitting of the feeding periods results in a bimodal temperature rhythm.[1765] The relation among murine circadian rhythms of rectal temperature, liver glycogen, and corneal mitosis differs as a function of whether feeding is permitted in early light or early darkness.[740]

Individuals show considerable variation in their response to desynchronosis, as well as variation in their rephasal rates after a time zone shift.[650,972,1170,1723] Studies have shown that 25-30% of transmeridian travellers have no or only few difficulties adjusting to the sudden displacement of time cues; however, about an equal percentage was estimated not to adjust at all.[972] "Larks" or "morning" people, individuals whose body temperatures rise and peak early in the day, tend to suffer more from transmeridian flight than "owls" or "evening" people whose temperatures rise and peak later in the day.[1021] "Larks" also react more adversely to night and shift-work than "owls."[258] The duration of re-entrainment is influenced by rhythm amplitude; the larger the amplitude, the longer the rephasal period.[1399] As a result, "larks," who typically have higher and more stable temperature amplitudes than "owls" usually require longer periods of time to adjust to time shifts.[652] Due to the fact that the body temperature rhythm of "larks" are phase-advanced, compared to "owls" (phase-delayed), the former tend to suffer more from sleep disturbances as a result of night or rotating shift-work.[1021]

Russian investigators are developing techniques by which overall "rhythm stabilities" can be assessed in individuals.[337,1247,1724,1728,1867] Stepanova states that individuals can be classified into three groups, "inert," "intermediate" and "labile" according to the extent of the temporal fluctuations observed in various circadian parameters. "Inert" individuals typically exhibit circadian rhythm patterns which are more stationary in time than "labile" individuals. According to Stepanova, the "labile" individuals would experience less difficulty adjusting to the unusual sleep-wakefulness schedules common in spaceflight conditions, and thus would make better candidates for space missions than would "inert" or "intermediate" individuals

In summary, in order to find ways of preventing or correcting the effects of desynchronosis, it is necessary to know the physiological mechanisms that are affected and to quantitatively determine their rates of recovery following a time zone change. To best accomplish this it is necessary not only to establish the rates of change brought about in performance and physiological systems during actual flight experiments, but to complement these observations with ground-based simulation experiments. A mathematical model was developed to quantitatively describe desynchronosis and was applied to data obtained from ground-based photoperiod shift studies using monkeys.[2025] The rephasal characteristics of the body temperature rhythm was quantitated following a 180° reversal of the light cycle. Estimated time for rephasal was: 37% in 2.6 days, 50% in 5.6 days, and 95% in 8.4 days. Similar rates of internal and external resynchronization have been obtained from human ground based experiments involving photoperiod shift.

E. Effects of Phase-Shift on Health

Transient internal dissociation, which occurs as a result of the differential rephasing rates of the various circadian parameters has not been shown to produce any acute effects on health to date in humans.[128] However, a shortening of life span due to a lifelong repetition of phase-shifts has been described in both blowflies[141] and codling moths[794] and also in mice exposed to weekly shifts beginning at 1 year of age.[720] Chronic menstrual cycle disorders occur with striking frequencies in stewardesses,[1481] and there is evidence that chronic health problems result from long-term shift-work (this will be further discussed in Section IV, Shift-Work). The extent to which less frequently experienced shifts could affect the well-being of man is still an open question. The mechanism by which continued phase-shifting affects the life span in animals is unknown; however, there are indications of possible compounding effects over the life span of the animal.[742]

Though it may be recommended to the occasional traveller to take a sleeping aid to ensure a good night's sleep upon arrival to a new time zone, it should not be encouraged in career aviation personnel. One survey showed that no less than 46% of flight crew members were, to a greater or lesser extent, using sleeping drugs on long flights, while only 13% ever used them outside the flying environment.[787] Alcohol is also used to a significant degree by flight personnel to aid relaxation and sleep onset after long flights.[787] Alcohol, however, is no solution to the problems induced by phase-shifts. It is addictive; it has an adverse aftereffect on performance and disrupts normal patterns of sleep. Work by Graeber[688] has suggested that altering the timing of certain synchronizers before flight departure may be quite successful in hastening rephasal after transmeridian flight. Results showed that the gradual, anticipatory phase-advancing of circadian body rhythms prior to the abrupt phase-shift induced from transmeridian flight significantly reduced the sleep disorders and subjective fatigue normally experienced on the first two days post-flight. Through a better understanding of circadian systems in man and the mechanisms by which they affect physiological and psychological variables, chronotherapies could be devised which could significantly reduce the adverse effects of desynchronization (see Section VI). A responsible consideration of flight safety in civil aviation must include such circadian phase-shift effects. Such a consideration would result in a safer work place and a higher quality of aircrew performance.

F. Interpretation of Phase-Shift Data

The problem of evaluating rephasal duration as a function of direction of transmeridian flight or phase-shift has been limited by inconsistencies in the estimation of rephasal duration. Most of the literature utilizes visual inspection of data or unspecified methods of determining rephasal duration values. Due to the unstable nature of rephasal transients, reflected in alterations in amplitude and waveform, visual estimates of rephasal have the potential for considerable inaccuracy. In addition, the presence of incomplete rephasal or latent desynchronosis[37] can alter readapted rhythm phases from their expected values, thereby rendering rephasal estimates subject to errors in interpretation. The model proposed by Beljan et al.[177] has shown that human performance rhythmic rephasal patterns follow an exponential function, with asymptotes approaching expected rephasal phase angles. Klein et al.[964] have also found this to be true. Given the inherent variability in phase-shift data and its apparent asymptotic properties, it is evident that criteria must be chosen to establish rephasal times, since with an exponential model rephasal is achieved only at infinite time. Moore-Ede et al.[1272] and Quay[1495] have approached this problem using simple exponential curve models or models based on the Beta-distribution function, respectively, which are fit to rephasal data by nonlinear least squares. The asymptotic problem is avoided by specifying rephasal in terms of a percentage (e.g., 50% or 90%). However, the nonlinear least squares approach may be used to fit any set of rephasal data, including data which may not show an exponential type pattern. The method developed by Beljan et al.[177] is more appropriate since it utilizes the method of moments, which conserves the area under the rephasal curve. It has been successfully applied to human performance rhythms following transmeridian flight[1568] and to subhuman primate phase-shift studies.[450] With the method-of-moment technique, if the rephasal data do not describe an exponential the curve-fitting process does not work, thus avoiding invalid interpretations of rephasal dynamics.

Aside from estimates of rephasal duration, the analysis of circadian rhythm rephasal dynamics is very difficult since one is dealing with a relatively short time series where nonstationary amplitude, phase, and period changes are occurring, and in which rhythmicity may temporarily disappear. At present, there are no reliable mathematical methods which will permit the distinguishing of phase and period changes during the transient rephasal period. Malbecq et al.[1145] suggest for conditions in which phase and amplitude slowly vary, that complex demodulation or chronobiological serial sections would be appropriate. In more unstable rephasal data, they advocate discrete spectral analysis which is less sensitive to correlated noise and rhythm shape. Other techniques which are more appropriate for analysis of desynchronized rhythmic data involve piecemeal analysis, by progressive (moving window) techniques or by summation dial analysis,[2031] in which rhythm parameters are calculated on single cycles.

G. Selected Bibliography on Phase-Shift

4	73	126	173	206	237	277	307	353	400	435	487	518
5	79	127	174	207	238	278	309	359	401	449	488	525
9	81	128	175	209	239	279	310	363	403	450	489	528
10	83	131	177	211	240	281	313	364	406	452	490	529
11	85	136	178	212	241	284	315	366	407	453	491	530
16	89	137	179	213	247	285	316	369	410	455	495	531
19	93	138	182	214	248	286	329	370	411	456	496	532
27	97	139	183	216	249	287	332	373	412	460	502	533
30	99	140	184	217	250	289	336	374	413	461	503	537
38	104	141	186	218	254	290	338	375	419	462	504	538
46	105	143	190	223	255	296	342	376	420	468	506	539
47	106	146	192	224	256	297	343	377	424	475	507	543
54	108	148	193	227	258	298	344	378	425	476	508	544
59	119	150	194	228	259	300	346	379	428	478	509	547
60	122	151	195	229	261	302	347	380	429	479	512	548
63	123	152	200	233	262	303	350	389	431	481	513	576
66	124	155	202	235	267	305	351	395	433	482	516	578
67	125	160	204	236	272	306	352	397	434	483	517	583

585	687	768	874	972	1154	1261	1356	1478	1624	1752	1877
587	688	769	876	973	1159	1262	1357	1479	1625	1754	1878
590	689	770	877	974	1161	1264	1358	1480	1626	1756	1879
592	690	774	878	975	1163	1265	1370	1481	1628	1757	1881
594	691	775	881	976	1165	1267	1371	1482	1629	1758	1884
598	698	778	883	981	1171	1268	1372	1483	1635	1759	1895
599	701	779	887	987	1172	1269	1384	1485	1637	1760	1901
600	705	780	888	988	1175	1270	1391	1486	1638	1762	1903
602	706	781	889	989	1178	1271	1392	1487	1639	1765	1926
603	707	782	891	990	1179	1272	1393	1488	1643	1766	1941
613	709	787	892	991	1180	1273	1395	1489	1646	1767	1951
614	713	788	893	998	1181	1274	1396	1495	1647	1768	1952
615	717	792	894	999	1187	1275	1397	1498	1648	1769	1953
616	718	793	897	1000	1194	1276	1398	1499	1653	1770	1954
617	720	794	900	1001	1201	1277	1401	1501	1654	1771	1956
618	721	801	901	1004	1211	1278	1405	1502	1663	1772	1957
619	722	802	905	1005	1212	1279	1406	1512	1667	1773	1958
620	723	805	906	1007	1213	1290	1408	1513	1669	1774	1959
621	724	806	909	1008	1215	1291	1411	1514	1670	1775	1961
624	726	807	913	1009	1216	1294	1423	1515a	1673	1776	1962
632	727	809	916	1012	1217	1296	1425	1524	1674	1777	1963
633	728	811	923	1013	1218	1301	1426	1525	1677	1778	1964
638	729	824	924	1014	1219	1304	1427	1527	1678	1787	1965
640	730	825	925	1017	1220	1305	1428	1529	1679	1788	1968
641	731	826	929	1018	1221	1308	1433	1534	1680	1789	1972
642	732	827	930	1020	1222	1311	1434	1535	1682	1792	1981
643	734	829	932	1022	1223	1312	1435	1536	1683	1793	1983
644	735	832	933	1023	1224	1316	1436	1541	1684	1794	1985
648	736	835	935	1024	1225	1321	1437	1547	1686	1795	1989
649	737	837	940	1025	1226	1323	1440	1548	1688	1796	1990
651	738	838	941	1026	1227	1324	1441	1549	1698	1806	1991
652	739	839	943	1027	1228	1325	1442	1555	1702	1809	1992
653	740	840	945	1028	1229	1326	1443	1556	1705	1812	1993
654	741	841	946	1029	1230	1327	1444	1557	1709	1813	1995
655	742	842	948	1030	1231	1328	1445	1565	1718	1814	1997
657	743	844	949	1033	1232	1329	1446	1568	1721	1815	1999
658	744	846	950	1036	1233	1330	1447	1571	1722	1816	2000
659	745	847	951	1037	1235	1331	1449	1572	1723	1817	2001
660	746	850	957	1039	1239	1339	1452	1573	1725	1818	2005
664	747	851	958	1043	1240	1340	1453	1575	1726	1819	2015
665	748	852	959	1045	1243	1341	1460	1576	1727	1821	2017
672	752	853	960	1048	1244	1342	1461	1579	1729	1822	2018
675	753	854	962	1051	1246	1346	1463	1589	1730	1836	2019
676	755	855	963	1067	1247	1347	1464	1591	1732	1850	2020
677	756	861	964	1095	1248	1348	1469	1601	1733	1856	2022
678	757	863	965	1096	1250	1349	1471	1603	1734	1861	2025
679	759	864	966	1097	1252	1350	1472	1607	1736	1862	2030
680	760	865	967	1116	1254	1351	1473	1610	1737	1863	2036
681	763	867	968	1132	1255	1352	1474	1611	1740	1866	2037
683	765	868	969	1133	1258	1353	1475	1620	1747	1868	2038
685	766	869	970	1145	1259	1354	1476	1621	1748	1871	2057
686	767	872	971	1149	1260	1355	1477	1622	1749	1872	2062

2063	2067	2070	2072	2075	2077	2082
2064	2069	2071	2073	2076	2079	2084

IV. SHIFT-WORK

A. Introduction

The purpose of this section is to review some of the major factors dealing with shift-work that pertain to chronobiology and to worker health and efficiency. A large volume of literature exists in this field (approximately 20% of our bibliography). Extensive research in this area has been performed by both chronobiologists and industrial psychologists. The shift-worker, particularly the rotating shift-worker, is an excellent subject for the study of long- and short-term effects of circadian phase alteration. Though he/she may not be exposed to the same environmental factors as aircrew in the cockpit environment, both groups of people experience similar circadian desynchrony resulting from light-dark cycle phase alteration that is experienced by transmeridian travellers. A major difference, however, may be conflicting Zeitgebers (especially social, see Section IV.F below). Nonetheless, the studies on shift-workers can provide understanding and insight into the investigation of transmeridian desynchronosis or flight crew work-rest scheduling conflicts.

The number of shift-workers in the labor force is considerable (approximately 20-26%) in both Europe and the United States.[13,1586,1798] The basic reason for having a shift system stems from the need to staff or man jobs around the clock. Tasto and Colligan[1798] have compiled a rather complete listing of industries in the United States that rely on shift-work scheduling. In a later report, however, they indicated the difficulty in obtaining health records from these industries for research purposes. These workers indicated that management is concerned about possible negative returns that this information might provide in impending labor negotiations.[1799] Though some people prefer shift-work, many studies indicate that a large percentage do not like this arrangement.[473,1591] This may be borne out by the monetary incentives offered to those that work the less desirable night, "swing," and rotating shifts. According to Tasto and Colligan,[1798] "In hours of work, it is noted that collective bargaining agreements generally do not prohibit night work entirely, but often require the payment of a wage differential as compensation for the undesirable features." They also noted that for the labor unions reporting the existence of shift-work within their industries, 60% reported that shift-work is not at all voluntary.

There have been several recent reviews covering shift-work and its psychological and physiological consequences.[13,177,1591,2032] This section will focus on information obtained since the 1972 report of Beljan et al.[177] and, in particular, the more recent developments. It should be noted that the 24 hour work day is usually divided into three shifts of 8 hours each, the day shift, the afternoon-evening ("swing") shift, and the night shift. There are, however, four general classes of shift-workers since the rotating shift-worker alternates from shift to shift on a somewhat regular basis. Several other shift systems exist and are reviewed by Rutenfranz et al.,[1591] and Tasto and Colligan.[1798]

The rotating shift-worker is of particular interest to the aviation industry since many of the air traffic control centers,[1195] airports, and flight crews work rotating shifts or duty rosters that are rotating in nature. A continual problem that investigators face when evaluating data from rotating shift-workers, however, is the question of "self selection," i.e., those on rotating shift schedules are "survivors" that can take the physiological and social disturbances that may result. According to Rutenfranz et al.,[1591] 20% of shift-workers are unable to continue working shifts and thus drop out (change to day shift) or change jobs.

B. Shift-Work and Physiological Rhythms

The concept of rhythmicity of physiological and psychological variables in humans and animals is currently accepted as dogma in the field of biology. The preponderance of data supports a modification of Cannon's original definition of homeostasis (the maintenance of a constant internal environment) to include rhythmic changes in the internal environment or "the maintenance of a dynamically regulated internal environment." Rhythmicity must be included as part of a definition of life. That living systems should display rhythmicity in function is not surprising considering that higher organisms have evolved over 3.5 billion years of regularly occurring, cycling geophysical forces ("Zeitgebers," time-givers) including light and darkness, geomagnetism, and radiation. The reviews of 24 hour (circadian) biological rhythms are numerous (see Beljan et al.[177] and Wever[1999]). A number of reviews dealing with rhythms in relation to aviation have recently appeared.[964,970,971,1523,1589]

It is not the purpose of this report to either list or discuss all the rhythms in human physiology and psychology. Suffice it that it is the exception to find a physiological or psychological parameter that when sampled with adequate frequency, does not show periodicity. This is the basis for understanding the physiological effects of shift-work. Under normal day-night and social conditions a person sleeps during the dark phase of the cycle and is awake during the light phase. His bodily rhythms (both physiological and psychological) are stable and in phase (entrained) with the external environmental time-setters (Zeitgebers). They are also entrained and in phase with one another (internally synchronized). Under these conditions the human body-mind system functions optimally and physiological decrements result when deviations from normal rhythmicity are induced (unpublished working hypothesis Winget, Holley, DeRoshia, Rosenblatt). In shift-workers, especially those on rotating shifts, the sleep-work cycle is often desynchronized from the external day-night cycle and from the prevailing social-interaction cycle. When the body rhythms begin to rephase to the new Zeitgebers they do so at different rates.[1999] The result is that many rhythms lose their phase relationship with one another, resulting in internal rhythmic discord or internal desynchronization (see Section V of this report).

Humans and non-human primates show the greatest susceptibility to internal desynchronization.[1999] Rats, however, are apparently resistant to this phenomenon.[849]

The aviation flight crews of most of the major airlines appear to be much like the shift-worker in terms of their chronic exposure to phase alterations. The trip schedule-bid system based on seniority assures that many of the younger crew members are flying less desirable schedules (i.e., flying night trips). Two schools of thought have polarized, however. One contends that due to rhythmic inertia it is desirable to work rapidly rotating shift schedules.[1591] The other holds that longer periods (greater than 7 days) on a fixed shift is desirable so as to allow re-entrainment or adaptation to the new sleep-wake schedule.[2032]

Studies have been conducted to identify people more able to withstand shift-work based on some physiological measure. A recent theory supported by Aschoff[127] contends that the amplitude of certain physiological rhythms, i.e., body core temperature can give an indication of a person's ability to rephase or adjust to a new sleep-wake schedule. Reinberg et al.[1536,1537] subsequently have provided data to support this concept, namely, that the lower the amplitude of various rhythms (i.e., core temperature, peak expiratory flow and urinary output of 17-OHCS) the quicker they rephase to a new Zeitgeber. Reinberg et al.[1524,1538] also showed that a greater amplitude of the circadian oral temperature rhythm is associated with a good clinical tolerance to shift-work in steel and chemical industry workers.

C. Effects on Health

C.1 General symptoms- A major difference between the transmeridian traveller and the rotating shift-worker is that the traveller experiences acute phase alteration, whereas the worker experiences repeated, chronic phase alterations. Symptoms reported after transmeridian travel, however, are very similar to those reported by shift-workers.[177] These include fatigue, insomnia, anxiety, and other sleep-wake disturbances, gastrointestinal dysfunction and psychosomatic manifestations. Tasto et al.,[1799] in a study of approximately 2000 rotating shift nurses and food processors, found increased incidences of fatigue, digestive troubles, colds, chest pains, menstrual problems, nervousness, use of stimulants, wheezing, alcohol consumption, and leg and foot cramps. They also found that these workers had comparatively less satisfactory psychological health, work performance, and domestic and social life. They concluded that the number of sick days leave taken is not a reliable indicator of health problems. When they looked at the reasons that nurses gave for taking sick leave, they found that those on rotating shifts tended to cite more serious medical reasons for taking sick leave than did those on fixed shifts.[358]

C.2 Disturbances to the "normal" diurnal sleep-wake cycle- The Association of Sleep Disorders Centers and the Association for the Psychophysiological Study of Sleep have recently published their "Diagnostic Classification of Sleep and Arousal Disorders."[96] This classification lists disorders of the sleep-wake schedule of both exogenous and endogenous etiology. This report states "In the event that sleep and awake periods are removed to new, temporal locations in the 24 hour cycle, their subterranean physiological affiliates tend to remain fixed. In other words, one may elect — as in rapid time zone change or 'work-shift' change — to reposition sleep-wake conduct, but one does not succeed in moving pari passu the whole spectrum of related processes. They tenaciously hold to their former temporal position. Though the impetus for resituation of the chronobiological contexts for new circadian sleep-wake schedule begins immediately, the actual realignment takes several weeks or months depending on the physiological parameter. Not only temperature, endocrine, and metabolic processes show this inertia; so do central nervous system processes related to alertness and sleepiness, namely the preparatory neurophysiology for the sleep-wake states. Accordingly, after an acute sleep-wake cycle shift, waking is superimposed on brain functions "biased" towards sleep; conversely, the position vacated by waking behavior and now replaced by sleep (or an attempt at sleep) maintains its physiological orientation to the awake state. That is why sleep is not generally successful at a new time for a considerable period following a sleep-wake schedule change."

This report classifies disorders of the sleep-wake schedule as transient (rapid time zone change "jet lag" syndrome, and simple "work-shift" change in conventional sleep-wake schedule) and persistent (frequently changing sleep-wake schedule). Symptoms of the time zone crossing disorder are sleepiness, fatigue, and their mental consequences during the wake period and insomnia during the sleep period. Symptoms of the shift-work disorder are similar and include sleepiness and performance decrements during the new work-wake period, and sleep (which is now scheduled during the former work-wake period, generally in the daytime) is disrupted and shortened. The frequently changing sleep-wake schedule is experienced by rotating shift-workers, flight crews, and regular air travellers, i.e., peripatetic businessmen and international negotiators. The classification states that frequently changing sleep-wake causes a mixed picture of chronic DIMS (disorders of initiating and maintaining sleep) and DOES (disorders of excessive somnolence) distinguished by disrupted and unusually shortened periods of sleep (sometimes occurring several times per day), sleepiness and performance decrements during any scheduled wake period, and difficulty in reestablishing a consolidated sleep period even when circumstances temporarily permit sleep schedule regularity. It is also stated that "among the somatic complications of this syndrome, a tendency for peptic ulcer disease to begin within a few years of starting [rotating] shift-work is fairly well established."

C.3 Emotional and behavioral correlates- Research on the psychological aspects of shift-work is not extensive. Workers in this field typically focus on job attitudes and tend to conclude that attitudes vary as a function of numerous, interacting variables, e.g., type of work, skill level required, type of industry, length of time on the job, characteristics of worker's communities, and general needs and demands.[1799] Some investigators recommend that individuals who are subject to depression and emotional problems should be considered carefully before being assigned to rotational shift-work, since there is a possibility that this type of shifting may place too great a stress on persons who, under other circumstances, might be able to cope with their emotional problems. To cite an extreme example, in a study in which the subjects were phase-shifted under careful experimental conditions, an apparently "normal" subject completed the experiment and not long thereafter committed suicide.[1851] Examination of this person's rhythm profiles showed that his rhythms did not rephase completely during the period following the shift. The authors suggest that circadian asynchrony and the inability to respond effectively to a phase-shift may characterize a presuicidal state.

Several studies have indicated that internal desynchronization may produce abnormal psychological symptoms, e.g., increased neuroticism.[1127,1128,1464] Tasto et al.[1799] found that rotating shift nurses were significantly more confused, depressed and anxious than other nurses. Folkard et al.[563] found a steady decrease in the subjective rating of "well-being" and "alertness" during night shifts from 2200 to 0600 hours. The same response was noted in the full- and part-time nurses studied by them.

<u>C.4 Complications of predisposed medical conditions</u>- A number of physiological disorders and conditions have been found to exhibit circadian variations and consequently can be exacerbated when individuals are subjected to rotational work-shifting at too rapid a rate. The problem areas are diabetes mellitus; respiratory, cardiovascular, and renal disorders; and epilepsy (see Winget[2032]). It has also been noted that persons with thyrotoxicosis or a history of digestive tract disorders should avoid shift-work.

Further problems exist in relation to treatment for existing acute or chronic medical problems with drugs. Regular and predictable changes in biologic susceptibility and response to a large variety of physical as well as chemical agents (i.e., drugs) can now be viewed as a rather common phenomenon in a normal person.[1515a] The field of "chronopharmacology" has developed substantially in the past decade. Timing of drug treatments to rotating shift-workers, however, is very difficult from a chronopharmacologic point of view since one can never be sure of a person's state of rhythmic adaptation to his current schedule or his state of internal rhythmic synchronization.

<u>C.5 Chronic shift-work and overall health and longevity</u>- A major unanswered question in relation to shift-work, particularly rotating shift-work, is whether continuous shift-work affects longevity or general health, e.g., psychological stability or resistance to disease or other pathological states. Hyndman,[882] on theoretic grounds concludes that the role of biological rhythms is the maintenance of precise homeostasis. It may be inferred from this that should rhythmic stability be altered on a chronic basis then <u>optimal</u> functioning of a biological system may not be possible. Szafarczyk et al.[1788] found that rats exposed to a weekly 8 hour shift in the light cycle for 9 weeks showed a 20% reduction in body weight when compared to controls. Halberg et al.[742] were able to manipulate the life cycle of insects depending on the shift schedule that they exposed them to from the larval stage. They found that in some cases the life span was decreased in insects reared on a schedule shift every 3 or 6 days, whereas insects reared on a schedule shift every 4 or 5 days showed an increase in life-span. The authors also presented data showing a significant 6% reduction of life-span of mice reared under conditions of weekly inversion of the light cycle. They conclude that it is necessary to integrate work on human and experimental animals and that these studies indicate that the optimization of human work schedules must consider chronobiology. Pittendrigh and Minis[144] exposed groups of <u>Drosophila</u> to four environments, a

normal 24 hour day, a 21 hour day, a 27 hour day, or constant light. In all experiments, the flies raised under the normal day length experienced significantly longer life-spans. They concluded that animal systems perform most effectively when they are entrained by light cycles close to their natural circadian frequency. Another study which emphasizes the importance of light cycles in animal physiology is that by Fuller et al.,[617] who showed that optimal temperature regulation in monkeys depended on internal rhythmic synchronization.

These animal studies do not in themselves prove that rotating shift-work (and/or internal desynchronization that may result) is harmful in humans. It does suggest, however, that adverse effects may result. The lack of long-term epidemiologic studies of shift-workers and the ever-present question of self selection in that population makes this a very difficult question to answer experimentally.

Cobb and Rose[355] reported a five-fold increase in risk of blood pressure elevation in air traffic controllers (representing a shift-worker population) as compared to second class airmen (representing workers on a "regular" schedule). This interpretation may be biased by differential work loads and responsibilities, however. Taylor and Pocock,[1831] using data between 1956 and 1968, investigated 8603 manual workers from 10 factories in Great Britain. Their objective was to assess the influence, if any, of 10 years or more of shift-work upon the expectation of life and cause of death. The conclusion that they arrived at was that shift-work had no adverse effect upon mortality. Taylor et al.[1832] also could not find evidence that any of the shift systems that they studied adversely affected health. Akerstedt and Torsvall,[35] however, using a questionnaire to sample worker attitude, found a substantial improvement in mental, physical, and social well-being when night work was eliminated from a worker's routine.

Aschoff[127] has recently reviewed the properties of circadian rhythms and their relevance for the design of shift-work scheduling. He states "The circadian system represents a temporal order which is mediated by the mutual coupling of a variety of oscillators and by the synchronizing effects of Zeitgebers. It is likely that the well-being of man depends partly on the maintenance of this order, and the repeated or long lasting disturbances to it will have harmful effects." Stenova (cited in 468) holds that internal synchronization of daily (circadian) rhythms of different physiological functions and biochemical parameters constitutes an optimum state of the body and that many disturbances of the body leading to disease start because of disruption of timing of different functions, so-called internal desynchronosis.

D. Effects of Shift-Work on Performance and Productivity

The circadian rhythmicity of task performance has been well documented (see Section II and refs. 177, 363). Rutenfranz and Colquhoun[1589] have recently reviewed this topic. They find that the performance rhythm is significantly influenced by such factors as fatigue and meal-timing and that the preponderance of evidence suggests that the observed fluctuations reflect an underlying 24 hour rhythm analogous to those shown by certain physiological processes which may be closely connected with the cycle of "sleep need." They also state that measures of performance taken during "night" hours are confounded by sleep deprivation or sleep interruption. Nevertheless, their results are of considerable practical interest and clearly have direct application to the problem of the night shift, on which efficiency is affected not only by daytime sleep duration and quality, but also by the phase-shifting of the rhythms that occurs during the period of adjustment to the altered rest-activity cycle. Rutenfranz and Colquhoun also noted that interpretation of performance rhythms in industrial situations is often masked by motivational and situational factors, such as the masking of productivity variations by workers out of fear of changes in piecework wages.

Klein and Wegmann[971] have also reviewed this area. They, too, point out the problems associated with field studies such as work output, frequency of failures and number of errors. These parameters, in principle, follow the circadian characteristics observed in laboratory research on human performance efficiency with best performance occurring at about 1600-2200 hour and poorest performance ranging from 0000-0700 hour as shown in the five examples cited (see also ref. 2032).

Folkard and Monk,[561] in their review cite six published studies that report relatively continuous, 24 hour real-life performance measures. They indicate that the paucity of data on this subject may be due to union or management opposition and problems in finding appropriate performance measures. In the studies noted, the major impairment of performance occurs during the night shift. They proposed a description model in which on-shift performance is dependent on the type of task, type of shift system, and type of person, with the three factors interacting via the worker's various circadian rhythms.

E. Shift-Work and Accidents

There has been relatively little recent research done on the relationship of shift-work to accident rates. Rutenfranz et al.,[1591] in a recent review, state that knowledge in this field is conspicuously absent. Some studies on safety records of shift-workers have correlated time of day with decrements. Industrial accidents seem to occur with the greatest frequency between 2200 and 0200 hours (cited in ref. 2032). Harris[757] found that most truck accidents occur because of driver error, and many likely were the result of failures in vigilance performance. Fatigue factors interacting with the circadian variation of arousal reportedly were responsible for the greater number of accidents occurring between midnight and 0800 hours.

F. Psycho-Social Aspects

Rutenfranz and Knauth[1594] point out that for the shift-workers themselves the most important problems are psycho-social ones, e.g., the extent to which shift-work interferes with family and social life. Even if a shift system is planned from a purely physiological point of view these systems might not be acceptable to the workers. Social interaction (i.e., the social Zeitgeber) has been shown to be one of the strongest rhythm entrainers in humans.[127,1999]

Thus, the shift-worker (especially the night and rotating shift-worker) may be faced with conflicting Zeitgebers, namely the work-rest cycle that is dictated by his job schedule and the social cycle dictated by activities of friends or family members in his life.

A major difference between the time zone air traveller and the shift-worker is that the shift-worker is faced with conflicting Zeitgebers as outlined above. The air traveller on the other hand arrives at his new destination where the prevailing social and day-night cycles are not conflicting but are probably relatively similar to the phase relationships at their home domiciles. Aschoff[127] discussed some quantitative differences in the rates of rephasal of certain physiological and psychological variables following phase-shift. He noted that opposite results are observed in terms of rates of rephasal of circadian rhythms following a phase advance of the Zeitgeber vs phase delay of the Zeitgeber in isolation studies when compared to actual flight studies. He indicated that these opposite, asymmetrical effects found after Zeitgeber shifts in the isolation unit vs flights across time zones have to be taken into consideration in the analysis of results from shift-work studies as well as in the design of shift-schedules.

Drenth et al.[473] have reviewed some of the psychosocial aspects of shift-work. They emphasize the unpopularity of shift-work and also warn of the natural selection process that complicates studies on this subject. The authors identified five major areas of concern to the shift worker. These include: 1) Social factors; for the most part his social life is restricted; 2) Home-life factors; he sleeps and eats at "abnormal" hours and this presents a range of extra problems for his wife and the family; 3) Health factors; it is important to recognize that health is an overall reaction to the total situation. The authors cite studies for both impairment and lack of impairment of health; 4) Financial factors; this may be the most important reason that a person participates in shift-work; and 5) Organizational factors; effects of shift-work on work performance, absenteeism, accidents, labor turnover, etc. These authors state that the evidence is not good enough to detect differences between shift- and non-shift-workers in terms of qualitative and quantitative aspects of production. The authors concluded that one important feature of shift-work is the influence, predominantly experienced as negative, of the shift rhythm; the interrupted sequence of the evening and night, and the frequent shift change. They go on to say that policy concerning shift-work has been based on a balanced model. On one side are thought to lie the conveniences and disadvantages, and on the other side so much compensation (and it usually occurs to few to think other than in money terms). These factors are adjusted so that the "scale" becomes approximately balanced. From a psychological point of view, it is doubtful whether this approach is correct. In the first place, money has a camouflaging function. The actual objections are not considered, and the sources of inconvenience are left undisturbed. Moreover, the bonus can become a wrong motive to choose shift-work. The bonus also has an habituating effect, and can result in an unrealistic evaluation of the work situation.

G. Conclusions

There is a large body of recent literature dealing with the physiology and psychology of shift-work. Interpretation of data from shift-work studies is complicated, however, by the problem of "self-selection" of the shift-working population. A large percentage of workers do not tolerate shift-work for either health, psychological, or social reasons. A major motive for workers to pick these schedules is the monetary bonus. Many studies confirm that shift-work may have negative health correlates. This again is clouded by the self-selection aspect and the possibility that some workers can adapt to shift-work. A serious deficiency exists in the literature of long-term epidemiologic studies of the health (physiological and mental) consequences of prolonged, continuous shift-work. Two schools of thought exist for the scheduling of workers based on an understanding of psychophysiology and rhythms; one advocates rapidly rotating shifts,[1591] the other longer periods on fixed shifts.[2032]

A major difference between the shift-worker and the transmeridian time zone traveller is the conflict in Zeitgebers which is often experienced by the shift-worker (social vs sleep-wake). Some experimental studies show quantitative differences in rhythmic rephasal characteristics following phase-shifts of shift-workers vs air travellers. It is estimated that 20% of the work force does not tolerate shift-work. It is unknown how many flight crew members working "rotation"-like schedules do not tolerate shift-work. A significant question is whether members of the pilot population who do not readily adjust to the deleterious effects of shift-work (as imposed by the trip-schedule seniority bid system) continue to work under these constraints. Are there drop-outs from the highly prestigious and well paid flight crew positions due to the negative aspects of shift-working or do these people simply attempt to cope? It is noteworthy that airline unions are beginning to recognize the importance of circadian timing in work scheduling. The Air Line Pilots Association has recently adopted as official policy a recommendation for diurnal duty time restriction in maximum hours on duty for flight crews in scheduled air transportation. It is based on the beginning time of the duty shift — the later the beginning of the duty period the less the maximum hours on duty.[676]

H. Selected Bibliography on Shift-Work

2	35	84	185	270	317	366	383	426	484	554	570	629
3	42	86	199	273	318	368	384	434	486	556	571	631
11	48	88	219	274	323	370	386	436	492	558	572	639
12	49	89	225	280	324	371	387	438	493	559	573	640
13	53	90	232	282	334	372	388	441	494	560	574	650
21	54	96	233	300	336	373	389	451	499	561	591	659
22	55	103	234	301	337	374	395	455	505	562	596	671
23	56	106	246	302	346	375	398	469	520	563	603	673
26	57	127	252	303	358	376	415	471	522	564	622	674
32	77	166	253	307	363	377	416	473	523	566	623	677
33	79	180	255	308	364	378	420	480	532	567	625	682
34	80	182	269	311	365	381	421	483	536	569	627	695

698	814	991	1108	1197	1318	1419	1529	1587	1688	1835	1899
701	817	997	1109	1200	1319	1420	1531	1590	1689	1838	1901
702	818	998	1113	1202	1320	1424	1532	1591	1690	1839	1907
707	819	999	1114	1203	1348	1430	1534	1593	1693	1842	1910
710	820	1002	1115	1204	1351	1432	1535	1594	1694	1843	1921
711	821	1003	1123	1206	1358	1439	1536	1595	1695	1844	1927
715	910	1004	1136	1207	1363	1451	1537	1596	1696	1845	1928
719	922	1005	1137	1214	1365	1454	1538	1597	1697	1851	1929
720	929	1006	1138	1222	1367	1455	1539	1604	1700	1857	1930
726	946	1008	1143	1225	1368	1463	1542	1605	1706	1859	1931
727	951	1009	1144	1228	1369	1468	1543	1609	1713	1865	1932
729	970	1032	1150	1229	1380	1489	1558	1623	1716	1869	1935
737	978	1060	1151	1234	1381	1490	1559	1629	1720	1870	1936
738	980	1071	1152	1235	1397	1491	1561	1640	1779	1871	1948
739	981	1078	1158	1255	1399	1505	1565	1649	1780	1872	1972
742	982	1079	1163	1256	1409	1517	1570	1655	1790	1873	1975
760	983	1080	1164	1257	1410	1519	1580	1657	1798	1876	2014
776	984	1088	1168	1263	1411	1522	1581	1658	1799	1879	2032
785	985	1094	1169	1282	1412	1524	1582	1659	1828	1890	2043
788	986	1101	1190	1290	1413	1525	1583	1660	1829	1892	2044
789	987	1104	1191	1306	1414	1526	1584	1666	1830	1896	2046
790	988	1105	1193	1307	1416	1527	1585	1668	1831	1897	2047
793	989	1106	1195	1314	1417	1528	1586	1687	1832	1898	2058
812	990	1107	1196	1317	1418						

V. INTERNAL DESYNCHRONIZATION

A. Introduction

According to Aschoff,[127] the human circadian system is characterized by: 1) its persistence under a variety of conditions and a certain "rigidity" against manipulations; 2) its being made up of many self-sustained oscillations which are usually coupled to each other; 3) its capability of becoming entrained by periodic factors in the environment (the "Zeitgebers"); and 4) differential reactions of the various oscillators to phase-shift. The differential reactions of the various oscillators to phase-shift of the Zeitgebers can result in altered rhythmic phase relationships of one parameter relative to others thus resulting in "desynchronization." This so-called internal desynchronization is often observed following Zeitgeber phase-shift produced by transmeridian flight. An understanding of the mechanisms and relationships involved is necessary in order to: 1) fully understand the physiological and psychological implications of the acute and chronic desynchronotic state; and 2) attempt to manipulate the circadian system to alleviate undesirable symptoms of this state (including performance decrement).

B. Internal Desynchronization

<u>B.1 Real internal desynchronization</u>- "Real" internal desynchronization describes the physiological state in which different rhythmic physiological

variables oscillate with different periods such that the phase-angle differences, that is, the differences in relative time between the peaks (acrophase) of these variables, constantly change.[118,142,779,1264,1917,1985] This mutual phase-shift between different rhythms must be endogenous, autonomous, and self-sustaining for greater than a full phase-shift in period (360°).[118,1999] A strict definition of internal desynchronization is imposed to distinguish between these continuously uncoupled internal rhythms, and those which uncouple during the transition of the entrained steady state to some new rhythmic state following a phase-shift of the Zeitgeber. This transition or transient state of internal desynchronization is called internal dissociation, and will be discussed in more detail in Section V.C.1.

Nearly all physiological functions undergo regular changes from day to night. These diverse rhythms keep distinct phase relationships to each other[142] representing a high degree of temporal order[1028] known as internal synchronization. Unlike exogenous rhythms which are a direct response to a physical change in the environment, endogenous rhythms persist under conditions lacking environmental time cues.[122] The persistence of endogenous physiological rhythms is not a learned conditioned response[404] but a function of one or more physiological driving mechanisms referred to as oscillators. Circadian oscillators under natural conditions are synchronized or entrained to a period length of 24 hours by periodic environmental stimuli or Zeitgebers.[116]

In the absence of environmental time cues, internal synchronization is maintained in most subjects.[1985] Approximately 28% of human subjects[142] and 25% of subhuman primates[1274] have shown real internal desynchronization of physiological or behavioral rhythms. Some rhythmic physiological variables reported to have internally desynchronized include: urinary hydroxycorticosteroids, urinary electrolytes, body temperature, locomotor activity, rest-wake activity and blood pressure.[134,741,1237,1264,1985] In experiments such as these, where real internal desynchronosis is induced by either total isolation[125,142,1021,1999] or by constant light exposure, rhythms may stay locked in phase for the first four days of experimental phase-shifts, before the physiological rhythmic variables (e.g., body temperature and urine parameters) totally uncouple.[1277] Thus, the manifestations of such uncouplings are typically delayed.

Real internal desynchronosis may have significant effects on a number of physiological regulatory systems including neural, hormonal, metabolic, cardiovascular, and respiratory systems.[2021] Such effects may produce significant decrements in performance.[1028] Thus, the mechanisms and interactions of oscillators with circadian physiological variables require further elucidation.

B.2 Apparent internal desynchronization- In the course of investigations which deal with internal desynchronization, some investigators observed that under isolated conditions lacking environmental time cues (Zeitgebers), the previously entrained circadian rhythms of some experimental subjects appeared to desynchronize. However, under closer observation it was noted that these rhythms had different periods, yet maintained a constant phase angle to one another.[134,1977,1991] This phenomenon is referred to as apparent internal desynchronization. In these experiments, rectal temperature of approximately

8% of the subjects had a period of twice or half the value of the activity period. The phase angle differences between these two rhythms remained in a constant integral ratio such that they were internally synchronized with each other, but in a 2:1 mode or 1:2 mode.[1991] Although apparent internal desynchronization has not been indicated outside of constant, isolation conditions in the laboratory, these studies have proven useful in the research of control mechanisms underlying desynchronosis.

B.3 Electromagnetic fields and internal desynchronosis- Wever[1984,1987,1999] has shown that body rhythms can be influenced by artificial electric fields that approximate the frequency of the earth's natural electromagnetic field (10 cycles per second). The subjects in his experiments were isolated from all known environmental time cues and one half were also shielded from 99% of the natural electromagnetic field. In the absence of time cues the physiologic circadian rhythms started to free-run but remained internally synchronized. After 2 weeks of isolation, real internal desynchronization between the activity-rest cycle and core body temperature rhythm occurred more often in subjects shielded from natural or artificial fields (15 of 50) than those exposed to these fields (0 of 30).[1987] Other effects included: 1) a change in the mean period length of the circadian system to a value intermediate between 24 hours and the free-running period; and 2) a reduced variability in period length among individuals.[1984] Though natural fields are 1000 times less intense than the artificially applied A.C. fields (2.5 V/m), they appear to have similar synchronizing effects on the circadian system. The intensity of natural fields is known to oscillate with a diurnal pattern.[1004a] A distinction was drawn between the effects of an oscillating field (A.C.), reported above, and a non-oscillating field (D.C.) which exerts no obvious effects on circadian rhythms.[1987] The synchronizing effect is apparently due to the oscillating characteristic rather than the electromagnetic nature of the field.

In addition to increasing our understanding of this synchronizing tendency, Wever stated that further research into the effects of EMF is warranted because of its possible usefulness as a subtle stimulus (consciously imperceptible) to test the sensitivity of the circadian system.[1987] Hawkins also concluded that application of 10 Hz electric fields could be used as a method to hasten resynchronization of the disrupted rhythm relationships encountered in the aviation environment.[788]

C. Transient States of Internal Desynchronization

C.1 Internal dissociation- Experiments devoid of environmental time cues in man and animals have shown that certain rhythmic physiologic variables take longer to resynchronize after a phase-shift than do others.[562,779,1154] In this situation, the desynchrony is a transient state experienced between the shift in phase and internal resynchronization. Desynchronous rhythms in which the mutual phase-shift is not greater than 360° are said to be internal rhythmic dissociation (cited in ref. 122). Thus, internal dissociation occurs at the beginning of each situation in which human circadian rhythms free-run. Numerous circadian physiological variables have been observed to internally dissociate. These include body temperature, urine, electrolytes and activity rhythms in primates[1770,1775] and in humans[1993]; and plasma cortisol, body temperature and sleep-wake cycles in humans,[404] to name a few. These studies have generally concluded that internal rhythmic dissociation strongly implicates a complex multioscillator model for internal rhythmic organization of circadian parameters.

Internal dissociation, also referred to as "transient internal desynchronosis,"[1264] is of particular importance to air travel. After a five hour flight westward, about two days are required for re-entrainment of the sleep-wake cycle, five days for body temperature rhythm and eight days or more for other rhythms, such as cortisol secretion.[123] Therefore, during the period of re-entrainment, the individual is in a state of transient internal desynchronosis. This impairment of "well-being" is postulated to cause performance decrements in man.[962,966]

<u>C.2 Internal rhythmic dissociation and conflicting temporal information</u>- Various environmental stimuli can act as Zeitgebers to physiologic rhythms. Such stimuli include feeding frequency,[1269,1769] light,[276] temperature,[123] and various social cues.[127,966] Although light has been indicated as a strong Zeitgeber in animals,[1887] it is not a strict Zeitgeber in man[123] and subhuman primates. Sulzman et al. examined the entrainment of two such agents: light-dark (LD) and eat-fast (EF) cycles. In a series of experiments, nonhuman primates under isolated conditions demonstrated that particular Zeitgebers could more tightly control particular circadian rhythms.[1768,1771] For example, eat-fast cycles produced more stable drinking and urinary rhythms than light-dark cycles. Light-dark cycles produced more stable colonic temperatures. Furthermore, resynchronization of free-running urine and drinking circadian rhythms occurred more rapidly in response to EF Zeitgebers than the resynchronization of colonic body temperature.[1771] Thus, the precise control of the timing of these rhythms by their respective Zeitgebers suggests that particular rhythmic parameters are more tightly coupled to the temporal information of certain specific Zeitgebers relative to other Zeitgebers. Altering the temporal information of more than one Zeitgeber with respect to one another provides two (or more) conflicting Zeitgebers concurrently. The conflicting phase or period information which results can cause different rhythmic components of the circadian timekeeping system to dissociate from each other. Sulzman et al.[1765] revealed in subhuman primates that when EF cycles and LD cycles are provided in either conflicting phase or period relationship to one another, those physiologic rhythmic parameters most readily entrained by them (i.e., urinary potassium excretion and rectal body temperature, respectively), would phase-shift independently of one another. Thus, two previously observed coupled oscillations dissociated from one another as a result of conflicting temporal information.

The results of studies in this area provide important information on the organization of the circadian timing system in higher animals. In order for Zeitgebers to function effectively, periodic environmental cues must be detected, transduced and the temporal information distributed throughout the body.[1771] Physiological coupling among the various tissues in the body which, in turn, produce rhythmic outputs is accomplished through neural and hormonal mediation.[1264,1274] In the aforementioned study by Sulzman et al.[1765] disparity in the strength of coupling of individual rhythms to the Zeitgeber was manifested as: 1) transient internal desynchronosis subsequent to a phase-shift; and 2) internal desynchronosis between different variables.

Recent studies with primates have investigated the phenomenon that certain circadian rhythms resynchronize more quickly than others. In one such study, Sulzman et al.[1771] found that transient internal desynchronization (dissociation) occurred after a phase-shift in the eat-fast Zeitgeber imposed upon subhuman primates. However, the physiologic rhythmic variables were different than those typically affected by the light-dark cycle. These observations open up the possibility that if both LD and EF cycles are phase-shifted simultaneously, physiological rhythms could be resynchronized more rapidly and the time of transient internal desynchronization could be reduced. These implications for possibly minimizing the symptoms of "jet-lag" are encouraging, but remain to be fully explored.

C.3 Internal dissociation during re-entrainment by partition- If two oscillating physiological variables phase-shift in opposite directions, subsequent to a phase-advance of the Zeitgeber, they are said to re-entrain by partition.[1979] Because dissociation of rhythmic variables occur during the course of this type of Zeitgeber phase-shift, it may be of particular relevance to the physiological effects of transmeridian flight.

Usually after a 6 hour phase-shift of the LD Zeitgeber, or after a flight across six time zones, all rhythmic functions are shifted into the same direction.[128] However, this is not always the case. After a 6 hour advance-shift of light (phase-advance), one out of seven subjects (in isolation studies) delayed his rhythm of rectal temperature 18 hours while the activity rhythm advanced by 6 hours.[1979] In flight experiments, such a partition between the activity rhythm and the rhythm of body temperature has also been observed after an eastbound (phase-advance) flight across nine time zones.[964] In this flight study, 50% of the subjects were re-entrained by partition.[127,964] Another example of re-entrainment by partition is a report of a 12 hour shift of sleep-time in a hospital in which analysis of urine constituents of one subject indicated an advance-shift for the rhythm of potassium excretion, and a delay shift for 17-hydroxycorticosteroids.[128]

Although studies have demonstrated partition phenomena in the advance-shifts of the Zeitgeber, after eastbound flights, and after a 12 hour shift of sleeptime, no partition has been found after delay shifts[1979] or after westbound flights.[964] It is further noteworthy that the transition state of re-entrainment partition lasts for up to a week in time,[1999] and its probability of occurrence may increase with the extent of the Zeitgeber shift, or with the number of time zones crossed.[128] Such findings are also in agreement with other similar studies.[127] Further, transitory temporal disorders that characterize re-entrainment, such as in the partition effects cited, probably contribute to the loss in performance during post flight days in man,[966] and may have immediate effects on health.[128]

C.4 Special forms of internal dissociation- This category includes two transient states of internal desynchronization which give insight into the mechanisms underlying internal desynchronosis, but which have limited practical application to performance. These limitations ensue from the strict environmental conditions under which these rhythm forms are elicited (i.e., constant light).

Splitting. An unusual pattern of circadian rhythmicity has been identified in which a single daily activity band, that is, the daily active portion of a circadian activity rhythm, dissociated into two components. These two components, which appear as a bimodal activity rhythm, free-run at different frequencies.[249] Such a pattern is known as splitting.[1440] This separation of a single circadian oscillating parameter occurs spontaneously, and generally does not separate by more than 180° in phase.[411] In addition to the appearance of this form of internal dissociation, splitting has been reported to "re-fuse" or internally re-entrain spontaneously or as a result of a reduction in light intensity.[1445] Rhythm splitting has been documented in the activity rhythms of humans,[1985] rodents,[249,1445] birds,[706] and tree shrews.[1873] It has also been demonstrated in primates that splitting occurs in temperature rhythms as well as activity rhythms.[616] Because splitting only occurs in some subjects or animals which are maintained in constant light for considerable duration (20-60 days) the relevance of splitting to performance is limited to further understanding of the underlying oscillating mechanisms.

Forced Internal Desynchronization. Each circadian physiologic variable has a period range in which a Zeitgeber can entrain it (range of entrainment) (cited in refs. 128, 139). The actual dimensions of this range relative to time differ from one oscillating physiological variable to the next. Evidence suggests that physiological variables such as body temperature and activity have narrow and wide ranges of entrainment, respectively.[1997] When an environmental Zeitgeber such as light occurred within the activity rhythm range of entrainment, but not the temperature rhythm range of entrainment, activity became entrained to the period of the Zeitgeber, and temperature free-ran.[1997] Thus, through these manipulations of the Zeitgeber, the subject experienced "forced internal desynchronization." Noting that some individuals have an especially strong tendency toward internal desynchronization, Wever[1997] suggested that the range of entrainment of various physiological rhythmic parameters may be variable from individual to individual, thus accounting for the different tendencies toward internal desynchronosis.

D. Internal Desynchronization and Sleep Disturbances

Sleep disorders are some of the most commonly reported complaints of aircrew and air travellers following transmeridianal flights.[186,303,763,788,1246,1965] The effects of sleep changes on performance are documented in other sections of this report. The concern of this section is to define how temporal disorganization of the circadian system contributes to sleep disturbances and the subsequent physiological effects on generalized performance parameters.

Many investigators regard internal desynchronization of circadian rhythms as the source of many of the sleep disturbances experienced by endogenous depressive patients[637,1034,1404,1942] and normal insomniacs[1930,1954,1955] as well as aircrew[760,972,1246,1346,1472] (see also Section IV.C.2).

D.1 Specific sleep problems- Commonly cited sleep problems include early awakening,[918,1246,1404,1942] sleep stage displacement within the sleep cycle (e.g., REM sleep occurs early),[1246,1404,1942] short sleep-wake cycle (less than 24 hours),[1034,1036] and long sleep latency.[788,972,1951,1955] These problems can be experimentally induced in normal subjects by sleep reversal.[1404,1942] Other effects of change in internal phase relationships between circadian rhythms are emotional and psychosomatic disturbances,[1813] and depression, hostility, or suicide.[1550]

D.2 Approaches to reordering temporal relationships of circadian rhythms- Many common sleep disturbances may be caused by disorder of the circadian system.[96] There have been several approaches taken by investigators to change the phase relationships between physiologic circadian rhythms and the sleep-wake cycle. Most operate from the hypothesis that the existing temporal relations are in a desynchronized state, thus causing the undesirable sleep symptoms. If this is true, then attempts to realign these physiologic circadian rhythms in synchrony with one another (i.e., eliminate the internal desynchronization) should alleviate the sleep disorders. Techniques used range from the use of drugs (lithium, tricyclic antidepressants), sleep deprivation, and rescheduling of sleeping times (see also Section VI, Chronotherapy).

A characteristic of some manic-depressive patients is a rapid cycling between the two behavioral states. The period of this cycling is similar to a free-running circadian rhythm that runs slightly faster than 24 hours.[147] Kripke has had some success using lithium for slowing or delaying these rhythms,[1035] perhaps enough to resynchronize them to a 24 hour period. Wehr found lithium carbonate to have no beneficial effect.[1942] However, a tricyclic antidepressant (desmethylimipramine) promoted a switch out of depression by a temporary advance of morning awakening. Wehr postulated that the same mechanism of altering the timing of circadian rhythms relative to the sleep-wake cycle operates for both experimentally designed schedule shifts and effects of tricyclics.[1942]

In response to sleep deprivation, depressive patients differ from normal subjects. There is a transient (2 day) antidepressant effect on 1/3 to 2/3 of depressives and an inactivated, dysphoric response in normals.[647] Again, the hypothesized mechanism of action is that sleep deprivation resynchronizes disorganized circadian rhythms.[1431] Post attributed the transitory activation to the nonspecific stress effect of sleep deprivation[1465] which may influence some parameters of a circadian rhythm (phase-shift, amplitude or frequency change) and lead to internal resynchronization and normalization of the sleep-wake cycle.[1404,1431] Taub cautioned that the detrimental effects seen in sleep deprivation or lengthening may be due to disruption of the established circadian pattern of sleep-wakefulness, since it necessarily involves a change in the timing of either sleep onset or awakening.[1809]

There are many instances of direct temporal relocation of the sleep-wake period.[405,1034,1942] Czeisler, 1979 and Weitzman, 1979, 1980 have successfully treated insomnia by "resetting a biological clock".[405,1951,1955] A series of phase delays of sleep onset, by 3 hours each of 5 days, essentially rotated sleep onset time. This method of phase delay may be more successful than phase advancement due to different upper and lower limits on the range of entrainment. A 27 hour day created by phase delay seems to be tolerated more easily than a 21 hour day resulting from phase-advancing. Wehr has reported some problems associated with changing circadian phase relations.[1942] Phase-advancing the sleep period of a depressive patient with respect to the remaining circadian rhythms induced clinical remission from depression, hypothesized to be due to the sudden change in internal temporal order between the two sets of rhythms. However, subsequent entrainment of all rhythms to the new schedule caused the original pathologic phase relation to be re-established, explaining the relapse into depression that accompanied synchronization. Another phenomenon also discussed by Wehr was an instance where the attempt to phase-advance the sleep period failed to advance the core temperature period, which phase delayed. Simultaneous movement of the two rhythms in opposite directions (re-entrainment by partition) cancelled the desired phase change and produced no change in depression levels.[1942]

Many researchers dealing with the effects of internal desynchronization on sleep disorders have demonstrated that most disturbances, especially a shift in phase of the sleep period resulted in a poorer response to vigilance tasks requiring accuracy and speed,[1811] calculation tests, and retention time.[1813]

E. Conclusions

The human body is composed of numerous delicately balanced physiological circadian variables. These variables have adapted to the temporal external environment such that they perform optimally. If this temporal environment is changed, the body attempts to adapt. Because various physiological parameters adapt, or re-entrain, at different rates, these endogenous physiological rhythms become internally desynchronized from one another. Internal desynchronosis is characterized by a number of physiological and performance decrements as previously described. These decrements show inter-individual variability, thus not all persons exhibit the same magnitude of performance decrement. The conclusion of many investigations into the source of common sleep disturbances points to change in the temporal order of physiologic circadian rhythms as a major factor.[147,760,1346,1472,1818] An activity known to induce such changes is transmeridian flight.[763,788,1246,1965]

F. Selected Bibliography on Internal Desynchronization

25	118	132	196	250	333	435	513	617	706	777	838	869
30	119	135	224	254	341	446	515	619	709	779	839	882
34	121	137	235	271	371	447	517	620	713	780	840	885
37	122	140	236	276	379	448	575	637	717	781	847	887
59	123	142	237	281	380	454	577	645	720	793	848	888
70	124	151	238	296	404	476	578	647	721	794	849	898
83	125	153	239	297	405	483	582	648	727	808	850	902
96	126	155	240	307	407	485	605	649	730	824	851	903
98	128	159	241	320	408	487	613	659	738	825	853	917
108	129	160	247	326	410	496	614	685	739	829	854	918
114	130	165	248	327	411	502	615	699	740	832	855	930
117	131	176	249	330	429	503	616	700	741	835	867	932

934	1055	1236	1302	1438	1593	1728	1787	1920	1980	2019
944	1065	1246	1304	1440	1601	1729	1788	1926	1981	2021
948	1066	1247	1305	1441	1602	1730	1789	1940	1982	2022
950	1067	1248	1308	1442	1606	1733	1792	1942	1983	2024
966	1068	1250	1309	1443	1607	1734	1793	1944	1984	2025
971	1069	1261	1312	1444	1610	1735	1794	1951	1985	2026
975	1075	1262	1316	1445	1611	1744	1803	1952	1986	2027
995	1095	1264	1323	1446	1615	1752	1828	1953	1987	2028
1010	1102	1266	1328	1447	1616	1753	1836	1954	1988	2029
1013	1103	1267	1340	1449	1620	1754	1850	1955	1990	2034
1014	1104	1269	1342	1452	1621	1756	1867	1956	1991	2035
1017	1131	1270	1366	1453	1624	1761	1873	1957	1993	2038
1020	1132	1271	1370	1456	1635	1765	1877	1958	1994	2039
1021	1133	1272	1372	1458	1643	1766	1880	1959	1995	2040
1023	1142	1273	1375	1459	1669	1767	1882	1960	1996	2041
1025	1159	1274	1387	1469	1670	1768	1883	1961	1997	2042
1028	1174	1275	1389	1497	1672	1769	1884	1962	1998	2058
1029	1182	1276	1393	1512	1682	1770	1885	1963	1999	2060
1030	1187	1277	1397	1513	1686	1771	1886	1964	2000	2062
1031	1192	1278	1400	1546	1702	1772	1895	1965	2001	2067
1033	1210	1279	1404	1548	1711	1773	1903	1967	2005	2075
1034	1214	1291	1406	1550	1720	1774	1905	1968	2006	2076
1036	1215	1292	1421	1551	1721	1775	1913	1973	2007	2079
1044	1217	1294	1431	1555	1723	1776	1915	1977	2015	2081
1051	1218	1295	1433	1557	1724	1777	1916	1978	2017	2082
1052	1219	1298	1434	1574	1725	1778	1917	1979	2018	2084
1053	1226	1300	1435	1575	1726	1786	1919			

VI. CHRONOTHERAPY

A. Introduction

Chronotherapy is a treatment administered according to temporal factors, notably rhythms.[722] These rhythms have three main properties: phase, amplitude, and period length. The phase relationships between entrained circadian rhythms of animals and their entraining periodic signals (Zeitgebers) are determined by properties of the organism's circadian system and by those of the Zeitgeber.[137,838,839] If the Zeitgeber is suddenly shifted in its phase relationship to that of the organism's circadian rhythm, then the direction of time of re-entrainment of the rhythms have been suggested to depend on the "strength" of the entraining signal, the phase-angle (circadian time) at which the shifted signal occurs with respect to the organism's endogenous rhythms, and the intrinsic characteristics of the organism's circadian period.[137,177,1453] Evidence in humans shows that rhythms readjust to altered environments at different rates.[1998] This explains why internal desynchronization occurs. The state of desynchronosis has been exhibited by individuals who cross several time zones in a single flight.[965] The symptoms of the desynchronotic state vary from individual to individual. These symptoms in decreasing order of frequency, as reported in the literature, include: fatigue, insomnia and sleep disturbances, chronic gastrointestinal complaints and anorexia, and psychological abnormalities and nervousness parameters which may be associated with the circadian performance curve. Other symptoms which have been reported by aircrews include: headaches, ocular malfocus, dyspnea, diaphoresis, occasional nightmares,[177] and menstrual abnormalities.[530,883,1477] Many of these symptoms can be ameliorated or prevented by a temporal manipulation of Zeitgebers, chronotherapy, and relaxation techniques.

B. Zeitgebers

B.1 Social- The strength of the entraining signal has been suggested to be very important to re-entrainment of the human circadian system.[121] Social signals have been shown to provide powerful Zeitgebers.[121,448,1028,1550] In fact, they appear to play the most important role in re-entrainment of human circadian rhythms.

After a transmeridian flight, the human system becomes desynchronized and prevailing Zeitgebers work to re-entrain the circadian system. Re-entrainment rates after a flight may depend on the individual's activities in relation to the social environment.[137] The social entrainment of human circadian rhythms has been emphasized by Aschoff and Klein[121,966] who demonstrated that, when allowed to perform an intermittent outdoor activity at the destination, travellers took less time for adaptation of psychomotor performance rhythm than those who remained in relatively isolated experimental facilities.

Under most conditions, social effects do not function as strong Zeitgebers in animals. However, given proper conditions, there are precedents for social interaction as a Zeitgeber in small mammals. Social effects on phase-shift and phase control were observed in deer mice (*Peromyscus maniculatus*),[529] and in nondominant rats.[1579] Blind mice housed with sighted mice may be entrained to light-dark cycles (after several months), presumably by social cues. Social effects have also been observed in the amphipod (*Talitrus saltator*) on the free-running period.[130] When the drinking and activity cycles of unrestrained squirrel monkeys were examined in the absence of other cues, social interaction and isolation proved to be ineffective Zeitgebers. Equally ineffective as Zeitgebers were cycles of water availability and deprivation, warm and cool temperature, sound, and quiet. Rohles and Osbaldistron,[1556] however, have shown social entrainment in Rhesus monkeys. The major Zeitgebers of drinking and activity cycles in the squirrel monkey have been cycles of light and dark, and cycles of food availability.[618,1768]

B.2 Sleep and light-dark cycles- Of the many physical complaints of the desynchronosis syndrome, insomnia and sleep disturbances, as well as an overall drop in REM sleep time,[525] are the most prevalent for several nights after arrival in a new time zone.[525,1244] These changes in sleep elicited by transmeridian flights have chiefly been attributed to time zone changes.[509] The difficulty is not in falling asleep but rather in preventing waking in the early morning hours.[525] Desynchronosis does not occur after long north-south flights. Therefore, the syndrome is not totally due to fatigue, lack of sleep or other nonspecific factors in the aviation environment but rather is largely chronophysiological in origin.[1965]

To ameliorate the time zone effects on sleep, the traveller should be as rested as possible before departing on a long east-west or west-east trip.[461] In fact, if possible, preadaptation to the new day-night sleep-wake pattern of the destination several days before departure is desirable. In travelling east, this would be accomplished by going to bed one hour earlier each evening progressively, and awakening one hour earlier each morning until the sleeping schedule is moved forward to coincide with the new local time of the destination. For a westbound trip, the schedule would be reversed, retiring one hour later and arising one hour later each day.[1178]

Airline pilots face difficulties in following such a rigorous schedule of preadaptation to time zone changes. They are not often allotted time to rearrange their sleeping schedules in such a manner. Cabin crews also frequently suffer loss of sleep.[1473] Sleep loss results in a reduction in skill,[170] an increase in reaction time, an upset in balanced judgment, and an impairment of complex decision making.[150,788]

There are several suggested ways to modify the effects of sleep loss on airline pilots. The first major remedy for improving sleep is to improve the opportunity for regular sleep at periodic intervals. Since the problem lies primarily in the irregular working and resting schedules of crew members, careful study and improvement of crew scheduling is indicated to minimize the effects of sleep deprivation and disturbance and the resultant fatigue and loss of performance.[788,905] Pilots should also understand the problems of flying successive tours involving multiple time zone changes and night flights where sleep deprivation may result. Instead of bidding in a money-oriented fashion, pilots should bid within their normal capabilities from a work-rest point of view, and consider the long term effect on health and performance.[1473] Secondly, the problem of body rhythm desynchronization can be greatly relieved by stationing at overseas bases. Companies (cost) and staff unions (social disruption) often strongly object to such arrangements. Yet this must be recognized as one of the most effective ways of reducing body-rhythm desynchronization.[788] Thirdly, it is recommended that adequate sound-proofed, air conditioned and darkened sleeping accommodations be provided for aircrew at all slip stations.[1473] Finally, the opportunity to sleep may not provide a total cure for "lack of sleep" (see Section IV.D.2. Disturbances to the "Normal" Sleep-Wake Cycle).

Animal experiments have shown that rats experiencing desynchrony exhibit disordered sleep patterns. Hagino[709] stated that female rats subjected to the light and dark schedule 12L:12D from birth through puberty exhibited a circadian rhythm of sleep, and paradoxical sleep; with peaks of sleep during the light phase. When these rats were transferred from LD to continuous illumination, the circadian rhythm of sleep was annihilated and indeed "all rhythms disappeared." It seems likely that light serves as a synchronizer or oscillator for regulation of circadian rhythm of sleep, wakefulness and paradoxical sleep in the rat.[709] The importance of animal work in this area of desynchrony and sleep disturbance is that dysrhythmia can be easily induced in animals in the laboratory in a controlled environment.

For small mammals under natural conditions in the arctic, even during the summer when the amplitude of the entraining light is 23:1, the light-dark cycle is the principal entraining agent of the endogenous rhythm.[1777] The acute sensitivity of animals to this Zeitgeber (light) is exquisite. For example, the squirrel monkey is very sensitive to short light pulses as brief as 1 second of light per day at 600 lux. This short light period was capable of entraining the drinking rhythm to a 24 hour period. Light pulses produced discrete changes in a duration-dependent fashion. These data underscore the potency of light as a Zeitgeber for diurnal primates.[1773,1774]

B.3 Meal time- Programmed feeding cycles are strong Zeitgebers for mammals, primates, and man.[495,714,855,1024,1579,1769] It has been shown that one meal consumed in the morning results in weight loss in the human, and the same amount of food consumed in the evening results in a significantly smaller loss of weight or else a gain.[718] Halberg stated that meal timing has an important effect on body rhythms.[718]

A diet plan to assure swift adjustments to the phase-shifts developed in humans during transmeridian flights has been suggested by Ehret, Groh, and Meinert.[495] Their diet is based upon the following physiological considerations: 1) the chronobiotic action of the methylated xanthines in tea and coffee[1171]; 2) the action of food as a Zeitgeber in feed-starve cycles, presumably efficacious because of glycogen depletion during the prolonged fasting phase; 3) the tendency of a high protein meal to favor synthesis of catecholamines associated with the active phase of the circadian rest-activity cycle[1427]; and 4) the tendency of a meal high in carbohydrates to favor the increased synthesis of serotonin which typically precedes sleep.[495,539,1426,1492,1673] This scheme alternates feast and famine days with excesses and absences of caffeine drinks, high protein meals, and periods of heavy and light activity. The model of Ehret et al. was tested by Graeber and his colleagues.[690] Along with the other countermeasures employed (rest activity schedules and social interaction) an overall reduction in fatigue associated with transmeridian flight was exhibited by the subjects.

Physiologic hypoglycemia from starvation or strenuous exercise is frequently present in persons with perfectly normal carbohydrate metabolism. It has been reported that the judgment required to carry out a skilled landing operation can be impaired by the effects of an empty stomach, particularly after an all-night flight.[322] For flight crew benefit, the need to provide 24 hour meal service at their hotels and flight bases cannot be ignored. Only in this manner will aircrews be in optimal physical and mental condition.[1473] Importantly, a regular meal time cycle is an extremely valuable and practical therapy to prevent possible decrements in performance that may be caused by acute fasting.

A shift of meal time can effect circadian rhythms by displacement of precursor availability. This cannot only result in alteration of the circadian rhythmicity of various enzymes, but can also desynchronize their activities relative to each other. Three specific enzymes of amino acid metabolism, tryptophan pyrrolase, tyrosine aminotransferase, and serine dehydrase, were found to react very differently to changes in the chronology of a protein meal. The circadian rhythms of tryptophan pyrrolase remained the same in rats receiving protein meals at either 0500, 0900, 1300, 1700, or 2300 hours and consuming their energetic (carbohydrate and fat) feed ad lib. during the night.

Tyrosine aminotransferase was systematically induced several fold after the protein meal. The increase was maximal when close to the beginning of the normal circadian rise. Serine dehydrase, although its level is strongly dependent on the overall protein content of the diet, was inducible by the protein meal only during the fasting period. Its activity was otherwise controlled by the ingestion of energetic material.[665] This demonstrated the more complex meal time relationship between energetic and protein intake. Thus, meal timing may act to increase or ameliorate desynchronosis.

Much of the mechanism by which meal timing affects the endogenous circadian timing system is still unknown. It is possible that the behavioral response induced by the daily provision of food to a fasted animal influences the daily central circadian pacemakers which apparently reside in the hypothalamus. Alternatively, some component of the ingested food may act directly or indirectly on the pacemakers of the circadian system. There is evidence which favors this latter possibility since an animal's diet is known to influence the biochemical composition of its brain and specifically the plasma levels of tryptophan and choline which influence the brain levels of the neurotransmitters serotonin and acetylcholine, respectively. A direct effect of any dietary component on the pacemakers of the circadian timing system is far from being proven, although currently it is a matter of intensive investigation.[2064]

In addressing the importance of meal time as a Zeitgeber, there are those who believe that in the rat the food-availability cycles are not acting as classic Zeitgebers and that mechanisms other than entrainment of an oscillator are at work.[9] In the rat and mouse, there is evidence that restrictive feeding or eat-fast cycles may affect rhythmic behavior but are not true Zeitgebers.[1769] Intact rats under constant conditions seem to be unable to anticipate 19- or 29-hour feeding schedules. Stephan found that under constant conditions rats with suprachiasmatic nuclear (SCN) lesions are capable of anticipating 24 hour eat-fast schedules, but not 18 hour feeding schedules.[1768] Other workers found that the activity rhythm in blind rats is not entrained by fixed-interval restrictive feeding cycles.[658] As another example, eat-fast cycles controlled or "drove" the overt drinking behavior of the rat, but this rhythm failed to entrain to the eat-fast period and returned to its underlying periodicity when food was made available ad lib.[247] Certain rhythmic parameters such as body temperature appear to be controlled by restrictive feeding schedules.[887,1762]

Cycles of eating and fasting are capable of synchronizing at least five different variables in the squirrel monkey. The reasons for classifying the eat-fast cycle as a true circadian Zeitgeber in the squirrel monkey are: 1) period control by period length of the eat-fast cycle; 2) phase control determined by the phase angle of the eat-fast cycle; and 3) stability of the waveform of the dependent rhythms.[1765] Urinary volume and potassium rhythms are more closely coupled to eat-fast cycles than to light-dark cycles. This is demonstrated by a transient rephasal period of one day following an eat-fast phase shift as compared to a seven-day lag to a comparable light-dark phase shift. These findings indicate that the circadian rhythms of urinary potassium, sodium, and water excretion are controlled by mechanisms that are not passively dependent on the behavioral patterns of feeding, drinking, and activity.[1270] In addition, drinking rhythms and body temperature will entrain to eat-fast cycles. Transient dissociation of drinking rhythms from eating rhythms has been seen in both rats and monkeys after a phase-shift of eat-fast cycles.[1771,1769]

In squirrel monkeys it has been found that transient internal desynchronization occurred after a phase-shift in the light-dark cycle and also after a shift in the eat-fast cycle but with internal desynchronization occurring between different variables.[1771] This confirmed the supposition that transient internal desynchronization is caused by disparities in the strengths of coupling of individual rhythms to the Zeitgeber which is being phase-shifted. This observation also opened up the intriguing possibility that if both light-dark and eat-fast cycles are phase-shifted simultaneously, all physiological rhythms could be resynchronized more rapidly, and transient internal desynchronization could be reduced. The implications of these findings for minimizing the symptoms of "jet-lag" are exciting, but remain to be fully explored.[1771]

C. Re-entrainment Following Phase-Shift of Zeitgebers

After discussing the effects of Zeitgebers on the human circadian system, it becomes important to discuss the processes of desynchronization and resynchronization and how and why they occur. Instant desynchronization of human circadian rhythms and the periodic time cues in the environment occur immediately following rapid air travel along latitudes. The result of this phase-shift is a dysrhythmia of the phase, amplitude, and period length of the body's oscillating processes. The resynchronization of the different rhythmic functions is variable. Each rhythm resynchronizes at its own rate.[1052,1938]

The urinary excretion rhythm of 17-hydroxycorticosteroids is slow to adjust to resynchronization in comparison to catecholamine excretion rhythms. It appears to require ten days for the re-entrainment of urinary steroid excretion in the human.[137] Rephasal rates of body temperature occur faster than those of 17-OHCS in the first 24 hours postflight. However, at later times the rephasal of body temperature slows down and the two rhythms begin resynchronization at similar rates.[1937] Differences in the rate of adjustment between noradrenaline and adrenaline have also been observed.[1938]

There is an asymmetry-effect with regard to the direction of the transmeridian flight.[137,965,1938] Simply defined, the asymmetry-effect refers to the fact that phase-shifts are slower and resynchronization takes longer after air travel from west to east than after travel from east to west (see also Section V). Attempts to explain this effect have proven to be difficult.[137] It was thought that the time of flight and/or the direction of flight in regards to the traveller's permanent home may have an influence upon the speed of adjustment. But these explanations have since proven incorrect.[1938] The asymmetry-effect does agree with the observation that it is easier to prolong a day by remaining awake as occurs after a westerly flight, than to sleep when one isn't tired (at an unaccustomed time) as would occur after an easterly flight.[965]

The rate of re-entrainment of the circadian system can generally be characterized by the following parameters: 1) is nonlinear over time; 2) is affected by the direction of flight, i.e., the asymmetry-effect; 3) is affected by the fact that the different physiological and psychological variables resynchronize at different rates; and 4) may be influenced greatly by the interaction of several Zeitgebers,[137,965] or application of chronotherapy.

D. Chronotherapy

Chronotherapy may be carried out with drugs (chronochemotherapy), meal timing (chronutrition), and rearrangement of activity schedules. Chronochemotherapy (drug therapy) is a difficult issue in relation to aircrews and their unusual sleeping patterns that result from transmeridian flight and the accompanying desynchronosis. Obviously, sleep deprivation affects performance but so can drugs, such as sedatives, depressants, hypnotics, stimulants, and antiepileptics.

The barbiturates are sedatives and central nervous system (CNS) depressants and are so variable in their effects and rates of excretion and, particularly, in their prolonged behavioral effects that their use by aircrews cannot be supported.[1473] Barbiturates are extremely dangerous in overdose, expecially in combination with alcohol and are also addictive.[788] Barbiturates at doses in the normal therapeutic range have an effect which impairs performance during most of the working day following ingestion.[1354] In addition, barbiturates have been found to depress REM sleep.[1359]

Alcohol is another general, nonselective, CNS depressant and must be considered as a drug. Twenty to thirty minutes after ingestion of a single dose of alcohol, maximum blood levels are reached. Initially, alcohol acts as a behavioral stimulant,[788] due to loss of behavioral inhibition. The next state exhibited after alcohol ingestion is sedation and drowsiness, then follow sleep, anaesthesia, coma, and death, depending on dosage.[150] Hawkins[788] indicated that approximately 50% of the cockpit crew used alcohol as an aid to sleep. Widespread use of alcohol can lead to the development of a dependence by flight crews, resulting in performance decrements and, finally, personality disorders.[788] Preston suggested that the dangers of alcohol in sleep-deprived subjects need to be made known to all pilots.[1473]

The benzodiazepines seem to be the hypnotics most commonly used by aviation personnel.[788] Their effects are characterized by uneven distribution throughout the blood and body tissues. They bind to specific tissues in the kidney, liver, and brain. The three most commonly used benzodiazepines are diazepam (Valium), nitrazepam (Mogadon), and flurazepam (Dalmane, Dalmadorm). They all impair memory and reduce performance of skilled tasks.[788] Nitrazepam (10 mg) and flurazepam hydrochloride (30 mg) led to performance decrements after overnight ingestion which persisted well into the next working day.[1355,1362] Diazepam (10 mg) leads to impaired performance for a few hours after ingestion but it does not extend into the next working day.[1362] However, diazepam does have an estimated half-life of 54 hours.[827] In the usual 5 mg dose, diazepam is unlikely to produce a sufficient full sleep period in an out-of-phase flight crew.[788]

The use of stimulants, apart from caffeine, is far less widespread among flight crews than is the use of hypnotics.[788] The use of caffeine, which is a methylated xanthine, is widespread in occupations where the human operator is required to carry out critical tasks when fatigued or when body rhythms are out-of-phase. Caffeine is readily absorbed in the body and can be detected in the blood within five minutes of ingestion. Its half-life is 3.5 hours. Caffeine, in significant quantity, has been demonstrated to cause: increased time to sleep onset, decreased total sleep, increase in wakenings, increase in light sleep, reduced REM and Delta sleep, increased number of sleep stage shifts, increased mental fatigue, and occasional gastric irritation. These effects are related to the amount of caffeine ingested.[926]

Animal pharmacologic circadian studies are qualitatively different from human studies in that animal studies often analyze several physiologic variables concomitantly over relatively long time spans under precisely controlled conditions. In addition, animal studies make use of methods which can be invasive and destructive. Thus, animal studies tend to be the best to study systems function at a mechanistic level. There has been some research in animals demonstrating effects of stimulants, sedatives, and antiepileptic drugs on circadian parameters.[496,513,1579,1762,1941]

Animal experiments have demonstrated that certain drugs can cause phase-shifts which may improve or exacerbate rephasal relationships following phase-shifts in Zeitgebers. In the rat, deep body temperature rhythms monitored by telemetry can be reset in a predictable direction by a stimulant (theophylline) and by a depressant (pentobarbital). When the drugs are applied immediately before or during the early active phases of the circadian cycle, the rhythm is set back (phase delay). When applied later, past the thermal peak, theophylline, but not pentobarbital, shifts the rhythm ahead (phase advance). Theophylline, and pentobarbital in addition to having a number of established pharmacological properties are now further identified as chronobiotics, i.e., drugs that may be used to alter the biological time structure by rephasing a circadian rhythm.[496]

Other drugs, such as antidepressants (tricyclic) and lithium affect the period length of circadian rhythms in animals. Two tricyclic antidepressants, imipramine and desmethylimipramine, accelerate the free-running circadian rhythm by shortening the circadian period of the rest-activity cycle. Secondly, the circadian rhythm of rest-activity of lithium-treated animals is less subject to disintegration in constant dark.[1941]

An antiepileptic pharmacologic, lithium chloride, has been shown to lengthen the activity periods by a small increment in the desert rat (<u>Meriones crassus</u>) and in the hamster, and therefore may find a useful place in chronotherapy.[573,496] A depressant, alcohol, may also prolong the period length. Acute exposure of rats to alcohol given as single intraperitoneal injections (1.5 g/Kg) four hours prior to a temperature measurement had no effect on the normal circadian rhythm of body temperature. Neither did alcohol affect the phase-shifts or amplitude changes of those rats on this acute dosage schedule who were entraining to an eat-fast cycle.[1762] However, a lengthening of period occurred in the activity period of hamsters when blind animals chronically injested 20% alcohol, indicating that the chronic effect of alcohol on circadian parameters may be different than the acute effect of the drug.[1579]

D.1 Chronobiotics- Quiadon, a compound synthesized by Merck, has properties that make it seem a potentially useful chronobiotic: 1) it is a tranquillizer; 2) it apparently increases subjective activity and improves performance in human subjects placed under mental pressure; 3) it is a depleter of 5-hydroxytryptamine (5-HT) which drives the circadian rhythm of pineal 5-HT and presumably other components of the circadian system onto the new daily schedule. In a double-blind trial, Quiadon was tested for possible use as a chronobiotic by Simpson and his colleagues in 1973.[1680] The results of the trial were unsuccessful. Both groups of subjects rapidly resynchronized, therefore, there was no phase-lag exhibited by the groups for the drug to act upon. Quiadon has not been retested as a chronobiotic since.[690,1680] Other drugs are currently being experimented with in animals to ascertain their chronotherapeutic value, e.g., nomifensine.[727]

D.2 Relaxation techniques- There are many techniques and methods available which may help to induce relaxation and sleep, ameliorating some of the effects of desynchronosis. Among them are the Relaxation Response, Autogenic Training, Hatha Yoga, biofeedback, electrosleep, and acupuncture. In order for these techniques to be effective, the subject must be highly motivated in its practice. Several of these methods were evaluated as treatments for insomnia resulting from transmeridianal desynchronosis.

The Relaxation Response is a type of meditation.[187] It was developed by Herbert Benson of the Harvard Medical School as a method of relaxation which leads to feelings of calmness, refreshment, and well-being. These subjective feelings varied among individuals. The Relaxation Response is achieved as the subject repeats the word "one" over and over again to eliminate distracting thoughts from his mind, while the subject sits quietly in a comfortable position. Many individuals have used the Relaxation Response while lying in bed to help them to achieve sleep without the use of sleep-inducing medication. Since the Relaxation Response requires only a slight change in lifestyle, it is ideal as a sleep-inducing aid for airline flight crews.[187]

A second technique used to induce sleep is the Autogenic Training Technique. This method was developed by J. Schultz in the early 1920s and has been further refined by W. Luthe.[788,884,1345] To induce relaxation the subject repeats suggestions of warmth and heaviness to himself over and over again inducing muscle relaxation and vasodilation.[1345] According to the results of a study done by P. Nicassio and R. Bootzin using insomniacs, Autogenic Training was very effective in reducing the amount of time needed to achieve sleep and improved the quality of sleep. Autogenic Training also resulted in an increase in physiological and emotional tolerance.[884] Therefore, it is anticipated that in the aviation environment this technique could possibly increase tolerance to stresses, and improve the ability to sleep in air crews.[788]

A third technique, Hatha Yoga, which incorporates physical and mental training, leads the subject to an "overall harmoniously balanced" mind and body. In considering possible channels for relief, this technique should not be ignored.[788]

Biofeedback is a fourth method utilized to induce relaxation and sleep. Control is maintained over muscle tension (electromyogram, EMG) and brain-wave frequency (electroencephalogram, EEG) by the placing of electrodes on the body which send signals back to the subject aurally and visually. In this way the subject is able to induce his body to relax. A study performed by Hawkins in Amsterdam in 1974 gave discouraging results in relation to the use of biofeedback to increase total sleep.[788] Further well-controlled experimental work seems justifiable.

A less common method of sleep induction is electrosleep. This is a state of consciousness unlike ordinary sleep. It is produced by the application of a weak electric current to the brain. Electrodes are placed over the eyes or on the forehead and at the back of the head. A 10-20 Hz current is applied just below the threshold of sensation. A state of relaxation is induced in the subject within ten minutes which is frequently followed by sleep. No adverse side effects have been determined with electrosleep's normal use. This method may be useful in the aviation environment, but a number of questions remain unanswered. It is preferable not to rely on a method which externally interferes with the normal functioning of the brain.[788]

The treatment of transmeridianal desynchronosis with acupuncture has been advocated by W. H. Khoe.[943] He claims that out of fifty patients treated with acupuncture for desynchronosis symptoms, 90% became asymptomatic within five to ten minutes after treatment. The acupuncture technique utilized was aquapuncture, in which 0.1 to 0.2 cc of Vitamin B-12 at 100 mcg/cc in saline was injected into the acupuncture points. The main points injected to treat desynchronosis are Gov-20, Gov-19, Gallbladder 16, Ammien 1 and 2. Again, further investigation is indicated.

E. Conclusions

An educational program should be developed to alert pilots to the importance of maintaining regular habits of sleep and nutrition. In addition, the program should warn air personnel of the dangers of alcohol and other drugs as sleeping aids in the work environment and the hazards which accompany excessive use of caffeine.

Further studies are indicated in many chronotherapeutic areas. Currently there is a great lack of information in the area of chronobiotics, indicating further research. There is a great need for a suitable, safe, short-acting hypnotic which can be prescribed to pilots on transmeridian flight schedules. Increased investigation is indicated in the area of meditation and relaxation techniques.

F. Selected Bibliography on Chronotherapy

5	170	409	529	705	839	1024	1252	1391		1759	2015
7	173	410	530	706	840	1025	1258	1395	1523	1760	2017
8	174	411	531	709	841	1026	1259	1397	1541	1762	2018
9	175	412	533	713	842	1027	1268	1398	1545	1765	2019
10	177	413	537	714	844	1028	1261	1403	1547	1766	2020
11	179	419	538	716	846	1029	1262	1405	1549	1767	2021
29	183	420	539	717	850	1030	1264	1423	1550	1768	2024
30	186	428	540	718	851	1033	1265	1426	1556	1769	2037
35	187	429	543	720	852	1036	1267	1427	1565	1770	2055
37	189	432	544	721	853	1039	1269	1428	1566	1771	2056
38	190	435	547	722	854	1048	1270	1433	1573	1772	2063
40	192	448	558	723	855	1052	1271	1434	1604	1773	2064
42	193	452	568	725	867	1053	1272	1435	1607	1774	2070
43	194	453	578	726	868	1056	1273	1440	1609	1775	2072
54	195	455	587	727	869	1067	1274	1441	1610	1776	2073
60	196	459	588	728	872	1075	1275	1442	1611	1777	2075
67	197	460	603	729	878	1089	1276	1443	1620	1778	2076
69	216	461	605	730	881	1095	1277	1444	1624	1787	2077
73	231	462	613	731	882	1096	1278	1445	1625	1788	2082
81	247	468	614	732	883	1097	1279	1446	1626	1789	2084
82	248	474	615	735	884	1112	1291	1447	1628	1792	
83	249	475	616	736	887	1116	1294	1449	1630	1793	
87	250	476	617	738	888	1121	1296	1452	1636	1794	
91	254	478	618	739	891	1122	1304	1453	1637	1796	
93	255	481	619	740	892	1124	1305	1459	1638	1805	
97	262	482	620	741	897	1132	1308	1464	1653	1836	
99	272	483	621	743	905	1133	1311	1466	1654	1850	
105	281	484	624	745	909	1145	1312	1469	1664	1861	
108	296	486	628	747	913	1149	1316	1471	1667	1862	
119	297	487	632	778	923	1154	1321	1473	1670	1863	
121	298	488	633	779	926	1159	1325	1474	1672	1866	
122	305	489	637	780	929	1171	1326	1475	1673	1881	
125	307	490	641	781	933	1172	1328	1477	1678	1903	
126	309	493	642	788	935	1177	1329	1479	1680	1926	
127	310	495	646	792	936	1178	1330	1480	1683	1937	
128	321	496	649	793	943	1179	1331	1485	1686	1938	
130	322	503	657	794	945	1181	1339	1486	1698	1941	
131	326	504	658	796	948	1187	1340	1492	1705	1965	
137	327	507	659	806	962	1198	1341	1495	1709	1967	
138	329	509	665	808	965	1212	1342	1496	1723	1974	
139	340	512	675	814	966	1213	1345	1498	1732	1975	
140	342	513	675a	824	970	1223	1353	1499	1733	1981	
141	345	515	678	825	991	1229	1354	1502	1734	1989	
142	347	516	679	826	1012	1231	1355	1506	1736	1993	
143	368	517	681	827	1013	1232	1362	1513	1737	1995	
144	373	518	683	829	1014	1239	1370	1514	1740	1998	
150	379	524	685	830	1017	1240	1371	1515	1754	1999	
151	380	525	688	835	1018	1241	1372	1515a	1756	2000	
153	397	527	689	837	1022	1243	1375	1520	1757	2001	
160	405	528	690	838	1023	1244	1389		1758	2005	

VII. THE BIORHYTHM THEORY

A. Introduction

The biorhythm theory (also known as biorhythmic, bio-curve, bio-cycle, and even biological rhythm) has been categorized as being a fraud[102,2080] and numerological nonsense and has been strongly criticized in several review articles.[16,17,76,157,443,697,799,969,1176,1338,1510,1627] Therefore, it would seem irrelevant to include a discussion of biorhythm theory in a review concerning pilot performance and its relationship with circadian rhythm desynchronization, fatigue, sleep loss, stress and other variables. However, the theory's many proponents, including some scientific investigators, have published claims that the theory can be used to predict cyclical changes in performance tendencies and predict days on which pilots are accident prone. If the theory is true, then pilot-caused accidents previously attributed to fatigue, stress, sleep loss, or rhythm desynchronization might well be secondary to performance decrement induced by adverse biorhythm-cycle phase relationships. Briefing of aircrew on biorhythm theory and scheduling of flights according to aircrew optimal biorhythm cycle phases, could result in a significant reduction in aircraft accidents.[102,1336,1599,1803,1970] The importance of the predictive value of the theory for improving aviation performance and safety, the widespread popularity and reported acceptance of the theory by influential people (see refs. 666, 1847) and portions of the airline industry,[102,666,1847,1970] and the evidence presented showing a relationship between accident frequency and biorhythm phase[666,800,1803,1847,1904,2010] support the need for a serious, critical examination in this report.

B. Historical Development of the Theory

The biorhythm theory was developed in Germany by Wilhelm Fliess[550,551] starting about 1897 and also, concurrently, by Hermann Swoboda,[1781,1782] who heard about the theory from Freud. It was revived and popularized by George Thommen in 1973.[1847] According to the version of Thommen, the theory postulates the existence of two cycles: a 23 day (physical or male) cycle that influences physical strength, endurance, energy, and physical confidence, and the 28 day (emotional or female) cycle that influences feeling, love, cooperation, and irritability. These cycles were reportedly derived from studies of periodic disease states, dreams, and anxiety by Fliess and Swoboda. The theory holds that these cycles are generated (synchronized) from the moment of birth and oscillate with constant period length throughout the lifetime of the individual. Each cycle is described by a sine wave having a positive and a negative phase with two crossing points at the transition point between positive and negative phases. This crossing point occurs at the birth times for the 28 day cycle, but for the 23 day cycle, where a crossing point occurs at 11.5 days, the crossing point occurs at birth time plus 12 hours. The thesis claims that performance levels correspond to phases of the two cycles with best performance at cycle peak and worst performance at the cycle trough. In the 1920s Alfred Teltscher found a 33 day cycle in student intellectual performance, reportedly verified by Rexford Hersey,[803,804] and thus the 33 day intellectual biorhythm, corresponding to learning, memory, and creative thinking, came into existence. Methods of conveniently calculating the charting biorhythms were later developed by Alfred Judt and Hans Fruh.[606,607,608,609] Hans Schwing[1651] first studied the relationship between accident frequencies and phases of the biorhythm cycles. He claimed accidents tended to cluster on the crossing point days, which were termed "critical days." On these days, performance is said to be unstable and an individual is more vulnerable to accidents than on noncritical days. The 33 day cycle is reputed to have less relative effects on performance levels and critical day effects than the other two cycles. Periods when the 23 and 28 day cycles are exactly out of phase or 2 or 3 of the cycles are at low phases are also claimed to be times of increased accident vulnerability.[1847] Simultaneous occurrence of critical days between 3 cycles (double or triple critical days) supposedly results in greater performance instability and corresponding increased accident susceptibility.

C. Wilhelm Fliess' Biorhythm Theory

A critical analysis of Fliess' development of the biorhythm theory by Gardner[630] provides a marked contrast to the evaluation and description of the work of Fliess by Thommen,[1847] Gittleson,[666] and others. Despite the publication of numerous books and articles on biorhythm theory, Gardner seems to be the only person discussing biorhythm theory beside Thommen (and perhaps also Demuth[443]) who has actually read the original Fliess literature. All other published accounts of Fliess' work appear to be only citations of the material in Thommen's book. This is remarkable in view of the tremendous proliferation of books, articles, calculators and biorhythm charting services, all of which are basically dependent upon the validity of Fliess' work. This negligence is certainly due in part to the fact that Fliess' books are in German, are long and difficult to read and also generally unavailable.[514] According to Gardner,[630] Fliess was obsessed with the numbers 23 and 28 and believed, in a general theory of bisexuality, that all living phenomena manifest a male cycle of 23 days and a female cycle of 28 days. Fliess' major book Der Ablauf des Lebens (The Course of Life) describes his development of the biorhythm theory. In Gardner's version the book states that all natural processes and events reflect the influence of the 23 and 28 day cycle and all of the integer multiples of these cycles. Fliess' basic formula can be written: $23X + 28Y$, where X and Y are positive or negative integers. Fliess fits this formula to phenomena ranging from the biological cell, to Schubert's musical composition dates, to the revolution of the moon and sunspot cycles. Fliess apparently did not realize that if any two particular integers that have no common divisor are substituted for 23 and 28 in his formula, it is possible to express any positive integer. Any event can be created as a multiple of 23 and 28 day cycles from a given starting point using this formula. For example;

$$1 = [23*(11*1)] + (28* - 9)$$
$$2 = [23*(11*2)] + [28*(-9*2)]$$
$$3 = [23*(11*3)] + [28*(-9*3)]$$
. . . etc.

Even if X and Y are limited to positive integers, it is still possible to express all positive integers greater than a certain integer[630] (N-593) with the formula. This means that any day in the life of a person more than 593 days old can be expressed by the combination of Fliess' 23 and 28 day cycles (i.e., every day would theoretically be a biorhythmic critical day). Neither Thommen or the other biorhythm proponents cite Fliess' earlier 1897 book, which is understandable, given its arcane ideas concerning the relationship between the nasal mucosa and sexual problems and their treatment by cocaine.

Thommen fails to mention the Fliess formulas as using integer multiples of 23 and 28 day cycles to correlate with biological events. The use of integer multiples of 23 and 28 days allowed Fliess to explain any biological event or cycle on the basis of his theory, including any biological events which would result from stochastic processes, thereby rendering the theory totally useless. Thommen also fails to mention that Fliess applied the biorhythm theory to animals, plants and even astronomical events. Is Gardner's[630] analysis of Fliess' work accurate? One of us has obtained a copy of Fliess' book Zur Periodenlehre.[553] In this book, Fliess definitely makes the following claims: biorhythm cycles are pure sinusoids, exact in period length to the last minute, and are present in horses and plants as well as in humans. He shows numerous examples of events in the lives of people (e.g., baby's first teeth to dates of Beethoven compositions) which are calculated as positive integer multiples of the 23 and 28 day cycles and, in addition, shows how biorhythm cycles are transmitted through a generation of families, using his formulas. In conclusion, the Fliess biorhythm theory is numerological nonsense. Fliess utilized totally uncontrolled, often irrelevant events in the lives of people and used this information, ex post facto, to support a theory of numerology* by means of mathematical methods which were totally invalid in that virtually any time interval could be expressed in terms of 23 and 28 day cycle multiples. Further, he constructed rationalizations which made refutation of his theory impossible. For example, Fliess was bothered by the fact that the human menstrual cycle was variable and did not exactly correspond to the 28 day biorhythm.[550] He explained this by asserting that the menstrual cycle was not a true biorhythm but represented an interaction between the 23 and 28 day biorhythms, which thereby resulted in its variable, non-28 day period. Since it is evident that this explanation could be applied to any psychological or physiological data which deviate from biorhythm theory, it then becomes impossible to test the validity of the biorhythm theory and, therefore, from a scientific point of view, it is useless.

D. Scientific Evidence for Biorhythm Theory

Scant scientific evidence exists in support of the biorhythm theory. Proponents of the theory cite a study[1511] showing a 23 day periodic recurrent fever. However, a study involving a single individual in a pathological state is hardly conclusive, particularly since the study shows the period varied

*According to the occult "science" of numerology, future events are predictable in terms of combinations of numbers with mystical significance. Odd numbers represent "male" elements and even numbers represent "female" elements. (Encycl. Amer. 20: 543, 1975) from 20 to 23 days, in violation of the biorhythmic period invariance criterion. In support of the 28 day cycle is a single study[175] showing a 28 day cycle in bioelectrical activity of the brain but this study has not been replicated. The discovery of the alleged 33 day cycle in intellectual function by Teltscher cannot be verified since his results were not published. Many biorhythm advocates[666,1139,1803,1900,1970] cite the work of Rexford Hersey[803,804] as evidence for a 33 day cycle. Hersey studied cycles in mood states in industrial workers over periods up to a year. However, close examination of these papers reveals that cycles ranged from 28 to 63 days in length. Calculation of the mean from Hersey's data yields a value of 35.7 ±10.6 std deviation. Thus the cycles are neither 33 days long nor constant, as required by the theory. The critical day hypothesis has not been confirmed in performance studies[514,1141,1156,2048]; it has no correlate in studies of circadian performance changes. The idea of biorhythm-cycle initiation at the time of birth is difficult to reconcile with the known latency of reproductive cycles until puberty, although Halberg[712] found some evidence for a 28 day body temperature rhythm prior to menarche. One of the foundations of the theory is the concept of period invariance. However, every paper in the literature involving a longitudinal study in which period estimates were performed through averaging or time series analysis reveals a great deal of variability in rhythm period lengths associated with the biorhythm cycle time domain (e.g., refs. 463, 465, 506, 526, 712, 723, 751, 1041, 1153, 1407, 1450, 1470, 1710, 1893, 2004). Although the menstrual cycle has been associated with the 28 day biorhythm,[666,1847,1900] it has been shown that the menstrual cycle actually varies from 24 to 30 days[1450] or 27 to 34 days[1470] and that its period length varies with age.[1893]

E. Biorhythm Theory and Singular Events

It is stated by biorhythm proponents that the primary proof of the theory lies in the significant relationship between the occurrence of singular events (accidents, deaths, etc.) and biorhythm cycle phase, particularly critical days. However, a number of papers have recently appeared which contradict the biorhythm-event relationship claims. The following section lists the studies presenting evidence which preponderantly supports or contradicts a significant relationship between biorhythm cycle phase and singular event occurrence.

Aircraft accidents:
- Support theory: 666, 800, 1599, 1803, 1847, 1904, 2010
- Contradict theory: 251, 942, 1050, 2048, 2050, 2051, 2052, 2053

Industrial accidents:
- Support theory: 51, 52, 100, 222, 656, 666, 1336, 1448, 1618, 1651, 1803, 1858, 2010
- Contradict theory: 443, 831, 1134, 1160, 1343, 1429, 1448

Vehicular accidents:
- Support theory: 149, 666, 696, 1063, 1738, 2012
- Contradict theory: 318, 921, 942, 1338, 1402

Suicides:
Support theory: 1803
Contradict theory: 443, 458, 1544

Death dates:
Support theory: 1651, 2012
Contradict theory: 157, 534, 845, 880, 942

From this survey, the cited evidence is approximately equal in support or against the biorhythm-event correspondence. However, serious questions have been raised about the quality of the citations in favor of the biorhythm effect in terms of small sample sizes, inadequate or missing information on critical day definition, and use of inaccurate critical day or accident calculated probabilities. Major attention here will be focused on aircraft accidents. Citations supporting the biorhythm critical day hypothesis with respect to aircraft accidents such as Weaver[1904] have been criticized as having inadequate sample size[2050] or inadequate critical day information[1050,2050] to evaluate the statistics. Also criticized were the studies of Williamson[2010] and Willis[2011] for calculating expected accident probability on the basis of a 24 hour day but using 72 or 48 hour critical day definitions, respectively, to determine accident frequencies.[443,1050] Recalculation of expected critical day probabilities (on the basis of the critical day definition) of studies reported by Willis,[2011] Kammerle,[1803] or Ault[149] showed that observed accidents did not significantly exceed expected frequencies as implied by the authors. In the largest studies conducted on aircraft accidents (9505 total), Wolcott et al.[2048,2050,2051,2052] found no significant relationship between biorhythm phase and accident frequencies, even though their data base included accidents used by Weaver,[1904] who claimed support for the biorhythm-accident relationship. It should also be noted that a substantial proportion of the evidence supporting the biorhythm-accident relationship comes from unpublished citations or from nonscientific publications. The Sacher[1599] study, while generally supporting biorhythm theory, actually found no significant relationship between accidents and biorhythm critical days.

All of the studies of the relationship between accidents and biorhythm phase, whether in support or contradiction of the theory, suffer from two major deficiencies. In theoretical terms, Gianotti[656] concluded that studies of the relationship between biorhythm cycles and accidents were inappropriate since they isolate the low performance phase of any biorhythm. From a methodological point of view, these studies have all examined singular events with respect to phases of 23, 28, or 33 day periods (with the sole exception of the Carvey and Nibler study,[318] in which they also examined other periodicities). As a result, these studies have utilized a biased sample of periodicities and have thereby excluded the possibility of other, nonbiorhythm periodicities, which may be significantly correlated with accidents or other singular events due to the effect of possible infradian alterations in performance levels. The biorhythm proponents cannot cite singular-event statistics in support of biorhythm theory unless they have demonstrated that the significant accident frequencies occur only with respect to the biorhythm cycles and not with other periodicities. Finally, in an elegant study, Chaffin and Skadburg[325] showed that above chance levels of accident frequencies on critical days could be obtained using visual inspection of biorhythm charts, but accident frequencies occurred at chance levels using numeric scoring methods. They demonstrated that a bias existed in hand scoring of critical day accident occurrences which was due to the psychological set of looking for hits. Thus any studies reporting above-chance accident frequencies on critical days which utilized biorhythm charts for scoring are of dubious value.

F. Biorhythm and Longitudinal Studies

This category includes, in general, studies where data were collected from subjects over a period of time, or studies in which the events were not singular (e.g., accidents or deaths) but were sampled at different time periods from a given population. It includes only studies specifically designed to test biorhythm theory (i.e., not infradian rhythm studies). A surge of recent interest in this area is evidenced by the presence of 15 Ph.D. theses since 1973. Studies are coded by P (positive-study generally supports biorhythm influence) or N (negative-study generally does not support biorhythm hypothesis). These studies were designed to test a statistical hypothesis that performance is or is not significantly correlated with biorhythm phases or critical days.

Emotional factors:
- Mood ratings: (292-P, 28 day), (293-P, 28 day), (634-P, 28 day), (1185-N), (1533-N), (1717-N)
- Emotional factors:
  - Student suspension dates: (304-N)
  - Academic motivation: (198-N)

Performance testing:
- Psychomotor: (356-P, 28, 33 day), (1303-P, 28, 33 day)
- Reaction time: (464-N), (1337-P, 23, 33 day), (1503-N), (1632-N), (2048-N), (2049-N)
- Body movement: (464-N)
- Manual dexterity: (1141-P, 23 day), (1503-N)
- Hand grip: (1303-P, 23 day), (1503-N), (1632-N)
- Aircraft landing: (514-N)
- Unspecified performance: (2068-N)

Intellectual factors (including exam scores, mental tests or information
- processing: (514-N), (656-P, 33 day), (1141-P, 33 day), (1185-N), (1337-P, 29 day), (1833-N), (157-N)

It is evident that a majority of these studies reject the hypothesis of a significant relationship between biorhythm cycle phase and performance. Examination of the studies supporting this relationship[292,294,319,356,656,1141,1156,1303] reveals that the biorhythm theory was not supported by all of the performance data in the given study (i.e., a relationship was found between performance and one of the cycles but not with all three of the cycles or with critical days). Methodological problems exist in many of these studies, including the studies supporting the biorhythm hypothesis and those rejecting it. The use of coded (performance above or below mean) data rather than actual performance values (e.g., refs. 1156, 1303, 1717) could bias statistical estimates since the data have essentially been reduced to binary, nonsinusoidal values. In many cases overly simple or inappropriate statistics (e.g., t-tests, in which variances are assumed to be equal and no estimate of correlation with biorhythm cycle phase is obtained) are commonly used.[292,294,319,1188,1503,1632] In some studies,[292,319] the described methodology does not rule out the possibility of the suggestive influence of any biorhythm knowledge as an influence on performance or performance evaluations. Other studies were limited by relatively small sample sizes (less than 10) or sample rates (1 or 2 samples/subject).[294,319,356,458,464,514,1337] Some investigators have biased their sample population (e.g., by selecting only high or low performance data, or testing only at high or low biorhythm cycle phases[634,942,1188,1503,1632,2049] which would tend to bias results in favor of biorhythm theory. In other studies, the investigator's conclusions are subject to question. For example, Garnett[634] concludes that certain mood patterns correlate with biorhythm cycles. However, in this study, no significant differences were found for behavioral ratings, or between groups of subjects given accurate or inaccurate biorhythm cycle information. Mosier[1303] used a significance criterion of 0.1 to demonstrate significant relationships between performance and 28 and 33 day biorhythm cycles, but most investigators would not accept the 0.1 level of statistical significance as a basis for the demonstration of a significant deviation from chance expectation.

Neil[1337] and Sink[1685] believe there is evidence from their data for a biorhythm contribution to performance. In this study, one of only two (refs. 1337 and 1755) studies to utilize time series analyses, periods approximating biorhythm cycles were found. The deviation of these periods from constant values demanded by biorhythm theory was explained as a masking effect due to the increased effort by the subjects. A simpler explanation, not requiring justification for results deviating from theory expectations, would have been that these periodicities reflected the presence of low-frequency biological oscillations. Stated controls for possible circadian influences were virtually absent in these studies. The circadian influences upon performance levels are well known.[177] If one assumes that timing of performance measurements is randomly distributed over the periods of data collection in these studies, then the circadian influence would likely induce noise (higher variability) into the biorhythm cycle phase-performance level correlations. However, if there were trends in the timing of these performance tests over the study period, then circadian effects could create low frequency artifacts in the data, possibly resulting in misleading significant correlations. These studies overall, except for those involving time series analysis, contain the same methodological weaknesses as the studies on biorhythm-singular event relationships. That is, the studies are biased by examining performance only with respect to the 23, 28, and 33 day periods, thereby failing to examine other possibly significant correlations of performance with nonbiorhythm periodicities. The Neil and Sink[1337,1685] studies clearly reveal the presence of many periodicities in performance (11, 11.5, 11.8, 14.8, 15, 16.25, 29, and 30 day periods) which would not all have been evident in the other studies.

In the studies of Wolcott et al.,[2052,2053] a certain number of significant correlations between biorhythm cycles and performance were expected, due to chance, from the large number calculated. Since a wide range of infradian periodicities was previously shown to be present in performance and physiological data, it is not unreasonable to expect that any longitudinal sample of performance data might contain nonbiorhythmic cycles which could yield significant correlations with the biorhythm cycles, if the infradian cycles were in phase with the presumed biorhythm cycles. By failing to analyze performance levels with respect to a wide range of infradian cycle lengths, most of the investigations in this area cannot exclude this possibility. The burden of proof rests upon those who claim evidence in support of biorhythm cycle influences upon events or performance. As Frazier[584] contends, the burden of proof rests upon those who claim the existence of an anomaly; extraordinary proof is necessary for extraordinary claims. In this regard, presentation of evidence in support of a theory based upon occult numerology (Fliess' version of the biorhythm theory) is indeed an extraordinary claim.

In conclusion, the biorhythm theory analysis of relationships with singular events and performance reveals serious methodological problems which greatly compromise the claims of biorhythm proponents. These inadequacies include lack of circadian controls and failure to examine relationships with periodicities other than the biorhythm cycle periods in nearly all studies. In addition, many of the studies in support of biorhythm theory suffer from inadequate sampling, inadequate or missing critical day information, incorrect calculation of observed with respect to expected accident frequencies, inappropriate statistics, biased sampling procedures, and failure to generally publish results in refereed scientific journals.

G. Neobiorhythm

In recent times, biorhythm theory has been further developed and modified (neobiorhythm) by biorhythm proponents which, in some cases, is an attempt to reconcile Fliess' original theory with conflicting scientific evidence.

Proponents of "neobiorhythm" have made numerous claims concerning the improvement of personal and occupational functioning with application of biorhythm scheduling and planning of various activities. These claims include most importantly, reduction of aviation and industrial accidents.[75,95,357,666,668,1803] However, the claims of the neobiorhythm proponents have recently come under extensive criticism. The most serious deficiency is the use of selective, ex post facto anecdotal accounts in support of biorhythm theory.[626,666,667,1699,1847,1900,1971] These selected accounts offer "proof" of the biorhythm theory by demonstrating coincidence between particular biorhythm phases or critical days and athletic performance, suicide, deaths, and accidents. These anecdotal reports have been denounced by critics[221,443,1627] as containing errors in the calculation of biorhythm cycles which then negate the stated biorhythm-event relationship. Aside from this, the use of selected anecdotal information as proof for a theory is not good science. It would have been much more convincing if the anecdotal reports had been selected randomly from a large population of events or if the theory had been tested against future events. Another criticism often leveled is the lack of documentation for much of the evidence and claims offered by biorhythm proponents. For example, it has been claimed, with respect to aviation, that in some airlines the copilot takes over from the pilot on the pilot's biorhythmically-adverse days,[1970] that Aeroflot makes up pilot schedules according to biorhythmic charts,[102] that United Airlines instituted a biorhythm safety program which helped reduce accidents,[666,2080] and that NASA used biorhythm theory to ensure optimum astronaut performance.[694] There is, however, no documented evidence supporting these claims. United Airlines, as well as many other companies[831] have denied the claims. Biorhythm proponents have also utilized excessive flexibility in the interpretation of the relationship between biorhythm theory and events, to the extent that the relationship between an event and virtually any combination of biorhythm cycles can be justified. For example, poor performance can be related to physical biorhythm low phase or critical days, or even high phase, if the other biorhythm cycles are low or critical (for examples see refs. 666 or 1847). This excessive flexibility in interpretation is abetted by the inbuilt vague definition of physical, emotional, and intellectual performance, according to the biorhythm theory. Although Hersey[804] studied mood states, which one would expect to correspond with the emotional or 28 day biorhythm, biorhythm proponents cited this study as evidence for the 33 day intellectual biorhythm. This was justified by claiming that the mood evaluation study involved an intellectual, not an emotional process.[666] There is virtually no performance task that does not involve a combination of physical, emotional, and intellectual processes and this reality allows biorhythm proponents to justify biorhythm-performance correlations with any of the three biorhythms. Other examples of invented rationalizations to cover deviations from biorhythm theory can be found in the articles by Demuth[443] and Baintridge.[157] Many authors appear to confuse the biorhythm theory with empirical biological rhythm research. They do so by referring to biorhythm cycles as biological rhythms[1156] or by discussing biorhythm theory and biological rhythm research interchangeably,[157,418,1148] as if biorhythm theory was a category of biological rhythm research, which it clearly is not (given the gross deviations of biorhythm theory from scientific evidence which were previously discussed).

The most important claim of biorhythm proponents is that aircraft[75,666] and industrial[95,357,666,668,1803] accidents can be reduced by 50% or more by application of biorhythm charting safety programs. This claim, if true, has very important implications for pilot performance and aviation accident reduction. However, all of the accounts connecting reduced accidents with biorhythm safety practices are published in popular books and articles and not in scientific publications where their methodology would be available for critical analysis. All of these studies also lack experimental controls for the possible effect of suggestive influences, resulting from biorhythm information and safety awareness, upon accident levels. The power of suggestion in its effect upon interpretation of biorhythm influences is quite remarkable. In two reported instances[157,1627] where individuals were given biorhythm theory and biorhythm phase information, in which the information was purposefully inaccurate or random, over 45% reported that the biorhythm charts accurately corresponded to their day-to-day lives. Students given inaccurate critical day information were significantly more likely to designate the false critical days as critical days in their lives than students given no critical day information. In the only study utilizing a control group given false biorhythm information, in a study of the relationship between biorhythm safety practice and accident reduction, accident reductions occurred in both groups, given either true or false critical day information. Therefore, the claims that biorhythm safety programs produce substantial accident reduction are invalid since this evidence shows that accident reduction can be attributed solely to the effects of increased safety awareness and suggestibility. Suggestive influences may have biased the outcome of certain studies supporting biorhythm theory.[319,328]

How does one explain the great popularity of biorhythm theory as evidenced by the extensive proliferation of charting services, sports prediction services, calculator watches, slide rules and computers, the alleged installment of biorhythm safety programs by a number of companies, and its advocacy for aviation safety and improvement of performance by professional personnel?[1336,1599,1803] The biorhythm theory must be considered in light of the evidence presented here that the theory itself is based upon occult numerology and invalid mathematics, that studies in support of the theory mostly reflect improper methodology, lack of documentation, unsubstantiated claims, calculation errors, faulty interpretation of results, and that the theory is contradicted by the entire literature on infradian biological rhythm research. A quotation from Frazier[584] with respect to the Bermuda triangle mystery is most appropriate. "It began because of careless research and was elaborated upon and perpetrated by writers who either purposefully or unknowningly made use of misconception, faulty reasoning, and sensationalism. It was repeated so many times that it began to take on the aura of truth." The numerological theory of Fliess, although heavily criticized, persisted in a cult of proponents in Germany, perhaps due to Fliess' association with Freud. In 1973 the theory was revived by Thommen,[1847] who seems to have grossly misinterpreted or misread Fliess' work, and presented the theory as being based upon empirical scientific analysis. Through carelessness or unavailable access to Fliess' original publications, the theory has been presented in an unending stream of unanalytical books and articles which invariably cite Thommen's version of the theory and accept it as truth. The power of suggestion has apparently influenced some investigations of the relationship between biorhythm cycles, performance and accidents to the extent that miscalculation, misinterpretation of results, and attempts to explain results of a modified biorhythm theory are common. The theory itself is very appealing in that it provides an order, rationale, and predictability for some of the events which occur in human life and provides means for scheduling human activities for the improvement of life and the reduction of untoward events. The failure of scientific investigators to get involved in serious studies of biorhythm theory on the basis that it is unworthy of study and the vested interest of biorhythm proponents in the lucrative biorhythm publishing, charting, and calculator markets[92,157] have undoubtedly contributed to the theory's perpetuation.

The perpetuation of belief in biorhythm theory has some detrimental consequences not the least of which is the time and effort required to investigate it. With respect to aviation and pilot performance, it has been recommended that pilots be given biorhythm safety meetings, be provided with charts and be subject to biorhythm work scheduling.[1336] It has also been suggested that sortie safety evaluation systems incorporate biorhythm[1599] and that autogenic training be used on adverse biorhythm days to overcome pilot performance decrement.[1803] There are dangers in these recommendations in that through the power of suggestion, pilots may be reluctant to fly on critical days. Suggestion may induce a psychological set in which pilots unconsciously adjust their performance capability or lower their performance expectations on biorhythmically adverse days. For this reason, the use of biorhythm charting by airline personnel should be discouraged.

H. Selected Bibliography on Biorhythm Theory

16	149	295	514	656	871	1063	1331	1504	1652	1783	1903
17	157	304	534	662	879	1072	1332	1510	1661	1784	1904
44	164	318	546	666	896	1074	1333	1544	1662	1785	1969
50	167	319	549	667	920	1117	1334	1553	1665	1800	1970
51	169	325	550	668	921	1134	1335	1598	1675	1801	1971
52	181	328	551	669	927	1139	1336	1599	1676	1802	2003
62	198	331	552	694	928	1141	1337	1612	1685	1803	2010
68	203	354	553	697	931	1146	1338	1613	1699	1826	2011
71	220	356	606	795	942	1147	1343	1614	1714	1827	2012
72	221	357	607	797	969	1148	1344	1618	1717	1833	2013
75	222	391	608	798	976	1155	1385	1627	1719	1837	2023
92	228	418	609	799	994	1156	1386	1631	1738	1846	2051
94	251	443	610	800	1015	1157	1388	1632	1742	1847	2052
95	263	444	611	803	1016	1160	1394	1638	1755	1848	2053
100	275	457	612	804	1042	1176	1429	1644	1763	1849	2055
102	292	458	630	831	1049	1185	1448	1650	1781	1900	2074
109	293	464	634	836	1050	1188	1500	1651	1782	1902	2080
113	294	472	636	845	1061	1303	1503				

I. Selected Bibliography on Infradian Rhythms

64	399	506	712	890	1041	1407	1470	1511	1710	2004	2059
175	463	511	723	947	1153	1450	1509	1533	1893	2065	2068
385	465	526	751	1040							

VIII. CONCLUSIONS

1. Circadian rhythmicity of performance efficiency has been well established with peaks occurring during the daylight hours and troughs during the early morning hours. The precise rhythm depends on the type of task being performed. The effect of sleep loss on performance is not well known and further work is warranted. There is a need for more integrative investigations in "realistic" operational environments which simultaneously study psychological parameters and performance as well as physiological functioning. Only with such studies can the understanding of the whole organism be complete enough to fully comprehend its limitations and capabilities. Due to the multiple environmental factors of the aviation environment it may be necessary to perform the aforementioned experiments in actual flight situations (flight studies) in order to accurately simulate conditions experienced by flight crews. Simulation studies should investigate effects of conflicting Zeitgeber shifts, i.e., social and light-dark cycle shifts. The physiological and/or psychological definition of fatigue is still vague. The development of an accurate measurement of "fatigue" (which usually connotes a performance

decrement) in the operational environment should be pursued. A method to measure those aspects of pilot (operator) performance necessary for optimal safety should also be developed for the operational environment.

2. Most studies of pilot performance investigate the effect of one potentially debilitating variable at a time, e.g., alcohol, hypoxia, dehydration, hypoglycemia, sleep loss, sleep reversal, noise, vibration, or drug use. Since there have been few attempts to study factors negatively affecting performance other than singly, it is not possible to determine whether the factors interact in a synergistic rather than an additive fashion. Nutrition and meal timing may play a significant role in pilot performance, particularly when considered in combination with other potentially debilitating factors, i.e., sleep-wake cycle alteration.

3. Internal desynchronization of physiological and psychological rhythms, one relative to another, can occur in humans following sleep-wake cycle alteration as may result when crossing time zones. This in itself has not been proven conclusively to cause performance decrement but may contribute or be incidental to this decrement. Further study in this area is needed.

4. There is a large body of recent literature dealing with the industrial shift-worker. Evaluation of the psychological and physiological responses exhibited by shift-workers (especially those on rotating shifts) can give tremendous insight into the body's response to sleep-wake cycle alteration as occurs in transmeridian air travel or rotating pilot duty schedules. The industrial situation, however, is not strictly applicable to flight crews. The flight crew experiences a multitude of other potentially debilitating environmental factors. In addition, the shift-worker may be exposed to conflicting Zeitgebers (in humans social interaction is an important Zeitgeber).

5. A large percentage of workers do not tolerate shift-work for either health, psychological, or social reasons. Much evidence supports the hypothesis that shift-work, especially rotating shift-work, can have negative health consequences. The conspicuous lack of long term epidemiologic studies on this subject preclude a definite answer. A serious complication to interpretation of studies on health consequences of shift-work is the possibility that many workers "drop out," thus leaving "survivors" who better tolerate shift-work. Flight crews that fly "rotating"-like schedules within the continental United States may show responses similar to rotating industrial workers. There is a need for long-term studies to evaluate health consequences of rotating scheduling and time zone travel in aircrews. Problems, however, may develop in finding an appropriate control with which to compare the flight group.

6. Though there have been many newspaper, journal, and popular articles elucidating and warning of the hazards of sleep-wake cycle and other rhythmic desynchronization, little effort has been made to initiate a formal training or educational program for flight crews.

7. Chronotherapy has received considerable attention in this decade. The possibility of developing techniques to modify rhythms or speed or delay their rephasal following disruption is encouraging. These include drugs (chronobiotics), manipulation of nutrition and/or meal timing or a variety of

other techniques, e.g., meditation, electrosleep, acupuncture, autogenic training and biofeedback. There is a need for a suitable, safe, short-acting hypnotic which can be prescribed to aircrews on transmeridian flight. Further research is warranted.

8. The need for animal research should not be overlooked. Flight studies or simulation studies with humans are excellent to show correlation and associations. Animal models are best, however, for the elucidation of mechanisms especially when novel drugs, destructive testing, or invasive techniques are dictated by the experimental design. In many cases, animal studies are preferable for long-term rhythm studies which require multiple sampling and isolation under strictly controlled conditions.

9. Quantitative techniques to evaluate rhythm alterations (e.g., rephasal times) currently exist in several laboratories. The ability to determine phase relationships between pairs of rhythms also exists. Therefore, it is possible to design integrative studies involving a number of variables and to quantitate their rhythmic relationships.

10. There is no scientific basis for the "biorhythm" theory. It appears to be based on invalid mathematical principles and has been supported by studies using questionable methodology. A danger of the theory is the possibility that it can influence a person's (a believer's) actions by the power of suggestion. The theory has been rejected by most serious scientists involved in research of biological rhythms.

IX. ANNOTATED BIBLIOGRAPHY

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Aanonsen, A. Shift work and health. Universitetsforlaget, Oslo, 1964.

2.
Acapovskaja, A. M., I. M. Rozet, and M. I. Sugako. Ergonomiceskie Predposylki Procktirovanija Proizvodstvennoj Sredy Dispecera, Rabotajuscego v Razlicnyh Rezimah (Ergonomic Layout of the workplace of load dispatchers on various work schedules). Techniceskaja Estetika 7: 20-22, 1978.

Literature survey of the complex tasks of these workers: study of the psychophysiological state of load dispatchers at various times of day and with various workloads (normal operation of distribution network during the day, interventions in the event of failure, night duty). During night shifts, there is a conflict between the natural biorhythm and the need for constant alertness. When remedial action was taken, there was a rapid rise in nervous and emotional stress. Measures are proposed to maintain work capacity and good health of the dispatchers (face and neck rubs with cool towels, coffee, stimulating music, improved lighting, microclimatic changes, gymnastic exercises, etc.).

3.
Ackermann, R. Probleme der Schicht- und Nachtarbeit in Industriebetrieben (Shiftwork and nightwork problems in industry). Sozialistische Arbeitswissenschaft, 15: 423-439, 1971.

Shiftwork problems are studied on the basis of studies in twenty-four plants covering a wide range of industrial activity; hours of work; length of shift periods; shift plans; work breaks; commuting; catering; plant service centres; productivity; fatigue; recovery during leisure time; morbidity and medical supervision. The attitudes of workers towards the disadvantages of shiftwork are analysed, and a number of measures are proposed and recommendations made.

4.
Adam, J. M. Nychthemeral rhythms in long-distance flights. Proc. R. Soc. Med. 65: 194, 1972.

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Adam, J., T. Brown, P. Colquhoun, P. Hamilton, J. Orsborn, I. Thomas, and D. Worsley. Nychthemeral rhythms and air trooping - some preliminary results from 'Exercise Medex.' In: Aspects of Human Efficiency: Diurnal Rhythm & Loss of Sleep, (Proc. of the Symp., Strasbourg, France, 1970.) edited by W. P. Colquhoun. London: English Universities Press, 1972, pp. 317-326.

Investigation of the effects of circadian rhythm disturbances on the fighting efficiency of military personnel crossing several time zones while flown to distant trouble spots. The general picture emerging from the preliminary results obtained suggests that phase adjustment of both physiological and performance rhythms occurs very rapidly following the time-zone transition from UK to Malaysia.

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Adams, A. H., H. F. Huddleston, B. M. Robson, and R. V. Wilson. Some effects of sleep loss on a simulated flying task. Farnbourough, England: Ministry of Defence, Royal Aircraft Establishment TR. No. 72168, 1972, 36 pp.

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Adams, B. N., and R. E. Cromwell. Morning and night people in the family: a preliminary statement. Family Coordinator 27: 5-13, 1978.

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Adler, N. T., and R. J. Pelchat. The effect of restricted food availability schedules on circadian rhythms. Soc. Neurosci. Abstr. 5: 213, 1979.

A series of experiments were performed to compare the entraining effects of food availability cycles to the known effects of light cycles on two rhythms - wheel-running activity and feeding as measured by an operant response which led to food delivery. Although some effects seem best explained by entrainment of an oscillator, others clearly do not fit the classic effects of entraining agents.

The results suggest that the food-availability cycles are not acting as classic Zeitgebers and that mechanisms other than entrainment of an oscillator are at work.

11.
Adler, A., and Y. Roll. Proposal for a standard shift pattern notation (abstract). In: International Symp. on Night- and Shift-Work, 5th, Rouen FR., 1980, p. I-1.

12.
Adum, O. Shiftwork of professional drivers. Int. J. Chronobiol. 3: 8, 1975.

The working hours of the majority of professional drivers begin at a different time each day. Consequently, the rhythm of working and rest periods, as well as that of taking meals is disturbed. The regular working hours of these workers are uninterrupted by the obligatory breaks which workers in other professions have. The overtime work of drivers on routes between towns and an international transport is a constant feature. Bus or coach drivers, who drive passengers on excursions or on holiday, often travel great distances and spend nearly fifteen hours a day at the wheel. During the annual holiday season, the drivers of buses and lorries on routes between towns, work over-time every day. It sometimes happens, that they are on duty for more than thirty days at a time.

Night work is a part of the working schedule of professional drivers. Many of them are on duty at least every third night. Like other workers, drivers find it difficult to work in the hours following midnight. A group of drivers was interviewed on their ability to stand night work.

One cannot speak of any regularity in the sequence of working shifts. Consequently, they are never able to entirely adapt themselves to their existing working hours.

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Agervold, M. Shiftwork - a critical review. Scand. J. Psychol. 17: 181-188, 1976.

Research concerning the social psychological, physiological, psychoneurotic, and psychosomatic consequences of shiftwork is reviwed with main emphasis on Scandinavian investigations. Most reports have found that shiftwork, especially working in three shifts, has a large number of negative social and sanitary consequences. The empirical studies and the theories that have been put forward to explain the results are shown to rest on a generally monocausal conception of the consequences of working conditions. The possibilities and implications of developing a more broadly conceived framework for interpretation and investigation of these issues are discussed.

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Agnew, H. W., Jr., and W. B. Webb. Measurement of sleep onset by EEG criteria. Am. J. EEG. Technol. 12: 127-134, 1972.

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Agnew, H. W., and W. B. Webb. The influence of time course variables on REM sleep. Bull. Psychon. Soc. 2: 131-133, 1973.

This paper studies the effect of age, length of prior wakefulness, length of sleep, and a circadian influence on REM sleep. Age is a major determinant of REM amount up to the early teens, but has little effect thereafter. Length of prior wakefulness has little or no effect on REM amount, with longer sleep times producing greater amounts of this type of sleep. There is a strong circadian effect on

REM, with early night sleep periods producing little REM and early morning periods a relatively great amount of REM.

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Ahlgren, A. Biorhythms. Int. J. Chronobiol. 2: 107-109, 1974.

This article is a critique of the paper of Wallerstein and Roberts (Human Behavior 2: 8-15, 1973) who advocated use of the Fliess' biorhythm method to predict sports performance, claiming the method is scientifically based. The author indicates that the "scientific basis" includes single patients, unreplicated studies, and wide ranges in period length which violate the period constancy axiom of the biorhythm theory. He claims that flexible arguments are introduced to connect biorhythm phases to performance events and that period invariance is very unlikely, given the influences of development, disease and travel.

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Ahlgren, A. Laboratory investigation of "biorhythm" (letter). Aviat. Space Environ. Med. 48: 678, 1977.

This letter criticizes the study of Neil and Sink (Aviat. Space Environ. Med., p. 4235, 1976) as failing to report time of day for performance testing, citing popular rather than scientific articles and failing to distinguish their long-term performance rhythms sufficiently from those predicted by biorhythm theory. Ahlgren insists that the serious study of biological rhythms should be distinguished from the "popular biorhythm fad" to avoid harm in the progress of aviation medicine. (for rebuttal see Neil 1977, Aviat. Space Environ. Med. 48: 678).

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Ainsworth, L. L., and H. P. Bishop. The effects of a 48-hour period of sustained field activity on tank crew performance. Alexandra, Va.: Human Resources Research Organization, Hum RRO-TR-71-16, 1971, 103 pp.

A 48-hour field experiment was conducted to determine the effects of sustained activity on the performance of tank crews in communication, driving, surveillance, gunnery, and maintenance activities. Only moving surveillance and some driving activities showed statistically significant performance deterioration over a 48-period of work without sleep, but these decrements were not considered to be of practical significance. The experiment showed that the diurnal rhythm of the subjects did not affect performance significantly. The research indicates that changes in unit organization or tactical doctrine are not necessary to accomplish continuous operations. The results of the experiment support the broad conclusion that tank crews using present equipment can maintain operational proficiency during 48 hours of sustained activity.

19
Ainsworth, L. L., and H. P. Bishop. Effects of forty-eight hours of sustained field activity on tank-crew performance. In: Proceedings of the Annual Convention of the American Psychological Association (part 2) 7: 625-626.

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Airapetyants, V. A. Comparative physiological evaluation of different work schedules of operators performing monotonous work. Gig. Tr. Prof. Zabol. 17: 47-50, 1973.

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Akerstedt, T. Interindividual differences in adjustment to shift work. Proc. Congr. Int. Ergonomics Assoc., 6th, Santa Monica, CA.: The Human Factors Society, 1976, pp. 510-514.

320 3-shift workers, 30 2-shift workers and 30 day workers filled out a questionnaire on work hours and well-being. For 3-shift workers highest ratings of well-being were reported for the afternoon shift, followed by morning, and night shifts. Two-shift workers gave ratings identical to those of the 3-shift workers on corresponding shifts. Multivariate analysis showed that neuroticism, mental demands on the job and, to some extent, also housing standards account for variance in well-being on the night shift. When sleep length was used as the dependent variable the most important predictors were age and experience of shift work. Finally, it was found that, above the age of 45, well-being on the night shift decreased with increased experience of shift work. In younger age groups no relations of this kind were found. (Age was held constant in all analyses.) It was suggested that the relations found may indicate the existence of a process of accumulation of costs of adjustment starting around the age of 45.

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Akerstedt, T. Shift-work and health - interdisciplinary aspects. In: Shift-work and Health, edited by P. G. Rentos and R. D. Shephard. Washington D.C.: U.S. Dept. of Health, Education, and Welfare, HEW Publ. No. 76-203, 1976, pp. 179-197.

23.
Akerstedt, T. Inversion of the sleep wakefulness pattern: effects on circadian variations in psychophysiological activation. Ergonomics 20: 459-474, 1977.

Thirty-six habitually dayworking railway repairmen were exposed to a 3 week period of nightwork. The subjects were studied with respect to circadian rhythms in catecholamine excretion, body temperature, subjective alertness and mood. For half the group the measurements covered one 24 h period before nightwork, the first week of night work, the third week of night work, and the first week after return to day work. For the other half measurements were made during the first and third day week after the night work. During day work weeks, all variables exhibited pronounced circadian variation, peaking in the early afternoon, with the exception of body temperature which reached its maximum in the evening. During the first week of night work the day-oriented pattern of adrenaline excretion persisted but the mean 24 h level was increased and day sleep levels were very high By the third week of night work the circadian pattern had flattened out at a very low mean level. For noradrenaline excretion considerable adjustment (comparable to and inversion) to night work was seen with high night values. For body temperature, selfrated alertness and mood circadian functions flattened out during night work. It was concluded that all variables were strongly affected by the exposure to night work and that adrenaline excretion indicated a stress response of the organism. With reference to other studies it was also concluded that adrenaline excretion is not easily phase-shifted through a three week spell on night work, while noradrenaline in contrast appears to adjust very rapidly.

24.
Akerstedt, T. Sleep deprivation and memory during pre- and postdeprivation sleep. Electroenceph. Clin. Neurophysiol. 43: 1977.

12 Ss were exposed to 64 hours of sleep deprivation. During pre- and postdeprivation sleep they were tested on a simple memory task. The subjects were awakened three times during slow wave sleep. The 1st time 4 playing cards were presented and the perception of the cards was acknowledged by the subject by reading out aloud the color and value of the cards. Approximately one hour later the subject was again awakened and tested for his retention of the previous awakening. Thereafter a new set of cards was presented. This procedure was repeated three times each night and upon awakening the subsequent morning. Results showed that memory performance on post-deprivation night being highly significant. Also, the behavior of the return to sleep was very rapid. Memory performance improved over awakenings during post-deprivation night. Thus, in spite of the control for sleep stage the sleep deprivation appears to have caused a behaviorally 'deeper' sleep. The speed of return to sleep during post-deprivation night suggests that one explanation of the deterioration of memory performance may be that the subjects did not remain awake sufficiently long to allow the laying down of memory traces. Noradrenaline excretion and self-rated stress did not exhibit any circadian or other variation over time. Adrenaline excretion, oral temperature, and fatigue ratings exhibited a significant covariation over time. The data were compared with those of a group of male subjects studied under similar conditions. Males and females exhibited almost identical circadian patterns, the only difference being that the males were characterized by increasing trends in ratings of fatigue and stress which were not found among the females.

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Akerstedt, T. Altered Sleep/Wake Patterns and Circadian Rhythms. Acta Physiol. Scand., Suppl. 469: 1-48, 1979.

Six studies on sleep/wake patterns and circadian rhythms were carried out. In summary: (1) Adrenaline excretion, self-rated activation, and body temperature rhythms persisted during sleep deprivation, resisted adjustment to rotating shift work, but adjusted rather well to permanent night work. Noradrenaline adjusted to most schedules and lost its rhythm during sleep deprivation. When night sleep was reintroduced the noradrenaline rhythm reappeared while the existing adrenaline rhythm was accentuated. (2) Exposure to a performance stressor at the rough raised adrenaline to daytime levels. An equally large response was seen at the peak. (3) Interindividual day-to-day consistency of 3 and 24 hour levels was high for both catecholamines. Intraindividual consistency of the 24-hour pattern was high for adrenaline but low for noradrenaline. Cosine estimates of adrenaline phase showed a considerable intraindividual consistency while interindividual consistency was poor. Noradrenaline had poor cosine fit. (4) Sleep deprivation did not change catecholamine excretion either during the vigil or during recovery sleep. (5) It was concluded that adrenaline excretion, rated alertness, and body temperature exhibited self-sustained circadian rhythms which made adjustment to new sleep/wake patterns very difficult, and that the noradrenaline excretion rhythm depended on exogenous factors.

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Akerstedt, T., and J. E. Froberg. Work hours and 24 hr temporal patterns in sympathetic-adrenal medullary activity and self-rated activation. Int. J. Chronobiol. 3: 6, 1975.

This paper reviews four recent investigations concerning the circadian patterns of urinary catecholamine excretion and self-rated alertness under conditions of day work, continous 24 hour work, experimental night work and three shift work. Each study was carried out on different groups with 74, 29, 17 and 42 subjects respectively. The results showed that adrenaline excretion and self-rated arousal exhibited circadian rhythms with maxima in the early to late afternoon. These rhythms strongly persisted even during continuous around-the-clock activity. Also during shift work we found the original, circadian rhythm persistent. However, the experienced shift-workers showed tendencies of adaptation in that night values rose significantly during the night shift. These values did not rise to the values expected for "perfect" adaptation. The implications were discussed.

27.
Akerstedt, T., and J. E. Froberg. Interindividual differences in circadian patterns of catecholamine excretion body temperature performance and subjective arousal. Biol. Psychol. 4: 277-292, 1976.

Interindividual differences in circadian rhythms of urinary catecholamine excretion, performance, self-ratings of arousal and oral temperature were studied in 80 subjects divided into three groups -

morning-active, evening-active, and intermediate. Catecholamine excretion, body temperature, and self-ratings of arousal exhibited pronounced circadian variations. Morning-active subjects exceeded other groups in the 24 h level of adrenaline excretion but crest phases did not differ, occurring close to 13.00 h. No differences between groups were found for noradrenaline excretion. Crest phases occurred close to noon. Self-rated alertness exhibited a significantly earlier (14.12 h) crest phase for morning-active than for evening-active subjects (16.09 h). The performance did not differ between groups.

28
Akerstedt, T., and J. E. Froberg. Psychophysiological circadian rhythms in women during 72 h of sleep deprivation. Waking and Sleeping 1: 387-394, 1977.

15 female subjects were kept continuously active for 15 h under well-controlled conditions isolated from the environment. Physiological and psychological variables were sampled every three hours. Variation over time was investigated with analysis of variance and fitting of cosine curves. Adrenaline excretion, body temperature and selfrated alertness exhibited a very pronounced circadian rhythm peaking between 1200 h and 1600 h for the two former and somewhat later for the latter. Also shooting accuracy exhibited a circadian rhythm with afternoon-evening peak.

29.
Akerstedt, T., and J. E. Froberg. Persistence of circadian rhythms in phenomenological and physiological arousal under conditions of continuous activity without sleep. Ergonomics 21: 866, 1978.

Persistence in circadian arousal rhythms is presumed to be one of the main causes of the disturbed alertness and sleep often associated with shift work. Thus it was considered important to identify the properties of such arousal variables. As the alternation between sleep and wakefulness may interfere with the identification of persistent rhythms, a condition of sleep deprivation was suggested as a suitable experimental setting for this purpose.

A series of studies showed that under conditions of constant activity and controlled intake of food and drink, as well as isolation from other synchronisers, pronounced circadian variations in body temperature, self-rated arousal, and the excretion of both adrenaline and melatonin persisted over a 75 h period; whereas the circadian variation of nonadrenaline excretion disappeared. It was also shown that the application of a performance stressor during the rough of the adrenaline rhythm completely obliterated this rough, while sleep at the corresponding time enhanced it. Finally, a close temporal co-variation was observed between the urinary excretion of melatonin on the one hand, and self-rated fatigue and (inverted) rectal temperature on the other. It was concluded that, in addition to body temperature, self-rated arousal and urinary excretion of adrenaline should also be measured in research on shift work, and that

observation of the rhythm of melatonin should be of value in such studies.

30.
Akerstedt, T., and J. E. Froberg. Sleep and stressor exposure in relation to circadian rhythms in catecholamine excretion. Biol. Psychol. 8: 69-80, 1979.

Twelve healthy male volunteers spent 64 h of continuous waking under strictly controlled environmental conditions (light, food, drink, activity) in isolation from the external world. Before and after the vigil the subjects slept in the laboratory. An additional group of five participated only during day time and spent the intervening night period asleep at home. Measurements were carried out in 3 h intervals except for sleep periods. Shortly before the circadian trough and peak of adrenaline excretion respectively, the subjects were exposed to a performance stressor. Results from the vigil showed a very pronounced circadian rhythm for adrenaline excretion but none for noradrenaline excretion. For an even more pronounced circadian pattern. For noradrenaline, night-time sleep caused a drop in excretion giving the impression of a circadian rhythm. These and previous results led to the conclusion that the excretion of adrenaline exhibits a self-sustained rhythm while a rhythm in noradrenaline excretion is found only when caused by external synchronizers such as sleep-wake alternation. No difference in magnitude of stress response between peak and trough was observed for any of the catecholamines. Night-time (trough) exposure completely obliterated the circadian rhythm of adrenaline excretion for the duration of the exposure. It was concluded that the normal pronounced night-time trough of adrenaline cannot be due to unavailability of adrenaline in the medulla. With respect to sleep deprivation, no effect was found on excretion levels during waking, during sleep, or in response to the stressor as deprivation progressed. Finally, there was also found to be a close temporal covariation between adrenaline excretion and both rectal temperature and self-rated fatigue (neg.).

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Akerstedt, T., J. E. Froberg, Y. Friberg, and L. Wetterberg. Melatonin excretion body temperature and subjective arousal during 64 hours of sleep deprivation. Psychoneuroendocrinology 4: 219-226, 1980.

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Akerstedt, T., and M. Gillberg. Sleep disturbances and shift-work (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, Fr., 1980, p. III-1.

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Akerstedt, T., P. Patkai, and K. Dahlgren. Field studies of shiftwork: II. temporal patterns in psychophysiological activation in workers alternating between night and day work. Ergonomics 20: 621-631, 1977.

34.
Akerstedt, T., and T. Theorell. Exposure to night work: serum gastrin reactions, psychosomatic complaints and personality variables. J. Psychosom. Res. 20: 479-484, 1976.

Seventeen day working railway repair men were subjected to a three week period of night work. Before, during, and after the night work period blood samples were obtained which were analysed with respect to content of gastrin. For corresponding weeks were obtained self-ratings of psychosomatic complaints concerning sleep, mood, gastric functioning and other problems. The subjects also filled out the Eysenck Personality Inventory scales of neuroticism and extraversion. Gastrin levels decreased during the night work period but returned afterwards although the variance of the latter was greatly increased. Psychosomatic complaints increased during night weeks. Correlation analysis showed that decreases in gastrin levels from before to after the night period was associated with increases in psychosomatic complaints. Also, the decrease in gastrin levels was found mainly among subjects with a higher degree of neuroticism before entering night work.

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Akerstedt, T., and L. Torsvall. Experimental changes in shift schedules - their effects on well-being. Ergonomics 21: 849-856, 1978.

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Albanese, R. A., R. C. McNee, E. J. Engelken, P. H. Henry, and B. O. Hartman. The human as an adaptive controller. In: Higher Mental Functioning in Operational Environments, edited by B. O. Hartman. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-181, 1976, pp. C6-1 - C6-8.

During flight, aircrew members often function as subsystems in feedback control loops. In particular, visual tracking tasks have been studied for many years. For these tasks, it has been observed that the human alters his control actions when the device to be controlled, or when the bandwidth of the signal to be cracked, is changed. Thus, the human operator appears to be an adaptive controller. This article reviews the adaptive nature of man's control function using previously published data, and introduces information theory metrics which show a regularity in these data. Also, new data obtained from twelve subjects flying the Link-Singer GAT-1 simulator while under the influence of orally administered 190 proof ethyl alcohol (0.0, 0.3, 0.6, and 0.9 gns/kg body weight) are presented. These results are related to previous studies, using both control and information theory metrics.

37.
Aljakrinskii, B. S. The problem of latent desynchronosis. Kosm. Biol. Med. 6(1):32-37, 1972.

This paper deals with the problem of adaptation of the human body to physical and social time sensors. The body responses to the effect of physical time sensors is the so-called adequate circadian rhythm. Under conditions of social life the circadian rhythms in the human body are regulated by constant time sensors. In acute disturbances of the customary system of time sensors the body is in a state of marked desynchronosis, the elimination of which does not mean a restoration of body well-being. The varied inertia of body vital functions makes it difficult to detect a state of internal desynchronosis by routine techniques, although a thorough investigation of this is of great practical importance for cosmonautics.

38.
Aliakrinskii, B. S. The central problem of space biorhythmology. Int. Cong. Aviat. Space Med., preprint, 1973, p. 79.

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Aliakrinskii, B. S. Osnovy nauchnoy organizatsii truda i otdykha kosmonavtov (Basis of the scientific organization of the work and rest of cosmonauts). Moscow: Meditsina, 1975.

40.
Aliakrinskii, B. S. The current status of space biorhythmology. Kosm. Biol. Aviakosm. Med. 11: 3-12, 1977.

A review is presented of work in general biorhythmology which paved the way for the study of biorhythms in space. Landmark observations in biorhythmology during the course of Soviet and American manned and unmanned space missions are summarized. The role of desynchronosis in the process of adaptation to the space environment is emphasized. Measures that can be taken to minimize or prevent desynchronosis are outlined. These include a rigorous selection procedure to identify individuals with high resistance to the negative effects of sleep loss, a program of pre-flight adaptation to the in-flight routine, and adaptation of relaxation techniques to be practiced in flight. Adoption of a 'space time' by the crew so that the hour is consistent with the flight routine, and adherence to this time scheme in all communications with the crew are suggested.

41.
Aliakrinskii, B. S. Time base of a cosmonaut's working operational. Probl. Kosm. Biol. 34: 120-30, 1977.

42.
Aliakrinskii, B. S. Scheduling work and rest periods during long-term space flights. Kosm. Biol. Aviakosm. Med. 14(1): 3-8, 1980.

Proper arrangement of work-rest cycles of crewmembers in long-duration space flight is practically important task of space

ergonomics, a field of science studying man's work capacity and methods of its increase. The basic principle of space ergonomics assuring high efficiency of space crewmembers is to cover every aspect of their activities. Of particular importance is the use of laws of biorhythmology, in order to select candidates lease susceptible to desynchronosis and closely resembling each other in their biorhythmological status. At the present time, work-rest cycles in a prolonged space flight should be arranged on a 24-hour basis with a normal day-night alternation, including 8 hour night sleep and 2-hour day rest. Optimization of cosmonauts' activities in space demands that they strictly adhere to the recommended work-rest cycle; this can be achieved through their highly motivated desire only.

43
Aliakrinskii, B. S., and S. I. Stepanova. Organizatsiia truda i otdykha chlenov ekipazhei korablei 'Soyuz' (The organization of work and rest for Soyuz crew members). In: Space Flights on Soyuz Spacecraft: Biomedical Studies. Moscow: Izdatel'stvo Nauk, 1976, pp. 161-183.

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Alibrandi, T. Biorhythm. Major Books, 160 pp., 1976.

45
Alluisi, E. A. Influence of work-rest scheduling and sleep loss on sustained performance. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep (Proceedings of a Symposium, Strasbourg, France, 1970), edited by W. P. Colquhoun. London: English Universities Press, 1972, pp. 199-214.

Study of sustained performance using a synthetic-work approach to provide measurements of multiple-task performances obtained in the work- behavior domain. The job or work situation is created by a subthesis of several time-shared tasks that represent functions which man is called upon to perform in typical jobs. A multiple-task performance (MTP) battery, the MTP work schedule, and the results of prior MTP research are briefly described, and the current MTP research program is outlined. Some of the benefits obtained, in terms of inferences made possible by comparisons of the results of different studies, are presented.

46
Alluisi, E. A. Problems in the measurement of human performance. Presented at NATO symposium, Drugs, Sleep, & Performance. Scotland: Aviemore, 1972.

47
Alluisi, E. A., G. D. Coates, and B. B. Morgan, Jr. Effects of temporal stressors on vigilance and information processing. In: Vigilance, edited by R. R. Mackie. N. Y.: Plenum Press, 1977, pp. 361-421.

The data of two control and ten experimental studies of the effects of continuous work and sleep loss on sustained multiple-task performance, representing more than 9 man-years of synthetic work by

89 different subjects, were reanalyzed to permit comparisons of the performances of three watchkeeping tasks and two active tasks that are time-shared in a multiple-task performance battery (MTPB). Specific comparisons were made of the two control groups, of the effects of 48 hours of continuous work and sleep loss with and without the employment of pulse rate and EEG-theta biofeedback and autoregulation, of the effects of the duration of continuous work and sleep loss (36, 44, or 48 hours), of the effects of the duration of rest and recovery following 36 hours of continuous work (12, 6, 4, 3, and 2 hours), and of circadian rhythm and 36-hour continuous work interactions. Eight specific conclusions are reached, the most general of which is that the relevance of typical laboratory research with single-task watchkeeping tests, including the capability of its findings being generalized to, and implemented in, practical situations involving monitoring performances within operational man-machine systems is seriously questioned, if not compromised, by the findings.

48.
Andersen, E. J. The main results of the Danish medico-psychosocial investigation of shiftworkers. In: Proceedings of the XII International Congress on Occupational Health, Helsinki, 1957, Helsinki, 1958, Vol. 3, pp. 135-136.

49.
Andersen, J. E. Treskiftsarbejde-en social medicinsk undersogelse (Three-shift work - a sociomedical study). Copenhagen: Socialforskningsinstitute, 1970.

50.
Anderson, R. K. Biorhythm - man's timing mechanism. Paper presented at the 35th Annual Eastern Regional Safety Convention, Greater New York Safety Council, 1965.

51.
Anderson, R. K. "Biorhythm" - man's timing mechanism. Park Ridge, Ill.: American Society of Safety Engineers, 1972.

Almost 70% of 300 industrial accidents occurred on biorhythm critical days.

52.
Anderson, R. K. Biorhythm - man's timing mechanism. American Society of Safety Engineers Journal 18: 17-21, 1973.

An analysis of 1000 industrial accidents showed 90% occurring on biorhythm critical days.

53.
Andlauer, P. Differentes modalites du travail en equipes alternantes. Arch. Mal. Prof. Med. 32: 393-395, 1973.

54.
Andlauer, P., J. Carpentier, and P. Cazamian. Ergonomie du Travail de Nuit et des Horaires Alternants (Ergonomics of Night Work and Rotating Work Schedules). Collection Education Permanente, Paris: Editions Cujas, 1977.

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Andlauer, P., and Metz, B. Le travail en equipes alternantes. In: Physiologie du travail - Ergonomie, edited by J. Scherrer,(tome II). Paris: Masson, 1967, pp. 272-281.

56.
Andlauer, P., A. Reinberg, L. Fourre, W. Battle, and G. Duverneuil. Amplitude of the oral temperature circadian rhythm and the tolerance to shift-work. J. Physiol. Paris 75: 507-512, 1979.

57.
Andlauer, P., A. Reinberg, L. Fourre, W. Battel, and G. Duverneuil. Relationship between the oral temperature circadian amplitude and the clinical tolerance to shift-work. Chronobiologia 6: 74, 1979.

58.
Andrews, R. V. Experimental Models of Behavioral-physiological Interactions in Social Chronobiology. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J. E. Pauly. Tokyo: Igaku Shoin, Ltd., 1974, pp. 576-81.

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Andrezheyuk, N. I., A. A. Veselova, N. N. Gurovskiy, B. A. Dushkov, L. R. Iseyev, F. P. Kosmolinskiy, M. I. Kozar, Y. M. Krotuva, and G. A. Manovtsev. Effects of different work and rest routines on subjects kept in relative isolation. Aviakosmicheskaya Meditsina (Aerospace Medicine), edited by V. V. Parin, and I. M. Khazen. Moscow: Noi, 1967, pp. 52-63.

60.
Angiboust, R., and M. Gouars. Tentative d'evaluation de l'efficacite operationelle du personnel de l'aeronautique militaire au cours de veilles nocturnes. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep (Proc. of a symposium, Strasbourg, FR., 1970.), edited by W. P. Colquhoun.London: English Univ. Press, 1972, pp. 151-170.

61.
Angus, R. G., D. G. Pearce, A. G. C. Buguet, and L. Olsen. Vigilance performance of men sleeping under Arctic conditions. Aviat. Space Environ. Med. 50: 692-696, 1979.

62.
Anonymous. Biorhythm theory claims ability to spot accident-prone periods. Aviation Week 74: 101-102, 1961.

Research to test the ability of the biorhythm theory to spot accident-prone periods is commencing at the Cornell Univ. Aviation Center and the FAA Bureau of Aviation Medicine. Scientists indicate that the method has produced numerous proponents but little scientific data.

63.
Anonymous. Aeromedical aspects of troop transport and combat readiness. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-40, 1968.

64.
Anonymous. What happens when you suppress immunity? J. Amer. Med. Assoc. 206: 1436-1437, 1968.

This article refers to a study by J. Alexander at the Univ. of Cincinnatti College of Medicine, who found cycles in neutrophil function of 15-21 days in men, and 24-32 days in women. If this is a valid study, it provides evidence against the biorhythm theory by showing a sexual difference in period length of a parameter measured in both sexes.

65.
Anonymous. Psychological aspects. Berkeley, CA.: Univ. of California, 1969, pp. 114-157.

66.
Anonymous. Fatigue in the context of flight safety. Flight International 100: 362-365, 1971.

67.
Anonymous. Pan Am cares--tips on time. Pan American World Airways, Inc., 1971, 26 pp.

68.
Anonymous. Are there strange forces in our lives? Family Safety, summer 1972, pp. 15, 16, 23.

69.
Anonymous. Circadian rhythm in man (editorial). The West Virginia Medical Journal 68: 351, 1972.

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Anonymous. Information Services For Comparative Analysis of Biorhythm Research. Final Report. NASA Ames Research Center, NAS2-6216, 1972, 206 pp.

71.
Anonymous. Science sheds new light on accident proneness. Occupational Hazards, September, 1973.

72.
Anonymous. Biorhythm blues. The National Observer, Dec. 7, 1974.

73. Anonymous. Medical Handbook for Pilots. Washington, D. C.: FAA, 1974, pp. 53-55.

74.
Anonymous. Rapid eye movement (REM) sleep deprivation, stress and intermediary metabolism. Neurochem. 22: 1157-1159, 1974.

75.
Anonymous. Biorhythms in the sky. Science Digest, pp. 16-17, 1975.

76.
Anonymous. Biorhythm theory laid to rest. The Cockpit, pp. 16-17, July 1977.

This review mainly cites the work of Wolcott, et. al., which negated a role for the biorhythm theory in accident frequencies.

77.
Anonymous. Relative a la Surveillance Medicale des Travailleurs Postes (Concerning the medical supervision of shift workers). Bulletin Officiel du Ministere du Travail, No. 5142, 1977, 6 pp.

An introduction on individual reactions to shift work is followed by instructions concerning plant physicians' duties in this connection: screening for early identification of effects of shift work in humans; determination of any lowering of shift work tolerance threshold following sickness; interviewing workers. Before assignment to shift work the employee should undergo a thorough screening covering a wide range of aspects such as: psychic instability, if any, organic or functional medical history; family and housing conditions, etc. and a clinical examination.

78.
Anonymous. Mosukuwa sen siumin jikan shosa hokoku (Survey report of the sleep time on the Moscow route). Aviation Human Engineering Research Team. Aviation and Space Laboratory, Tokyo, 1976. 22 pp. (Eng. transl. NASA TT-F-17, 530, 1977.)

79.
Anonymous. XIVe Journees Nationales de Medicine du Travail-Lyon, 1976. Table Ronde sur la Vigilance, Arch. Mal. Prof. Med. 38: 133-156, 1977. (14th National Symposium on Occupational Medicine, - Round Table Meeting on Vigilance.)

The various communications deal with: contribution of experimental psychology through laboratory and workplace studies; effect of work schedules and the type of work on vigilance tests; mental fatigue in industry in relation to shift work; self-rating and self-measuring techniques to determine the effects of changes in the work-rest schedule on different circadian rhythms; applied research on the organisation of shift work; psychophysiological function testing methods for study of mental fatigue in industry; possible causes of loss of vigilance; vigilance and safety in the building industry; protective effects of amineptine on vigilance disorders caused by certain therapies; objective assessment of mental load.

80.
Anonymous. Working shifts [Editorial]. Lancet 1: 523, 1977.

81.
Anonymous. As time goes by. Chemistry 51: 22-23, 1978.

Managers at Kennedy Airport at New York have observed a 50% decrease in accidents since implementation of a biorhythm program. The airport supervisor M. Bertalot says that its main value is in safety awareness.

82.
Anonymous. Chronotherapeutics, a new clinical science [Editorial]. Br. Med. J. 1(6124): 1376, 1978.

83.
Anonymous. Circadian dysrhythmias. The Lancet 1: 195, 1978.

84.
Anonymous. Does shift-work make sick? MMW, Muench. Med. Wochenschr. 120: 915-6, 1978.

85.
Anonymous. Flight crew-member flight and duty time limitation and rest requirements. Federal Register 43 (39): 27 Feb., 1978.

86.
Anonymous. Occupational Stress. Proc. of the Conference on Occupational Stress, Los Angeles, 3 November 1977. DHEW (NIOSH) Publication No. 78-156, 1978, 78 pp.

This volume contains the proceedings of a conference on occupational stress, a subject of increasing concern. The psychological causes and problems of occupational stress are examined; situations leading to feelings of insecurity and inadequacy along with role incongruity are seen as stress producers. Recent NIOSH psychological stress research is reviewed. These studies include stress-related disease and mental health incidence rates by occupation, mass psychogenic contagion reaction in industry and the relationship of machine pacing and stress. A study of the health consequences of shiftwork found no evidence that shiftworkers suffered from severe health problems, however, shift work might be related to decreased psychological well-being. The personality profile of individuals prone to develop heart disease is discussed. Physicians must learn to recognize this 'Type A' behaviour pattern. Ongoing stress management programs - one in an aerospace company, one in a hospital are described. Biofeedback, as one successful approach to stress reduction, is described and discussed. The preceding presentations are reviewed and implications for further study and action are set forth. Stressors specific to the individual work situation should be identified; the interaction between job-stressors and other life-stressors must be considered, particularly for working women. Physicians must be sensitized to signs of stress; and managers must be made aware of their impact on the feelings of employees.

87.
Anonymous. Proceedings of the symposium on Man-system interface: advances in workload study. Washington, D. C.: Air Line Pilots Association. 1978, 149 pp.

88.
Anonymous. Rotating shift work causes many problems. Occupational Health and Safety 47: 21, 1978.

89.
Anonymous. Salyut-6 -- Soyuz-29 Flight Report. Circadian rhythms and work-rest periods. Meditsinskaya Gazeta, June 1978, p. 3.

The experimental regime of "migrating" hours, when every day the circadian rhythm was shifted by 1/2 hour, as was tried aboard Salyut-on Kolmuk and Sevast'yanov, proved to be an obstacle in the normal performance of the two cosmonauts; Sevast'yanov says this regimen was a real scourge during their mission. The regimen was also tried experimentally for 30 and 50 days on earth, aboard a Salyut mockup, but without success. Desynchronization of the circadian rhythm was an inherent component of stress states observed in test subjects. Grechko, who had been subjected to adverse effects of desynchronization and "migrating" hours during his flight aboard Salyut-4 in 1975, praised the advantages of the normal circadian rhythm regimen introduced on Salyut-6.

90.
Anonymous. Shiftworking. London: Department of Employment, Work Research Unit, Bibliography No. 8, 1978, 4 pp.

91.
Anonymous. Sinking spells. U. S. Army Aviat. Dig., pp. 12-13, Feb., 1978.

Cockpit slumber parties are one of the more dramatic effects of severe fatigue. Several things can contribute to those awful sinking spells. But some of these factors can be controlled. Lack of sleep is the most obvious cause of pilot fatigue but sleep is a complex subject that scientists are only beginning to understand. Considerable research has established a clear need for both types of sleep, deep sleep and REM sleep. Another factor to consider is hypoglycemia or low blood sugar, which can cause malaise, fatigue, disorientation, and even lapse of consciousness. Dietary practices will prevent reactive hypoglycemia. Caffeine toxicity which can cause poor sleeping, nervousness, headaches, and lethargy should also be considered.

92.
Anonymous. Those biorhythms and blues. Time, pp. 50-51, Feb. 27, 1978.

This article describes the popular surge of interest in the biorhythm theory, including calculator watches, computers, calculators and charting services for predicting the results of professional football games, and its use by various companies and celebrities. Biorhythm also provides income for a swelling number of entrepreneurs.

93.
Anonymous. An empirical longitudinal study of airline pilot subjective values of sleepiness and fatigue. The Aviation Safety Institute, Report 79-4, 1979, 51 pp.

An empirical study was conducted to measure the utility of a subjective rating system for determining changes in aircraft pilot fatigue over a 92 day period of on and off-duty activity. Thirty-two experienced airline pilots served as Ss. Each S was asked to report up to 32 different items each day for three months. Each S was asked to report on a scale from one to ten his estimate of his level of fatigue and level of sleepiness at the beginning and end of each day.

The results revealed that a subjective rating system can be employed on a moderately large S size for an extended period of time. And, one can expect that these Ss will attempt to be as precise and consistent as possible while making distinctions between feelings of sleepiness and of fatigue.

The study showed that differential strategies were employed by the two study groups, i.e., the international and domestic flight schedule pilots. The international Ss attempted to obtain as much pre-duty day rest as posible in order to withstand the deteriorating effects of long duty periods, multiple time zone crossings, and other more subtle contributory factors.

94.
Anonymous. Biorhythm 'n' blues. Saturday Review 6:6, 1979.

This article cites T. Hines of Cornell Medical College who claims that the bulk of biorhythm studies find no correlation between critical biorhythmic days and ill fortune, intellectual, physical or emotional performance.

95.
Anonymous. Biorhythm wristwatches. Penninsula Times Tribune, Nov. 1, 1979.

This article reports that Romanian taxi drivers wear "biorhythm" wristwatches which provide information on physical, emotional and intellectual cycles for any given state. The use of these watches reportedly reduced taxi traffic accidents 83% and almost halved taxi accident injuries. A report indicates that if this trend continues, taxi-related injuries will be reduced from 3600 to 244.

96.
Anonymous. Diagnostic classification of sleep and arousal disorders. C. Disorders of the sleep-wake schedule. Sleep 2: 87-98, 1979.

97.
Anonymous. Do's and dont's for coping with jet lag. Glamour 77: 50, 1979.

98.
Anonymous. No pathological changes reported in animals during biosat mission. Joint Publications Research Service, Space, 1979. No. 1, 21.

99.
Anonymous. Plan for travel between time zones (time-zone syndrome). Southern Living 14: 70, 1979.

100.
Anonymous. Reducing the accident rate with biorhythms. Business Week, p. 90, March 5, 1979.

This article cites British studies of the relation between biorhythm cycle phases and accidents, including the British Railway Board, which found 61/88 injuries occurring on critical days, and the Transport and Road Research Lab, which will analyze 100,000 road accidents with respect to biorhythm critical days. The findings are expected to be negative.

101.
Anonymous. Sleep, Wakefulness and Circadian Rhythm. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-LS-105, 1979.

102
Anonymous. When biorhythms say "danger", Soviet cabbies stay home. Medical World News 20: 49, 52, 1979.

This article reports that 5000 taxi drivers in Leningrad have been working shifts based on their biorhythm cycle charts. It is claimed that 2/3 of traffic accidents occur on accident prone days. Aeroflot, the Soviet airline, is also said to be making up some pilot schedules after consulting the biorhythm people. However, an American, Dr. Charles F. Ehret of Argonne National Labs. claims that biorhythm is a complete fraud.

103.
Anonymous. Work Rx for shift workers, rotate hours at your peril. Hum. Behav. 8: 36, 1979.

104.
Anonymous. Aircraft Accident Report, Air New England, Inc., DeHavilland DHC -6-300, N383 EX, Hyannis, Masssachusetts, June 17, 1979 (NTSB-AAR-80-1). Washington D.C.: National Transportation Safety Board, 1980, 25 pp.

About 2248 e.d.t., on June 17, 1979, Air New England, Inc., Flight 248 crashed into a heavily wooded area about 1.5 nmi northeast of Barnstable Municipal Airport, Hyannis, Massachusetts. The crash occurred during an instrument landing system approach to runway 24 in instrument meteorological conditions. Of the eight passengers and a crew of two aboard, the captain was killed, the first officer and six passengers were injured seriously, and two passengers received minor injuries. The aircraft was destroyed. The National Transportation Safety Board determines that the probable cause of the accident was the failure of the flightcrew to recognize and react in a timely manner to the gross deviation from acceptable approach parameters, resulting in a continuation of the descent well below decision height during a precision approach without visual contact with the runway environment. Although the Board was unable to determine conclusively the reason for the failure to recognize and react to the gross deviation, it is believed that the degraded physiological condition of the captain seriously impaired his performance. Also, the lack of adequate crew coordination practices and procedures contributed to the first officer's failure to detect and react to the situation in a timely manner.

105.
Anonymous. Easy ways to beat jet lag. Ladies Home Journal 97: 32, 1980.

106.
Anonymous. Proceedings of the Fifth International Symposium on Night - and Shift-Work., Rouen- France: (This symposium in press). Advances in Studies on Night and Shift-Work, edited by A. Reinberg. Oxford: Pergamon Press, 1980.

107
Apfelbaum, M. Effects of some environmental factors on human circadian rhythms. Israel J. Med. Sci. 12: 780-785, 1976.

108.
Apfelbaum, M., et al. Human or murine encocrine and metabolic rhythms after changes in meal timing with or without a fixed activity schedule. Proc. 56th Meeting of the Endocrine Society, Abstract No. 308, 1974.

109.
Appel, W. A. Biorhythmik: die Biologische Erfolgsuhr (Biorhythmic: the biological success clock). Munich: Moderne Verlags Gesellschaft, 1975, 160 pp.

110.
Appel, C. P. A measure of chronohygiene as an alternative approach to the determination of individual differences in circadian rhythms. Goteborg Psychological Reports, Vol. 7, 15 pp., 1977.

Two alternative approaches to the assessment of individual differences in circadian rhythms are discussed. One is a questionnaire proposed by Ostberg (1973), which provides a measure of habitual preferences with regard to the time for diurnal activity maxima; the other is an objective checklist which measures momentary feelings of activation (Appel and Svenson, 1975). This checklist can be used repeatedly in order to determine the exact course of variation on any particular day. It is pointed out that the two measures differ not only with regard to their methodology, but also with respect to kinds of information, which, it is suggested, should be seen as complimentary to each other. It is proposed that the degree of congruences between the two measures could be used and an index of 'psychological chronohygiene.

The diagnostic efficiency of the proposed index is illustrated by analysis of individual differences in memory for brightness, paired associate learning, Hidden Figure test levels, examination results, and time estimation. Subjects with 'positive' chronohygiene scores on the index had significantly higher levels of performance than those with 'negative' chronohygiene scores.

111.
Aracil, A. S. Circadian rhythms in aerospace medicine. Rev. Aeron. y. Astronautica 37: 109-118, 1977.

The cyclical nature of bodily functions is reviewed, in particular those functions likely to affect pilot performance.

112.
Arand, D., and D. J. McGinty. Self-assessed circadian rhythms in individuals with sleep complaints (abstract). Sleep Res. 7: 301, 1978.

113. Araoz, D. L. Biorhythm in couple counseling. International Journal of Family Counseling 5: 34-39, 1977.

114.
Aschoff, J., Frequenzanderung der Aktivitatsperiodik bei Mausen im Dauerlicht und Dauerdunkel (Frequency change in the activity period of mice in constant light and constant dark). Pflugers Arch. 255: 197-203, 1952.

115.
Aschoff, J. Spontane lokomotorische Aktivitat. Handbuch der Zoologie 8: 1-76, 1962.

116.
Aschoff, J., Circadian Clocks. Amsterdam, Holland: North Holland Publ. Co. 1965, 479 pp.

117.
Aschoff, J. Circadian rhythms in man. Science 148: 1427-1432, 1965.

118.
Aschoff, J. Tagesrhythmus des Menschen bei volliger isolation. Umschau 66: 378-383, 1966.

119.
Aschoff, J. Desynchronization and resynchronization of human circadian rhythms. Aerosp. Med. 40: 844-849, 1969.

120.
Aschoff, J. Circadian periodicity as a basis of the sleep-wakefulness rhythm. In: Fatigue Sleep, and Dream, edited by W. Baust. Stuttgart: Wissenschaftliche Verlagsgesellschaft MBH. , 1970, pp. 59-98.

121.
Aschoff, J. Circadian rhythms in space medicine. In: International Symposium on Basic Environmental Problems of Man in Space, 4th., Erevin, U.S.S.R., 1971, p. 264-284.

122.
Aschoff, J. Internal dissociation and desynchronization of circadian systems. Int. Cong. Aviat. Space Med., 21st, Munich, 1973, preprint, p. 255.

The circadian system is one of the frame-works for temporal order within the organism. It consists of a multiplicity of rhythms which have been described in morphological structures as well as in physiological and psychological functions, and it is characterized by specific phase-relationships between and specific amplitudes of these rhythms. The circadian system is further characterized by its capacity to oscillate in the absence of periodic factors in the environment. Under those conditions, the system behaves like a self-sustained oscillator, 'free-running' with its own frequency which usually deviates slightly from that of the earth's rotation. This self- sustained oscillator can be, and normally is, entrained by different types of periodic inputs from the environment, the synchronizing Zeitgeber.

122
Aschoff, J. Internal dissociation and desynchronization of circadian systems. Int. Cong. Aviat. Space Med., 21st, Munich, 1973, preprint, p. 255.

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123.
Aschoff, J. Circadian systems in man and their implications. Hosp. Pract. 11:51-57, 1976.

124.
Aschoff, J. Complexity and order of the human circadian system. Societa Italiana de Biologia Sperimentale 52: 1-11, 1976.

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Aschoff, J. Circadian rhythms within and outside their ranges of entrainment. In: Environmental Endocrinology, edited by J. Assenmacher and D. S. Farner. N. Y.: Springer-Verlag, 1978, pp. 172-181.

126.
Aschoff, J. Circadiane Rhythmen im endokrinen System. Klinsiche Wochenschrift 56: 425-435, 1978.

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Aschoff, J. Features of circadian rhythms relevant for the design of shift schedules. Ergonomics 21: 739-754, 1978.

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Aschoff, J. Problems of re-entrainment of circadian rhythms: asymmetry effect. Dissociation and partition. In: Environmental Endocrinology, edited by I. Assenmacher and D. S. Farner. New York: Springer-Verlag, 1978, ch. 9, pp. 185-195.

129.
Aschoff, J. Zirkadiane Rhythmen des Menschen (Circadian rhythms in man). Arzneim. Forsch. 28: 1850-1857, 1978.

130.
Aschoff, J. Circadian rhythms: influences of internal and external factors on the period measured in constant conditions. Z. Tierpsychol. 49: 225-249, 1979.

The article reviews most of the data available on the period (tau) of freerunning circadian rhythms, measured in constant conditions. Emphasis is placed on the effects of light intensity and ambient temperature on (tau), with references to influences of other external as well as internal factors. In the introduction, examples are given of spontaneous and induced variations in (tau) and its dependence on the experimental history. The discussion concentrates largely on results obtained from arthropods and vertebrates.

131.
Aschoff, J., S. Daan, J. Figala and K. Muller. Precision of entrained circadian activity rhythms under natural photoperiodic conditions. Naturwissenchaften 59: 176-277, 1976.

132.
Aschoff, J., M. Fatranska, U. Gerecke, and H. Giedke. Twenty-four-hour rhythms of rectal temperature in humans: effects of sleep-interruptions and of test-session. Pflugers Arch. 346: 215-222, 1974.

Rectal temperature has been recorded continuously in 6 male subjects in groups of two on a rigorous time-schedule with 7 h sleep in an isolation chamber, first for 8 days in a 16:8-h light-dark cycle (LD), thereafter for 4 days in complete darkeness (DD). Urine samples have been collected and performance tests made in 3-h intervals during the daytime and also at 02:00 and 05:00 on 7 of the 12 nights. The overall picture of the rhythm of rectal temperature is similar in all subjects, showing mimima towards the end of sleep-time and maxima in the second half of wakefulness. Superimposed on this general curve are small increases of rectal temperature accompanying each test session; we consider these increases to be due to emotional stress ("psychogenic fever"). There is no difference between LD- and DD-conditions with regard to phase, mean level and range of oscillation of the temperature rhythm. Similarly, no significant difference exists between the curve averaged from days with uninterrupted sleep and the curve averaged from days with sleep interrupted twice.

133.
Aschoff, J. M. Fantranska, H. Giedke, P. Doer, D. Stamm, and H. Wisser: Human circadian rhythms in continuous darkness: Entrainment by social time cues. Science 171: 213-215.

134.
Aschoff, J., U. Gerecke, and R. Wever. Desynchronization of human circadian rhythms. Jap. J. Physiol. 17: 450-457, 1967.

135.
Aschoff, J., U. Gerecke, and R. Wever. Phasenbeziehungen zwischen den circadianen Perioden der Aktivitat und der Kerntemperatur beim Menschen (Phase relations between circadian activity periods and body temperature in man). Pflugers Arch. 295: 173-183, 1967.

136.
Aschoff, J., H. Giedke, E. Poppel, R. Wever. The influence of sleep interruption and of sleep-deprivation on circadian rhythms in human performance. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep (Proceedings of the symposium, Strasbourg, France, 1970.), edited by W. P. Colquhoun. London: English Universities Press, 1972, pp. 135-149.

Several performance tests have been conducted to study the effect of (1) normal living routine with sleep interruptions, (2) continuous darkness, (3) noninterrupted versus interrupted sleep, and (4) sleep deprivation on circadian rhythms in human performance. Results are given graphically and discussed. Free running circadian rhythms have also been studied.

137.
Aschoff, J., K. Hoffman, H., Pohl, and R. Wever. Re-entrainment of circadian rhythms after phase-shifts of the Zeitgeber. Chronobiologia 2: 23-78, 1975.

138.
Aschoff, J. and J. Meyer-Lohmann. Die Aktivitatsperiodik ven Nagern im kunstlichen 24-Stunden-Tag mit 6-20 Stunden Lichtzeit. Z. vergl. Physiol. 37: 107-117, 1955.

139.
Aschoff, J., and H. Pohl. Phase relations between a circadian rhythm and its Zeitgeber within the range of entrainment. Naturwissenschaften 65: 80-84, 1978.

140.
Aschoff, J. and U. V. Saint Paul. Survival of the blowfly (Phormia terraenovae Rd.) as a function of lighting conditions. Pflugers Arch. 377: R26, 1978.

141.
Aschoff, J., U. V. St. Paul, and R. Wever. Die Lebensdauer von Fliegen unter demEinfluss von Zeit-Verschiebungen. Naturwiss. 58: 574, 1971.

142.
Aschoff, J., and R. Wever. Human circadian rhythms: a multioscillatory system. Fed. Proc. 35: 2326-2332, 1976.

143.
Ashkenazi, I. E., N. Amite, A. Dotan, and L. Peleg. Induction of phase-shifts by external and internal synchronizers: relevance to chronotherapy (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. II-1.

144.
Ashley, R. Out of sync. Cosmopolitan 187: 54, 190, 1979.

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Aslanian, N. L., D. G. Assatrian, R. A. Bagassarian, A. G. Kurginian, and V. M. Shukhian. Circadian rhythms of electrolyte excretion in hypertensive patients and healthy subjects. Chronobiologia 5: 251-262, 1978.

146.
Athanassenas, G., and C. L. Wolters. Sleep after transmeridian flights (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen FR., 1980, p. III-2.

147.
Atkinson, M., D. F. Kripke, and S. R. Wolf. Autorhythmometry in manic depressives. Chronobiologia 2: 325-335, 1975.

148.
Auffret, R. Physiological Changes During Operational Flights of Long Duration. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace and Research Development, AGARD-CP-101, 1972, pp. 9-1 - 9-12.

149.
Ault, M., and K. Kinkade. Biorhythm analysis of single car fatalities. Joplin, Mo.: Missouri Southern State college, 1973.

Of 100 auto accidents, 46% occurred on a critical day, 57% occurred on critical and adjacent days. More than half of the fatalities occured on the emotionally critical day. It should be noted that biorhythm critical plus adjacent days constitute over 50% of all days.

150.
Austin, W. P., and C. Cameron. Aircrew fatigue in international jet-transport operations. Dept. of Supply, Aust. Defense Scientific Service, Aero. Research Labs. 1969.

151.
Avery, D. L. The relationship of light-dark reversal transients and free-running rhythms. Int. J. Chronobiol. 2: 223-232, 1974.

The transient periods observed in rats following a reversal of the light-dark (LD) regimen were found to correlate highly with the free-running period observed in continuous light of the intensity used in the LD entrainment. Such a relationship was not found between LD reversal transient periods and periods observed in continuous dark or dim red light. The above correlations were observed for activity, feeding, and drinking circadian rhythms. These findings support the theory that the non-24-h periods often reported for rats in continuous light are the result of continuous phase resetting of a near-24-h underlying rhythm by the abnormal lighting schedule.

c-2

152.
Baark. H. Zeitlich Richtige Einnahme von Medikamenten bei Interkontinentalen Flugen (Temporally correct administration of medication for intercontinental flights). Proceedings of the XXI International Congress of Aviation and Space Medicine, Munich, preprints, 1973, pp. 229-230.

The problem of drug administration in relation to the changing of activity with respect to circadian rhythm phase is discussed. The author provides instructions for the administration of drugs for diabetics and also for birth control pills. A table is provided for daily post flight administration of insulin, birth control pills and anticoagulants.

153.
Baevskii, R. M. The problem of forecasting the condition of man under space flight conditions. Fiziol. Zh. SSSR 58: 819-827, 1972.

154.
Baevskii, R. M., G. A. Berezina, B. A. Dushkov, F. P. Kosmolinskiy, V. I. Kudryavtseva, T. D. Semenova, and S. A. Chernyayeva. Investigation of performance of a man-operator during 64-hour sleep deprivation. Kosm. Biol. Med. 3(3): 53-61, 1969.

The purpose of this study was to determine the effects of 64-hour continuous work on the performance level of a man-operator could perform at a sufficiently high level by receiving information transmitted as a digital, sound or tactile code . Under these circumstances the performance level depended on the motivation and interest of the test subject. Despite good performance, the overall health of the test subjects steadily deteriorated during the course of the 64-hour experiment. This was indicated by changes in the function of the central nervous and muscular systems and variations in biochemical indices. The 64-hour sleep deprivation and strenuous work resulted in serious disorders of the adaptation potentials of the body and this, in part, led to shifts in circadian rhythms of certain parameters.

155.
Baevskii, R. M., G. A. Nikulina, and T. D. Semonova. Issledovanie sutochnoi periodiki fiziologicheskikh funktsii dlya otsenki sostoyaniya regulyatornykh sistem organizma pri ekstremal'nykh vozdeist vozdeistviyakh (Circadian rhythms of physiological functions as indicators of the state of the organism's regulatory systems under extreme conditions). Fiziol. Chel. 3: 387-392, 1977.

This paper reports the results of an experiment to establish criteria for distinguishing stress and over-stress to environmental factors. The circadian rhythms of the organism's physiological functions reflect various stages of adaptation to changes in environmental conditions. Fairly simple methods for evaluating this environmental adaptation are developed by analysis of the experimental data obtained. This work is a step towards the goal of simply and constantly monitoring the condition of astronauts and others who must stay in confined, inadequate environments for long periods of time.

156.
Baier, H., and Ch. Rompel-Purckhauer. Tagesrhythmische Variationen der Kreislauf- und Thermoregulation und der Trainierbarkeit. Sportmedizin. 11: 323-328, 1978.

157.
Bainbridge, W. Biorhythms: evaluating a pseudoscience. The Skeptical Inquirer 2: 40-56, 1978.

This article combines a critical review of the biorhythm theory and some of the authors' own investigations. He cites examples of biorhythm charting services which were initiated for profit motives and which have not investigated the validity of the theory. In a class experiment, students were given random biorhythm phase information and asked to indicate on a questionnaire if the birohythm phase corresponded to their self-evaluation for the day. 45% of 108 students indicated that the false information corresponded to their own self evaluation, which indicated the strong influence of suggestibility. Next the performances of 243 golf performances by Arnold Palmer, 229 golf performances of women golfers, 143 golf performances of men, and 95 no-hit baseball pitching performances were evaluated with respect to biorhythm high phases. No significant relationship between performance and biorhythm high phases was demonstrated in any of these cases. Significant deviation from expected frequencies by Arnold Palmer with respect to 23 and 28 day cycles was found to reflect invalid statistical assumptions: a) that sequential performance events are independent of each other, and b) events associated with the 28 day biorhythm may be biased due to weekly acitivity cycles, since the phases of the 28 day biorhythm occur on the same day every other week from the time of birth. The author then investigated death dates for 274 baseball pitches, the relationship between dates of birth for first children and biorhythm critical days for the mother, the performance of 105 students on 2 multiple-choice tests held 16 days apart with respect to intellectual biorhythm phase, and the correlation between sexual indentity and biorhythm phase at the time of conception for 100 men and 100 women. No significant deviations from chance frequencies or correlations with biorhythm phases were found. The author, perhaps more carefully then other investigators, has evaluated his statistical assumptions on the basis of the sample population with which he is dealing. However, more information could have been supplied on statistical methods and a critical day definition.

158.
Bakach, T. Ecology of rest. Gig. Sanit. (USSR) 2: 73-76, 1973.

159.
Baker, T. L., and D. J. McGinty. Blind man living in normal society has circadian rhythms of 24.9 hours. Science 198: 421-423, 1977.

A psychologically normal blind man, living and working in normal society, suffered from a severe cyclic sleep-wake disorder. Investigations showed that he had circadian rhythms of body temperature, alertness, performance, cortisol secretion, and urinary electrolyte excretion which were desynchronized from the 24-hour societal schedule. These rhythms all had periods which were longer than 24 hours and indistinguishable from the period of the lunar day.

160.
Balagura, S., L. E. Harrell, and E. Roy. Effect of the light-dark cycle on neuroendocrine and behavioral responses to scheduled feeding. Physiol. Behav. 15: 245-247, 1975.

Rats, nocturnal animals, adapt both behaviorally and physiologically to a restricted feeding schedule. Such adaptations occur faster and more efficiently during the dark portion of a light-dark cycle as indicated by measurements of latency to eat, amount of food consumed, body weight, and insulin levels.

161.
Baranov, V. M. Diurnal changes in human gas exchange indices. Kosm. Biol. Med. 6(1): 55-58, 1972.

A study was made to determine gas exchange and metabolic rates of test subjects confined in a small chamber. This was the first investigation conducted under conditions of normal and inverted day-night schedules. The purpose of the study was to determine the absolute gas exchange and metabolic rate at different time intervals, as well as to establish the duration of human adaptation to a displaced (by 12 hours) day-night schedule.

162.
Barbashova, Z. I. Cycle research on man in the USSR by the participants of the International Biological Program. J. Interdiscipl. Cycle. Res. 3: 197-205, 1972.

The shifts in the daily cycles and the coefficient of correlation of different physiological functions, at different periods of the day, can be utilized for establishing the extent of hardness and stress in different types of labor. It is of great importance of course in the process of establishing optimum labor conditions.

163.
Barber, J. L. Remarks on research requirements for continuous operations. Conf. Military Requirements for Research on Continuous Operations (Human Engineering Labs), Lubbock, TX, 1971, pp. 1-7.

164.
Barclay, D. Charts predict future? The Atlanta Journal, p. 8-E, Oct. 29, 1975.

165.
Bare, J. K. Hunger, deprivation, and the day-night cycle. J. Comp. Physiol. Psychol. 52: 129-131, 1959.

Six groups of white rats were taught to secure their food by performing a lever-pressing response, and were then subjected to a single deprivation of 2, 4, 8, 12, 18, or 24 hrs. The deprivation was begun at 7 P. M. and was accomplished by removing the lever from the apparatus. Subsequent 24-hr. measures of food intake reveal that the normal cyclic differences in rate of intake are clearly apparent in the behavior following deprivation, and may counteract the expected increase in intake normally produced by deprivation.

166.
Barhad, B., and M. Pafnote. Contributions a l'etude du travail en equipes alternantes (Contributions to work study in shift-work). Le Travail Humain 33: 1-19, 1979.

Studies on shift work adaptation in connection with the rotating shift system and the characteristics of work are presented: frequent rotation of work-shifts, every two days (2-2-2 system), in control board operators of thermopower stations; weekly rotations with three days of rest at the end of the working day cycle (6-6-6 system) in operators of an oil refinery; weekly turning of shifts with Sunday rest in forgers (medium intensity of physical effort) and in workers of a precision tool room (perceptual tasks); in miners (hard physical effort) and in operators of tire assembling machines (perceptual and physical strain). Investigations on reaction time, optic rheobase, tests of attention, pulse rate, energy exchange during work and rest as well as social and opinion inquiry showed the characteristics of physiological responses during the work in the three shifts (morning, afternoon and night shifts) as well as adaptation features to different intervals of changing the shifts. The type of activity, the level of physiological strain and the social factors seem to have a more pronounced influence on adaptation to shift work than the actual rotating schedule.

167.
Barnes, J. Everybody's got biorhythm. Sunday Magazine, pp. 2-7, May 20, 1973.

168.
Barrett, T. R., and B. R. Ekstrand. Effect of sleep on memory: III. Controlling for time-of-day effects. J. Exp. Psychol. 96: 321-327, 1972.

Compared retention of a paired-associate list in 3 groups of 10 undergraduates each who all learned and recalled at the same time of day (the retention interval was always defined from 2:50-6:50 a. m.). 1 group was awake during the interval, 1 group experienced sleep characterized by high amounts of Stage IV sleep and low amounts of REM sleep, and the 3rd group experienced sleep characterized by low amounts of Stage IV and high amounts of REM. Results demonstrate that memory over a sleep interval was superior to memory over a waking interval. Of the 2 sleep intervals, retention over the high REM sleep interval was inferior to retention over the high Stage IV interval. These 2 effects cannot be explained as artifacts of a circadian rhythm effect on memory. Implications of the results for understanding the effects of sleep on memory are discussed.

169.
Bartel, P. C. Biorhythm: Discovering Your Natural Ups and Downs. New York: Watts, 1978, 77 pp.

The author summarizes the history of biorhythmic research and its current applications in industry, technology, and various service occupations. She clearly explains the emotional, physical and intellectual cycles that comprise biorhythmic theory in light of data collected since 1897. Unfortunately, the coverage is heavily statistical and not tailored to its audience, though the inclusion of curious facts (e. g., following the "tempo of the seasonal changes - children grow rapidly in the spring"), instructions on how to do biorhythm charts, biorhythmic obituaries, and advice on how to behave to avoid conflict or accident on "critical" and "minus" days add some narrative appeal.

170.
Bartter, F. C. Periodicity and medicine. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J. E. Pauly. Tokyo: Igaku Shoin, Ltd., 1974, pp. 6-13.

171.
Bason, R., C. E. Billings, G. W. Hoffler, and H. S. Turner. An attempt to produce acclimatization to hypoxia by intermittent altitude exposure with vigorous exercise. Aerosp. Med. 40: 971-976, 1969.

172.
Baust, W. Fatigue, Sleep, and Dream. Stuttgart: Wissenschaftliche Verlagsgesellschaft MBH, 1970, 322 pp.

173.
Bazin, R., M. Apfelbaum, R. Assan, F. Halberg, and P. DeGasquet. Timing of meals manipulates amplitude and acrophase of circadian rhythms in human plasma insulin. Chronobiologia 5: 203-204, 1978.

174.
Becker, E. E., and H. R. Kissileff. Inhibitory controls of feeding by the ventromedial hypothalamus. Am. J. Physiol. 226: 383 -396, 1974.

175.
Becker, R. O., C. H. Bachman, and H. Friedman. The direct current: A link between environment and organism. N.Y. State J. Med. 62: 1169-1176, 1962.

The authors have collected evidence that biological organisms are surrounded by natural D.C. electrical potential gradients. In a preliminary study the transcranial D.C. potentials of 2 normal and 2 schizophrenic patients were determined daily for a period of 2 months.

A cyclic pattern was evident in all subjects with a periodicity of approximately 28 days. Note: this study has been often cited as evidence for the 28 day emotional biorhythm. The authors, however, state the periods were approximately 28 days, not exactly 28 days, as biorhythm theory requires. This preliminary study reportedly has not been replicated (Ahlgren, A. 1974 Int. J. Chronobiol. 2: 107-109).

176.
Beljan, J. R., L. F. Chapman, D. Rockwell, J. Vernikos-Danellis, and C. M. Winget. The influence of 105 days of social deprivation on habitability. Aerosp. Med. Assoc. Preprints, 1974, p. 90.

177.
Beljan, J. R., L. S. Rosenblatt, N. W. Hetherington, J. L. Lyman, S. T. Flaim, G. T. Dale, and D. C. Holley. Human Performance in the Aviation Environment. Final Report; Dec. 31, 1972; NASA Contract NAS2-6657, 1972. Five Parts, 318 pp.

178.
Beljan, J. R., C. W. Winget, and L. S. Rosenblatt. The desynchronosis syndrome. Aerosp. Med. Assoc. Preprints, 1973, pp. 223-224.

179.
Bellinger, L. L., L. L. Bernardis, and V. E. Mendel. Effect of ventromedial and dorsomedial hypothalamic lesions on circadian corticosterone rhythms. Neuroendocrinology 22: 216-225, 1976.

180.
Belova, T. A., and V. N. Vasilev. Functional activity of the adrenal cortex in man during intensely emotional alternate shift work. Fiziol. Zh. SSSR. 60: 329-333, 1974.

Study of the adrenal cortex function in human subjects under conditions of alternate shift work associated with mental and neuro-emotional stress. The excretion of urinary metabolites of 17-oxy- and 17-deoxycorticosteroids measured by chromatography techniques was found to be in stress-exposed subjects twice as high as in the stress-spared control group.

181.
Belowich, D. L., and M. L. Sachs. Biorhythms and swimming performance: a comprehensive evaluation. Paper presented at the meeting of the North American Society for the Psychology of Sport and Physical Activity, Tallahassee, Fla., May, 1978.

182.
Bena, E., M. Noskova, and V. Poche. Bewertung des Vigilanzzustandes von Lokfuhrern von Elektrischen und Diesel-Elektrischen Lokomotiven mit Hilfe der Taglichen Rhythmen der Korpertemperatur, des Blutdruckes, der Pulsfrequenz und der Excitationsschwelle des Achilles-Schnenreflexes (Use of body temperature, biorhythms, pulse frequency, blood pressure and Achilles tendon threshold for evaluation of the degree of vigilance during train driving). Proc. of a Symp. on Ergonomics in Machine Design, Prague, 1967. Geneva: ILO, 1: 291-300, 1969.

Factors in the load of vigilance: (1) Attention to signals (long intervals between the signals or bad visibility). Without stimulation by the second engine driver vigilance lasts only for two to three hours. Independent driving should not exceed three to four hours. (2) Climate and monotonous cab noise (require suitable cab design). (3) Irregular cycles of shifts: shifts begin and end at all hours of the day and night. Thus the twenty-four hour rhythm of sleep and vigilance is broken into irregular fractions and the synchronisation between the brain cortex and autonomic nervous system, and hence body temperature, pulse frequency and blood pressure are disturbed. These factors are related to mental blocks during driving (accumulation of sleep debts). This may be tested for example during the second night of driving. The driver starts the evening already in the trophotropic stage, which imperils his vigilance more easily. The tests enable us to estimate the synchronisation of autonomic rhythms with the cortical function as it affects vigilant driving, and to make proposals concerning cycling of shifts.

183.
Benedek, G., and F. Obal. Interaction between sleep-waking cycle and thermoregulation in rats. Acta Physiol. Hung. 52: 201, 1978.

184.
Benoit, O. Wakefulness sleep rhythm and mode of life. Rev. Prat. 26: 1945-1954, 1976.

185.
Bensimon, G., O. Benoit, J. Foret, and N. Vieux. Quality of sleep, age, and shift-work (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen FR., 1980, p. III-3.

186.
Benson A. J., Technical evaluation. In: Rest and Activity Cycles for the Maintenance of Efficiency of Personnel concerned with Military Flight Operations. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-74, 1970, 4 pp.

187.
Benson, H. The Relaxation Response. New York: William Morrow and Company, Inc., 1976, 158 pp.

This book brings together and synthesizes recent scientific data with age-old Eastern and Western writings that establish the existence of an innate human capability: the relaxation Response. The scientific research and religious and literary works cited represent a compilation of vastly different fields of knowledge. The actual method utilized to attain the Relaxation Response is outlined in detail. Applictions of the method as a treatment for various physiological canditions such as high blood pressure are suggested.

188.
Berger, R. J. Bioenergetic functions of sleep and activity rhythms and their possible relevance to aging. Fed. Proc., 34: 97-102, 1975.

The hypothesis is proposed that sleep constitutes a period of dormancy in which energy is conserved to partially offset the increased energy demands of homeothermy. Phylogenetic data indicate that the complete physiological and behavioral manifestations of sleep are unique to homeotherms: furthermore "Ontogeny recapitulates phylogeny" in the parallel development of slow wave sleep and thermoregulation as exemplified in the opossum. Thus, sleep constitutes a state of reduced metabolism that may represent a variation on the theme of dormancy, functionally lyinng on a continuum of energy conservation processes, ranging from inactivity and estivation to torpor and hibernation. The high amounts of sleep in infancy may involve conservation of energy and its consequent availability for growth. Decreased amounts of stage 4 and total sleep with aging in humans may represent reduced energy demands reflected by parallel declines in basal metabolic rate and physical activity. Disruptions of circadian rhythms of sleep and wakefulness in humans produce impairments in mood and performance independent of total amounts of sleep obtained, and reduce the amplitude of physiological rhythms. It is suggested that aging processes might also be affected by such disruptions in activity rhythms.

189.
Berger, R. J., J. M. Taub, and J. M. Walker. Sleep as a biological adaptive process. In: The Nature of Sleep, edited by V. Jovanovic. Stuttgart: Fischer, 1973, pp. 252-255.

190.
Bergin, K. G. The effects of fatigue on health and flight safety. The Air Line Pilot 45: 30-33, 1976.

191.
Bergstrom, B. The effect of sleep loss and threat-induced stress upon tracking. Scand. J. Psychol. 13: 54-60, 1972.

The effect of sleep loss and threat-induced stress upon tracking. 18 conscript soldiers were divided into 2 matched groups and trained on a missile-type tracking task for 6 hrs. The experimental group was deprived of sleep for 75 hrs and both groups were then subjected to stress induced by electric shocks. Tracking performance was unaffected by sleep loss, probably due to the short duration of each trial. Performance under stress deteriorated in the control group but not in the experimental group. Heart rate decreased gradually under sleep loss but rose markedly under stress, and more so in the control group. Although somewhat inconsistent, the findings indicate that the effects of threat and sleep loss oppose each other by over-arousing and de-arousing, respectively.

192.
Bergstrom, B., M. Gillberg, and P. Arnberg. Effects of sleep loss and stress upon radar watching. J. Appl. Psychol. 58: 158-162, 1973.

Detection performance in a 40 min radar watching task was studied using 20 soldiers, divided into 2 matched groups. The experimental group was deprived of sleep for 78 hr. and both groups were then subjected to stress induced by unpleasant electric shocks. It was hypothesized that the effects of sleep loss and stress oppose each other through dearousing and overarousing, respectively. Results indicated significant impairment of performance when subjects were deprived of sleep, but they indicated an improvement under stress. Changes were accompanied by small but reliable heart rate reduction and elevation respectively, thus lending support to the hypothesis.

193.
Bergstrom, B., R. Hedberg, and P. Skold. The effect of sleep loss and threat-induced stress upon tracking. MPI B - Rapport, No. 55, 1971, 9 p.

194.
Berkhout, J., Psychophysiological stress: environmental factors leading to degraded performance. In: Systems Psychol., edited by K. B. DeGreene. New York: McGraw Hill Book Co., 1970.

195.
Bernstein, B. E. The effect of circadian rhythms and personality on mental performance. J. Soc. Occup. Med. 27: 34-36, 1977.

One hundred and thirty-eight female college undergraduates have been investigated to ascertain whether there is some underlying difference between those who choose to work on early and late schedules. The subjects in the 'early, 'midday' and 'late' schedules were tested for academic motivation and scholastic aptitude. The results show no significant differences between the groups. The effect of our daily physiological ups and downs on work performance is obviously an important issue to industry and educational institutions. If on-the-job performance is found to fluctuate between morning and evening hours, the present study rules out attributing this to ability or motivation differences. Hence any such fluctuations should be attributed to circadian temperature variations.

196.
Berry, C. A. Summary of medical experience in the Apollo 7 through 11 manned spaceflights. Aerosp. Med. 41: 500-519, 1970.

The 3105 hours of exposing man to space flight during the Apollo gprogram have added greatly to knowledge of man's response to space travel. The spacecraft cabin environment has been suitably maintained for the crew. The radiation environment has been benign, no solar flares occurring during the Apollo program missions. Crews have generally adapted well to weightlessness, and have learned to utilize it to their advantage. Improvements have been made in in-flight food, with the addition of moisturized packs and such items as sandwiches and dried fruit. The body weight losses, which have continued to occur during space missions, are not entirely due to body fluids loss. Work-sleep cycles have been improved somewhat by having all crew

members sleep at the same time, and by having cycles more closely related to those during training period. Cardiovascular deconditioning has been identified postflight with both lower body negative pressure and 90° passive standing techniques. Microbiological studies have shown that organisms transfer between crewmembers. Moreover, the growth of opportunist organisms appears to be favored by these shifts. Extravehicular activities on the lunar surface during the Apollo 11 mission were conducted within expected energy costs, at an average of 1,200 BTU per hour. The liquid-cooled-garment-temperature method of energy cost estimation is the most suitable. It appears that lunar surface time can be expanded safely. The Apollo 11 quarantine was a demanding operation, conducted very successfully.

197.
Berry, C. A., and M. Smith. What we've learnt from space exploration. Nutrition Today, Sept/Oct, 1972, 4-11, 29-32.

198.
Berube, B. P. Absence of Correlation Between Measured Performance In College Students and Biorhythm Information Calculated from their Individual Birth Dates. (Ph. D. thesis) George Washington University, 1977. (Diss. Abstr. 38: 1337A, 1977.)

Personal hygiene examination scores (375) and academic motivation scores (51) were collected from 51 college students and were analyzed for coincidence with 23, 23 and 33 day biorhythm cycles (regression coefficient analysis) and critical days (t-test). The author concludes that these scores are not predictable from phase of biorhythm cycles. Personal hygiene exam scores were not significantly different on critical days than on non-critical days. Combinations of biorhythm cycles did not correlate with exam scores. The author concludes that predicting human performance on the basis of birthdate and biorhythm phase has no rational foundation.

199.
Bessou, J. and R. Pechker. Repartition des accidents due travail a l'EDF, Arch. Mal. Prof. 24: 184-190, 1963.

200.
Bethea, N. J. J. Human Performance, Physiological Rhythms and Circadian Time Relations. (Ph. D. Thesis). Texas Technological Univ., 1975, 199 pp.

During performance testing, three groups of subjects recorded their oral temperature and resting heart rate at intervals throughout the day. At the same time they worked multiplication or addition problems to simulate mental performance. All subjects collected urine voided during the testing weeks. The volumes were measured and specimens analyzed for sodium, potassium, chloride, urea nitrogen, uric acid, creatinine, and inorganic phosphate. Testing of

psychomotor performance and rhythmometric analyses found some consistent phase relationships between physiological variables, performance levels, and individual rhythms. Some indication of circadian variability were observed.

201.
Bhanji, S., G. A. Roy, and C. Baulieu. Analysis of mood change during and following sleep deprivation therapy. Acta Psychiatr. Scand. 58: 379-383, 1978.

Recent work suggests that depriving endogenous depressives of sleep for 1 night may be followed by an alleviation of their illness. In order to facilitate further study of the mechanisms underlying this effect, hourly self-rated measurements of mood were obtained throughout the sleepless night and the time of onset of any response noted. Of the patients who improved, some did so during the day following sleep deprivation; in others the response did not occur until after the next night's sleep. The 2 groups of responders differed interms of self-reported emotional arousal during the course of the sleepless night. The implications of these findings are discussed in relation to further studies of sleep deprivation therapy.

202.
Bicakova-Rocher, A., A. Gorceix, and A. Reinberg. Possible circadian rhythm alterations in certain healthy human adults before and during the administration of pseudo drug (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. VI-1.

203.
Bigham, B. How to put your rhythms to work on your blues. Writer's Digest, pp. 14-15, Aug. 1975.

The author suggests that "writer's block" may be due to the effect of biorhythm critical days and recommends that writers schedule their writing activity according to biorhythmic phases. Anecdotal examples of famous writers with writers block on critical days are presented.

204.
Billings, C. E. Studies of pilot performance. I. Aerosp. Med. 39: 17-19, 1968.

205.
Billings, C. E. Evaluation of performance using the Gedye task. Aerosp. Med. 45: 128-131, 1974.

This report describes studies of a complex psychomotor task designed for assessment of performance and state of consciousness at high altitude. Baseline learning curves were obtained from five subjects at seal level and at 8000 ft. The results indicate that, while initial learning of the task is rapid, there are long-term trends indicative of further improvement in performance. More rapid learning of particular permutations was observed when subjects breathed oxygen at 8000 ft. than when air was breathed.

206.
Billings, C. E., R. C. Chase, J. J. Eggspuehler, and R. J. Gerke. Studies of pilot performance. II. Aerosp. Med. 39: 19-31, 1968.

207.
Billings, C. E., R. J. Gerke, R. C. Chase, and J. J. Eggspuehler. Stress and strain in student helicopter pilots. Aerosp. Med. 44: 1031-1035, 1973.

The heart rates of nine volunteer subjects were studied during 223 hours of primary helicopter flight training. Heart rates after flights were generally higher than before the same flights. Heart rates on the ground tended to increase over 20 to 25 hours of flight instruction. This trend toward increases in heart rates was also observed during dual flights, whether the instructors or students were flying. During solo flight, in contrast, heart rates tended to decrease in most students. Student heart rates were highest during flight checks in eight of nine subjects. It is concluded that these data are indicative of a moderate and sequentially increasing level of psychological stress in students undergoing dual flight instruction in helicopters.

208.
Billings, C. E., R. J. Gerke, R. C. Chase, and J. J. Eggspuehler. Studies of pilot performance. III - Validation of objective performance measures for rotary-wing aircraft. Aerosp. Med. 44: 1026-1030, 1973.

Nine subjects whose fixed-wing piloting experience varied from zero to several thousand hours were given primary helicopter flight training in a Hiller 12-E (CH-23G) helicopter. The vehicle was instrumented to permit recording of rotor velocity and the positions of all flight controls. Computer reduction of the resulting data revealed differences in the precision with which rotor velocity was controlled between the flight instructors and their students, and systematic trends in the students' control of engine rpm during their flight instruction. These findings support the hypothesis that rpm variability is a valid index of pilot skill in helicopters in which this variable is under the direct control of the pilot.

209.
Billings, C. E., R. J. Gerke, and R. L. Wick, Jr. Comparisons of pilot performance in simulated and actual flight -- effects of ingested barbiturates. Aviat. Space. Environ. Med. 46: 304-308, 1975.

Five highly experienced professional pilots performed instrument land systems approaches under simulated instrument flight conditions in a Cessna 172 airplane and in a Link-Singer GAT-1 simulator while under the influence of orally administrered secobarbital (0, 100, and 200 mg). Tracking performance in two axes and airspeed control were evaluated continuously during each approach. Error and RMS variability were about half as large in the simulator as in the airplane. The observed data were more strongly associated with the drug level in the simulator than in the airplane. Further, the drug-related effects were more consistent in the simulator. Improvement in performance suggestive of learning effects were seen in the simulator, but not in actual flight.

210.
Billings, C. E., L. L. Kulak, R. L. Wick, Jr. Epidemiological study of in-flight airline pilot incapacitation. Aerosp. Med. 42: 670-672, 1971

211.
Billings, C. E., J. K. Lauber, and G. E. Cooper. Human error in aviation operations. In: Human Factors in Safe Flight Operations: Proceedings of the Twenty-seventh Annual International Air Safety Seminar, Williamsburg, Va., November 10-14, 1974. Arlington, Va., Flight Safety Foundation, Inc., 1974, pp. 181-183.

This report is a brief description of research being undertaken by the National Aeronautics and Space Administration. The project is designed to seek out factors in the aviation system which contribute to human error, and to search for ways of minimizing the potential threat posed by these factors. The philosophy and assumptions underlying the study are discussed, together with an outline of the research plan.

212.
Billings, C. E., J. K. Lauber, G. E. Cooper, and H. P. Ruffell-Smith. Retrospective studies of operating problems in air transport. National Aeronautics and Space Administration. Ames Research Center. In: Aircraft Safety and Operating Problems, 1976, pp. 585-590.

An epidemiological model for the study of human errors in aviation is presented. In this approach, retrospective data are used as the basis for formulation of hypotheses as to system factors which may have contributed to such errors. Prospective experimental studies of aviation operations are also required in order to prove or disprove the hypotheses, and to evaluate the effectiveness of the intervention techniques designed to solve operational problems in the aviation system.

213.
Billings, C. E., R. L. Wick, Jr., R. Gerke, and R. C. Chase. The effects of alcohol on pilot performance during instrument flight. Columbus: Ohio State Univ., Rpt. FAA-AM-72-4, 1972, 79 pp.

Sixteen instrument-rated pilots, eight of whom were very experienced professional aviators, flew Instrument Landing System approaches in a Cessna 172 under simulated instrument flight conditions while sober and while under the influence of 40, 80, and 120 mg% of blood ethyl alcohol. Each pilot flew four approaches to minimums on each of two occasions at each alcohol level. The data collected during these approaches included continuous measurement of aircraft position with respect to localizer and glide path centerlines and airspeed. Note was made of procedural errors committed during the flights. The subjects showed significant and progressive decremental effects of alcohol at all of the levels studied. The more experienced pilots maintained their ability to guide the aircraft better than did the less experienced subjects, particularly at high levels of blood alcohol. Both groups, however, demonstrated progressive increases in the number and seriousness of procedural errors with increasing levels of alcohol. It is concluded that even 40 mg% of blood alcohol exerts decremental effects on performance which are incompatible with flight safety.

214.
Billings, C. E., R. W. Wick, Jr., R. Gerke, and R. C. Chase. Effects of ethyl alcohol on pilot performance. Aerosp. Med. 44: 379-382, 1973.

Sixteen instrument-rated pilots flew instrument landing system (ILS) approaches at night in a light airplane while under the influence of 0, 0.04., 0.08, and 0.12% blood concentrations of ethyl alcohol. Tracking data in two axes were recorded continuously from pilot's cross-pointer instrument: procedural errors were recorded by an experienced safety pilot. Procedure errors increased significantly in frequency and potential seriousness with each increase in blood alcohol level. At the highest level, the subjects lost control of the aircraft 16 times in 30 flights. Tracking error and variability also increased with alcohol levels: the tracking decrements were much more pronounceed in less experienced pilots. The data suggest that even very low blood concentrations of alcohol cause significant performance decrements in flights.

215.
Billings, C. E., R. L. Wick, Jr., R. J. Gerke, and R. C. Chase. Ethyl alcohol and pilot performance: Military implications of in-flight studies. In: The Use of Medication and Drugs in Flying Personnel Neuilly-sur-Seine NATO, Advisory Group for Aerospace and Reserch Development, AGARD-CP-108, 1973, pp. A10-1 - A10-11.

Sixteen instrument-rated civil pilots flew 501 instrument landing system approaches in a light airplane at night under simulated instrument flight conditions while sober and while under the influence of .04, .08, and .12 G% blood ethyl alcohol concentrations. Data included continuous measurement of deviations from localizer and glide path centerline: note was made of all procedural errors. While the highly experienced pilots maintained better tracking performance than the less experienced subjects, particularly at high blood alcohol levels, both groups demonstrated progressive increases in the number and seriousness of procedural errors with each increase in alcohol level. These results indicate that alcohol-induced performance degradation may occur first in secondary tasks rather than in the primary flying task. They also indicate that there is potentially dangerous deterioration in the performance of even highly skilled aviators at blood alcohol levels as low as .04%.

216.
Black, I. B., and D. J. Reis. Central neural regulation by adrenergic nerves of the daily rhythm in hepatic tyrosine transaminase activity. J. Physiol. 219: 267-280, 1971.

217.
Blake, M. J. F. Relationship Between Circadian Rhythm of Body Temperature and Introversion-Extraversion. London: Royal Naval Personnel Research Committee, 1969, 9 pp.

218.
Blake, M. J. F., and D. W. J. Corcoran. Introversion-extroversion and circadian rhythms. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep (Proc. of the Symp., Strasbourg, France, 1970) edited by W. P. Colquhoun. London: English Universities Press, 1972, pp. 261-272.

Individual differences observed in the circadian rhythm are experimentally examined in terms of the biochemical, physiological, and performance changes over the 24-hr period, as well as the ease with which with these rhythms can be changed in some subjects compared with the difficulty experienced with others. Emphasis is placed on introversion-extraversion as the external measure discriminating 'morning' and 'evening' types of people. It is suggested that some general difference exists in the arousal mechanism which differentiates introverts and extraverts. It is found that introverts are higher in arousal than extraverts whatever the time of day at which the readings are taken, yet the results obtained suggest that circadian rhythms are certainly involved.

219.
Blakelock, E. H. A study of some social and psychological effects of rotating shift work (Ph. D. thesis). Diss. Abst. 28: 2335-A, 1967.

220.
Blechman, F. Biorhythm clock. Predict your good and bad days. Radio-Electronics 48: 33-37, 1977.

Plans are presented for building an electronic "biorhythm" clock for under $30 which will enable the user to monitor biorhythm cycles on a daily basis.

221.
Blount, R. Biorhythm and the big game. Esquire 89: 28, 30, 1978.

This is a short review on the application of biorhythm to sports forecasting. The author tested some of Gittelsons (Biorhythm-Personal Science and Sport Forecasting, 1977) relationships between sports forecasting and biorhythm phase and found errors in dates and found errors in dates which invalidate some of the sports performance-biorhythm phase relationships.

222.
Bochow, R. Der Unfall im landwirtschaftlichen Betrieb. Untersuchung uber seine Erscheinung, Ursache und Auswirkung. (Accidents in the agricultural industry. Investigations on their appearance, origin and effects). Wissenschaftliche Zeitschrift der Humboldt-Universitat zu Berlin 4: 507-539, 1954/55.

In an analysis of 497 accidents, he found 46.5% occurring on biorhythm double critical days (1.2% of total days) and 24.75% occurring on triple critical days (.3% of total days). The incidence of accidents claimed to occur on triple critical days is remarkable. For critique see Schadewald, R. (Fate 32: 75-80, 1979)

223.
Bodanowitz, M. Die Veranderung tagesperiodische Schwankungen der psychomotorischen Leistung nach transmeridianen Flugen (The change of circadian rhythms of psychomotor performance after transmeridian flights). Linder Hohe, Ger.: Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt E. V. Institute for Flight Medicine, DLR-FB 73-52, 1972, 46 pp.

224.
Bodenheimer, S., J. S. D., Winter, and C. Faiman. Diurnal rhythms of serum gonadotropins, testosterone, estradiol and cortisol in blind men. J. Clin. Endocrinol. Metab. 37: 472-475, 1973.

Overall levels and diurnal rhythms of FSH and testosterone did not differ in a group of 7 totally blind males, age 20-36, from those observed in a previously studied comparable group of sighted subjects. LH levels were also not different between the 2 groups and no diurnal cyclicity of LH was seen in either. A diurnal rhythm in serum estradiol levels, similar to the one in testosterone, was seen in the blind subjects. Highest levels of FSH, testosterone and estradiol occurred near 08:00 hr. There was an apparent phase shift in circulating cortisol levels in blind subjects. Peak levels in the blind subjects occurred between 08:00 and 16:00 hr whereas in the sighted subjects the peak was at 08:00 hr and values were failing between 08:00 and 16:00 hr. These findings suggest that light is not an important determinant of diurnal gonadotropin and testosterone patterns but is an important regulatory factor of the diurnal cortisol rhythm in man.

225.
Bodrov, V. A. Meditsinskie problemy ratsionalizatsii rezhima truda i otdykha kosmonavtov (Medical problems of rationalizing the work-rest regimen of astronauts). In: Characteristics of Cosmonaut Activities During Flight. Moscow: Izdatel'stvo Mashinostroenie, 1976, pp. 34-45.

Experimental data are analyzed to reveal the impairment of physiological, psychological, and hormonal functions related to the circadian rhythm of astronauts during space flight. The reasons for which it is impossible to adopt a ground-based circadian rhythm during space flight are the absence of biological rhythm time sensors in the spacecraft cabin (alternation of day and night, diurnal fluctuations of the environment, etc.), displacement of the diurnal cycle during flight, necessity of having someone on duty around the clock, restrained muscular activity, and other causes. The complexity of developing a rational work-rest regimen is discussed in terms of creating and maintaining a predetermined wakefulness-sleep rhythm with appropriate allocation of rest time in the spacecraft.

226.
Bohlin, G., and A. Kjellbert. Self-reported arousal during sleep deprivation and its relation to performance and physiological variables. Scand. Psychol. 14: 78-86, 1973.

Factor analyzed R. E. Thayer's Activation-Deactivation Adjective Check List (AD-ACL). 4 factors emerged: Sleep-Wakefulness, Stress, Euphoria, and Energy. 20 undergraduates participated in a 1-night sleep deprivation study in which EEG, skin conductance, and body temperature data were obtained. The AD-ACL was administered to all Ss every hour. All 4 factors showed decreasing trends and, except for the Stress factor, all were correlated with body temperature variations. Sleep-Wakefulness and Energy decreased significantly as a result of sleep deprivation. Negative relations between the Energy, Sleep-Wakefulness, and Euphoria factors and performance on a reaction time task with different levels of feedback were found. A model of phenomenological arousal is suggested.

227.
Boissin, J. P., and L. Abbas. Variations de certains parametres du systeme oculaire in fonction de la fatigue lors des vols long courriers (Variations of some parameters of the ocular system in relation to fatigue during long transmeridian flights). Rev. Med. Aeronaut. Spat. 14: 65-67, 1975.

228.
Bolch, J. Biorhythms: A key to your ups and downs. Reader's Digest 111: 63-67, 1977.

229.
Bollinger, R. R., R. D. O'Donnell, and B. O. Hartman. Physiological costs of extended airborne command and control operations. In: Simulation and Study of High Workload Operations. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace and Research Development, AGARD-CP-146, 1974, 9 pp.

During Exercise Night Star the personnel of the National Emergency Airborne Command Post successfully documented their ability to maintain a continuous airborne alert for an extended period. Biomedical evaluation began with a pre-exercise baseline study and continued through a postexercise observation period. A variety of psychological and physiological parameters were measured in order to determine the degree of stress, fatigue, and change in performance induced by the extended airborne alert. This biomedical evaluation showed that performance was maintained by the missior teams, flight crews, and ground support personnel. When significant fatigue did occur, whether in flight or on the ground, it developed near the beginning of the exercise. The only cases of marked or persistent fatigue were seen in those groups whose day/night, work/rest cycles were shifted and can be attributed in major part to the resulting sleep loss. However, all groups appeared to adapt to their new work schedules as the exercise progressed. Partial physiologic and complete psychologic recovery were evident within the first 36 hours after the exercise.

230.
Bondarev, E. V., T. T. Dzhamgarov, and G. E. Gurvich. Changes in the rate of information processing by flight personnel during extended flights. In: Problemy irzhenernoy psikhologii (Problmes of engineering psychology), edited by B. F. Lomov. Moscow: Nauka, 1967, pp. 82-86. (Engl. transl. in Human Reactions to Stress in Specific Situations. Washington, D. C.: Joint Publications Research Service, 1968, pp. 23028.)

231.
Bondarev, E. V., V. A. Yegorov, and O. F. Zakharova. Change in the functional state of analyzers of flight crews during prolonged flights. Kosm. Biol. Med. 6(3): 64-67, 1972.

During prolonged flights the functional state of analyzers of airline crew members undergoes changes under the influence of adverse factors that to a certain degree are similar to spaceflight factors. The rate of information processing and the carrying capacity based on the speed and accuracy of responses to signals (acoustic and optical stimuli) decline most significantly. The responses to vibrotactile signals remain virtually unchanged. The degree of the decrease in these indices depends greatly on crew activity.

232.
Bonjer, F. H. Physiological aspects of shiftwork. Ergonomics 4: 279, 1961.

Productivity, frequency of errors, physiological responses to well standardized work and the performance at different physiological and psycho-physiological tests of a group of subjects were compared at morning, afternoon and night shifts. No consistent difference in output, working capacity or test scores between the shifts could be demonstrated by the applied methods of investigation. There was an outspoken physiological adaptation to night work occurring after a few days. This adaptation is probably completely lost however after a free weekend or even after a single off-day. Although there is no proof, it is believed that the adaptation of the diurnal rhythm of physiological functions to night shifts is an advantage.

233.
Bonnet, M. H., and W. B. Webb. The effect of repetition of relevant and irrelevant tasks over day and night work periods. Ergonomics 21: 999-1005, 1978.

The effects of repetition on the Wilkinson Vigilance Task and an unobtrusive performance measure (crossword completiton) were

examined in 18 subjects over two 8 h work periods. Vigilance trials alternated with breaks in 25 min segments across a work period from 0900 to 1700h and a period from 2400 to 0800 h. Performance decrements were seen in hit rate and on the irrelevant task measure across the night session, and in hit rate across the day session. Decrements were greater at night than during the day on both measures. The number of attempts on the vigilance task decreased across trials similarly in both testing sessions. It was concluded that specific task repetition results in performance decrements, even when circadian incremental effects would be predicted, and that the placement of such task repetition at night magnifies those decrements and extends them to intrinsically as well as extrinsically motivated tasks.

234.
Bonnevie, P., and J. E. Andersen. Shiftwork and Health. Oslo: Scandinavian University Books, 1960.

235.
Borbely, A. A. Circadian rhythm of vigilance in rats: modulation by short light-dark cycles. Neurosci. Lett. 1: 67-71, 1975.

Sleep in the rat was enhanced during light and reduced during darkness under a schedule of one hour light and one hour darkness. The changes were superimposed on a free-running circadian rhythm which exhibited an asymmetric time-course. During the circadian phase of maximum sleep, changes in illumination differentially affected slow wave sleep and paradoxical sleep.

236.
Borbely, A. A. Sleep and motor activity of the rat during ultra-short light-dark cycles. Brain Res. 114: 305-17, 1976.

237.
Borbely, A. A. Effects of light on sleep and activity rhythms. Prog. Neurobiol. 10: 1-31, 1978.

238.
Borbely,A. A., and J. P. Huston. Effect of two-hour light-dark cycles on feeding, drinking and motor activity of the rat. Physiol. Behav. 13: 795-802, 1974.

The effect of two-hour light-dark cycles on feeding, drinking and motor activity in the rat was compared with behavior under the usual 12/12 hour cycle. The two-hour cycles consisted of 60/60 min, 80/40 min and 40/80 min light-dark schedules which were maintained each for 7 days. Water intake, frequency of feeding, and motor activity were still significantly higher during dark than during light, although their occurrence during dark was reduced as compared to the 12/12 hour control schedule. A free-running circadian rhythm of consummatory behavior with a period length exceeding 24 hours was present throughout the experimental period. The amplitude of the circadian feeding rhythm gradually decreased over time, whereas the percentage of feeding during dark increased. During the circadian phase of minimal food intake, illumination changes affected feeding behavior more strongly than during the phase of maximal food intake. After restoration of the original 12/12 hour cycle, the amplitude of the nocturnal feeding rhythm increased gradually over several days, whereas the amplitude of the drinking rhythm showed a more rapid recovery. The experiments show that even short cycles of illumination may exert control over the rat's consummatory and motor activity. Short light-dark schedules provide a way for studying separately effects of illumination and of circadian rhythms.

239.
Borbely, A. A., J. P. Huston, and P. G. Waser. Control of sleep states in the rat by short light-dark cycles. Brain Res. 95: 89-101, 1975.

240.
Borbely, A. A. and H. A. Neuhaus. Circadian rhythm of sleep and motor activity in the rat during skeleton photoperiod, continuous darkness and continuous light. J. Comp. Physiol. 128: 37-46, 1978.

241.
Borbely, A. A., and H. U. Neuhaus. Synchronized and free-running circadian rhythms of sleep and motor activity in the rat. Neurosci. Lett. 1: 5327, 1978.

The vigilance states and motor activity (MA) were continuously recorded by telemetry in the unrestrained rat. The circadian rhythms were (a) synchronized by the 12-h light - 12-h dark cycle (LD 12:12) or a skeleton photoperiod (SP) consisting of 20-min L-pulses at 12-h intervals; or (b) free-running during continuous darkness (DD) or continuous light (LL). As compared to LD 12:12 the circadian rhythms were most attenuated during LL and least attenuated during DD. The circadian amplitude (A) of paradoxical sleep (PS) during LD 12:12 was higher than A of waking and slow wave sleep, and was less reduced during SP, DD and LL. The daily amounts of MA during DD, and of PS during LL, were signigicantly increased. The selective changes of PS are consistent with the assumption that separate processes control the circadian pattern of the two sleep states.

242.
Borland, R. C., and Nicholson, A. N. Use of hypnotics by aircrew: Adaptive tracking as a technique for the evaluation of performance decrements related to the flying task. Royal Air Force Inst. of Aviation Medicine. In: The Use of Medication and Drugs in Flying Personnel, Neuilly-sur-Seine: NATO, Advisory Group for Aerospace and Research Development, AGARD, 1973, 5 pp.

The mean performance of 6 subjects tested folowing the oral administration of secobarbitone at a dose of 3.3 mg/kg of body weight in an adaptive tracking task provides a reasonable approach to evaluating drug after-effects of possible significance to the flying task. Nevertheless, training of personnel and the experimental procedures involved demand considerable effort on the part of subjects and experimenters.

243.
Borland R. G., and A. N. Nicholson. Comparison of the residual effects of two benzodiazepines (nitrazepam and flurazepam hydrochloride) and pentobarbitone sodium on human performance. Br. J. Clin. Pharmacol. 2: 9-17, 1975.

244.
Borland, R. G., and A. N. Nicholson. Immediate effects on human performance of 1, 50-benzodiazepine (clobazam) compared with the 1, 4-benzodiazepines, chlordiazepoxide hydrochloride and diazepam. Br. J. Clin. Pharmacol. 2: 215-221, 1975.

245.
Bortels, H., D. Massfeller, and E. Wedler. Zeitliche und Orliche Variarionen der Atmungs und Garungsintensitat von Saccharomyces-Hefe (abstract). J. Interdiscipl. Cycle. Res. 1: 107, 1970.

246.
Bosworth, D. L., and P. J. Dawkins. The private and social costs and benefits of night- and shift-work (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. IV-1.

247.
Boulos, Z. A. The timing of food availability and the circadian organization of behavior in the rat (Ph.D. thesis). Northeastern University, 1979, 144 pp.

Feeding and drinking behavior of rats maintained in constant light were recorded before, during and after feeding schedules with periods lying within or outside the range of circadian entrainment. Regardless of period, all schedules immediately resulted in the partial or complete synchronization of drinking behavior, but failed to entrain the free-running circadian feeding rhythms. This indicates that drinking can be passively driven by periodic access to food. However, other results suggested that a separate circadian system was entrained by feeding schedules. These results provide evidence for the participation of two distinct circadian systems in the control of behavior in the rat. The two systems appear to have different entrainment characteristics and separate physiological substrates.

248.
Boulos, Z., A. Rosenwasser, and M. Terman. Limited daily access to food drives - but fails to entrain - circadian rhythms in rats (abstract). Soc. Neurosci. Abstr., 3: 161, 1977.

Rats maintained under constant light with free access to food and water showed free-running circadian rhythms of feeding and drinking with periods greater than 24 h. Access to food was then limited to 4 h per day over 3-8 wk, while water remained continuously available. Under the feeding schedule the drinking rhythm rapidly assumed 24-h periodicity, with most of the animals' daily water intake occurring during the feeding segment. When food was subsequently made freely available both feeding and drinking assumed their original free-running periods. However, the phase of these free-running rhythms was not determined by the phase of the preceding food-access schedule. Rather, the rhythms assumed the phase they would have shown had they been free-running throughout the feeding schedule. Under true entrainment (as with light-dark schedules), free-running rhythms would be expected to assume an initial phase set by the preceding cyclic environmental agent. The results indicate that the daily feeding schedule controlled the overt phase of the feeding and drinking rhythms, but did not alter the free-running characteristics of the underlying circadian pacemaker(s). The 24-h periodicity shown during the feeding schedule would seem to result from a temporary uncoupling of the behaviors from their pacemaker(s), allowing ingestion to be passively driven.

249.
Boulos, Z., and M. Terman. Splitting of circadian rhythms in the rat. J. Comp. Physiol. 134: 75-83, 1979.

250.
Box, B., D. Saudino, and G. J. Mogenson. Light-dark rhythms and drinking behavior in the rat. Behav. Biol. 24: 107-112, 1978.

Male Wistar rats were divided into two groups maintained either on a normal lighting schedule with the 12-hr light period from 7 A. M. to 7 P. M. or on a reversed lighting schedule. The intake of water in response to ip injections of hypertonic saline or renin, given at 9 A. M. was found to be approximately equal for both groups, while drinking of a palatable 0.01 M saccharin solution was significantly greater for the group in the dark. The results suggest that the sensitivity of the primary thirst mechanisms does not vary during a 24-hr. day, whereas those controlling secondary drinking are more responsive during the dark period. The relation of these observations to the circadian pattern of water intake in the rat is discussed.

251.
Brady, T. Bio-What? TAC Attack 12: 16-19, 1972.

Of 59 aircraft accidents studied involving pilots, 13 occurred on a critical day for one of the pilots (22% accidents on biorhythmic critical day found, 20.4% expected). The difference was not statistically significant but the study was limited by small sample size.

252.
Brandt, A. Uber den einfluss der Schichtarbeit auf den Gesundheitszustand und das Krankheitsgeschchen der Werktatigen (On the influence of shiftwork on the health conditions and occurrence of illness in workers). Stud. Labor. Salut. 4: 124-152, 1969.

253.
Brandt, A. On the influence of various shift systems on the health of the workers. In: XVI International Congress on Occupational Health, Tokyo, Japan. Tokyo 1971, pp. 105-107.

254.
Braun, R. G. Influence of sociality following isolation on feeding rhythms of monkeys entrained to artificial light schedules. Folia Primatol. 32: 47-64, 1979.

Socialization following a period of isolation disrupted the feeding rhythms of monkeys entrained to artificial light schedules. When isolation was reinstituted, the performances of the subjects, which had shifted during socialization, reverted to profiles similar to but not the same as they were in the initial isolation period. The strength of the social factor may have derived, in part, from the effects of the isolation which preceded the socialization phase.

255.
Breithaupt, H., M. Gehse, G. Hildebrandt, and I. Stratmann. The course of adaptation of the circadian system to night work in night-nurses. Chronobiologia 6: 81, 1979.

In 2 studies on 6 and 7 night-nurses respectively, the daily courses of heart rate, rectal temperature and other parameters were monitored during interpolated 24-h breaks, at varying times within a night-duty period and after a recovery interval. The investigations were carried out under constant conditions in a sound-protected chamber on bed rest and with low-protein diet.

The temporal shifts of the circadian acrophase, and the amplitude and frequency modulations of the daily courses were analyzed and presented in relation to the individual circadian phase position.

256.
Breithaupt, H., G. Hildebrandt, D. Dohre, F. Josch, U. Sieber, and M. Werner. Tolerance to shift of sleep, as related to the individual's circadian phase position. Ergonomics 21: 767-774, 1978.

257.
Breithaupt, H., G. Hildebrandt, and M. Werner. Circadian type questionnaire and objective circadian characteristics In: Int. Symp. on Night- and Shift-work, 5th, Rouen, France, 1980, p. VIII-1.

258.
Brictson, C. A. Methods to assess pilot work load and other temporal indicators of pilot performance effectiveness. Neuilly-sur-Seine: NATO, Adivsory Group for Aerospace Research and Development, AGARD-CP-217, 1977, pp. B9-1 - B9-7.

259.
Brictson, C. A., W. McHugh, and P. Naitoh. Prediction of pilot performance: biochemical and sleep-mood correlates under high workload conditions. In: Simulation and Study of High Workload Operations, edited by A. N. Nicholson. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-146, 1974, pp. A13-1 - A13-10.

Because of their great theoretical and practical value, studies of the factors affecting pilot performance have interested flight surgeons and aviation psychologists for a number of years. Identification of the skills and factors involved in operating high performance aircraft would facilitate the rational design of successful training programs and would permit the development of selection procedures to assure efficient use of such training. In addition, knowledge of the factors and skills involved in pilot performance could lead to greater safety and efficiency of air operations.

260.
Brigoink, G. M. The safety role of regulatory, corporate and personal initiatives in the 1980's. Forum - Int. Soc. Air Safety Investigators 13: 26-28, 1980.

261.
Brockway, B. The 48-hr day simulated by the lighting regimen in the context of related spectral studies on human beings. Chronobiologia 4: 102-103, 1977.

262.
Brockway, B. P., M. Kaveh, E. W. Powell, L. E. Scheving, and F. Halberg. Transient partial frequency demultiplication of intraperitoneal temperature rhythms in Fischer rats by desynchronization with 48-h cycles of lighting and feeding (abstract). Chronobiologia 5: 343, 1978.

Eight singly housed male inbred Fischer rats, of which 2 were subjected to a sham-operation and 6 to an intended lesioning of the suprachiasmatic nucleus, were desynchronized with food (F) and light (L). Light and darkness alternated at 24-h intervals; food was available during the first 8-h of darkness. A combined autoregressive-linear-non-linear least-squares analysis revealed for all animals a statistically significant dicircadian (about 48h) rhythm, while 7 of these same rats showed also a circadian rhythm

($p < 0.05$ level), which in 6 rats was more prominent than the dicircadian component. These series demonstrated an average dicircadian-circadian amplitude ratio of 1.0 + 0.2. The magnitude of this ratio changes with time in individual rats, contributing data over several weeks. On a regimen of LD 12:12 with food and water freely available, 7 sham-operated rats showed a ratio of 0.22 + 0.01. Disynchronization with a 48-h "day", if possible, awaits tests of possible applications in fields as diverse ychiatry (sleep deprivation advocated as therapy), cancer c erapy (to prolong chronotolerance), and aging.

263.
Brooks, J. Bio-rhythms. Argosy, Sept., 1974.

This article discusses the application of biorhythm cycles to the prediction of the outcome of automobile races. The predictions are limited by small sample size and the flexibility of the interpretations of the relation between driving performance and biorhythm phase.

264.
Broughton, R. Biorhythmic variations in conciousness and psychological functions. Can. Psychol. Rev. 16: 217-239, 1975.

Indices of concious awareness of external and internal events exhibit both ultradian approximately 90 - 100 min (in adulthood) and circadian 24-hour variations. The phylogenetically older ultradian rhythm represents the basic rest-activity cycle (BRAC) OF Kleitman, is continuous, and appears to contain alternation of mental activity of thought-like and fantasy type at this periodicity in wakefulness and in NREM and REM SLEEP. This suggests continuous cyclic alternation of relative predominance of the left and right hemispheres inherent in the BRAC. Super-imposed circadian fluctuations of conciousness in a diurnally active adult typically show lowest levels in the first hours after usual sleep onset and a later dip at about 5:00 - 6:00 a.m., if the person remains awake.

After a night of sleep, daytime consciousness and performance improve in the morning, usually show an early afternoon "post-lunch dip", a sustained increase in the late afternoon and early evening, and a decrease before sleep onset. It is postulated that cortical, mainly prefrontal, hyperpolarization in NREM sleep resets the cortex for renewed high-level perceptual awareness the next day. Consciousness is not a static attribute but shows definite biorhythmic fluctuations in level and type.

265.
Broussard, G. Bioritmi e stress lavorativo. (Biological rhythms and stress arising as a result of work). Minerva Med. 63: 3919-3924, 1972.

Biological rhythms and stress arising as a result of work. Consideration is primarily given to biological rhythms with a 24-hr period. These endogenic rhythms are influenced by habit and by environmental factors. Intercorrelations and interdependences alike are governed by the hypothalamus. This organ receives both endogenous and exogenous stimuli and acts by means of a complex neurohumoral and nervous mechanism. Particular importance is attached to adrenal excretion rhythms, primarily with respect to causes of stress.

266.
Browman, C. P., and D. I. Tepas. The effects of presleep activity on all-night sleep. Psychophysiology 13: 536-540, 1976.

The effects of different presleep activities on all-night sleep were assessed. Nine young adult males engaged in brief periods of progressive relaxation (Relaxation), light dynamic exercise (Exercise), or a boring monotonous vigilance task (Vigilance) immediately before bed on consecutive nights. Standard electrophysiological data were recorded during the 7.5 hrs of sleep. The latency of sleep onset was shortest after Relaxation and longest after Exercise. Presleep heart rate and electromyograph levels were not related to sleep onset. Sleep stages were not differentiated by condition and no sleep parameter differed from normative data. The results suggest that it is possible to alter sleep latency by manipulating presleep behavior without disrupting the normal sleep pattern.

267.
Brown, B. R. and B. B. Morgan, Jr. Interaction of the circadian rhythm with the effects of continuous work and sleep loss. In: Proc. of the 7th Annual Meeting of the Human Factors Society, edited by M. P. Ranc, Jr. and T. B. Malone. Santa Monica, CA: Human Factors Soc., Inc., 1973, pp. 433-439.

268.
Brown, B. R., B. B. Morgan, and H. J. G. Zwaga. The effects of continuous work and sleep loss on time-sharing aspects of sustained performance. Annual Meet. Psychonomic Soc., 13th, St. Louis, 1972, 99 pp.

Ten Ss were required to time-share the concurrent performance of as many as five different tasks (watchkeeping, arithmetic computations, target identification, group probvlem solving) during a 48 h continuous work period. Overall performance efficiency was severely impaired after 40 h of continuous work. For certain task combinations, however, Ss' adoption of more efficient time-sharing strategies during the stress period reduced the magnitude of performance deterioration.

269.
Brown, D. Shiftwork: a survey of the sociological implications of studies of male shiftworkers. J. Occup. Psychol. 48: 231-240, 1975.

The literature on the physiological and psychological effects of shiftwork is now readily available to the researcher interested in the effects of shiftwork on male employees (Walker, 1970; Sergean, 1971). This paper reviews some of the insights that social psychological and sociological approaches to shiftwork have offered.

270.
Brown, D. Shiftwork among women: some preliminary observations. Ergonomics 21: 870, 1978.

Interviews in one hospital with 18 nurses and in one factory with 11 women making boxes suggest that the problems for women on shift-work are not as acute as usually predicted. Respondents consistently reported facilitated dual role performance rather than greater interference by work with their other important areas of social activity.

The hospital system was distinguished by: permanent and self-selected night staff; duty rosters worked out for individual work groups and allowing for preferences for not working particular duties; and day nurses who worked a double day system involving both early and late turns each week. Nurses evaluated this system positively and commented on the convenient hours of shifts and the in-built flexibility. Day nurses indicated that the mix of shifts in the week gave a valued balance between the harder but more interesting early shifts, and the easier afternoon shifts which allowed morning lie-ins.

The factory women predominantly had long experience of their three shift continuous system, which involved nights every third week , but still positively evaluated their jobs. There was, however, a shortage of jobs for women in the area.

Three groups appeared to use shiftwork consciously to solve problems in their out-of-work life : those who used shifts to match work time with that of their husband or boyfriend; married women with children who chose shifts to allow them to work out a system so that their children were looked after by one of their parents rather than anyone else; and divorced and widowed mothers who chose shiftwork/night work to allow them to earn enough to meet their financial commitments.

271.
Brown, F. A. Interrelations between biological rhythms and clocks. In: Aging and Biological Rhythms, edited by H. V. Samis and S. Capobianco. New York: Plenum Press, 1978, pp. 215-234.

The concept of extrinsic timing of the biological clock system proposed here, with much recent evidence of its support, provides an explanation of the uncanny precision of rhythms not only over single cycles but over long series of consecutive cycles. Circadian rhythms have been monitored for many months, monthly cycles for more than two years, and annual ones for more than three years in unvarying Zeitgeber fields. Readiness to accept even one autonomously timed cycle, difficult as it is for biologists at large, becomes intolerably difficult for series lasting even years in organisms deprived of all cues. This concept provides an explanation not only of this astounding rhythm stability but also of all their other numerous remarkable properties including the small effects of diverse factors on free-running periods. This concept does not deny, indeed even demands, a complex and sophisticated dynamic molecular organization of life that must be resolved (Brown, 1976). This organization, as basic as life itself, is capable of pulsing in response to the pervasive ambient atmospheric environment. The resolution of the clock mystery will demand the cooperation of scholars ranging the spectrum from molecular biologists and biophysicists through physiologists and biogeophysicists.

272.
Brown, F. M. Viability-rate factors suggested for experimental rodents under altered 24-h. lighting regimens. Chronobiol. 4: 103, 1977.

273.
Brown, I. D. Practical considerations in applying experimental findings, and methods of evaluation. Ergonomics 2: 872, 1978.

Laboratory and field studies of the long-distance driver have identified a number of problem areas from which accidents may be generated. Attention, perception and decision skills appear particularly vulnerable to the effects of prolonged driving. These adverse effects are attributable not only to the task, the vehicle and the environment, but also to a number of organisational and social factors.

A good deal of information on these factors has accumulated from studies of night and shift work carried out in other contexts. This paper reviews the potential application of such findings to the specific problem of accident reduction among long distance drivers.

Particular consideration is given to the practical application of the resulting accident countermeasures among professional truck drivers. The paper adopts an epidemiological approach, addressing itself to the relative potential for improvement within the man, the

vehicle and the traffic environment, in relation to the different types of operating schedules worked within the industry.

274.
Browne, R. C., The day and night performance of teleprinter switchboard operations. Occup. Psychol. 23: 121-126, 1949.

275.
Brownley, M. W. and C. E. Sandler. Biorhythm - an accident prevention aid? Proc. of the Annual Meeting of the Human Factors Society, 21st, San Francisco, CA, pp. 188-192, 1977.

Review of the literature concerning the relationship of biorhythm theory to human error accidents indicates there is much inconsistency. This study attempted to resolve some of the existing variability through careful selection and statistical analysis of a driver-error subject population. Fatalities involving 506 U. S. Naval off-duty personnel were examined. Birth dates were compared with accident dates to determine if the differences between observed and expected accident frequencies were significant. No chi-square values were found to be statistically significant at the 0.05 level. It was concluded that biorhythm is not a useful accident prevention aid. Inconsistency in human error research will continue to be reported until experimenters more precisely define birth and accident times and combine this information with more rigidly designed research methodology.

276.
Bruce, U. G. Environmental entrainment of circadian rhythms. Cold Spring Harbor Symp. Quant. Biol. 25: 29-48, 1960.

277.
Bruener, H., D. Jovy, K. E. Klein, J. P. Marbarger, A. Rimpler, and H. M. Wegmann. Effects of transmeridian flights on the diurnal excretion pattern of 17-hydroxycorticosteroids. Aerospace Med. 41: 1003-1005, 1970.

278.
Bruener, H., K. E. Klein, and H. M. Wegmann. The effect of flight stresses on several blood components. Int. Z. Angew. Physiol. Einschl. Arbeitsphysiol. 23: 293-304, 1967.

279.
Bruener, H., K. E. Klein, and H. M. Wegmann. Impairment of pilot efficiency by alcohol and drugs. An attempt to deduce standard limits from experimental results. Wehrmed. Monatsschr. 13: 193-199, 1969.

280.
Brunsgard, A. Shift work as an occupational health problem. In: On Night and Shift Work, edited by A. Swensson, Stockholm, National Institute of Occupational Health, pp. 9-14, 1970.

281.
Bruss, R. T., E. Jacobson, F. Halberg, H. A. Zander, and J. J. Bittner. Effects of lighting regimen and blinding upon gross motor activity of mice. Fed. Proc. 17: 21, 1958.

282.
Bryden, G. and T. L. Holdstock. Effects of night duty on sleep patterns of nurses. Psychophysiology 10: 36-42, 1973.

The diurnal sleep patterns of female nurses working night duty were compared to their nocturnal sleep patterns while they were working regular hours during the day. Continuous EEG, EOG, and EMG recordings were made at the end of 2 month periods of night and day duty respectively. Day and night sleep differed with respect to both duration and pattern. Despite an earlier onset, the major sleep period was shorter during the day than the night and seemed to be more interrupted later in the session. This finding is in keeping with the increased amount of Stage 1 and decreased amount of slow wave sleep during the day than the night. Although no differences were evident with respect to overall percent REM, differences in the distribution of REM did occur. REM sleep occurred sooner during day than night sleep and there was more of it during the first part of day sleep. Thus night duty seemed to affect the pattern of sleep stage distribution as well as the absolute amount of, not only total sleep, but also some sleep stages, such as Stage SS. It is an open question how the naps of extended duration taken while on night duty influence the pattern of sleep during the day.

283.
Buchsbaum, M. S. The chemistry of brain clocks. Psychol. Today 12: 124, 1979.

284.
Buck, L. Sleep deprivation effects on accuracy and speed of response selection and execution. Canada, Natl. Res. Council, Div. of Mech. Eng. and Natl. Aeronautical Estab. Quarterly Bull. 2: 1-7, 9-12, 1973.

Ss performed a subject-paced step-tracking task after zero, one and two nights without sleep. Their performance compared to performance when following a similar regime with normal sleep showed no change in accuracy but a progressive reduction in speed. Movement times increased with sleep loss and reaction times increased to an amount dependent on signal probability.

285.
Buck, L. Sleep loss effects on movement time. Ergonomics 18: 415-525, 1975.

Subjects were tested on a subject-paced step-tracking task three times every four hours under both of two regimes: one in which they slept for 6:30 hours at night and one in which they remained awake. 12 subjects werre tested for two days under each condition, and 8 subjects for three days. Reaction times for correct responses increased following sleep loss to a much greater extent. It is concluded that movement time is a more sensitive index of performance deterioration due to sleep loss and that movement time and reaction time represent separate processes.

286.
Buck, L. Psychomotor test performance and sleep patterns of aircrew flying transmeridianal routes. Aviat. Space Environ. Med. 47: 979-986, 1976.

Pilots and flight attendants flying scheduled services between Vancouver and Tokyo and between Toronto and Rome were tested on a tracking task before and after flights in each direction. Flights were included in schedules involving both 24-h and 7-d layovers at the overseas station. During these periods, they recorded their sleep patterns. The data showed that, following flight, subjects made an immediate attempt to adapt their behaviour to local time and the changes in their performance scores could be interpreted on that basis. It was concluded that behavioural circadian rhythms adapt rapidly to a new time zone.

287.
Buck, L. Circadian rhythms in step-input pursuit tracking. Ergonomics 20: 19-31, 1977.

Subjects performed a step-input pursuit tracking task at regular intervals over two days. Performance varied with time of day in a manner and to an extent dependent upon the choice of index so that circadian rhythms for speed scores were in inverse phase with those for accuracy scores. Presence or absence of knowledge of results made no significant difference to the time of day effect but increased short term memory demands disturbed the movement time rhythm supporting the hypothesis that psychomotor and short/term memory functions vary in inverse phase with time of day.

288.
Buck, L., and C. B. Gibbs. Sleep loss and information processing. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep (Proc. of the Symp., Strasbourg, FR., 1970.), edited by W. P. Colquhoun. London: English Univ. Press, 1972, p. 47-58.

289.
Buck, L., and R. Leornardo. Circadian rhythm in performance on the NRC stressalyser. Canada, National Research Council, Division of Mechanical Engineering and National Aeronautical Establishment, Quarterly Bulletin 2: 11-21, 23-31, 1975.

Forty subjects followed schedules of self-administered tests on the NRC STRESSANALYSER over a period of three days. Performance varied systematically according to time of day of testing, with the circadian rhythm more evident for movement times than for reaction times. The rhythm of accuracy scores was out of phase with that for speed scores, with performance being slowest but most accurate early in the waking day.

290.
Bugard, P., et al. Stress, fatigue et depression dans la vie quotidienne (Sress, fatigue and depression in everyday life). Paris: Editions Doin, 2 volumes, 1974, 295 and 302 pp.

General study of stress, fatigue, asthenia and depression in everyday life. Contents: Vol. 1: muscular fatigue; sensorial fatigue; stress and fatigue; nervous, mental fatigue; ergonomics and fatigue; case studies; fatigue in nuclear plants; stress and fatigue in air pilots and cosmonauts; methods of studying stress and fatigue; Vol. 2: traumatic neuroses (e.g. due to occupational accidents); neurophysiology of stress; various aspects of urban fatigue (asthenia, depression); mechanisms of pathogenic relationships (occupational medicine and fatigue, mental health and work, etc.); prevention and treatment of stress, fatigue and asthenia, etc. Some of the chapters and sections are of direct concern to the plant physician (mental fatigue and working environment; fatigue due to vigilance tasks), and give case studies illustrating the points covered; heat-exposed workers; vigilance required of train drivers, bank employees, radio and television workers; stresses in the work of air-traffic controllers, personnel of 'hot' laboratories in nuclear plants, workers on assembly lines or performing fragmented or repetitive work.

291.
Bugge, J. F., P. K. Opstad, and P. M. Magnus. Changes in the circadian rhythm of performance and mood in healthy young men exposed to prolonged, heavy physical work, sleep deprivation, and caloric deficit. Aviat. Space Environ. Med. 50: 663-668, 1979.

There were 18 young men who participated in a ranger training course in June 1978 with more than 100 h continuous activities, almost without sleep. The subjects used about 10,000 k cal/d and their food intake gave only about 1,600 kcal/d. Changes from circadian rhythm in performance and mood were studied once in the week before the course, on the first and last day of the course, and once in the week after the course. The subjects were tested at 4-h intervals. Significant and substantial impairment were observed in all tests, as well as in mood during the course (more pronounced on the last). The impairment was mainly in reduced capacity, although there were minor increases in errors. The oscillations in circadian rhythm during baseline and recovery were small ($\pm$10% of the 24-h mean), with a tendency to have low values in the early morning. The oscillation increased during the course to 20-40% of the 24-h mean; the tendency was to increase the fluctuations of the natural circadian rhythm with a crest in the afternoon and a trough in the early morning. The profile of mood-state showed similar fluctuations and was highly correlated to performance. After 4 d of rest, there was complete restitution of performance and mood in our tests.

292.
Burstein, G. The Relationships Between Biorhythms and Perceived Emotional States (abstract). (Ph. D. Thesis). California School of Professional Psychology, Diss. Abstr. 36: 5781B, 1976.

Five families (n=21) completed daily rating scales (range 1-3) on quality of emotional state and quality of family interaction. The #1 and #3 ratings were correlated to their occurrences on biorhythmic critical days. For both rating scales in the adults, but not the minors, significant correlations were obtained between rating scales 1 and 3 and biorhythm critical days. The most significant correlation was obtained with the 28 day emotional cycle. The 33 day cycle did not demonstrate significant correlations. Accidents recorded by participants fell more frequently on critical days than expected. The author concludes that 23 and 28 day biorhythmic cycles significantly affect human performance and perceived emotional states. However, the use of simplified rating scales, the use of simple correlational statistics rather than time series analysis, and the possibility of results influenced by suggestibility (not excluded in abstract) diminish the validity of the authors' conclusions.

293.
Buttery, T. J. The influence of biorhythms on human physical, emotional, and intellectual behavior. Education 98: 117-121, 1977.

This review article on the Fliess' biorhythm theory cites evidence connecting biorhythmic cycle phases to accidents and performance but cautions that the theory lacks a substantive research base and is limitied by the supposed invariability of the 23, 28 and 33 day cycles. The author suggests that biorhythm theory may be applicable to teaching children with learning disabilities by timing instruction to biorhythm phases when they are more receptive to learning.

294.
Buttery, T. J., and W. F. White. Student teachers' affective behavior and selected biorhythm patterns. Percept. Motor Skills 46: 1033-1034, 1978.

A group of 20 female teachers filled out semantic differential technique tests twice a week for 7 weeks. Scores were compared with high and low phases of the 28 day emotional biorhythm cycle using the test. Significant differences between the high phase and the low phase of the 28 day cycle for three measured factors were obtained, indicating significant modification in affective ratings occurred during the high-low phases of the emotional biorhythm cycle. This study's findings are limited by small sample size and limited sampling rate, as well as the lack of more sophisticated analyses (regressional, chi square or time series analysis).

295.
Buxton, C. Scientists tune in to biorhythms. San Jose News, May 5, 1975.

This article cites the finding of biorhythm type periodicities in performance tests by D. Neil and the use of biorhythm in marital counseling by W. Yabroff. These psychologists, however, state that the commercial use of biorhythm to plan daily activities is "dangerous and highly unethical".

296.
Cabanac, M. Temperature regulation. Ann. Rev. Physiol. 37: 415-439, 1975.

297.
Cabanac, M., G. Hildebrandt, B. Massonnet, and H. Strempel. A study of the nycthemeral cycle of behavioural temperature regulation in man. J. Physiol. 267: 275-291, 1976.

298.
Caille, E. J. Fractionnement suivant le rythme de base et alternance optimale. Int. Cong. Aviat. Space Med., 21st, Munich, 1973, preprints p. 81-82.

299.
Caille, E. J., and Bassano, J. L. Biorhythm and watch rhythms: hemeral watch rhythm and anhemeral watch rhythm in simulated permanent duty. In: Vigilance: Theory, Operational Performance and Physiological Correlates, edited by R. R. Mackie. New York: Plenum Press, 1977, pp. 461-509.

The simulation of a 30-day submarine submersion with a volunteer crew of 24 men provided the framework for a comparison between two work/rest cycles within a crossover balanced design: a 72-hour period rhythm, as practiced in the Navy, with 4 hours of sleep shifting or sleep splitting in cyclic transposition for each third part of the crew; and a 24-hour period rhythm, with permanent 8 hours or 16 hours of sleep shifting for each third part of the crew. The strong advantage of the second alternative compared to the first is evidenced in the sleep process, behavioral efficiency, mood, and circadian biochemical parameters.

300.
Caille, E. J. P., A. M. Quideau, J. F. J. Girard, J. C. Grubar, and A. C. Monteil. Loss of sleep and combat efficiency: Effects of the work/rest cycle. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep (Proc. of the Conf.), edited by W. P. Colquhoun. London: English Universities Press, 1972, pp. 177-193.

A 64 hours to 72 hours sleep loss did not severely impair the fighting capabilities of a small volunteer group of well trained and well motivated enlisted men. Only long-term memory and decision making proved to be very sensitive to such a deprivation. Between-subject differences were brought out particularly clearly when 2 x 12, 1 x 6 and 6 x 4 work/rest cycles were followed; these differences were more marked during night-work than during day-work.

Consequently, if the military authorities require the members of a group to display homogeneous capabilities, it would be advantageous to adopt a 3 x 8 work/rest cycle, since this minimizes the between-subject differences. If, however, there is a requirement for men who are able to sustain high levels of performance when working either on 2 x 12, 2 x 6 or 6 x 4 cycles, it is recommended that individuals should be selected according to the psychological and physiological

criteria described in the present investigation, which have been shown to be statistically reliable.

301.
Caillot, R. Consequences sociales du travail a feu continu. Econ. Hum. 122: 62-72, 1959.

302.
Cameron, C. Fatigue problems in modern industry. Ergonomics 14: 713-720, 1971.

303.
Cameron, C. A theory of fatigue. Ergonomics 16: 633-648, 1973.

304.
Candelario, G. The Relationship of Biorhythms and Student Behavior: Critical Days, Physical, Emotional, and Intellectual Biocurves and Their Influence On High School Students' Behavior At The Time Of Suspension From School. (Ph.D. Thesis). Michigan State University, 1977.

Chi-square analysis was made of the self-initiated suspension dates of 141 high school students with respect to biorhythmic critical days or biorhythmic cycle low phases. No significant relationship was found between suspension dates and critical days or biorhythmic high or low phases. The author concludes that the popular biorhythm theory of Thommen and Gittelson is without merit.

305.
Cantrell, G. K., et al. Long-term aircrew effectiveness. A literature study. (Work environment and task factor effects on long term aircrew effectiveness.) Brooks AFB, Tex.: School of Aerospace Medicine, SAM-TR-71-41, 1971, 15 pp.

306.
Caplan, R. D., S. Cobb and J. R. P. French, Jr. White collar work load and cortisol: disruption of a circadian rhythm by job stress? J. Psychosom. Res. 23: 181-192, 1979.

Perceived white collar work load was studied as a determinant of cortisol, an adrenal hormone with a pronounced circadian rhythm. Two hundred male NASA employees in administration, engineering and science, mean age 40, completed self-report questionnaires and gave blood samples. Respondents were grouped according to the time of day when their blood was sampled and were grouped into high, medium and low tertiles on an index of subjective quantitative work load. There was no main effect of work load on mean cortisol. There was a significant effect of level of work load on the relationship between time of day sampled and cortisol. High work load employees showed lower than normal morning cortisol values and did not show the expected decrease in cortisol from morning to afternoon. Low work load employees showed the expected circadian rhythm. We test two

hypotheses which may further explain the results--(1) job satisfaction mediates the effect of work load on circadian rhythm and (2) personality traits produce self-selection into high work load environments - and discuss other interpretations.

307.
Carandente, F. Experimental research in the rat using chronobiologic methods simulating various work shifts of man. Ann. Ist. Super Sanita 13: 491-7, 1977.

308.
Carandente, F., and F. Halberg. Chronobiologic view of shift work and ulcers. In: Shift Work and Health, A Symposium, 1975, Cincinnati, Ohio. U. S. Department of Health, Education, and Welfare, 1976, pp. 273-283.

309.
Carandente, F., F. Halberg, D. Sutherland, K. Kawahara, R. B. Sothern, P. Gorecki, P. Ernsberger, E. Haus, and G. Pozza. Circadian ecphasia and other thermal and urinary dyschronism following schedule shifts in association with murine diabetes mellitus (abstract). Chronobiol. 6: 86, 1979.

Adult female inbred Lewis rats kept in continuous light (1), more or less synchronized in frequency by cyclic human activities were transferred to a regimen of L and darkness (D) alternating at 12-h intervals in single cages at a room temperature of 24°C, with food and water ad libitum. Under ether anesthesia, a temperature transensor was implanted in healthy rats and rats rendered diabetic by the administration of streptozotocin. Some of the diabetic rats were left untreated; casual blood sampling showed gross hyperglycemia. Other rats were treated by pancreatic grafts from ethionine-prepared donors, either isografts in rats of the Lewis strain or allografts of the pancrease from inbred Fisher rats transplanted to Lewis rats. Intraperitoneal temperature was telemetered by 10-min. intervals for 3 weeks following transplanation. Urine volumes were determined from rats in metabolic cages. Data were analyzed rhythmometrically. Following sensor implanation and transfer to an LD 12:12 regimen, the adjustment of the thermal acrophase consistently near the middle of the daily dark span occurred within approximately 7 days in healthy rats and in streptozotocin-diabetic rats cured by an isograft. Thermal acrophase adjustment was slower for animals rendered diabetic by streptozotocin and left untreated or for animals thus rendered diabetic which had rejected a pancreatic allograft (as documented by hyperglycemia in casually sampled blood). The eventual synchronization of the circadian temperature rhythm of allografted rats differed from one rat to the other and, for some allografted animals, from the consistent synchronization of the circadian rhythm in telemetered intraperitoneal temperature of 1. diabetic and 2. non-diabetic Lewis rats. The acrophase of the circadian rhythm in urine volume of healthy rats or of a rat with a pancreatic isograft (which cured a prior streptozotocin-induced diabetes) differed with statistical significance from that of rats with untreated diabetes, some in the state after the rejection of a pancreatic allograft.

Tests of synchronizability are indicated in human as well as murine diabetes mellitus.

310.
Carandente, F., et al. Access time to water, overriding lighting regimen, synchronizes circadian rhythm in telemetered intraperitoneal temperature of ad-libitum fed mice. Chronobiologia 2: 12, 1975.

311.
Carpentier, J. Le Travail par Equipes Successives (Shift Work). Paris, France: Institut National de Recherche et de Securite, Edition INRS N. 523, 1975, 34 pp.

Intended for readers in industry, this booklet takes stock of present knowledge on shift and night work: general remarks; consequences of shift work for health (biological rhythms, sleep, nutrition, nervous effects, fatigue); consequences for everyday life (role of the individual within the family, participation in family activities); consequences for working life (productivity, errors, accident), economic aspects (consequences for the individual, the undertaking, society). Recommendations on setting a shift work system and the timetables so as to minimize the deleterious effects of shift work. The non-physiological character of shift work and the individual, family and social upheavals to which it gives rise justify its limitation, as well as that of night work.

312.
Carriero, N. J. Physiological correlates of performance in a long duration repetitive visual task. In: Vigilance: Theory, Operational Performance, and Physiological Correlates, edited by R. R. Mackie. New York: Plenum Press, 1977, pp. 307-330.

313.
Carruthers, M., A. E. Arguelles, and A. Mosovich. Man in transit: biochemical and physiological changes during intercontinental flights. Lancet 1: 977-980, 1976.

314.
Carskadon, M. A., and W. D. Dement. A 90-minute schedule of sleep and wakefulness (abstract). Sleep Res. 4: 156, 1975.

315.
Carskadon, M. A., and W. C. Dement. Sleep studies on a 90-minute day. Electroenceph. Clin. Neurophysiol. 39: 145-155, 1975.

After 2 adaptation and 2 baseline all-night sleep recordings, 5 normal young adult subjects (3 males) were placed on a schedule alternating 60 min of wakefulness and 30 min of sleep for 5 1/3 24-h periods. A 2-day recovery period followed: One male subject (MA_{15}) was later placed on the identical protocol with the exception that he was allotted periods of 75 min of wakefulness and 15 min of sleep

during the experimental period. One male narcolepsy cataplexy patient was placed on the 60-30 schedule for 48-h.

All subjects showed REM sleep during the schedule manipulation. REM sleep occurred within 10 min of sleep onset (SOREMP) on 79 of 110 REM sleep occasions on the 5 normals, on all 29 REM episodes in MA_{15}, and on 16 of 17 REM periods in the narcoleptic. In the normals, REM sleep showed a tendency to recur on alternate 90-min cycles, while in the narcoleptic REM recurred on consecutive periods. Compared to baseline, REM sleep 24-h was decreased in the normals and increased in the narcoleptic.

Time spent in slow wave sleep and stage 2 was also reduced in the normal subjects on the 90-min schedule, and stage 1 sleep time was increased . Peak sleep times for the 5 normals occurred between 09.00 and 12.30 and lowest sleep times from 21.00 to 02.00. During the first recovery night, sleep times ranged from 11.5 to 18.5 h, including significant increases of slow wave sleep and REM sleep. Except for SOREMPs, no signs of the narcolepsy-cataplexy syndrome was seen in any of the normal subjects.

316.
Carskadon, M. A., and W. C. Dement. Sleepiness and sleep state on a 90-min schedule. Psychophysiology 14: 127-133, 1976.

317.
Carugati, F., et. al. The effect of alteration of the circadian rhythm on some psychic functions in a group of state railways workers. Bolletino di Psicologia Aplicata, 103-105: 79-91, 1971.

318.
Carvey, D. W, and R. G. Nibler. Biorhythmic cycles and the incident of industrial accidents. Personnel Psychology 30: 447-454, 1977.

This paper examines empirically the biorhythm theory of accident explanation that has been increasingly popularized in the business press. Data were used from cases of municipal employees adjudged to be at fault in 150 work related vehicular accidents and municipal employees involved in 210 on-the-job accidents. Results show no systematic relationship between biorhythmic critical days or cycle high and low points and accident occurrence. The data were also evaluated stepwise for cycles other than the biorhythm periods. No useful level of association existed for any cyclic combination investigated. It is concluded that while other groups or events may exhibit measureable cyclic patterns, it seems likely that the relationships are more complex than a simple association such as that posited on the basis of biorhythm theory. Note: this is the only paper in the literature which has attempted to examine a possible relationship between accidents and cycles other than the 23, 28 and 33 day biorhythm cycles.

319.
Case, J. Predictive Powers in Bio-Rhythm Analysis in the Performance of Football Players. Missouri Southern State College, Joplin, Mo., 1972.

The performance of 24 college football players was rated in 6 categories on a ten point scale every day for 27 days. A close correspondence was found between performance and biorhythm individual cycle curves. In the final spring practice game, biorhythmic predictions of player performance were 60% accurate. Biorhythm charts were drawn for 38 players in 1972. A prediction of individual performance based upon biorhythm calculations was given to the coach prior to each game. Post game evaluations of each players' performance revealed the biorhythmic prediction to be accurate in 77% of cases. It was also found that 69% of football injuries occurred on biorhythmic critical days. The validity of these studies is seriously limited by the use of short sampling intervals, lack of any time series or statistical analysis, and the possible influence of suggestive influences by the coach on player performance.

320.
Catalano, G. T., C. M. Winget, A. Laursen, H. Sandler, C. W. DeRoshia, and J. Reitman. A measurement of motor activity during bedrest and ambulation. Proc. San Diego Biomedical Symp., San Diego, 1977, pp. 375-385.

321.
Catalano, G. T., C. M. Winget, H. Sandler, C. W. DeRoshia, P. J. Haro, and S. Davidovich. Averaging methods of measuring motor activity and its relationship with drug disposition and heart rate. Association for the Advancement of Medical Instrumentation, August 1977 (abstract).

322.
Catlett, G. F., and G. J. Kidera. Detection and management of latent diabetes in commercial pilots. Aerosp. Med. 37: 545-551, 1966.

323.
Cayman, L. Prevalence of shift work in Belgium. Ergonomics 21: 871, 1978.

The extent of shift work in Belgium is surveyed in two ways: first, by considering the number of companies in which it has been adopted and secondly, by examining the proportion of shift workers in the total work force of these companies. The incidence of shift work in different manufacturing and service branches of industry is reviewed, and related to sex and to individual occupation. The organization of shift work into two-shift, semi-continuous, continuous and other shift systems in the various sectors is also described.

324.
Cervinka R., M. Haider, M. Koller, and M. Kundi. Psychophysiological and psychosocial studies on female shift- and day-workers (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. VIII-2.

325.
Chaffin, R. and J. Skadburg. Effect of scoring set on biorhythm data. J. Appl. Psychol. 64: 213-217, 1979.

Biorhythm theory predicts that people are more likely to have accidents on critical days in their biorhythm cycles. In experiment 1, the hit rate, defined as the percentage of accidents occurring on critical days for 410 single individual industrial accidents was above chance level when the data were scored by conventional visual inspection but did not differ from chance when an error-free numeric method was used. The hit rate for control data, created by randomly pairing the accident dates and birth data in the experimental data, was also above chance level for the visual inspection method and at chance level for the numeric scoring method. Experiment 2 showed that the bias in the visual inspection method was due to the scoring set of looking for hits rather than due to bias in favor of the experimental hypothesis. Nine undergraduate students used the visual inspection scoring method; however, they were told only that the purpose of the experiment was to see how accurately they could read the curves. The hit rates were similar to those for the visual inspection method in experiment 1. It was suggested that the above-chance hit rates of other investigators could be attributable to a similar scoring bias.

326.
Chambers, A., and H. C. Vykukal. The effects of bed rest on crew performance curing simulated shuttle reentry. Moffett Field, CA.: NASA, NASA TN D-7504, 1974, 33 pp.

327.
Chambers, A. B., and H. C. Vykukal. A study to determine the effects of bed rest on pilot performance and physiological responses during simulated space shuttle reentry. Aerospace Med. Assoc., Preprints pp. 139-140, 1975.

328.
Chan, J. Biorhythm: Charting your ups and downs. McCalls 105: 55-56, 1978.

329.
Chapek, A. V. Some psychophysiological causes of flight accidents and measures for ensuring flight safety in civil aviation. Kosm. Biol. Aviakosm. Med. 8(4): 39-43, 1974.

This paper discusses the reasons for flight accidents associated with personality factors of crew members and ground controlpersonnel. The psychophysiological mechanisms of certain erroneous actions of the pilot and controller in an emergency situation are discussed. Some safety measures are suggested.

330.
Chapman, L. F., C. Winget, D. Rockwell, and J. Vernikos-Danellis. EEF changes following prolonged social isolation. Aerospace Med. Assoc., Preprints, p. 262, 1975.

331.
Chase, M. Relationship Between Selected Biological Rhythms and Performance of Professional Women Golfers. (Ph.D. Thesis). University of Utah, 1976.

The competitive golf scores of 26 participants on the Ladies Professional Association circuit above and below each competitors median were tabulated according to biorhythm phase and critical day period of each cycle. Analysis of the data by chi square designs showed no significant relationships existed between phases of physical, emotional intellectual or any combination of these cycles and golf scores. In addition, no significant relationships were found between golf scores and biorhythm critical days.

332.
Chatelier, G., P. Galban, M. Gouars, and M. Guillermin. Influence de certains facteurs d'environnement (hypoxie, decalage horaire, sonic boom) sur l'apprentissage et la performance a differents tests. Rev. Med. Aeronaut. Spat. 47: 484-487, 1973.

333.
Chavarri, M., A. Ganguly, J. A. Luetscher, and P. G. Zager. Effect of bedrest on circadian rhythms of plasma renin, aldosterone, and cortisol. Aviat. Space Environ. Med. 48: 633-636, 1977.

334.
Chazalette, A., Une etude sur les consequences du travail en equipes alternantes et les facteurs explicatifs. Lyon: Groupe de Sociolgie Urbaine, 1973.

335.
Chernik, D. A. Effect of REM sleep deprivation on learning and recall by humans. Percept. Mot. Skills, 34: 283-294, 1972.

336.
Chernik, D. A., and J. Mendels. Sleep reversal: disturbances in day-time sleep patterns. Clin. Electroenceph. 5: 143-148, 1974.

337.
Chernyakova, V. N. Encephalographic investigations of the process of human adaptation to a modified daily schedule. Kosm. Biol. Med. 6(1): 38-42, 1972.

The period of man's adaptation to an inverted work and rest schedule is dependendent on his individual characteristics. Test subjects with unstable circadian rhythms of cerebral bioelectric activity adapted themselves most rapidiy. A 72-hour period of wakefulness used as a disturbing factor shortened the time of the restructuring only during the early period of exposure to the inverted schedule. The restructuring period was characterized by a great scatter of observational data even during the periods when the mean curve exhibited a tendency to acquire a new rhythm. The scatter decreased as the newly developed rhythm became more stable.

338.
Chevrier, J. P. Etude experimentale des variations physiologiques du sodium et du potassium urinaires, liees au decalage horaire. (Experimental study of physiological variations in urinary sodium and potassium related to time zone changes. Transl. by NASA TT F-16, 281 1975.) C. R. Soc. Biol. (Paris) 167: 2014-2018, 1973.

339.
Chevrolle, J. Horaires de travail et infarctus du myocarde chez les employes de l'asisstence publique. Arch. Mal. Prof. Med. 24: 146-147, 1963.

340.
Childs, J. M. Caffeine consumption and target scanning performance. Human Factors 20: 91-96, 1978.

Twenty-five minutes after ingesting one of three possible dosages (placebo, 200 mg. or 400 mg.) of caffeine, 48 subjects individually participated in two short-term visual target scanning tasks (subject-paced and experimenter-paced). Assignment of subjects to treatment groups was made on the basis of a priori coffee consumption rates. Subjects who reported that they normally consumed less than three cups of coffee per week were assigned to the low usage rate group (LR), while those who reported average consumption rates of three cups or more per week were assigned to the high usage rate group (HR). Significant differences in latencies were obtained between LR and HR only with 400 mg caffeine dosages. LR exhibited significantly higher latencies as a function of these dosages than did HR. No reliable differences occurred between LR and HR for correct detection percentages.

341.
Chouvet, G., J. Mouret, J. Coindet, M. Siffre, and M. Jouvet. Bicircadian period of sleep-waking cycle in "beyond time" isolation. A Polygraphic study. Electroenceph. Clin. Neurophysiol. 37: 367-380, 1974.

342.
Christie, G. A., J. R. Daly, M. C. Path, J. I. Evans, S. A. Lewis, and M. Moore-Robinson, C. C. Gullett, and K. A. Bergin. Project Pegasus. Aerospace Med. Assoc. Preprints, 1971, pp. 103-104.

343.
Christie, G. A., and M. Moore-Robinson. Project Pegasus: Circadian rhythms and new aspects of corticosteroids. Clin. Trials J. 7: 7-135, 1970.

344.
Chugunov, G. Ya. Skill in performing piloting duties in prolonged night flight. Kosm. Biol. Aviakosm. Med. 12(2): 73-74, 1978.

345.
Church, M. W., and L. C. Johnson. Mood and performance of poor sleepers during repeated use of flurazepam. Psychopharmacology 61: 309-316, 1979.

346.
Cizmic, S., and L. Slainberger. Povredena Radu Radnika sa Razlicitim Doevnim Rirmom Zivotnih i Radnih Navika (Injuries at Work of Workers with Differing Daily Rhythms of Living and Working Habits). Ergonomija 5: 5-11, 1978.

From a physiological and psychological point of view, the authors interest was focused on how changes in man's rhythm in the course of 24 hours, i.e., circadian rhythm, affect his working ability, readiness to commence, continue and stop work, or make mistakes at work and follow less safe procedures leading to injury at work. The investigation was conducted in two working organizations with the aid of specially designed questionnaires aimed at obtaining data on the living and working habits of workers. The questionnaires offered a choice of five answers. The authors made use of the results obtained from an earlier investigation of physiological and psychological parameters. The results thus obtained indicate that the daily rhythm of working and living habits formed under the influence of external factors, changes the usual circadian cycle, so that, among other things, it influences, to a lesser or larger extent, accident-proneness in certain periods of the day. The investigation has also confirmed several already known regularities observed with the type of accidents work occurring in the course of shift-work. The results of the investigation show an inaccuracy of proofreading and complex data sorting. Intertask differences appeared to outweigh interpersonal ones.

347.
Clancy, A., and P. H. Redfern. A passive avoidance response in mice--the effects of phase-shift and chlorodiazepoxide. J. Pharm. Pharmacol. 30, Suppl: 35, 1978.

348.
Clarke, C. H., and A. N. Nicholson. Immediate and residual effects on human performance of the hydroxylated metabolities of diazepam (proceedings). Br. J. Clin. Pharmacol. 4: 400P-401P, 1977.

349.
Cmiral, J., V. Dolezel, J. Dvorak, M. Pipal, J. Sulc. Possibilities and dangers during long working periods in space rescue. In: Proc. Space Rescue Symp. 4th, 1971, Paris: International Academy of Astronautics, 1972, pp. 273-279.

It is pointed out that during rescue operations it is sometimes necessary for individuals to work periods substantially longer than usual. The performance of operators working for 24 hours with only short periods of rest was studied. It is emphasized that the conclusions reached on the basis of the test results refer to situations which do not involve a highly responsible task, although the work load is great. It was found that in long operations and during uninterrupted working processes, the 24 hour work shift, followed by two days of rest, was acceptable.

350.
Cmiral J., and J. Dvorak. Zmeny Reakee Sledovani Cile Behem 29 Hodin Prace (Changes in reaction in target monitoring during 29 hours of work). Ceskoslovenska Hygiena, 18: 114-118, 1973

Nine subjects were examined in the course of predominantly mental work for 29 hours. No circadian perodicity in pulse rate and body temperature was found. The reactions of target monitoring were analyzed in seven subjects of the group. Errors in monitoring and changes in amplitude and phase delay in monitoring the sinus signal altered clearly and in a characteristic fashion during the 29 hours. Work capacity decreased substantially after 26 hours as was shown by the monitoring test.

351.
Coates, G. D. Interactions of continuous work and sleep loss with the effects of circadian rhythm- II. Sustained Performance and Recovery During Continuous Operations. Norfolk, Virgina: ITR-74-2, 1974, pp. 21-38.

352.
Coates, G. D., B. R. Brown, and B. B. Morgan. Interactions of the circadian rhythm with the effects of continuous work and sleep-II. Proc. Ann. Meet. Human Factors Soc., 18th, Huntsville, Ala., 1974, p. 486.

The synthetic-work approach was employed in an investigation of the effects of continuous work and sleep loss on sustained performance. Two crews of five subjects each worked continuously for 36 hr., slept 4 hr., and then returned to work 8 hr. per day. During the continuous work period, one crew began at 0400 hr. and the other at 1600 hr. Performance decrements were found to be significantly larger (33% as compared to 11%) and recovery to be less complete for the crew whose continuous work began during the low portion of the subjects' circadian rhythm (i.e., the crew beginning at 0400 hr.). Comparisons of these data with other continuous-work investigations (in which the continuous-work periods began at other points of the subjects' circadian rhythm) indicate that the circadian rhythm constitutes a primary determiner of man's ability to work continuously for extended periods of time and to recover from the effects of continuous work and sleep loss.

353.
Coates, G. D., et al. Human performance during extended periods of continuous work-III. Proc. Ann. Meet. Human Factors Soc., 16th, Los Angeles, 1972, pp. 189-190 .

The extent to which man can work without sleep for relatively extended periods of time, on either an occasional or a regularly scheduled basis, and still maintain acceptable levels of performance efficiency, health, motivation, etc., cannot be specified at present. Although something is known about the effects of certain of the relevant variables on performance, there are many unanswered questions regarding man's endurance in the continuous-work situation--questions such as the following: (a) How long will he be able to maintain his performance efficiency? (b) How will his performance efficiency fall as a function of the combined effects of the continuous work and associated sleep loss? (c) To what extent will performance efficiency be affected by the interaction of the work-rest schedule and man's circadian rhythm? (d) What is the form of the "recovery" pattern especially as a function of different lengths of the rest period provided between continous work sessions? Researchers at the Performance Research Laboratory of the University of Louisville have instituted a series of investigations that will provide answers to some of these questions.

354.
Coates, L. D., et al. A Study of Biorhythm Cycles, Astrological Forecasts, and Personal Evaluations. Joplin, Mo: Missouri Southern State College, 1972.

355.
Cobb, S., and R. M. Rose. Hypertension, peptic ulcer and diabetes in air traffic controllers. J. Amer. Med. Assoc. 224:489-492, 1973.

356.
Cobb, W. W. Human Performance of Biorhythms. (M.S. Thesis) Naval Postgraduate School, Monterey, CA., 1974, pp. 42.

Four subjects, unaware of their biorhythmic cycles were given a daily psychomotor performance task for 15 weeks. Dependency of performance levels on biorhythmic phase was tested by chi square contingency analysis. A regression analysis was also performed to see if performance cycles corresponded to a sinusoidal wave form. The analysis revealed a significant dependency (.05) of performance upon the 28 and 33, but not 23 day cycles. No significant relationship was found between performance levels and critical days. The hypothesis that performance cycles were sinusoidal was rejected. The finding of 28 and 33 day biorhythm cycles and performance dependency is compromised by the small number of subjects, the lack of specification of whether circadian time of day effects were controlled and the lack of periodicity analyses to determine if the three cycles were actually present in the data.

357.
Cohen, D. Biorhythms in Your Life. Greenwich, Conn.: Fawcett Publications, 1976, pp. 192.

The author provides a basic introduction on biorhythm methodology, the history of its development and also discusses circadian rhythms, jet lag, sleep, ultradian rhythms and the relationship between rhythms and psychopathology. Fliess first presented evidence for 23 and 28 day biorhythm cycles. Swoboda first stresses the importance of "critical" days and the Teltscher collected evidence for 33 day cycles in intellectual functions. Hersey later identified mood cycles in industrial workers which, although imprecise, became identified with Teltschers 33 day cycles. Thommen, who was a student of Swoboda became responsible for the recent biorhythm revival. The author quotes Y. Shirai of the Japan Biorhythm Assoc. who claims the Meiji Bread Co. reduced driver accidents by 45% through biorhythm practices and claims the the Seibu Transport Co. of Japan transferred keypunch operators to less sensitive jobs on critical days, resulting in a 35% reductions in errors. He emphasizes that biorhythm cycles are not absolute but only influence tendencies in performance and accidents. However, he confuses the relationship between biorhythms and the more empirically derived studies on circadian and infradian rhythmicity by failing to point out the important distinctions, both theoretical and experimental, between the biorhythm model and the results of biological rhythm research.

358.
Colligan, M. J., I. J. Frockt, and D. L. Tasto. Frequency of sickness absence and worksite clinic visits among nurses as a function of shift. Applied Ergonomics 10: 79-85, 1979.

The records of 1219 nurses on permanent day, afternoon, night and rotating shifts were examined to assess the effects of shift schedule on sick leave and frequency of worksite clinic visits. Relative to nurses on permanent shifts, rotators exhibited a significantly high rate of clinic visits and took more sick days for serious illnesses.

359.
Collins, W. E. Some effects of sleep deprivation on tracking performance in static and dynamic environments. J. Appl. Psychol. 62: 567-573, 1977.

The influence of 34 and 55 hours of sleep deprivation on scores derived from manually tracking the localizer needle on an aircraft instrument was assessed under both static (no motion) and dynamic (whole-body angular acceleration) laboratory conditions. In each of two experiments, 20 young men, equally divided into control and sleep-deprived groups, were tested in an enclosed rotator, in darkness with the exception of the illuminated tracking display. Significant decrements in dynamic performance were uniformly obtained after 24 hours and more of sleep loss. Static scores were less consistently impaired. Administration of d-amphetamine after 55 hours of sleep loss reduced error for both static and dynamic tracking; although performance at both tasks remained poorer for sleep-deprived subjects, their static tracking scores did not differ significantly from control subjects 2 hours after drug ingestion. The study indicates clear performance impairment for an aviation-related task after a night without sleep. Impairment is generally greater with increasing amounts of sleep loss and is more pervasive in motion environments.

360.
Collins, W. E. Performance effects of alcohol intoxication and hangover at ground level and at simulated altitude. Aviat. Space Environ. Med. 51: 327-335, 1980.

361.
Collins, W. E., and W. D. Chiles. Laboratory Performance During Acute Intoxication and Hangover. Oklahoma City, Okla.: Civil Aeromedical Inst., FAA-AM79-7, 1979, 30 pp.

Eleven private pilots (7 men and 4 women) were recruited and trained on the multiple task performance battery (MTPB) static and dynamic tracking of a localizer/glide slope instrument. A speech intelligibility test (single words with a background of aircraft noise) and use of the intoxilyzer. The experiment comprised four test sessions (vodka, bourbon, placebo, and control sessions) held at weekly intervals. Results showed clear deleterious effects of alcohol on the MTPB and the tracking tasks immediately following drinking. During the morning (hangover) tests, scores on the MTPB and on the static and dynamic tracking tasks showed small circadian effects (scores were better) without impairment due to the alcohol. Speech perception scores were unaffected by alcohol; scores were always best in the evening and poorest in the morning. There were no congener effects. These results thus offer no evident contrary to the "eight hour rule".

362.
Colls, J. E. Tests to Measure Performance Changes in Mental Work. Corporate Engineering Laboratory, British Steel Corporation, Report N. CEL/HF/19/72, 1972, 6 pp.

Body temperature follows a distinct circadian rhythm -- highest in the evening, lowest in the early morning -- and various authors have established that performance in simple psychological tests follows a similar rhythm. The aim of this study has been to corroborate this finding in short tests which could be used in the steel industry to predict performance, in place of the more difficult and job specific measures such as production rate and error rate. Three five-minute tests were developed: (a) Cancelling vowels in random letters, (b) cancelling 'e's and 'k's in normal prose, (c) Wilkinson's simple addition. It was discovered that, although there was a correlation between performance and temperature over twenty-four hours, this was due only to the strong night time correlation, and in fact performance fluctuated randomly during the day. In addition, during a continuous twenty-eight-hour experiment, a marked temporary increase in performance level was recorded which coincided with the arrival of dawn. This "dawn peak" was a psychological phenomenon not reflected in a change in temperature.

363.
Colquhoun, W. P. Biological Rhythms and Human Performance. London and New York: Academic Press, 1971, 283 pp.

364.
Colquhoun, W. P. Circadian variations in mental efficiency. In: Biological Rhythms and Human Performance, edited by W. P. Colquhoun. New York: Academic Press, 1971, pp. 39-108.

365.
Colquhoun, W. P. Diurnal Rhythms and Shift Work. British Association for the Advancement of Science Annual Meeting 1971, 10 pp.

366.
Colquhoun, W. P., editor. Aspects of Human Efficiency: Diurnal Rhythms and Loss of Sleep (Preceedings of the Symposium, Strasbourg, Fr., 1970), London: English Universities Press, 1972, 340 pp.

367.
Colquhoun, W. P. Body rhythms and efficiency. New Behaviour, 1: 386-389. 1975.

Circadian rhythms do not only exist in the body's physiological processes but also in performance functions. This article examines the practical implications for the industrial context of fluctuations in performance efficiency.

368.
Colquhoun, W. P. Watchkeeping and safety. Proceedings of the First International Conference on Human Factors in the Design and Operation of Ships, edited by D. Anderson, H. Istance, and J Spencer. Sweden: Gotheberg, 1978, pp. 538-549.

At sea, the safety of a vessel and its occupants depends to a large extent on the vigilance of those members of the crew assigned to watchkeeping duties. Experimental studies of watchkeeping have shown that performance efficiency varies considerably in different watches, and is closely related to circadian rhythms. Alertness will therefore fluctuate systematically round the clock, being lowest during the night hours; the implications for safety are obvious. Different forms of watchkeeping schedules are reviewed, and it is concluded that there is a strong case for the replacement of existing traditional schedules, with short and/or rotating watches, by a system which involves long, "fixed" watches. Only with such a system can the deleterious effects of circadian rhythms be mitigated. The importance of taking these rhythms into account not only under present circumstances, but in the light of future technological developments, is emphasized.

369.
Colquhoun, W. P. Phase shift in temperature rhythm after transmeridian flight, as related to individual pre-flight phase angle (abstract). Ergonomics 21: 861, 1978.

Further analysis of temperature rhythms obtained in a study of 38 subjects subjected to an 8 h eastward transmeridian flight (Adam et al. 1972) showed that the extent to which the phase of the rhythm was shifted after the flight was significantly related to the phase angle of the pre-flight rhythm. "Late peakers" shifted more than "early peakers", and this difference between the two types was still as large after 12 days in the new time zones as on the first day. Thus the pre-flight individual differences in phase-angle failed to re-appear. It is suggested that this may have been due to an increase in the rigidity of the routine in the post-flight stage of the study, and that a similar effect may also occur in a switch from day to shift-work.

370.
Colquhoun, W. P. Introversion-extraversion and the adaptation of the body-temperature rhythm to night work (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. VIII-3.

371.
Colquhoun, W. P., and J. Folkard. Personality differences in body-temperature rhythm, and their relation to adjustment to night work. Ergonomics 21: 811-817, 1978.

A re-analysis of Blake's (1967) data indicated that the difference he observed in the temperature rhythm of introverts and extroverts was considerably more marked in "neurotic" than in "stable" subjects. That this difference may be related to the ease with which the rhythm adjusts to a phase change is demonstrated (a) by an examination ofthe persistence of the pre-flight rhythm immediately after an 8 h eastward time-zone transition (phase advance), and (b) by an assessment of the trends in temperature during a 12 h night shift (phase delay). In

both cases the temperature of "neurotic" extroverts exhibited the greatest degree of adjustment. It is further shown that the temperature of extroverts is more variable from day to day than that of introverts. It is suggested that, taken together, these findings may reflect the existence of an underlying periodicity greater than 24 h in at least "neurotic" extroverts, and that (to some extent) this group may correspond with the "evening" type identified in other research.

372.
Colquhoun, W. P., S. Folkard, P. Knauth, and J. Rutenfranz. Experimental Studies of Shiftwork, Proc. Int. Symp. on Night and Shiftwork, 3rd, Dusseldorf: Wesdeutscher Verlag, 1974.

373.
Colquhoun, W. P, and P. Hamilton. Signal Detection Efficiency in the Morning Watch. Effects of Prior Sleep, Diurnal Rhythm and Fatigue. London: Royal Navy Personnel Research Committee OES-10/74, 1974, 33 pp.

An experiment was carried out to determine whether staying awake before the morning (0400-0800) watch (a custom observed in submariners on prolonged patrols) is likely to exert a detrimental effect on operations such as sonar monitoring carried out continuously throughout the watch. The main experiment and control experiment are described in detail. The report concludes that statistically significant changes in performance at a signal detection task carried out continuously during the morning watch are produced by staying awake rather than turning in for 4 h immediately beforehand. Different aspects of performance are affected in different ways and at different times within the watch, but the most important finding is probably that detection rates are consistently lower during the second half of the watch when operators have had no prior sleep.

374.
Colquhoun, W. P., P. Hamilton and R. S. Edwards. Effects of circadian rhythm, sleep deprivation, and fatigue on watchkeeping performance during the night hours (abstract). Int. J. Chronobiol. 3: 15-16, 1975.

375.
Colquhoun, W. P., P. Hamilton and R. S. Edwards. Effects of circadian rhythm, sleep deprivation, and fatigue on watchkeeping performance during the night hours. In: Experimental Studies on Shiftwork, edited by W. P. Colquhoun, S. Folkard, P. Knauth, and J. Rutenfranz. Opladen: Westdeutscher Verlag, 1975, pp. 29-28.

376.
Colquhoun, W. P., M. W. P. H. Paine, and A. Fort. Changes in the temperature rhythm of submariners following a rapidly rotating watchkeeping system for a prolonged period. Ergonomics 2: 861-862, 1978.

On-watch readings of oral temperature were obtained at hourly intervals from submariners during two continuously submerged voyages of 48 days duration. The subjects followed a rapidly rotating watchkeeping system of 4 h duty-spell during the entire period. In the majority of cases, the amplitude of the circadian temperature rhythm progressively declined, and this was accompanied by a tendency for the rhythm to disintegrate into shorter periods associated with the length of the duty spell and the particular pattern of sleep adopted. On one voyage, one subject's rhythm showed a tendency to "free-run", with a period of 24.6 h. It is concluded that the results give pointers to the kind of effect to be looked for in studies of shift-workers following similarly highly irregular patterns of work.

377.
Colquhoun, W. P., M. W. P. H. Paine, and A. Fort. Circadian rhythm of body temperature during prolonged undersea voyages. Aviat. Space Environ. Med. 49: 671-678, 1978.

Circadian rhythms of oral temperature were assessed in 12 watchkeepers during a prolonged submarine voyage and compared with a "standard" rhythm obtained from nonwatchkeepers ashore. Initially, the parameters of the rhythms were similar to those of the standard; however, among eight ratings working 4-h watches in a rapidly rotating cycle, considerable changes in the rhythms occurred as the voyage progressed, and concurrent alterations in sleep patterning were observed. The most characteristic change in the rhythm was a marked decline in its amplitude. In most subjects, the rhythm also tended to depart from its original circadian pattern; in at least one case, it effectively disintegrated. One subject's rhythm appeared to "free-run" with a period greater than 24 h. A strong circadian rhythm was maintained in only one of these eight subjects. In four officers whose watch times were at fixed hours, adaptation of the rhythm to unusual times of sleep occurred in 2 of 3 cases where the schedule demanded it. The results are discussed in relation to the design of optimal watchkeeping systems for submariners.

378.
Colquhoun, W. P., M. W. Paine, and A. Fort. Changes in temperature rhythm of submariners following a rapidly watchkeeping system for a prolonged period. Int. Arch Occup. Environ. Health; 42: 185-190, 1979.

On-watch readings of oral temperature were obtained at hourly intervals from submariners during two continuously submerged voyages of 48 days duration. The subjects followed a rapidly rotating watchkeeping system of 4-h duty-spells during the entire period. In the majority of cases, the amplitude of the circadian temperature rhythm progressively declined, and this was accompanied by a tendency for the rhythm to disintegrate into shorter periods, associated with the length of the duty spell and the particular pattern of sleep adopted. On one voyage, one subject's rhythm showed a tendency to "free-run", with a period of 24.6 h. It is concluded that the results give pointers to the kind of effect to be looked for in studies of shift-workers following similarly highly irregular patterns of work.

379.
Connolly, M. Spontaneous murine mesor-hypertension, aggravated by social isolation, ameliorated by elimination of lighting regimen cycles (abstract). Chronobiologia 6: 88-89, 1979.

To investigate how lighting and housing affect the development of blood pressure elevation in the spontaneously mesor-hypertensive rat (SMHR), 12 females SMHR conceived by mothers kept in continuous dim red light (DD) were reared themselves in DD (<0.1 ft candles). Concomitantly another 12 female SMHR were reared in LD 12:12 (12h white light: 12h dim red light). At 6 weeks of age the rats were weaned and 6 rats in each lighting condition singly housed in cages with a running wheel.
Running wheel records indicate that the circadian activity rhythms of the rats singly housed in DD were free- running. Either the absence of white light or (free-running circadian systems ameliorated the aggravation of spontaneous mesor-hypertension associated with social isolation.

380.
Connolly, M. S. Absence of a synchronizer results in interindividual differences among the timing characteristics of circadian blood pressure rhythms in the SH rat (abstract). Chronobiologia 4: 105-106, 1977.

381.
Conroy, R. T. W. L., and J. N. Mills. Circadian rhythm and shift working. In: Night and Shift Work, edited by A. Swensson. Stockholm: Ints. Occup. Health, 1969, pp. 42-46.

382.
Conroy, R.T.W.L., and M. O'Brian: Diurnal variation in athletic performance. J. Physiol. 236: 51, 1973.

383.
Cook, F. O. Shiftwork. London: Institute of Personnel Management. London: 1954.

384.
Cop, F. Triozmensko Delo Nasproti Delu v Dnevnih Izmenah (Triple shift versus double shift work schedule). Organizacija in Kadri, 11: 383-392, 1978.

The author has used two working organizations to determine the differences in some aspects of work contributions of workers who work in three shifts as compared to those who work in two daylight shifts. The findings, which are, of course, valid for the workers of the mentioned organizations only, do not show the triple shift and night shift work in a totally negative light. According to the findings, the workers who work in triple shifts have more disciplinary offences, are younger, have less sick leave, and sleep less during their night shifts as the workers in both daylight shifts do. The workers who work three shifts are also more satisfied with their earnings, do not turn down the night shifts or rather they turn them down less often than the workers on the daylight shifts, but they are less satisfied with their superiors. The causes of the obtained results are quite global and some of them hard to explain. The two points that are more surprising are less absenteeism due to sickness and greater work satisfaction of workers on triple shifts. The latter can be explained with considerably greater earnings of these workers, because this confirms the determined congruence between earnings and degree of work satisfaction. Lesser absenteeism can on the other hand be explained with lower age limit of these workers and a more thorough selection with regards to physical condition of job candidates. Whatever, the results do not point to the abolition of triple work shifts by all means but place humanization of work as the basic reason for gradual abolition of this particular organizational form of work.

385.
Corker, C. S., and D. Exley. Daily changes in urinary testosterone levels of the human male. J. Endocr. 40: 255-256, 1968.

Urine samples wre collected from 2 men daily for 42 days. Visual inspection of the data revealed about a 9 day cycle in testosterone.

386.
Costa, G., P. Apostoli, F. D'Andrea, and E. Gaffuri. Gastrointestinal and neurotic disorders in textile shift-workers (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, IV-2.

387.
Costa, G., and E. Gaffuri. Percezione dello sforzo fisico in differenti condizoni di lavoro (The perception of physical performance in different work conditions). Lav. Uman 27: 129-138, 1975.

Borg's method of rating of perceived exertion was used by the authors to evaluate physical performance of healthy subjects during exercise tests performed either in the night or daytime and involving different muscle masses (upper and lower limbs). The reliability of the perceived exertion rating scale was confirmed. The perception of physical performance appeared to be higher at night and when upper limbs were involved.

388.
Costa, G., E. Gaffure, G. Perfranceschi, and M. Tansella. Psychological and physical performance in hospital shift workers (abstract). Ergonomics 21: 864, 1978.

Eighteen normal male nurses gave a self-rating of tiredness, performed a battery of simple psychomotor tasks (Simple Auditory Reaction Time, Digit Symbol Substitution Test, Gibson Spiral Maze) and were subjected to several physiological tests (ventilation, respiratory frequency, oxygen intake, carbon dioxide elimination, heart rate, systolic blood pressure), during the sixth (last) day of each of their three shifts (morning, afternoon, night), which rotated weekly. The shifts were sampled in an order which fully controlled for practice effects, and all measures were taken between the third and the fifth hour after beginning work (which started at 0600 h, 1400 h, and 2200 h, respectively.) The subjects rated themseleves as most tired on the night shift, and reported higher perceived exertion (Borg scale) on this shift during work on a bicycle ergometer at different loads. However, of the performance and physiological variables only heart rate and blood pressure showed significant intershift differences; both of these indices were lower in the night, the former at rest and with a light workload, the latter with a heavy workload. A very high correlation was found between perceived exertion and heart rate in all three shifts, while a negative correlation between perceived exertion and extraversion emerged in the night shift only. The results are interpreted as suggesting that, on most of the tests used, adaption to the night shift in this weekly rotating shift system had occurred by the sixth day.

389.
Costa, G., E. Gaffuri, G. Perfranceschi, and M. Tansella. Reentrainment of diurnal variation of psychological and physiological performance at the end of a slowly rotated shift system in hospital workers. Int. Arch. Occup. Environ. Health 44: 165-175, 1979.

390.
Costello, L., and R. Ogilvie. Effects of REM deprivation on performance (abstract). Sleep Res. 3: 149, 1974.

391.
Cowley, S. C. They've got rhythm. Newsweek, Sept. 15, 1975, p. 83.

392.
Cox, J. J. Train control, stress and vigilance. Human Factors in Transportation. Proc. of 10th Ann. Conf. Ergonomics Soc. of Australia and New Zealand, Sidney, 1973, pp. 16.1-16.22.

Modern railway operation, due to the control exerted on the man-machine-pathway combination is the safest form of transportation available. The vehicle pathway is continuously monitored and is the safest form of transportation available. The vehicle pathway is continuously monitored and both front and rear end protection is provided to prevent collisions. Man, although extremely versatile, is known to be the weak link in the man-machine system. Consequently, his duties need to be arranged to match his capabilities. An examination is made of human factors research, levels of arousal, driving efficiency and driver stress, fatigue, diurnal body rhythm and vigilance. Accident rates have been progressively reduced by various safeguards instituted to guard against human failure. Measurements of driver stress under various conditions of high speed train operations have been carried out and changes in stress in accordance with train speed, hours of duty, periods of rest, and day and night operation determined. There are a series of railway signalling and vigilance control devices which successively reduce the effect of the human element. These have further developed into semi-automatic and automatic train operation.

393.
Craig, A. Discrimination, temperature, and time of day. Human Factors 21: 61-68, 1979.

Performance measures on a binary discrimination task and oral temperature readings, were obtained at two times of day, morning (0800) and evening (2000), from each of 18 subjects. On the task, subjects reported not only the presence of signal A or B, but also the confidence of their judgment. A signal detection theory approach was applied to derive separate measures of perceptual efficiency and of the decision-making aspects. THe results indicate that whereas efficiency, indexed by d', did not alter significantly between testing times, both response-bias and report confidence did change significantly, the latter showing an increase between morning and evening. A parallel rise in oral temperature was also found, and significant correlations between temperature and confidence were obtained. Neither efficiency nor response-bias was significantly related to temperature. The results are discussed in relation to previous reports that perceptual efficiency and body temperature are related and change in parallel during the normal waking day.

394.
Crawford, J. P. Endogenous anxiety and circadian rhythms. Brit. Med. J. 1: 662, 1979.

395.
Crockett, P. W. Effects of Fatigue on Human Behaviour and Performance (A Bibliography with Abstracts). Report for 1964-Feb. 1978. Report No. NTIS PS-78/0126/9GA, 1978, 169 pp.

The bibliography cites references on the psychological and physiological effects of mental and physical fatigue. Reports on circadian rhythm, work-rest schedules, sleep deprivation, and physical endurance are included. (This updated bibliography contains 164 abstracts, 29 of which are new entries to the previous edition).

396.
Crump, J. H. Review of stress in air traffic control: Its measurement and effects. Aviat. Space Environ. Med. 50: 243-248, 1979.

A large number of investigations have been conducted into air traffic control stress by researchers from different disciplines. This paper attempts to draw together this work by examining the

methodologies and interpretations that have been use. The purpose of this approach is to highlight the research gaps in the area and to emphasize the need for greater interdisciplinary cooperation in the measurement and interpretation of air traffic control stress.

397.
Currie, W. Change your Zeitgebers and beat jet lag. Peninsula Times Tribune, 15 May, 1979.

398.
Curtis, G. C., and M. L. Fogel. Random living schedule: psychological effects in man. J. Psychiat. Res. 9: 315-323, 1972.

399.
Curtis, G. C., and D. McEvoy. Low amplitude infradian cycles of urinary 17-hydroxycorticosteroid excretion in a healthy male subject. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J. E. Pauly. Tokyo: Igaku Shoin, Ltd., 1974, pp. 523-526.

In measurements made on a healthy male subject over a 4 year period, low amplitude cycles of urinary 17-OHCS excretion with periods of about 8.5, 11, 18, 30, 45.6, 52, 182 and 348 days have been tentatively detected.

400.
Cuthbert, B. N., R. C. Graeber, H. C. Sing, and R. J. Schneider. Rapid Transmeridian Deployment: II. Effects of Age and Countermeasures Under Field Conditions. Proceedings of the XIV. Internat'l. Conf. of the International Soc. for Chronobiology, Hannover, FRG, 3012, 1979, Milan: Il Ponte, 1980, in press.

401.
Cuthbert, B. N., R. C. Graeber, H. C. Sing, R. J. Schneider, F. J. Sodetz, and C. F. Tyner. Rapid transmeridian deployment II. Effects of age and countermeasures under field conditions (abstract). Chronobiologia 6: 91, 1979.

This study attempted to replicate and extend previous findings that chronobiologic countermeasures hastened circadian adjustment following rapid transmeridian flight. The experiment comprised 2 parts, both conducted during a winter field deployment exercise from Kansas to West Germany (+7 h). The experimental group underwent the countermeasures as described previously; controls followed normal military airlift procedures. Part 2 compared a group of 31 young subjects (mean age 21.0 years) with 29 older subjects (mean age 34.2 years) following deployment without any countermeasures. They completed an extensive cognitive test battery at each session in addition to the test in part 1. Despite arduous field conditions the countermeasures again reduced the amount of subjective fatigue for 48 h following arrival. Encoding- decoding performance diminished in both part 1 groups after deployment but was not differentially affected by the countermeasures. Performance on most part 2 cognitive tasks deteriorated following arrival and then gradually recovered, depending on the task, over 24 to 72 h. Some suggestion of circadian patterning emerged from these data, but there were no consistent age effects except that the older group slept less in both Kansas and Germany.

402.
Cutler N. R. and H. B. Cohen. The effect of one night's sleep loss on mood in normal subjects. Comprehensive Psychiatry 20: 61-66, 1979.

403.
Cymerman, A., R. Francesconi, and S. Robinson. Alteration of diurnal rhythmicities of urinary 3-methoxy-4-hydroxyphenyglycol (MHPG) and vanillylmandelic acid (VMA) in man during cold exposure. Fed. Proc. 33: 245, 1974.

Six males (19-23 yrs.) underwent a 7-day stabilization period with respect to diet and temperature (22C), followed by a 2-day exposure to 15C and a 2-day recovery period (22C). Urine collections were made every 8 hours commencing at 2300 hours; MHPG and VMA were assayed using gas-liquid chromatography. During the stabilization period a diurnal rhythmicity was demonstrated for MHPG and VMA with maxima at 0700-1500 hours. Creatinine also exhibited a diurnal rhythmicity, peaking during 2300-0700 hours. Mean excretion per mg creatinine (SE) for MHPG and VMA was 0.67 ± 0.04 ug and 2.6 ± 1.6 ug, respectively. Cold exposure abolished the rhythms for MHPG, VMA and creatinine and caused a 25-30% increase in MHPG excretion. In contrast, VMA excretion was not increased during cold exposure. The 3 subjects with the highest MHPG excretion during the stabilization period (0.90 ± 0.06 ug/mg creatinine) showed no significant change in MHPG excretion during cold exposure, while the 3 subjects with the lowest MHPG excretion (0.50 ± 0.38 ug/mg creatinine) had significant increases (0.75 ± 0.3 ug/mg creatinine, $P<0.02$). The finding that MHPG was increased in the cold without a corresponding increase in VMA further supports the concept that MHPG excretion in urine may be indicative of changes in catecholamine metabolism in the central nervous system.

404.
Czeisler, C. A. Human Circadian Physiology: Internal Organization of Temperature, Sleep-wake and Neuroendocrine Rhythms Monitored in an Environment Free of Time Cues (Ph. D. dissertation). Stanford University, 1978, 345 pp. (abstract in Diss. Abst. 39: 4205-B, 1979).

405.
Czeisler, C. A., G. S. Richardson, R. Coleman, W. C. Dement, and E. D. Weitzman. Successful non-drug treatment of delayed sleep phase syndrome with chronotherapy: resetting a biological clock in man (unpublished abstract, personal communication with Dr. Weitzman, Montefiore Hospital, Bronx, N. Y.). APSS, 1979.

406.
Czeisler, C. A., G. S. Richardson, M. C. Moore-Ede, and E. D. Weitzman. Entrainment of human circadian rhythms by light dark cycles: a reassessment. Proc. Amer. Soc. Photobiology, 1978.

407.
Czeisler, C. A., E. D. Weitzman, M. C. Moore-Ede, and A. L. Krauss. Relationship of the circadian rhythms of skin and core body temperatures under entrained and free-running conditions in man. Fed. Proc. 36: 423, 1977.

It is generally accepted that the major mechanism underlying the circadian rhythm of core body temperature is one of daily changes in heat loss from the extremities rather than variations in metabolic heat production. Temperatures of 5 normal young adult male Ss were recorded every minute for 95 24-hr periods, including two weeks each in an environment free of time cues, when each S developed a free-running period length (FRPL) greater than 24 hrs. Instead of the steep fall of rectal temperature (T_r) which follows bedtime under entrained conditions, Tr began falling 4 to 8 hours before bedtime and then rose during the latter half of sleep in Ss with a FRPL near 25 hrs. Wrist skin temperature (T_s) and Tr were concurrently measured for 25 days each in two S_s. Short term (ultradian) rhythms were often seen in both Tr and Ts during both sleep and waking. A sharp rise in T_s just preceding a steep Tr decrease occurrred during every polygraphically monitored sleep period, both entrained and FR. However, under FR conditions the progressive T_r fall prior to bedtime and the subsequent T_r rise during sleep were not accompanied by a similar reciprocal T_s change. This dissociation suggests that a circadian oscillation independent of heat loss from the extremities may be a significant component of the T_r rhythm under FR conditions, whereas the circadian rise of Ts appears to be tied to sleep or some event correlated with sleep.

408.
Czeisler, C. A., E. D. Weitzman, M. C. Moore-Ede, R. E. Kronauer, J. C. Zimmerman and C. Campbell. Human sleep; its duration and structure depend on the interation of two separate circadian oscillators. (Unpublished abstract, personal communication with Dr. Weitzman, Montefiore Hospital Medical Center, Bronx, N. Y.).

409.
Czeisler, C. A., J. C. Zimmerman, J. Ronda, M. C. Moore-Ede and E. D. Weitzman. Timing of REM sleep is coupled to the circadian rhythm of body temperature in man. (Unpublished abstract, personal communication with Dr. Weitzman, Montefiore Hospital Medical Center, Bronx, N. Y.).

410.
Daan, S. Tonic and phasic effects of light in the entrainment of circadian rhythms. Ann. N.Y. Acad. Sci. 290: 51-59, 1977.

411
Daan, S., and C. Berde. Two coupled oscillators: simulations of the circadian pacemaker in mammalian activity rhythms. J. Theor. Biol. 70: 297-313, 1978.

In the activity rhythms of captive small mammals a variety of features, most notably "splitting", suggest that two coupled oscillators may constitute the pacemaker system which underlies the rhythms. A phenomenological model proposed by Pittendrigh is developed and expanded here using an explicit quantitative structure. It is found that such a system can simulate several qualitiative features in the experimental data: the interdependence of free-running period (tau) and activity time (a) with changing light intensity described in Aschoff's rule, after-effects on tau and a of prior conditions, and the occasional existence of two stable phase relationships, with different tau values for a given light intensity, as observed in "splitting". It is hoped that the model will suggest experiments aimed at the elucidation of the physiological basis of these phenomena.

412
Daan, S., D. Damassa, C. Pittendrigh, and E. Smith. An effect of castration and testosterone replacement on a circadian pacemaker in mice. Proc. Nat'l Acad. Sci. USA. 72: 3744-3747, 1975.

Castration of mice in freerunning conditions (total darkness, DD) causes a reduction of running wheel activity in the beginning of the active period and stimulates activity at the end of (tau). Simultaneously, the period of the freerunning rhythm is increased. Both effects are abolished by implanation of a Silastic capsule from which a physiological dose of testosterone is released at a constant rate. The results are tentatively explained by differential endocrine influences on two oscillating components in the pacemaker of the circadian activity rhythm.

413
Daan, S., and C. S. Pittendrigh. A functional analysis of circadian pacemakers in nocturnal rodents. III. Heavy water and constant light: homestasis of frequency? J. Comp. Physiol. 106: 267-290, 1976.

414
Daftuar, N., and J. K. Sinha. Sleep deprivation and human performance. Psychologia: 15:122-126, 1972.

415
Dahlgren, K. Studies of sleep among permanent night workers and shiftworkers. Ergonomics 21: 873, 1978.

The quantity and quality of sleep in workers on permanent night work was compared, in the laboratory, with that in workers on a rotating day and night shift system. Polygraphic records of EEG, EOG and EMG were made, self-recorded sleep length diaries were kept, and measures of subjective sleep quality were taken. Three day and one night sleeps were observed. The day sleeps were at the beginning, at the end and immediately folowing the night shift week. Night sleep was measured on an off-day. For each observed sleep, body temperature was measured at three-hour intervals during the waking period preceding and following it, and continuously during the sleep itself. The urinary excretion of catecholamines was also measured for each sleep period.

In general, the results show that the permanent night workers were better adjusted to night work than the rotating shift workers, both with regard to the adjustment of the body temeprature rhythm and the quantity and quality of sleep.

416
Dahlgren, K. Adjustment of circadian rhythms to rapidly rotating shift-work - a field study of two shift systems (abstract). In: Int. Symp. on Night- and Shift- work, 5th, Rouen, FR., 1980, p. VII-1.

417
Dailey, J. T. Management factors in reducing ATCS stress. International Symposium on Air Traffic Control, Stockholm, March, 1976, p. 14-16.

418
Dale, A. Biorhythm. New York: Kangaroo Books, 1976, 191 pp.

This book is a basic introduction to rhythmicity in general, including the biorhythm method, biorhythm charting methods, circadian rhythmicity, jet lag, shift work. The author presents a set of simple performance tests the reader can perform over a period of time to establish the relative amplitudes and cycle lengths of individual rhythms with the objective of allowing the individual to adjust daily activity levels according to the phase of the self-measured cycles. The book emphasizes the biorhythm method although the author does not openly endorse the Fliess biorhythm method. However, the author derives no clear distinction between the Fliess biorhythm and biological rhythm data in the scientific literature. The author notes that Wilhelm Fliess, and associate of Freud, was also responsible for a theory of mental illness based on the presence of so-called "interior genital cells" in the nose and that Fliess treated emotional problems by applying cocaine to the nasal mucosa.

419.
Danguir, J., and S. Nicolaidis. Sleep and feeding patterns in the ventromedial hypothalamic lesioned rat. Physiol. Behav. 21: 769-777, 1978.

420.
David, J., R. S. Grewal, and G. P. Wagle. The effect of a reversed cycle of sleep and wakefulness on diurnal EEG patterns in rhesus monkeys. Life Sciences 12: 297-305, 1973.

The modification of established daytime EEG patterns in four Rhesus monkeys was effected by a reversal of the sleep-waking cycle. The lighting regimen was automatically controlled on a 12 h light, 12 h light, 12 h dark period and was phase shifted through 180° for a three month period. A progressive and significant reduction in wakefulness with a concomitant increase in sleep, along with the emergence of cyclic REM episodes occurred during reversal. A decrease in the latency to onset of sleep and the REM state was also observed. Behavioural observations suggested that motility was predominant during the lighted period. The EEG patterns returned to baseline conditions when the normal lighting regimen was reimposed.

421.
Davies, D. G., Human Problems in Shift Work. Journal of the Iron and Steel Institute, 209: 114-120, 1971.

The author discusses the physiological and psychological effects of shift work in the light of existing literature and attempts to determine optimum shift systems on the basis of recorded data on sickness and absenteeism rates and work performance for various sectors of industry.

422.
Davis, C. T. M., and A. J. Sargent: Circadian variation in physiological responses to exercise on a stationary bicycle ergometer. Brit. J. Industr. Med. 32: 110-114, 1975.

423.
Davydov, G. I., and V. V. Antipov. Some general principles of studying the combined effect of spaceflight factors. Kosmicheskiye Issledovaniya 12: 285-298, 1974.

424.
Day, N. R. Fatigue in the safety equation. Business and Commercial Aviation 39: 148-161, 1976.

425
Dearnaley, E. J., and P. B. Warr. Aircrew Stress in Wartime Operations. London and New York: Academic Press, 1979, 230 pp.

Papers concerning the reactions of air crews to the stress associated with wartime operations during World War II are presented. Specific topics include the historical background to wartime

psychological research in the Royal Air Force, neurosis precipitated by flight duties, the influence of psychological disorders on operational flight efficiency., fluctuations in navigator performance during bombing sorties, physical and psychological measures of the effects of operational stress on bomber crews, the relation of landing accidents to pilot fatigue, the psychological aspects of airsickness, and experimental studies of mental fatigue and pilot error.

426.
Debry, G., and R. Bleyer. Influence du rythme des trois-huit sur l'alimentation des travailleurs. (The influence of the 3-8 cycle on food intake in shift-workers.) In: Alimentation et Travail, edited by G. Debry and R. Bleyer. Premier Symposium International, 1971. Paris: Masson Et C, Editeurs, 1972, pp. 154-177.

The authors describe the food habits of shiftworkers. The material of this study is mostly their own and partly those of the bibliography. They considered the part played by numerous factors interfering with the rhythm of shift-work in the modification of eating habits. They show that if the average intake of workers doing a job requiring moderate physical activity is reduced to 3000 calories, shift-work does not change the caloric level, but there are important changes corresponding to the different shift but for the same workers. Alcohol does not contribute to the total caloric intake to any great degree (8 per c. to 20 per c.) if alcoholic beverages are forbidden during work-time and at the place of work, but even this level can increase to 33 per c. under difficult social conditions. Shift-work modifies the caloric distribution of the different meals and profoundly disturbs the social surroundings at mealtimes, shift-work also entails changes in the kind of food consumed. Shift-workers do not exhibit a higher incidence of gastric ulcers but on the other hand, the incidence of dyspepsy is greater. It is found that those with dyspepsy are the heaviest smokers whether they are shift- workers or day-workers. The problem of the shift-workers health and nutritional education are not bounded exclusively by questions of food intake, but concern also social and economic factors, as well as the relation between the workers food habits and his geographical origin.

427.
Decoster, F., and J. Foret. Sleep onset and first cycle of sleep in human subjects: change with time of day. Electroenceph. Clin. Neurophysiol. 46: 531-537, 1979.

428.
DeCoursey, P. LD ratios and the entrainment of circadian activity in a nocturnal and a diurnal rodent. J. Comp. Physiol. 78: 221-235, 1972.

The activity rhythms of 5 flying squirrels, Glaucomys volans, and 7 chipmunks, Tamias striatus, were examined under controlled conditions in the laboratory. Free-running, circadian rhythms were demonstrated using a total of 25 LL or DD experiments. With 46 LD schedules the limits of entrainment in a 24-hour day were determined, and the phase angle difference for each schedule measured. Glaucomys was able to synchronize to schedules ranging from 1 second of light per 24-hour day to at least 18 hours light per day with little or no change in the phase angle. Tamias showed an oscillatory type of entrainment when the photoperiod was less than 3 hours per 24-hour day or greater than 23 hours, but in the intervening region was capable of stable entrainment. A tendency was evident for the phase angle difference to become less positive as the LD ratio increased. In Glaucomys single, isolated light pulses of either one second or 24 hours duration were able to bring about relatively large shifts in the phase of the activity rhythm.

429.
Decoursey, P. J. Free-running rhythms and patterns of circadian entrainment in three species of diurnal rodents. J. Interdiscipl. Cycle Res. 4: 67-77, 1973.

Activity rhythms of 3 species of day-active sciurid rodents under various constant lighting conditions and in L/D schedules were studied. The animals included 8 white-tailed antelope squirrel Ammospermophilus leucurus, 5 black-tailed antelope squirrel A. harrisi, and 5 eastern chipmunk Tamias striatus. All species showed free-running rhythms in constant conditions, with the period decreasing at higher intensities. The 3 species synchronized readily to a variety of light schedules, with the exact response dependent upon the phase relationship of activity to the new light schedule.

430.
Defayolle, M. La Fatigue operationnelle. Psychologie Medicale 10: 2005-2014, 1978.

431.
Defayolle, M. Vigilance and attention. In: Sleep, Wakefulness and Circadian Rhythm. Neuilly Sur-Seine: NATO, Advisory Group for Aerospace Research and Development. AGARD-LS-105, 1979, pp. 5-15 - 5-27.

The relations between vigilance and attention are considered using computer analyses and psychological and physiological techniques. After considering the different types of available measures, the factors influencing attention are reviewed. The characteristics of signals, the environmental conditions, the individual features and the possible interactions between these factors are then considered.

The various theories are reviewed and followed by a proposed mathematical model which integrates activation, the use of processing ability and filtering, taking into consideration the data relative to the environment and to motivation.

The conclusion, different methods are envisaged from ergonomical, psychological and pharmacological directions.

432
Defayolle, M. Psychostimulants. In: Sleep, Wakefulness and Circadian Rhythm. Neuilly-Sur-Seine: NATO, Advisory Group for Aerospace Research and Development. AGARD-LS-105, 1979, pp. 11-1 - 11.4.

This review of the state-of-the-art of psychostimulants starts with a brief historical and geographical survey.
The basic neuro-chemical data on vigilance are then dealt with, and the various systems of mediators involved in synaptic conductions, differentiated from each other.
The methodology of therapeutic tests on psychotropes is then tackled and the effects induced by the use of various types of drugs available (noo-analeptics, nootropes, thymoanaleptics and metabolic adjuvants) are considered.
After an attempt at incorporating these data into a general model of vigilance including the data handling capacity and filtering concepts, the paper ends with the indications and contraindications as to the use of psychostimulants.

433.
Defayolle, M., J. Jacq, and J. Fourcade. Assessment of vigilance. L'Encephale 4: 19-32, 1978.

434.
DeFayolle, M., J. M. Liegeois, and J. Jacq. Influence des horaires et du type de travail sur les epreuves de vigilance. (Influence of schedules and of the type of work upon vigilance tests). Arch. Mal. Prof. Med. 38: 139-142, 1977.

435.
Deguchi, T. Circadian rhythms of enzyme and running activity under ultradian lighting schedule. Am. J. Physiol. 232: E375-E381, 1977.

Serotonin N-acetyltransferase activity in the pineal gland and running activity of rats were measured under an ultradian lighting schedule (light/dark 6:6). When rats were moved from a diurnal lighting condition to the ultradian conditions, N-acetyltransferase activity showed a circadian rhythm, increasing once a day. N-acetyltransferase activity in the pups born and raised under the ultradian lighting conditions also exhibited a circadian change, the phase of which concided with that of the mother. When pups were raised by a foster mother with an inverted rhythmic phase from that of the original mother, the phase of the rhythm in N-acetyltransferase activity of the pups synchronized with that of the foster mother. When pups were separated from their mothers for 12 h. day, the circadian increase of N-acetyltransferase activity appeared during the dark period when they were separated from their mother. The circadian rhythms of running activity were in phase with those of N-acetyltransferase activity in the pineal gland.

DeHart, R. D. (see citation # 760, p. 286 under Hart, R. D.)

436.
De La Mare, G., and J. Walker. Factors influencing the choice of shift rotation. Occup. Psychol. 42: 1-21, 1968.

437.
De Marchi, W. G., Psycho physiological aspects of the menstrual cycle. J. Psychosom. Res. 20: 279-287, 1976.

438.
Demaret, D., et J. Fialaire. L'ulcere gastroduodenal en milieu de travail. Sa relation possible avec le regime des 3 x 8. Arch. Mal. Prof. Med. 35: 432-438, 1974.

439.
Dement, W. C. Sleep deprivation and the organization of the behavioral states. In: Sleep and the Maturing Nervous System, edited by C. D. Clemente, D. P. Purpura, and F. E. Mayer. New York: Academic Press, 1972, pp. 319-355.

440.
Dement, W. C. Sleep disorders, nosology and treatment. Presentation to The Association for Psychophysiological study of Sleep, annual meeting. Los Angeles: UCLA Brain Information Service/BRI Publications, B/S Conf. Rpt. #32, 1973, pp. 73-84.

441.
Dement, W. C. Some Must Watch; While Some Must Sleep. New York: Scribner, 1974, 148 pp.

442.
Dement, W., J. Kelley, E. Laughlin, S. Carpenter, J. Simmons, K. Sidorie, and R. Lentz. Life on the basic rest-activity cycle (BRAC): sleep studies of a ninety minute day. Psychophysiology 9: 132, 1972.

443.
Demuth, P. Wobbly biorhythms. Human Behavior 8: 53-55, 1979.

In this critical review of the biorhythm theory, the author indicates that Wilhelm Fliess in his major book (Der Ablauf des Lebens, 1906), applied the 23 and 28 day cycles to uncontrolled events such as dates of an infants, conceptions, birth, appearance of teeth, beginning to walk, onset of first menstruation, deaths, illness, the life course of plants and animals and the composition of all of Schuberts Lieder, etc. Although developed by Fliess, the theory was first published by Hermann Swoboda, to whom the information has been leaked. The author criticizes studies in support of the relationship of the theory to accidents by Harold Willis as being invalid since either the expected accident frequency did not exceed chance when correctly calculated (Ohmi vehicle accident study in Japan) or the critical day was taken to be 48 instead of 24 hours, resulting in invalid calculations of critical day probability. The author cites a study by F. Damron and D. Leetz at the Univ. of Wisconsin who analyzed 379 industrial accidents and found no evidence that biorhythms had any influence on accident occurrence. The author studied 100 student counseling center dro-ins, 50 patients admitted to a Community Mental Health outpatient clinic, 50 people who came to a hospital emergency room having made a suicidal gesture, and 50 suicides from the County Coroner's Office records with respect to biorhythm critical days. No relationship between any biorhythm phases and these events was found. In another study, a biorhythm lecturer was given to a class of 44 students. Half the students had critical days marked on their calendars but the critical day information was false. The students were instructed to mark any day which they felt would be a critical day over a 2 week period. The students given no critical day information hit their biorhythm critical days at the chance level, but the students given misinformation were statistically significantly more likely to designate their false biorhythm critical days as critical. The author cites this study as evidence that biorhythm can work by the power of suggestion.

444.
Denver, E. Chart the rhythms that make you what you are. American Home Magazine, 1975, p. 14.

445.
Deribere, M. L'eclairage en liason avec les rythmes biologiques, Communic. Groupe d'Etude Rythmes Biologiques, Paris, 1972.

Fatigue varies with the time of day. In turn, the better the illumination (within limits) the better the performance. The relation between performance, illumination, fatigue and time of day is a rather complex one.

A relation between biological and performance rhythms on one side, and lighting on the other side cannot be excluded, in principle. Both, quality and quantity of light have to be taken into account. With reference to annual rhythms it should be recalled that in winter the individuals seem to prefer warm hues, in summer, cold ones. This seems in relation with the change occurring in the natural environment. With reference to diurnal rhythms, it is recalled that warm hues are preferred in the morning, cold hues in the afternoon. Differences are found, however, between people living in the North- and people living in the South- of Europe, respectively. In general, there seems to be the trend to join warm hues and feeble illuminations. The quantitative aspect of the problem, however, is other than simple, because of the disparity among levels (natural illuminations vary from 10 to, say, 100000 lux, artificial illuminations from 10 to 700 lux). This variability renders puzzling the entrainment to biological rhythms.

446.
De Roshia, C. An Analysis of Heart Rate Circadian Rhythm Data from Denton Bed Rest Study Feb.-May 1971. Manuscript 1972.

447.
De Roshia, C. Determination of the Rate of Onset of Cardiovascular Deconditioning Induced by Bedrest. Preliminary Report on the Circadian Rhythm Data, Manuscript. 1974, 30 pp.

448.
De Roshia, C. W., and C. M. Winget. Comparison of the effects of horizontal ad antiorthostatic hypokinesia upon circadian rhythmicity in male subjects. Preliminary Report of the Joint US/USSR Hypokinesia Study, Ames Research Center, Moffett Field, CA, 1979, 7 pp.

449.
De Roshia, C. W., C. M. Winget, and G. H. Bond. Two mechanisms of rephasal of circadian rhythms in response to a 180 phase shift (simulator 12-hour time zone change). Aerospace Med. Assoc., Preprints, 1975, pp. 43-44.

The rate of resynchronization of circadian rhythms following translongitudinal flight and the mechanisms underlying the rephasal are not well understood. Considerable discussion has emerged in this field based on arguments invoking the direction of flight, whether it was homeward or not, time of departure, time of arrival and duration and stress of flight as determinants of the rate of resynchronization. Recent collaborative work from our laboratory has provided evidence in man that the homeward direction was unimportant in the determination of resynchronization rates but that there was a significant difference depending on whether the flight was eastward or westward. Hence, on an average, subjects had shown 95% resynchronization in approximately 3 days for the westward flight and approximately 8 days for the eastward. Wever's suggestion that the endogenous periodicity may also influence the rate of rephasal prompted us to investigate this possibility using the Deep Body Temperature (DBT) rhythm in unrestrained subhuman primates exposed to photoperiod shifts simulating eastward and westward time zone changes as a model. Using mathematical techniques developed in our laboratory which afford us the opportunity to determine changes occurring during the transient state, intermediate between the initial base line steady state rhythms and the final post-shift steady state rhythms, we analyzed behavior of the rhythms during resynchronization.

450.
De Roshia, C. W., C. M. Winget, and G. H. Bond. Two mechanisms of rephasal of circadian rhythms in response to a 180° phase shift (simulated 12-hr time zone change). J. Interdiscipl. Cycle Res. 7: 279-286, 1976.

451.
Dervillee, P., and H. J. Lazarini. A propos du travail en equipe avec changement d'horaires. Incidences familiales et repercussion possible sur la sante des travailleurs. Arch Mal. Prof. Med. 20: 306-309, 1959.

452.
Desir, D., F. S. Fang, C. Jadot, E. Van Cauter, E. Martino, S. Refetoff, and G. Copinschi. Effects of transmeridian transportation on plasma cortisol circadian and ultradian variations. European J. Clin. Invest. 8: 349, 1978.

453.
Desir, D., E. Van Cauter, J. Golstein, M. Fevre, C. Jadot, S. Refetoff, and G. Copinschi. Adaptation of the nyctohemeral variations of pituitary and related hormones after transmeridian transportation in normal man (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p.VII-2.

454.
Devos, J. E., and I. Carruthers-Jones. Drug-induced modifications in the circadian rhythm and EEG of rats. Sleep: Europ. Congr. Sleep Res., 3rd, Montpellier, 1976, edited by W. P. Koella and P. Levin. Basel: Karger, 1977, pp. 355-357.

455.
Dexter, H. E. Pilot fatigue study: a first look. Air Line Pilot 44: 18-19, 1975.

456.
Dexter, J. D., D. G. Hof, and C. E. Mengel. Effect of sleep-wake reversal and sleep deprivation on the circadian rhythm of oxygen toxicity seizure susceptibility. Aerosp. Med. 43: 1075-1078, 1972.

The effect of sleep-wake reversal and sleep deprivation on the circadian rhythm of oxygen toxicity seizure susceptibility was investigated in an attempt to more clearly define its nature. Albino Sprague-Dawley rats were exposed in a previously O_2 flushed, CO_2 free chamber. The exposure began with attainment of 60 psi (gauge) and the end point was the first generalized seizure. Part I. Animals were exposed to reversal diurnal conditions since weanlings until their sleep-wake cycles had completely reversed, and then divided into four groups of 20 based on the time of day exposed. The time of exposure to OHP prior to seizure was now significantly longer in the group exposed from 1900-2000 hrs and a reversal of the circadian rhythm of oxygen toxicity seizure susceptibility was noted. Part II. Animals maintained on normal diurnal conditions were deprived of sleep on the day of exposure for the 12 hours prior to exposure at 1900 hrs, while controls were allowed to sleep. There was no significant differences in the time prior to seizure between the deprived animals and the controls with an n=40. Thus the inherent threshold in susceptibility to OHP seizures seems not to be a function of sleep itself, but of some biochemical/physiologic event which manifests a circadian rhythm.

457
Deyo, M. E. Is today for the birds-or the birdies? The Professional Golfer, pp. 18-26, April 1976.

458.
Dezelsky, T. L., and J. V. Toohey. Biorhythms and the prediction of suicide behavior. J. School Health. pp. 399-403, Sept. 1978.

The suicide dates of 19 Arizona students were evaluated in terms of the biorhythm critical day criterion using the technique of probabilities of nonoverlapping events. No incidences of suicide above chance expected levels were found for critical days of the 23, 28, or 33 day cycles; however, the results should not be considered definitive due to the small number of suicide samples.

459.
Dhenin, G. H. Troop transport operations. Aeromedical aspects of troop transport and combat readiness. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development. AGARD-CP-40:1-1-1-2, 1968.

460.
Dierlich, U. Auswirkungen der Zeitverschiebung auf die Tagesrhythmik der 17-Hydroxycorticosteroide (Effects of time shift on the diurnal excretion pattern of 17-hydroxycorticosteroids). Bonn-Bad Godesberg: Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt, Institut fur Flugmedizin, DLR-FB 73-25, 1973, 60 pp. (transl. in Engl. by European Space Research Organization, ESRO TT-34, 1974).

The urinary excretion of conjugated and unconjugated 17-Hydroxycorticosteriods (17-OHCS) was studied in 8 male students in 3-hour intervals during periods of 24 hours. Two 24-hour pre-flight periods revealed the basic normal daily periodicity of 17-OHCS excretion. Effects of a 6-hour time shift were evaluated by determining the excretion rates after flights from Germany to the USA and vice versa on day 1, 3, 5, and 8 after arrival. A desynchronization with the new local time was observed after flights in both directions, the diurnal 17-OHCS excretion patterns being more disturbed, however, after the West-East flight. The resynchronization time of maximum and minimum excretion was 3-5 days after the westward travel and 5-8 or more after travelling in the opposite direction. It is suggested that the unfavorable flight conditions of the West- East flight (night flight) mainly account for the more marked time shift effects observed after the eastward flight.

461.
Dille, J. R., H. L. Gibbons, and S. R. Mohler. Circadian rhythms and the effects of long-distance flights. Air Line Pilot 37: 15-17, 1968.

462.
Dodge, M. B. Jet lag: the new solutions. Harper's Bazaar, Aug. 1979, pp. 38-39.

463.
Doering, C. H., H. C. Kraemer, H. Keith, H. Brodie, and D. A. Hamburg. A cycle of plasma testosterone in the human male. J. Clin. Endocrinol. Metab. 40: 492-500, 1975.

Blood samples were obtained in the morning on alternate days for 2 months from 20 males. Analysis for testosterone periodicity included spectral analysis, sine wave analysis, and ANOVA and revealed a period range of 8-30 days with a cluster at 20-22 days. There was a close agreement among the methods for 12/20 subjects. The majority of the cycles were statistically significant (.05).

464.
Donnelly, J. E. The Relationship Between Biorhythms and Human Performance. Ph.D. Thesis, West Virginia University, 1978.

Choice hand reaction time and whole body movement and performance times were recorded from 75 subjects from swimming and gymnastics teams and general physical education classes in 10 randomly scheduled sessions. The data were analyzed with respect to biorhythm cycles using analysis of variance for unequal sub-class numbers. Significant F-ratios were found for the intellectual emotional cycle interactions (women gymnastics) and physical-emotional interactions (general P.E. reaction time), but not in accordance with the defined biorhythm theory. Significant F-ratios were also found in the intellectual cycle (whole body reaction time and performance times) but were felt by the author to be insufficient evidence to support the theory of biorhythms in the parameters tested. He concludes that coaches, instructors and behavior scientists will not benefit from utilizing biorhythms to predict performance. However, this experimental design, utilizing only 10 test sessions, uncontrolled for circadian changes, would have rendered any conclusions concerning the relationship between biorhythm and performance invalid, whether the findings were positive or negative.

465.
Dorland, J., and N. Brinker. Fluctuations in human mood (A preliminary study). J. Interdiscipl. Cycle Res. 4: 25-29, 1973.

One subject rated his mood daily for 1500 consecutive days. Variance spectral analysis revealed a dominant period of 7 days and also significant cycles of 2.4, 3.7, 5.5, 10.5, 18, 19.7, 28 and 57.8 days were found.

466.
Doskin, V. A., and N. A. Lavrent'yeva. Periods of maximum performance and circadian rhythm of physiological functions. Sovetskaya Meditsina 8: 140-145, 1974.

467.
Doskin, V. A. , and N. A. Lavrent'yeva. Biorhythm principles of establishing the human nutritional regimen. Library of Congress Scinece and Technology (S & T) Alert, Item No. 4613, 18 April 1978.

The rhythms of nutritional requirements differ significantly in morning and evening types of people: there are 54% morning people, 19% evening, and the rest are arrhythmic or unclassified. The authors imply a need for adjusting nutritional patterns to biological rhythms.

468.
Doskin, V. A., and N. A. Lavrent'yeva. Pressing problems of space biorhythmology discussed in new book. (Book review of "Aktual'nye problem kosmicheskoy bioritmologii" by S. E. Stepanova, Moscow: Nauka, 1977, 311p.) Kosm. Biol. Aviakosm., Med. 13(5): 88-90, 1979.

469.
Doskin, V. A., N. A. Lavrentieva, A. G. Podlesny, and V. B. Sharay. Biorhythmical prerequisites in organizing a shift-wise labour cycle for young workers. Gig. Trud. Prof. Zabol. 4: 9-13, 1976.

470.
Dowd, P. J. Sleep deprivation effects on the vestibular habituation process. J. Appl. Psych. 59: 748-752, 1974.

The effects of sleep deprivation on habituation of the vestibular system in a stressful situation were examined. One hundred forty three experienced pilots were exposed to two tests of Coriolis acceleration after periods of sleep deprivation (24-30 hours) or rest (6 hours). Nystagmus responses to Coriolis stimulation were recorded after four right-to-left tilts. Sleep deprivation resulted in (a) increased sensitivity to Coriolis stimulation; (b) a decreased recovery rate; and consequently (c) interference with the vestibular habituation process. The implications of sleep loss in increasing the hazards of flying are discussed.

471.
Downie, J. H. Some social and industrial implications of shiftwork. London: Industrial Welfare Society, 1963

472.
Dreiske, P. Are there strange forces in our lives? Family Safety Magazine 31: 14-16, 1972.

473.
Drenth, P. J., G. Hoolwerf, and H. Thierry. Psychological aspects of shift work. In: Personal Goals and Work Design, edited by P. Warr, New York: John Wiley & Sons, 1976, Ch. 14, pp. 209-223.

474.
Drew, G. C. An experimental study of mental fatigue. In: Aircrew Stress in Wartime Operations, edited by E. J. Dearnaley and P. B. Warr. London and New York, Academic Press. 1979, pp. 135-177.

The chances in human behavior occurring in a situation expected to bring about mental fatigue are investigated. Pilot trainees were asked to perform a fixed set of maneuvers in a cockpit simulator, and the responses were scored. After two hours of testing, subjects reported the subjective malaise characteristic of fatigue, and significant deteriorations of side-slip, air speed, altitude and directional performance were observed. The deterioration is attributed to a general lowering of standards as the test progresses, an increase in the magnitude of the errors made, the disregard of relationships between actions, difficulties with the artificial horizon, and increasing irritability. Other effects observed include unreliability of pilot reports on what had occurred during the test, a growing awareness of physical discomfort, forgetting to monitor minor instruments, and the appearance of entirely abnormal and inappropriate responses. Means of preventing the development of mental fatigue in operational situations are suggested.

475.
Druzhinin, Yu.P., Ye.J. Zubkova-Mikhaylova, and G. N. Podluzhnaya. Circadian changes in activity of the hypothalamus-hypophysis adrenal system in animals differing in individual radiosensitivity. Kosm. Biol. Aviakosm. Med. 11(6): 40-45, 1973.

476.
Dube, M. G. Food as a Zeitgeber: effect of one hour light phase food access on sleep in the rat (abstract). Sleep Res. 5: 214, 1976.

477.
Dudek, R. A. Performance, recovery and man-machine effectiveness. Texas Tech. Univ. Lubbock Center of Biotechnology and Human Performance. Semi-annual progress rep., 1973, 22 pp.

478.
Dudek, R. A., M. M. Ayoub, M. A. El-Nawawi, and T. M. Kahlil. Work-rest schedules under prolonged vibration with implications to military operations. Conf. on Military Requirements for Research on Continuous Operations (Human Engineering Labs.), Lubbock, TX., 1971, pp. 51-69.

The research discussed here focused attention upon investigation of work schedules for single and multi-station crews performing tasks, viz. a conpensatory tracking task, when subjected to a vibrational environment. Indications of beneficial work schedules and work-rest ratios are provided.

479.
Dukes-Dobos, F. N. Fatigue from the point of view of urinary metabolites. Ergonomics 14: 31-40, 1971.

480.
Dunham, R. B. Shift-work: A review and theoretical analysis. Academy of Management Review 2: 624-634, 1977.

A review of research on worker responses to shift-work which emphasizes the identification of workers' problems. The theoretical analysis suggested that many shift related problems were the result of lack of community orientation toward shift-work schedules.

481.
Dunn, J. D., A. Arimura, and L. E. Scheving. Effect of stress on circadian periodicity in serum LH and prolactin concentration. Endocrinology 90: 29-33, 1972.

482.
Dupont, W., PL. Bourgeois, J. M. Berepion, F. Gaumer, P. Bourgeois-Victor, and A. Reinberg. Disappearance of circadian rhythm of a physiological parameter at a particular time of the year, in natural conditions: the teaching of the animal model (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, II-2.

483.
Dushkov, B. A., N. N. Gurovskiy, P. R. Iseev, Z. M. Karelina, F. P. Kosmolinskiy, M. I. Kozarv, A. A. Veselova, S. N. Zaloguev, and V. V. Zhuravlev. Effects of various work and rest schedules on the functional condition of man during prolonged confinement in hermetically sealed cabins. In: Psychophysiology of the Work of Cosmonauts (Psikhofiziologii Truda Kosmonavtov). Edited by N. N. Gurovskii, Moscow: Izdatelstvo Meditsina, 1967, pp 76-106.

484.
Dushkov, B. A., and S. A. Kosilov. Physiological basis of human adaptation to specific work conditions. In: Psychophysiology of the Work of Cosmonauts (Psikhofiziologii Truda Kosmonavtov). Edited by N. N. Gurovskii, Moscow: Izdatelstvo Meditsina, 1967, pp. 14-32.

Discussion of fatigue encountered by cosmonauts and the urgent need for a scientifically based fatigue-prevention problem. An effective method of preventing fatigue is a rational work and rest schedule. Physical and mental fatigue, adaptation to altered circadian rhythms, and mechanisms of such adaptation are treated in detail. The complicating effects of weightlessness and emotional tension on fatigue and biorhythms are considered, and the use of hypnosis, electrosleep, and drugs is suggested as a means of facilitating adaptation to the working conditions prevailing during prolonged space flights.

485.
Eastman, C. Circadian rhythms of sleep, activity and temperature in the rat (abstract). Sleep Res. 7: 302, 1978.

486.
Eaves, D. Night duty: time for a change. Nurs. Mirror 150: 22-24, 1980

487.
Ebihara, S., K. Tsuji, and K. Kondo. Strain differences of the mouse's free-running circadian rhythm in continuous darkness. Physiol. Behav. 20: 795-799, 1978.

488.
Edmonds, S. C. Food and light as entrainers of circadian running activity in the rat. Physiol. Behav. 18: 915-919, 1977.

The purpose of this experiment was to determine the extent to which circadian running activity could be controlled by two different environmental cues: periodic access to food and ambient light cycles. Seven male rats were successively exposed to the following four conditions: (1) With light cycles (LD 12:12) and continuous access to food, the animals displayed a basically noctunal pattern of running. (2) With access to food for two hours during the illuminated portion of the LD cycle, all of the animals showed a burst of running preceding food presentation. Three of these seven animals concurrently showed diminished running associated with the light cycle. (3) The animals continued to access to food, and still exposed to constant light, the animals continued to show bursts of running around the time that food had been delivered. Rats' circadian activity cycles were therefore influenced by periodic access to food. Moreover, when periodic food was offered during the illuminated portion of the LD cycle (when rats are normally inactive) food presentation was a more potent entrainer than photic cues in controlling running activity.

489.
Edmonds, S. C. and N. T. Adler. The multiplicity of biological oscillators in the control of circadian running activity in the rat. Physiol. Behav. 18: 921-930, 1977.

The purpose of this experiment was to determine the degree to which a circadian running activity could be controlled by multiple biological oscillators within a single organism. Twelve male rats, housed in running wheels, had access to food from noon to 1 p. m. daily in addition to this noon or fixed feeding, the rats received a moving feeding during which they had access to food for 1 hr every 25 hr. These two circadian feedings had a continually shifting phase relationship to each other. The animals responded to this regime by displaying separate bursts of running activity which were in relative coordination. Each animal's behavior shifted between the three following general patterns: (1) one cycle of activity, either before the fixed or the moving feed; (2) two bursts of activity, one before the fixed feeding and one preceding the moving feeding; or (3) a burst of activity not entrained to either one of the feedings but rather free running between the two. When the animals were subsequently offered continuous access to food, 10 of the 12 rats maintained two bursts of activity.

490.
Edmunds, L. N. Clocked cell cycle clocks. Implication toward chronopharmacology and aging. In: Aging and Biological Rhythms, edited by H. V. Samis, and S. Capobianco. New York-London: Plenum Press, 1978, pp. 125-184.

491.
Ehrenstein, W. Circadiane Rhythmen, Zeitgeber und Verhatten (Circadian rhythms, Zeitgeber and behavior.) Arbeitsmedizin Socialmedizin 12(1): 13-16, 1977.

The behaviour of man is determined by exogenous factors and endogenous rhythms. The mutual effects of behaviour and circadian vegetative rhythms on each other are shown with the sleep-waking-cycle as a relevant example of behaviour. The hypothesis is presented, that a Zeitgeber is probably not working by primary information processes. Alterations of behaviour, causing an avalanche effect of synchronous informations in numerous information channels of the body are believed to be much more effective. Vegetative rhythms are coupled with rhythms of behaviour to a different degree. Therefore a sudden phase shift of a behavioural rhythm causes an internal desynchronization of vegetative rhythms. Depending on the actual circumstances the pressure of the desynchronized state results in a phase shift of behaviour back to the prior phases or a slow shift of the resistent vegetative rhythms to the new phase of the behavioural rhythm.

492.
Ehrenstein, W., and W. Muller-Limmroth. Changes in sleep patterns caused by shift work and traffic noise. In: Experimental Studies in Shiftwork, edited by W. P. Colquhoun, S. Folkard, P. Knauth, and J. Rutenfranz. Forschungsbericht des Landes NRW, Nr. 2513. Opladen: Westdeutscher Verlag, 1975, pp. 48-56.

493.
Ehrenstein, W., W. Muller-Limmroth, and K. Schaffler. An electrophysiological contribution to investigation on the effect of 7-chloro-1, 3-dehydro-3-hydroxy-5-phenyl-2H-1,4-benzodiazepin-2-one on the sleep during daytime following a night shift. Arzneimittel-Forschung 19: 1656-1659, 1969.

Adumbran administered 1 h before day sleep normalized the duration of paradox sleep, lengthened the deep sleep in the second half of sleep, though not to the full duration observed in night sleep, decreased number and duration of waking phases. It did not shorten the periods compared with those of night sleep, increased heart and repiration rate without influencing the heart heat/respiration ratio and slightly increased the motor activity during sleep, which, nevertheless, remained far below that seen in night sleep. So, Adumbran markedly improves the badly disturbed day sleep of the night worker but cannot accomplish a complete normalization adequate to night sleep.

494.
Ehret, C. F. New approaches of chronohygiene for the shift-worker in the nuclear power industry (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. V-1.

495.
Ehret, C. F., K. R. Groh, and J. C. Meinert. Circadian dyschronism and chronotypic ecophilia as factors in aging and longevity. Adv. Exper. Med. Biol. 108: 185-213, 1978.

496.
Ehret, C. F., V. R. Potter, and K. W. Dobra. Chronotypic action of theophylline and of pentobarbital as circadian Zeitgebers in the rat. Science 188: 1212-1214, 1975.

In the rat the deep body temperature rhythm, monitored by telemetry, can be reset in a predictable direction by a stimulant (theophylline) and by a depressant (pentobarbital). When the drugs are applied immediately before or during the early active phases of the circadian cycle, the rhythm is set back (phase delay). When applied later, past the thermal peak, theophylline, but not pentobarbital, shifts the rhythm ahead (phase advance). Theophylline and pentobarbital in addition to having a number of already established pharmacological properties are now further identified a chronobiotics: they are drugs that may be used to alter the biological time structure by rephasing a circadian rhythm.

497.
Ekstrand, B. R., T. R. Barrett, J. N. West, and W. G. Mater. The effect of sleep on human long-term memory. In: Neurobiology of Sleep and Memory, edited by R. R. Drucker-Colin and J. L. McGaugh. New York: Academic Press, 1977, pp. 419-438.

In the prototype experiment, subjects learn a list of associations by the paired-associate learning method. Upon reaching a common learning criterion, the subjects are divided into two groups, sleep and awake. After a specified retention interval of either sleeping or being awake and carrying out normal waking activities, the two groups are tested for recall of the learned associations. The sleep effect refers to the fact that recall of memory is higher in the group which stayed awake. As we said, the sleep effect has been demonstrated many times. There is no argument about the reliability of the effect. There is an argument about why the effect occurs.

498.
El Batawi, M. A. Food intake and work performance: A study in the effect of fasting on work output in the eastern mediterranean. In: Alimentation et Travail, edited by G. Debry and R. Bleyer. Paris: Masson, 1972, pp. 261-265.

499.
Elias, R. and H. Christman. Etude du travail poste dans un poste de telecommande de hauts-fourneaux. (Study of shift working in a remote-control station of blast furnaces). Arch. Mal. Prof. Med. 40: 370-375, 1979.

500.
Elizarov, E. N. Characteristics of the phase changes in blood coagulation in submariners. Voenno-Med. Zh. No. 3, pp. 57-59, 1978.

501.
Elkin, A. J., and D. J. Murray. The effects of sleep loss on short term recognition memory. Canad. J. Psychol. 28: 192-198, 1974.

The performance of 20 sleep deprived subjects on a probe recognition memory task was compared with that of 20 non-deprived controls over periods up to 55 hours. Recognition was either immediate or delayed by 20 seconds. The results showed that the sleep deprived group made significantly more errors in the perception of the material, and, under the delay condition, retained less adequately those times correctly perceived. It is argued that these findings are consistent with the notion that sleep loss causes a deficit in attention, leading to misperception and a failure to rehearse adequently material presented or memorization.

502.
Elliott, A. L., J. N. Mills, D. S. Minors, and J. M. Waterhouse. The effect of real and simulated time zone shifts upon the circadian rhythms of body temperature, plasma 11-hydroxycorticosteroids and renal excretion in human subjects. J. Physiol. 221: 227-257, 1972.

503.
Elliott, J. A. Circadian rhythms and photoperiodic time measurement in animals. Fed. Proc. 35: 2239-2245, 1976.

504.
Elomaa, E., and G. G. Johansson. Daily rhythm of locomotor activity is abolished during rapid eye movement sleep deprivation in the rat. Physiol. Behav. 24: 327-330, 1980.

Applying a modified flowerpot technique, which made it possible to use a test animal as its own control, twenty-four hour cycles of locomotor activity were recorded in eight juvenile male rates on 12:12 hr. light dark (LD) schedule during six days of rapid eye movement

(REM) sleep deprivation. It was found that the LD difference in locomotor activity unrelated to feeding was instantaneously abolished during REM sleep deprivations. The dark rhythm of food directed activity, however, was only gradually attenuated. Due to this equalization in the light and dark activity, the rats gave an impression of hyperactivity during the light hours, although the total daily motor output after an initial increase returned close to the baseline value.

505.
Emde, F., G. Hildebrandt, P. Knauth, I. Lowenthal, and J. Rutenfranz. Physiological circadian rhythms of shift workers in three groups of the services and one of the industrial sector. Chronobiologia 6: 95, 1979.

The study included 93 shift-workers in the services area and 40 shift-workers in the electro-industry.

Of the first group 37 shift-workers worked in municipal undertakings concerned with gas and water supply. Forty-one firemen and 15 ambulance men were occupied at the biggest German airport. The 40 industrial workers were involved in plastic production. In the different shift-systems, the number of night-shifts worked in succession varied between 1 and 7. All subjects were asked to record oral temperature every 2 h during work and leisure time. About a third of them interrupted their sleep for an additional temperature reading. In the municipal undertakings, urine samples were colected parallel to the oral temperature readings. The potassium, sodium, adrenaline and noradrenaline excretion in the urine were analyzed.

The oral temperature curve over the course of the day changed with increasing number of night-shifts in succession. After 7 night-shift the re-entrainment took more than 2 days. The longer the period of the night-shift, the smaller the amplitude of the daily rhythms of all analyzed excretions in the urine during the following days off-duty.

506.
Empson, J. Periodicity in body temperature in man. Experientia 33:342-343, 1977.

507.
Endo, S., and E. Koga. The effect of time zone changes on sleep. Sleep Res. 4: 264, 1975.

508.
Endo, S., and M. Sasaki. Alterations of sleep rhythms due to time zone changes. Adv. Neurol. Sci. 19: 779-785, 1975.

509.
Endo, S., and T. Yamamoto. Effects of time zone changes on sleep west-east flight, and east-west flight. Jikeikai Med. J. 25: 249-268, 1978.

Studies on the effects of time zone changes on biological rhythm were discussed with emphasis on sleep. On the basis of four experiments, the results were summarized as followed: 1) Changes in sleep after Tokyo/San Francisco (TYO/SFO) flight (Eastward flight). Slow wave sleep (SWS) was significantly elevated and REM sleep was markedly depressed, although the distribution of both types of sleep was not altered. It took 8 days for the sleep rhythm in the night of SFO to synchronize with the local time, and more than 10 days for pulse rate: 2) Changes in sleep after the home going flight from SFO (Westward flight). There was enhancement of Rem sleep but SWS did no change. Sleep latency and REM sleep latency were significantly abbreviated with frequent appearance of sleep onset REM periods. It took 8 days for the sleep rhythm after SFO/TYO flight to synchronize with Japan time, and about 5 days for pulse rate. 30 Changes in sleep after southward and northward flights as a control study. There was no change of REM sleep but marked enhancement of SWS on the first night flights in both directions due to one night sleep deprivation. There was clear evidence of circadian effects to overnight sleep due to alteration in time zone.

510.
Engel, P., and G. Hildebrandt. Die rhythmischen Sachwankungen der Reaktionszeit beim Menschen. Psychol. Forsch. 32: 324-336, 1969.

Reaction time is found to undergo some cyclical changes, the period of which is age-dependent.

511.
Engel, P., and G. Hildebrandt. Rhythmic variations in reaction time, heart rate, and blood pressure at different durations of the menstrual cycle. In: Biorhythms and Human Reproduction, edited by M. Ferin, F. Halberg, R. M. Richart, and R. L. Vandewiele. New York: John Wiley, 1974, pp. 325-333.

Wave form and phase position of blood pressure, heart rate and reaction time rhythms were studied in relation to menstrual cycle length. Interindividual differences were found in the phase position of the cyclic variations. In general, with increasing menstrual cycle duration the phase of these rhythms advances within the menstrual cycle. The rhythms are not sinusoidal but tend to be multiphasic and asymmetric in shape.

512.
Engeland, W. C., J. Shinsako, C. M. Winget, J. Vernikos-Danellis, and M. F. Dallman. Circadian patterns of stress-induced ACTH secretion are modified by corticosterone responses. Endocrinology 100: 138-147, 1977.

513.
Engelmann, W. A slowing down of circadian rhythms by lithium ions. Z. Naturforsch. 28c: 733-736, 1973.

Under the permanent influence of lithium ions the circadian rhythm of movement of Kalanchoe petals is effectively lengthened but a pulse administered up to 12 hours has no influence. Lithium ions could also be demonstrated to similarly slow down the circadian activity rhythm of a small mammal (Meriones crassus). It is hypothesized that the therapeutic effect of lithium salts in endogenous depressions in human beings may result also from its acting on the human circadian system.

514.
Englund, C. E., and P. Naitoh. An attempted validation study of the birthdate- based biorhythm (BBB) hypothesis. Aviat. Space Environ. Med. 51: 583-590, 1980.

The authors refer to the biorhythm theory as the birthdate based biorhythm hypothesis (BBB) to distinguish it from scientific biological rhythm research. Two studies were performed in which examination scores from 26 students were obtained along with carrier landing performance quality evaluations from 7 Naval aviators. A multiple regression equation and multiple correlation coefficient were computed for each subject between performance scores and BBB cycles. In addition, student test scores, obtained over several weeks were subjected to least squares frequency analysis. Regression equations could not be computed to predict either performance on tests or carrier landing performance. The frequency analysis indicated no consistent individual or group patterns showing the reputed BBB periods of 23, 28 or 33 days. Although the critical day relationship with performance was not tested, the authors conclude that the BBB theory is not a reliable predictor of performance since their results do not support the theory and also because the theory is based on faulty assumptions and creates confusion by incorporating cognitive, emotional and physical performance factors under a single biological model.

515.
Eremin, A. V., R. M. Bogdashevskii, and E. F. Baburin. Preservation of man's efficiency during long-term space flight. In: Weightlessness: Medical-biological Investigations. Moscow: Izdatel'stvo Meditsina, pp. 326-341, 1974.

It is shown that the changes in the functional state of the principal systems of the human organism during space flight occur in certain stages that are closely associated with the duration of the flight. A characteristic of the changes in cosmonaut efficiency is that, in addition to the regular diurnal phases, there exist secondary phases, whose occurrence covers the entire flight period, and which are associated with the stages of adaptation to weightlessness and to other unfavorable factors. (Some of the secondary phases need not manifest themselves during short-duration missions.) The "disorganization" phenomenon is seen to be largely responsible for the development of these stages and phases.

516.
Erikson, L. B. Diurnal temperature variation in the Rhesus monkey under normal and experimental conditions. Nature 186: 83-84, 1960.

517.
Erkert, H. G. Der Einfluss der Schwingungsbreite von Licht-Dunkel-Cyclen auf Phasenlage und Resynchronisation der circadianen Aktivitatsperiodik dunkelaktiver Tiere. J. Interdiscipl. Cycle Res. 7: 71-91, 1976.

518.
Erkinaro, E. Der Verlauf desynchronisierter, circadianer Periodik einer Waldmaus (Apodemus flavicollis) in Nordfinnland. Z. Vergl. Physiologie 64: 407-410, 1969.

519.
Erne, H. Circadian variation in performance and personality variables. Psychologie - Schweizerische Zeitschrift fur Psychologie und ihre Anwendungen 35: 185-197, 1976.

520.
Ernst, G., and J. Rutenfranz. Flexibility in shift work-some suggestions. Ergonomics 21: 872,1978.

This paper suggests that, in addition to the frequently discussed conventional solutions, the introduction of flexibility into the design of shift systems would seem to be a possible way to reduce the incidence of complaints associated with shift work. Such flexible systems should not be initiated without the full participation of the workers, and it is therefore necessary to make an accurate analysis of the social organization of the particular industry before any attempt is made to change existing arrangements within it.

521.
Erwin, C. W., E. L. Wiener, M. I. Linnoila, and T. R. Truscott. Alcohol-induced drowsiness and vigilance performance. J. Stud. Alcohol 39: 505-516, 1978.

Detection of signals in a visual vigilance task decreased significantly after drinking 1.2 g of alcohol per kg. Two mechanisms for the detection decrement are discussed.

522.
Estevez Bravo, J. El sueno y la turnicidad (relacion con la patologia observada), (Sleep and shift work (relationship to pathology observed)). Revista Seguridad Aviles 53: 38-43, 1974.

With the aid of ten tables the author analyses a population of 1,099 workers engaged or not engaged in shift work. He studies, in particular, the interrelationships obtaining between the shift, insomnia, and pathological manifestations, these last being distinctly more common in shift workers.

523.
Estryn-Behar, M. C. Gadbois, and E. Vaichere. Effecs du travail de nuit en equipes fixes sur une population feminine. Resultats d'une enquete dans le secteur hospitalier. (Effects of night shift working upon a feminine population. Results of a survey in the hospital sector.) Arch. Mal. Prof. Med. 39: 531-534, 1978.

524.
Evans, F. J., M. R. Cook, H. D. Cohen, E. C. Orne, and M. T. Orne. Appetitive and replacement naps: EEG and behavior. Science 197: 687-689, 1977.

Consistent subjective, behavioral, and electroencephalographic sleep-state differences were found between afternoon naps of 11 habitual appetitive nappers (who nap lightly for psychological reasons apparently unrelated to reported sleep needs) and 10 replacement nappers (who apparently nap regularly in response to temporary sleep deficits). Both types of naps were compared with naps of 12 confirmed non-nappers.

525.
Evans, J. I., G. A. Christie, S. A. Lewis, J. Daly, and M. Moore-Robinson. Sleep and time zone changes. A study in acute sleep reversal. Arch. Neurol. 26: 36-48, 1972.

Alterations occurred in the overnight sleep patterns of four healthy male subjects before and after trans-Atlantic flights in both directions. On the first night after a London/San Francisco flight, stage 4 sleep was enhanced, and rapid eye movement (REM) sleep was depressed, although the distribution of both types of sleep during the night was not altered. Early morning waking was a feature of the first five nights in the new time zone, particularly in the older subjects. Similar changes occurred after the return flight. There was no evidence of enhancement of REM sleep and the alteration in the distribuiton of REM sleep which has been noted in laboratory studies of sleep reversal. However, the changes found were in accord with travelers' complaints. No definite evidence of circadian effects due to alteration in time zone were demonstrated.

526.
Exley, D., and C. S. Corker. The human male cycle of urinary oestrone and 17-oxysteroids. J. Endocrinol. 35: 83-99, 1966.

A study was made of urinary oestrone and 17-oxysteroids in 5 men collected over 17-47, days. Analysis by autoregression, analysis of variance and Kendalls turning point test revealed significant 8-10 day cycles in both variables.

527.
Fabbro, G. D. I voli di "lungo raggio" ed i ritmi circadiani (Long distance flights and circadian rhythms). Minerva Med. 61: 3922-3928, 1970.

528.
Fabrikant, G. That old jet lagging has me in its spell-but try these counter tactic for the clock wise. Apartment Life 10: E4, 1978.

529.
Farr, L., and R. V. Andrews. Rank-associated desynchronization of metabolic and activity rhythms of Peromyscus maniculatus in response to social pressure. Comp. Biochem. Physiol. 61A: 539-542, 1978.

Saturation level population density conditions drastically affected the level and timing of subordinate males' metabolic rate and locomotor activity and feeding rhythm. The increased daily metabolic rates of subordinate animals was expressed in the face of depressed locomotor and feeding activity levels. A phase shift in the metabolic peak of dominant animals occurred at high density, but close synchrony between activity and metabolic rate persisted with no increase in metabolic cost. Subordinate animals showed desynchronization of activity rhythm at high density; this effect imposed a higher bioenergetic cost upon the subordinate than upon the dominant mice.

530.
Farrell, B. L., and M. F. Allen. Physiologic/psychologic changes reported by USAF female flight nurses during flying duties. Nurs. Res. 22: 31-36, 1973.

The responses of 444 United States Air Force active duty female flight nurses to a questionnaire survey pertaining to physiologic/psychologic changes associated with flying duty showed significant changes ($p<.05$) for all items except one--blurred vision after flight. The questionnaires revealed that a larger percentage of the nurses who flew in jet aircraft exclusively ($N = 102$) experienced a change in the factors covered than did the nurses who flew only in propeller aircraft ($N = 168$). These percentages were significantly higher (at least $p<.05$) for changes associated with the menstrual function (frequency, flow, and dysmenorrhea), with bruising of thighs and legs, and in bowel habits, sleep patterns, and weight.

531.
Farrer, N., and J. W. Ternes. Illumination intensity and behavioral circadian rhythms. In: Circadian Rhythms in Nonhuman Primates, edited by F. H. Rohles. Bibl. Primatol. Basel: S. Karger, 1969, pp. 1-7.

532.
Fedorov, R. Effects of unusual work rest cycles in cosmonauts. Library of Congress Science and Technology (S & T Alert), Item No. 4719.

An experiment was conducted using a two week test on 16 hour cycles with 5 hour sleep periods. At first the shortened schedule had

no effect, but then work capacity deteriorated. Subjects complained of insomnia and sleepiness.

533.
Feinberg, I. Changes in sleep cycle patterns with age. J. Psychiatr. Res. 10: 283-306, 1974.

534.
Feinleib, M., and R. Fabsitz. Do biorhythms influence day of death? New Engl. J. Med. 298: 1153, 1978.

Frequency of occurrence of 960 deaths due to coronary heart disease and non-coronary heart disease on biorhythmic critical days was compared to frequencies expected by chance. These frequencies were indistinguishable and therefore the authors conclude that it is highly unlikely that biorhythmic cycles influence time of death.

535.
Fenz, W. D., and J. G. Graig. Autonomic arousal and performance during sixty hours of sleep deprivation. Perceptual and Motor Skills 34: 543-553, 1972.

536.
Ferguson, D. A. Shift Work and Health. Personnel Practice Bulletin 27: 113-122, 1971.

A brief review of the biological and medical effects of shift work and the relationship between shift work and performance. The author outlines ways in which shift conditions can be made as acceptable to the workers as possible (selection of new employees, choice of shift cycle time, facilitation of shift work by providing a good canteen service, avoiding long periods of work tension, etc., and educating shift workers to make optimum use of leisure).

537.
Fernstrom, J. D. The effect of nutritional factors on brain amino acid levels and monamine synthesis. Fed. Proc. 35: 1151-1156, 1976.

538.
Fernstrom, J. D. Effects on the diet and brain neurotransmitters. Metabolism 26: 207-223, 1977.

539.
Fernstrom, J. D., and R. Wurtman. Nutrition and the brain. Sci. Am. 230: 84-91, 1974.

540.
Ferrari, E., et al. Environmental influences on the circadian rhythm of the CRH-ACTH-adrenal cortical system in man. Probl. Actuels Endocrinol. Nur. 19: 223-240, 1975.

541
Fincher, J. Sleepers are given polygraph tests to solve a riddle. Smithsonian, pp. 85-95, 1978.

542.
Finger, R. The modification of the circadian rhythm by age and sex in humans. Bad Godesberg: Deutsche Versuchsanstalt fuer Luft-und Raumfahrt. Inst. Fuer Flugmedizin, DLR-FB-68-31, 1968, 69 pp.

543.
Finkelstein, J. S., F. R. Baum, and C. S. Campbell. Entrainment of the female hamster to reversed photoperiod: role of the pineal. Physiol. Behav. 21: 105-111, 1978.

The effects of pinealectomy and photoperiod reversal on locomotor activity and behavioral receptivity rhythms were investigated in the hamster. Activity rhythms of the control animals required 7.3 days to reentrain to the reversed photperiod,while pinealectomized animals showed a precocious reentrainment of running activity. Behavioral receptivity reentrained to the new photoperiod within the first estrous cycle after photoperiod reversal in all animals. Thus there was a dissociation between the rhythms of activity and behavioral receptivity following photoperiod reversal, suggesting that two circadian rhythms that are thought to be regulated by a common circadian system can become uncoupled from each other. The estrous cycle rhythms of estradiol, progesterone, FSH and uterine wet weight all appeared to be reentrained by at least the third estrous cycle after photoperiod reversal. This suggests that sex hormone rhythms are more rapidly reentrained than had been previously thought possible from studies on reentrainment of ovulation.

544.
Finkelstein, S. Rest can help travellers after long flights. Montreal: Int. Civil Aviation Organiz, Bulletin, 1973.

545.
Fiorica, V., E. A. Higgins, P. F. Lampietro, M. T. Lategola, and A. W. Davis. Physiological responses of men during sleep deprivation. J. Appl. Physiol. 24: 167-176, 1968.

546.
Firsova, N. Are we affected by biorhythms? Trud, Sept. 1978, 3 pp.

A review of low-frequency biological rhythms by a Russian psychologist indicates that Russian investigators are aware of the biorhythm theory but no position is taken on the validity of biorhythms.

547.
Fischer, C. Driver Fatigue...and what to do about it. Family Safety, Summer 1979, pp. 24-27.

548.
Fitzgerald, H. E., and T. W. Allen. Effects of circadian rhythms on autonomic functioning and its relationship with performance. Psychophysiology 14: 93, 1977.

The effects of biological rhythms on the relationship between autonomic functions and performance have been the subject of recent search. Although some studies have shown circadian changes in heart rate (HR) activity, the relationship between HR activity during various phases of the circadian cycle and performance has not been examined. The purpose of the present study was to investigate changes in HR activity, performance, and their relationship during selected phases of the circadian cycle. Twenty subjects were assigned to each of the following conditions: a) a pre-low HR activity group, b) a low HR activity group, and c) a post-low HR group. Ten subjects were tested using simple reaction time (RT) task with a fixed warning interval. The remaining subjects were tested during a RT task with a variable warning interval. Dependent variables were RT, magnitude of HR deceleration, and HR variance (HRV). Subjects in the low HR activity group produced the slowest RTs while subjects in the post-low HR activity group produced the fastest RTs. Magnitude of HR deceleration and HRV was smallest for subjects in the low HR activity group while largest for subjects in the post-HR activity group. A significant relationship was found between the deceleration and variability aspects of HR activity and RT performance for subjects in the low and post-low HR activity groups only. The findings indicate that circadian rhythms should be viewed as providing a physiological context which interacts to influence the nature and magnitude of phasic and tonic autonomic activity.

549.
Fix, A. J. Biorhythms and sports performance. The Zetetic 1: 53-57, 1976.

The performances of the best hitters on every major league baseball team for the 1975 season were analyzed with respect to biorhythm cycles. Their hitting wasn't significantly different on high, low or critical days.

550.
Fliess, W. Der Ablauf des Lebens: Grundlegung zur Exakten Biologie (The course of life, foundation of an exact biology). Leipzig-Vienna: Franz Deuticke, 1906, 564 pp.

This is Fliess' major book describing his discovery of the 23 and 28 day biorhythms. His basic theory states that all natural biological processes and events reflect the influence of 23 day (male) and 28 day (female) cycles and all of the integer multiples of these cycles. His basic formula can be written 23X + 28Y, where X and Y are positive or negative integers. On almost every page, Fliess fits this formula to natural phenomena ranging from the cell to revolution of the moon and sunspot cycles. The book's appendix is filled with such tables as multiples of 23, 28, 23*28, 644(23*28) and others. Other

tables list numbers from 1 to 28 or 1 to 51, each expressed as a difference between multiples of 23 and 28 (e.g., 13 = (21*28)-(25*23). Fliess apparently did not realize that if any two positive integers that have no common divisor are substituted for 23 and 28 in his formula, it is possible to express any positive integer whatever. Any event can be recreated as a multiple of 23 and 28 day cycles from a given starting point using this formula. For example: 1 = (23*11) + (28* - 9), 2= (23*(11*2)) + (28*(-9*2)), 3 = (23*(11*3)) + (28*(9*3)) ...etc. Even if x and y are limited to positive integers, it is still possible to express all positive integers greater than a certain integer (593) with the formula. Note: for integers less than 593, as N increases the interval between a day number which is a positive integral multiple of 23 and 28 converges. For example, on day 46 after birth (where the reputed biorhythms originate), the interval is 23 days, on day 102, it is 5 days, and by day 163 it is 2 days. Beyond day 593 it is one day. This means that any day in the life of a person more than 593 days old can be expressed as the combination of Fliess' 23 and 28 day biorhythm cycles (i.e., every day would theoretically be a biorhythm critical day!). This analysis of the Fliess biorhythm theory is in marked contrast to that of Thommen, who claims Fliess discovered the 23 and 28 day cycles while studying periodicity in disease states. Neither Thommen or the other biorhythm proponents cite Fliess' earlier 1897 book (for description, see Gardner, Scientific Amer. 215: 108, July 1966) which is understandable given its arcane ideas concerning the relationship between the nasal mucosa and sexual irregularities and their treatment by cocaine. Thommen fails to mention the Fliess formulas as using integer multiples of 23 and 28 day cycles to correlate with biological events. The use of integer multiples of 23 and 28 days allowed Fliess to explain any biological event or cycle on the basis of his theory, including biological events which result from stochastic processes, thereby rendering the theory totally useless. Thommen also fails to mention that Fliess applied the biorhythm theory to animals, plants and even astronomical events.

551.
Fliess, W. Vom Leben and vom Tod (Of Life and Death). Jena: Eugen Diederichs, 1909, 109 pp.

552.
Fliess, W. Das Jahr im Lebendigen. (This year in the life). Jena: Eugen Diederichs, 1918, 312 pp.

553.
Fliess, W. Zur Periodenlehre. (On periodic theory). Jena: Eugen Diederichs, 1925, 257 pp.

554.
Foley, M. F., and M. Babbitz. Effects of shift work on employee health. Aerospace Med. Assoc., Preprints, 1980, pp. 176-177.

555.
Folkard, S. Diurnal variation in logical reasoning. Br. J. Psychol. 66: 1-8, 1975.

556.
Folkard, S. The nature of diurnal variations in performance and their implications for shift work studies (abstract). Int. J. Chronobiol. 3: 16, 1975.

557.
Folkard, S. Circadian rhythms and human memory (abstract). Chronobiologia 6: 98, 1979.

This paper reviews the early and more recent literature on the effects of time of day on human memory, and on the performance of other tasks involving a high memory load. A distinction will be drawn between immediate and delayed memory. It will be shown that, in general, immediate memory decreases over most of the normal waking day. In contrast, delayed retention is superior for information originally presented in the afternoon or evening, but the time of day at which people attempt to retrieve information from memory has little, if any, effect on performance. The current theoretical interpretation of these findings will be discussed, together with their implications for scheduling of different types of task in both "normal day" and "shift work" situations.

558.
Folkard, S., and S. M. Haines. Adjustment to night work in full and part-time night nurses. J. Physiol. (Lond.) 267: 23P-24P, 1977.

559.
Folkard S., P. Knauth, T. H. Monk, J. Rutenfranz. The effect of memory load on the circadian variation in performance efficiency under a rapidly rotating shift system. Ergonomics, 19: 479-488, 1976.

Experimental shift work studies have typically found body temperature and performance efficiency to show very similar circadian rhythms. However, the performance tasks used have placed little, if any, reliance on short term memory. Studies of the variation in performance during the normal waking day have found performance on most tasks to improve over the day but that on short term memory tasks to decrease. The present paper reports an experimental study of the performance of two subjects on a rapidly rotating (2-2-2) shift system. Three versions of a new performance test, each with a different memory load, were administered four times per shift. With the low memory load version, performance showed a high positive correlation with body temperature and was poor during the nightshift. However, with the high memory load version, performance was negatively correlated with temperature and was best during the night shift. It is concluded that future shift work studies must take into account the memory load of the task under investigation.

560.
Folkard, S., and T. H. Monk. Individual differences, and personality factors, in adjustment to shift work (abstract). Ergonomics 21: 868, 1978.

The present paper reports the results of a preliminary study in which the 48 "permanent" night nurses taking part in a large shift work study were given a specially developed questionnaire, designed to distinguish between "good" and "poor" adjusters to shift work. Factor analyses indicated that there were three main factors: (i) the rigidity or flexibility of people's sleeping habits, (ii) people's ability to overcome drowsiness, and (iii) whether people were "morning" or "evening" types. Significant correlations were found between the nurses"scores to each of these factors and a number of psychological and physiological measures of adjustment of circadian rhythm, thus indicating that the factors had at least concurrent validity. It is concluded that it may prove feasible to develop a questionnaire that would predict people's ability to adjust their rhythms to shift work, and that flexibility of sleeping habits and the ability to overcome drowsiness should be components of such a questionnaire.

561.
Folkard, S., and T. H. Monk. Shiftwork and performance. Human Factors 21: 483-492, 1979.

562.
Folkard S., and T. H. Monk. Difference in the circadian response to a slowly rotating shift system (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. VII-3.

563.
Folkard, S., T. H. Monk, and M. C. Lobban. Short and long-term adjustment of circadian rhythms in 'permanent' night nurses. Ergonomics 21: 785-799, 1978.

Two studies are described in which differences were found in the adjustment of the circadian rhythms of full and part-time night nurses to night work. A distinction was drawn between short-term adjustment that takes place over successive night shifts, and long-term adjustment that may take the form either of a permanent "flattening" of the rhythm, or of a facilitations of short-term adjustment. The results from the first study indicated that even when the potential for greater short-term adjustment was controlled for, the full-time staff showed greater adjustment to night work. The second study examined these differences in long-term adjustment in greater detail. No evidence was found of a permanent "flattening" of the full timers' circadian rhythms, although they showed clear evidence of adjustment even in on the first of a period of successive night shifts. The full-timers also showed more evidence of adjustment from the first to the second night shift. It is suggested that these differences in long-term adjustment may reflect differences in the degree to which the nurses scheduled their lives towards night work.

564.
Folkard, S., T. H. Monk, and M. C. Lobban. Towards a predictive test of adjustment to shift work. Ergonomics 22: 79-91, 1979.

565.
Ford, L. R. Recommended Procedure for Evaluation of the Effects of Biological Rhythms on a Maintenance Task. (Report No. AD-786/499/4GA), 1974, 40 pp.

The paper examines past research concerning biological rhythms and human performance and suggests methods for future research concerning biological rhythms of their effects of performance of a maintenance type task. Many studies have been done concerning biological rhythms but relatively little research has been directed toward the effects of biological rhythms on performance of an actual motor task. While no substantial conclusions can be drawn from this paper, it does point out that future research is desirable and suggestions are offered for directing future research.

566.
Foret, J. Sommeil et Horaries de Travail Irreguliers. (Ph.D Thesis). Lille 1973.

567.
Foret, J. Horaires de travail et vieillissement. In: Age et Contraintes de Travail, edited by A. Laville, C. Teiger and A. Wisner. France: Jouyen-Josas, 1975, pp. 82-86.

568.
Foret, J., and O. Benoit. Structure du sommeil chez des travailleurs a horaires alternants. Electroencephalography and Clinical Neurophysiology 37: 337-344, 1974.

569.
Foret, J., and O. Benoit. Nightwork: adaptation of the sleep after schedule inversion in permanent and occasional shiftworkers (abstract). Sleep Res. 6: 217, 1977.

570.
Foret, J., and O. Benoit. Shift work and sleep. In: Memory, Environment, Epilepsy, Sleep Staging, edited by W. P. Koella and P. Leum, New York: Karger Press, 1977, pp. 81-86.

571.
Foret, J., and O. Benoit. Etude due sommeil de travailleurs a horaires alternantes. Adaptation et recuperation dans le cas de rotation rapide de post (3-4 jours). Eur. J. Appl. Physiol. 38: 71-82, 1978.

572.
Foret, J. and O. Benoit. Shiftwork: the level of adjustment to schedule reversal assessed by a sleep study. Waking and Sleeping 2: 107-112, 1978.

The sleep of shiftworkers of an oil refinery was studied. Abrupt modifications of sleep patterns occur when Ss shift from night sleep to day sleep and vice versa. During the diurnal sleeps in succession, an adaptation is evident but it remains limited, even at the fourth day sleep. This limited adjustment is due to the internal structure of sleep which is clearly abnormal at the first day sleep but progressively tends towards the structure of a nocturnal sleep. The interindividual variability was emphasized. Average results conceal individual "sleep strategies". Some Ss seem to be very sensitive to sleep deficit. In contrast some others have rigid sleep structure which hinders a quick adjustment to schedule reversal.

573.
Foret, J., O. Benoit, and B. Merle. Can the short-term adjustment of an individual to schedule inversion be predicted? Chronobiologia 6: 98-99, 1979.

We performed a laboratory study on the effects of schedule inversion and sleep deprivation (without phase-shifting) on sleep patterns and some other physiological and psychophysiological functions: temperature, heart rate, mood, vigilance. Two groups of subjects were used: natural long sleepers (LS) and short sleepers (SS) (<6 h, n = 5) (>9 h of sleep/day, n = 5). Results: a. under regular conditions, there is: a signficant difference in the time of temperature peak; a significant difference in temperature amplitude between LS and SS. b. after schedule inversion (that is, 24 h of wakefulness), there is: a negative correlation (Spearman) between temperature amplitude and phase-shifting, in agreement with Reinberg (1978). c. after sleep deprivation (that is, 36 h of wakefulness) there is: a positive correlation (Spearman) between spontaneous sleep duration and phase-shifting.

Most striking is the non-difference in morning sleep between the different groups. In the recovering nights after inversion or sleep deprivation the differences between LS and SS are the same type as in reference nights (more PS in LS and the same amount of SWS), as previously described in other studies.

574.
Foret, J., and G. Lantin. The sleep of train drivers: an example of the effects of irregular work schedules on sleep. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep (Proc. of the Symposium), Strasbourg, Fr., 1970, edited by W. P. Colquhoun. London: English Univ. Press, 1972, pp. 273-282.

575.
Forgays, D. G. and J. M. Levin. Man in isolation and/or enclosed space - Report of activities at NATO symposium in Rome, Italy, 1969. Burlington: Vermont Univ. 1969, 19 pp.

576.
Fort, A., D. B. Furguson, K. M. P. E. Kiecher, and C. A. Boichway. The use of saliva in monitoring adjustment to experimental phase shifts. Ergonomics 21: 865-866, 1978.

Each of the physiological and psychological variables used to study adjustment to phase shifts has problems associated with its use. Since the flow rate and concentration of some components of saliva show circadian variation, and its collection is easy and painless, we have attempted to discover which type of saliva could be used most readily to demonstrate adjustment of phase shifts. In comparing rhythms in saliva from different glands, we obtained data for every hours of day and night. In phase shift experiments we used a more convenient schedule with saliva collections at 0800, 1200, 2000 and 2400 h. At least 10 of 16 subjects showed circadian variation in sodium, chloride, potassium, calcium, phosphate, protein and nitrogen concentrations in parotid, submandibular and whole salivas. Cross-lagged correlations showed that rhythms were in phase in the three types of saliva, for sodium, chloride and nitrogen concentrations. Peak concentration times were most consistent for flow rate and sodium and chloride concentration. Phase shifts of eight hours advancement of retardation caused the rhythms in whole saliva variables to change or disappear. The diurnal patterns in chloride concentration and, less obviously, sodium concentration and flow rate returned in 3-6 days. Adjustment of rhythms was monitored by examining peak times of flow rate or concentration, and by correlations of the diurnal patterns. Whole saliva provides an easily obtainable physiological fluid with reproducible circadian variation in flow rate, sodium and chloride concentrations (easily measured variables) and rhythms of these variables provide a means of assessing adjustment to phase shifts.

577.
Fort, A., J. A. Gabbay, R. Jackett, M. C. Jones, S. M. Jones and J. N. Mills. The relationship between deep body temperature and performance on psychometric tests. J. Physiol. 219: 17P-18P, 1971.

578.
Fort, A., M. T. Harrison, and J. N. Mills. Psychometric performance: circadian rhythms and effect of raising body temperature. J. Physiol. 231: 114P-115P, 1973.

579.
Fort, A., and J. N. Mills. Influence of sleep, lack of sleep and circadian rhythm on psychometric test performance. In: Aspects of human efficiency: Diurnal Rhythm and Loss of Sleep (Proceedings of the Symposium, Strasbourg, France, 1970), edited by W. P. Colquhoun. London: English Univ. Press, 1972. pp. 115-127.

The effects of sleep, lack of sleep, and circadian rhythm on the performance of subjects were studied. Psychometric tests based on two different methods were used to assess the influence of nychthemeral variation. The results of the tests are presented in diagrams and discussed.

580.
Fowler, M. F., M. J. Sullivan, and B. R. Ekstrand. Sleep and memory. Science 179: 302-304, 1974.

Two experiments demonstrated that memory over an interval with relatively high amounts of rapid eye movement (REM) sleep was inferior to memory over an interval with relatively high amounts of stage 4 sleep. The results suggest that, at least for humans, REM sleep does not facilitate memory consolidation and that stage 4 sleep may be beneficial to memory.

581.
Fox, J., and R. Fox. Biorhythm for computers. Byte 1: 20-23, 1976.

This article provides a computer program for user calculation and plotting of the Fliess' biorhythm cycles. The output provides dates on the left hand side and a line printer plot of the three biorhythm cycles: physical (P), emotional (E), and intellectual (I) on the right side.

582.
Fraisse, P. Temporal isolation, activity rhythms, and time estimation. In: Man in Isolation and Confinement, Chicago: Aldine Publishing Co., 1973, pp. 84-97.

French cave studies are considered together with the sleep-wakefulness rhythm, the body temperature rhythm, questions regarding he evolution of vigilance and performance, the estimation of duration, the estimation of the length of a stay underground, and the estimation of long and short durations. It is attempted to study some consequences of the complete temporal isolation on subjects confined to caves or bunkers in the "free- running" condition. In this condition, the subject is free to organize his life in his own way.

583.
Francesconi, R. P., J. W. Stokes, L. E. Banderet, and D. M. Kowal. Sustained operations and sleep deprivation: effects on indices of stress. Aviat. Space Environ. Med. 49: 1271-1274, 1978.

Two groups of highly-trained and motivated military personnel were deprived of sleep while sustaining performance of their assigned military tasks in a laboratory simulation: one team (I) was sleep deprived for 48 h while the second team (II) was deprived of sleep for two consecutive 39-h periods separated by a 33-h rest interval. Six-hour urine samples were collected on a 24-h basis after an appropriate control period for each team. During sleep deprivation, each team performed its functions as an artillery fire direction center (FDC) in response to a sustained simulated combat scenario. Results suggested that anticipation and perception of the experimental situation affected the common urinary indices of stress. For example, team I, informed that they might be required to sustain operation for

86-h. had significant increases in both urinary 17-hydroxycorticosteroids (10-OHCS) ($p<0.01$, 36 h) and total catecholamines ($p<0.01$, 24 h). Alternatively, team II, realizing that each of their sustained operations challenges would not exceed 42 h, had significantly decreased 17-OHCS due largely to decrements in the usually high outputs recorded between 0600-1200 hours (e. g. $p<0.25$, 30 h). Analogously, total catecholamines were significantly reduced after 24 ($p<0.02$) and 30 ($p<0.05$) h. We conclude from these studies that, under these conditions, generally similar effects are noted for sympathicoadrenomedullary and adrenocortical activity. Further, the responses are affected by situational uncertainty as well as apparent cumulative fatigue.

584.
Frazier, K. Science and the parascience cults. Science News 109: 346-348, 350, 1976.

This article reviews the flood of interest in what is variously called fringe science, borderline science, pseudoscience, paranormal phenomena, occultism, the new irrationalism, etc. Fortunes are made by exploiting the public's fascination with the unknown and the typical scientists' reaction is disgust. The problem is difficult for science since the time and effort required to systematically point out the errors in fact and logic in a complex pseudoscience theory are not trivial. Some scientists consider this effort to be useless since regardless of the facts there will always be a certain number of proponents willing to believe in any claim. What distinguishes science from pseudoscience is not subject matter but methodology. Scientific methodology includes falsifiability (one will get a negative result if the hypothesis is not true), replicability, intersubjective verifiability (agreement between advocate and critic of criteria for verifying) and Occam's Razor (the simplest of two equally satisfactory explanations takes precedence). The burden of proof is on those who claim the existence of an anomaly; extraordinary proof is necessary for extraordinary claims. Examples of faulty logic and faulty evidence are given for the claims of proponents of UFO's, telekinesis, Von Daniken's books and the Bermuda Triangle mystery. The genesis of pseudoscience is summed up in a quote: "the legend of the Bermuda Triangle is a manufactured mystery. It began because of careless research and was elaborated upon and perpetuated by writers who either purposely or unknowingly made use of misconceptions, faulty reasoning and sensationalism.

585.
Frazier T. W., V. A. Benignus, M. G. Every, and J. F. Parker, Jr. Effects of 72-hour partial sleep deprivation human behavioral and physiological response measures. Falls Church, Va.: Biotechnology, Inc., 1971, 44 pp.

Ten adult males were subjected to partial sleep deprivation experiments in order to study the effects of progressive sleep deprivation on the basic biological rhythms underlying performance on signal detection tasks and to assess the value of using change in biological rhythms as an objective measure of human response to such types of stress. The data obtained were subjected to a power density spectral analysis with a program based upon the Fast Fourier Transform. The results show that signal detection measures, response latency, and heart rate are all highly sensitive in reflecting progressive loss of performance capability. Power spectral data also show changes as a function of sleep deprivation, indicating that one feature of this type of stress may be an alteration of basic human biorhythms.

586.
Frazier, T. W., V. West, M. G. Every, and J. F. P. Parker. Use of special analyses in the study of human behavioral and physiological response measures. Washington D.C.: Army Medical Research and Development Command-Office of the Surgeon General, AD-732 951, 1971, 79 pp.

In assessing changes in behavior, such as those found with sleep loss, the principal problem is one of measurement. The objective of the series of studies described in this report was to develop and validate a measurement and analysis technique for examining human responses occurring through time. In the six studies reported, power spectra were computed for experimental data, along with coherence analyses and tests of significance. Behavioral results were compared with one another and with simultaneously recorded physiological data. The data from these studies indicate there are several rather stable biological rhythms, or oscillations, which occur in performance patterns. Several oscillations were identified in addition to the large (1.1 cycles/day) oscillation which corresponds to circadian rhythm. Oscillations of weaker intensities were found at 4.5, 9.0 (close to the work/rest cycle), and 18 cycles/day. The imposition of mild stress conditions was found, in many instances, to have a significant effect on the character of the basic biorhythms. It is felt that the use of time series data, in which rhythmicities in performance are identified and studies as the organism is exposed to unusual or stressful environments, represents a relatively new and potentially fruitful approach to behavioral research.

587.
Freivalds, A. Investigation of Circadian Rhythms on Select Psychomotor and Neurological Functions. (Thesis). University of Michigan, 1979, 280 pp. (Abstracted in Diss. Abstr. 40: 4913-B, 1980).

This investigation was designed to examine the existence of circadian rhythms in response variables that relate most meaningfully to the physiological and neurological state of the body throughout the day and also be indices of performance. The physiological variables included: deep body temperature, oxygen consumption, respiration rate, blood pressure, forearm blood flow, heart rate and basal skin resistance. The performance measures included the amplitude of

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electromyogram for given muscle tension (called efficiency of electrical activity) Achilles tendon reflex, maximum nerve conduction velocity, physiological tremor, simple reaction time, maximum information processing rate for a choice-response task and critical eye-hand tracking capacity. An analysis of variance of the data showed: 1) the existence of an hourly variation for all but three variables: basal skin resistance, mean arterial pressure, and slope of the EEA, 2) a significant subject variation for heart rate, oxygen consumption, Achilles tendon reflex.

588.
Friedman, R. C., J. Bigger, and D. S. Kornfeld. The intern and sleep loss. N. Engl. J. Med. 285: 201-203, 1971.

589.
Friedmann, J., G. Globus, A. Huntley, D. Mullaney, P. Naitoh, and L. Johnson. Performance and mood during and after gradual sleep reduction. Psychophysiology 14: 245-250, 1977.

590.
Friedmann, J., G. Globus, A. Huntley, D. Mullaney, P. Naitoh, L. Johnson. Performance and mood during and after gradual sleep reduction (abstract). Sleep Res. 7: 412, 1978.

591.
Fritzsch, W., et. al. Zeitschrifte fuer die Hygiene und ihre Grenzgebiete (Night-shift work and the health status of working women. Z. Gesamte Hyg. 23: 885-888, 1977.

592.
Froberg, J. E. Circadian Rhythms in Catecholamine Excretion, Performance and Selfratings. Laboratory for Clinical Stress Research, Departments of Medicine and Psychiatry, Karolinska Sjukhuset, Stockholm, Sweden, Report No. 36, 1974, 22 pp.

Circadian variations have been found in adrenaline excretion as well as in performance and subjective arousal. No study, however, has yet been reported in which all three aspects of arousal-physiological, subjective and behavioural-have been measured simultaneously. We have studied-in a series of experiments designed to test the ability of military personnel to endure a three-day vigil under conditions of continuous activity and a "stressful" milieu-circadian rhythms in catecholamine excretion, performance and "subjective arousal". The present paper is concerned with two experiments, in which a total of twenty-nine subjects were deprived of sleep for seventy-two hours with three hourly measurements of urinary catecholamines, self-ratings, and performance. The purpose of this study was to answer the following questions: (1) Are there psychophysiologic circadian rhythms which persist under conditions of sleep deprivations with continuous activity and regularly spaced meals? (2) If so, what are their characteristics in terms of the shape of the curves, phases and amplitudes? (3) What time relationships exist between different functions, i.e., physiologic, subjective and performance measures?

593.
Froberg, J. E. Psychophysiological circadian rhythms. A literature review. Stockholm: Research Inst. of National Defense, 1975, 28 pp.

594.
Froberg, J. E. Twenty-four hour patterns in human performance, subjective and physiological variables and differences between morning and evening active subjects. Biol. Psychol. 5: 119-134, 1977.

595.
Froberg, J. E. Task complexity and 24-hr performance patterns in morning and evening active subjects. Stockholm: Research Inst. of National Defense, 1978, 16 pp.

One morning active and one evening active group of subjects were deprived of sleep for 72 hours. Measures of performance in a coding task were obtained at three different levels of complexity, and in conditions with an incentive or an auditory disturbance, respectively. The results showed that complexity of the task did not affect 24 hour patterns in performance, while other two conditions tended to enhance performance in the morning hours, and this was especially pronounced in the morning active group.

596.
Froberg, J. E., and Akerstedt. Effects of Shift Work on Health and Well-Being. Paper presented at the International Technical Fair on Working Environment and Outside Air Protection and Noise Problems, Jonkoping, Sweden, 1974, 18 pp.

Shift work in the narrower sense concerns only a small percentage of the working population. Thus it is reported in a Swedish investigation recently carried out (Ribbing & Froberg 1973) that about 3% of all gainfully employed work in 2 shifts and about 2% in 3 shifts. If the definition of shift work is also extended to cover those who work in conditions similar to shift work, as in medical service, transport work, etc., the proportion will be much larger. The authors consider aspects such as sleep problems, gastro-enteritic complaints and nervous symptoms. They examine the social effects of shift work as well as performance and shift work.

597.
Froberg, J., C. G. Karlsson, and L. Levi. Shift work: a study of catecholamine excretion, self-ratings and attitudes. In: Night and Shift Work, edited by A. Swensson. Studia Laboris et Salutis 11: 10-20, 1972.

598.
Froberg, J. E., C. G. Karlsson, and L. Levi. Circadian rhythms of catecholamine excretion, shooting range performance and self-ratings of fatigue during sleep deprivation. Biol. Psychol. 2: 175-188, 1975.

Circadian rhythms in urinary catecholamine excretion, performance and self-ratings were studied in two experiments with a total of 29 subjects who were deprived of sleep for 72 hr. Adrenaline excretion and fatigue ratings showed the most consistent circadian variations; noradrenaline and performance rhythms were more irregular. The average crest phase of adrenaline excretion was around 1400 hr, for noradrenaline about 0800 hr, for performance 1700 hr and for fatigue 0500 hr. Twenty-four hour levels of performance and "subjective arousal" decreased over the three days of sleep deprivation, while adrenaline excretion levels increased.

599.
Froberg, J., C. G. Karlsson, L. Levi, and L. Lidberg. Circadian variations in performance, psychological ratings, catecholamine excretion and diuresis during prolonged sleep deprivation. Int. J. Psychobiol. 2: 23-36, 1972.

600.
Froberg, J. E., C. G. Karlsson, L. Levi, and K, Lidberg. Circadian variations in performance, psychological ratings, catecholamine excretion and urine flow during prolonged sleep deprivation. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep (Proc. of the Symp. Strasbourg, France, 1970), edited by W. P. Colquhoun. London: English Univ. Press, 1972, pp. 247-259.

Results of two sleep-deprivation experiments in which sixty-three persons were examined every three hours over a period of seventy-five hours to determine catecholamine excretion, psychomotor performance and certain other psychological values. Measurements showed adrenalin excretion to be greatest in the morning. The roughs of the curve plotted for fatigue agreed approximately with those of the curve for adrenalin excretion. Whereas performance declined and fatigue increased, daily catecholamine and urine excretion did not vary to any marked extent. Significant psychophysiological correlations were established (e.g., between adrenalin excretion and performance).

601.
Froberg, J., C. G. Karlsson, L. Levi, L. Lidberg, and K. Seeman. Conditions of work: psychological and endocrine stress reactions. Arch. Environ. Health 21: 789-797, 1970.

Psychosocial stressors in modern working life and measurement of their psychophysiological effects are briefly discussed and three stress studies presented. First, officers and soldiers were exposed to a stressful 75-hour vigil. Significant stress reactions occurred with respect to erythrocyte sedimentation rate, protein-bound iodine, serum iron level, electrocardiogram pattern, behavior, and catecholamine excretion. Pronounced circadian rhythms and significant psychophysiological correlations were demonstrated. Second, the renumeration of salaried invoicing clerks was abruptly changed to piece- wages. The subjects exhibited a sharp rise in performance but also an increase in discomfort ratings and catecholamine excretion. Third, office clerks were moved to and from various types of offices. In general, moving from a conventional office to an office landscape was accompanied by an increase in fatigue ratings and catecholamine excretion. The implications of these findings for environmental health are briefly discussed.

602.
Froberg, J. E., et al. Psychobiological circadian rhythms during a 72 hour vigil. Forsvarmedicin 11: 192-201, 1975.

603.
Frolov, N. I. Evaluation of the work capacity of the pilot in the course of a flight shift. Voenno-Med. Zh. No. 7, pp. 65-68, 1976.

604.
Frost, J. D., Jr., W. H. Shumate, J. G. Salamy, and C. R. Booher. Sleep characteristics during the 28- and 59-day Skylab missions. Presented at Seventh Annual Symposium, Texas Research Institute of Mental Sciences, Behavior and Brain Electrical Activity, 28-30 November 1973, Houston, Texas.

605.
Frost, J. D., W. H. Shumate, J. G. Salamy, and C. R. Booher. Sleep monitoring: the second manned skylab mission. Aviat. Space Environ. Med. 47: 372-382, 1976.

The first objective measurements of man's ability to obtain adequate sleep during prolonged space flight were made during the three manned Skylab missions. EEG, EOG, and head-motion signals were acquired during sleep by use of an elastic recording cap containing sponge electrodes and an attached miniature preamplifier/accelerometer unit. A control-panel assembly, mounted inthe sleep compartment, tested electrodes, preserved analog signals, and automatically analyzed data in real time (providing a telemetered indication of sleep stage). One subject was studied during each manned mission and, while there was considerable variation among individuals, several characteristics were common to all three: stage 3 sleep increased during the flight and decreased in the postflight period; stage 4 was consistently decreased postflight, although this stage was variable during the flight; stage REM (rapid eye movement) was elevated, and REM latency decreased in the late postflight period (after day 3 post-recovery and the number of awakenings during sleeep either showed no change or decreased during the flight. In only the 28-d mission (Skylab 2 was there a significant decrease in total sleep time; in that case it was a result of voluntarily reduced rest time and was not due to difficulty in sleeping nor frequent awakening. The subject on the 84-d mission (Skylab 4) experienced some difficulty in the first half of the flight, showing a decreased total sleep time and increased sleep latency, but this resolved itself with time. Sleep latency presented no problem in the other flights. While many of the findings are statistically significant, in no case would they be expected to produce a noticeable decrement of performance capability. These findings suggest that men are able to obtain adequate sleep in regularly scheduled 8-h rest periods during extended space flights. It seems likely, based upon these results, that the problems encountered in earlier space flights did not arise from the zero-g environment per se but possibly were a result of more restricted living and working areas in the pre-Skylab spacecraft.

606.
Fruh, H. Von der Periodenlehre zur Biorhythmenlehre (From Periodic Theory to Biorhythmic Theory). Zurich-Leipzig: Wegweiser-Verlag,, 1939-1942.

607.
Fruh, H. Rhythmenpraxis. (Rhythm Usage). Zurich: Verlag H. R. Fruh, 1943.

608.
Fruh, H. Kraft, Gesundheit und Leistung-Der Rhythmus der Krafte im Menschen. (Vigor, Health and Work-the Rhythm of Vigor in Humans). Switzerland: Selbstverlag, 1946.

609.
Fruh, H. Deine Leistungskurve (Your Performance Curve). Zurich: Verlag H. R. Fruh, 1953.

610.
Fruh, H. Triumph der Lebensrhythmen (Triumph of the life rhythms). Switzerland: Lebensweiser-Verlag, 1954.

611.
Fruh, H. Keine Angst vor der Operation (No Anxiety about Operations). Switzerland: Schrifenreihe der Schweiz. Gesellschaft fur Periodischelehre und Forschung, second edition., 1971.

This book discusses the use of biorhythm for the timing of surgical operations for the reduction of post-surgical complications. He claims post-surgery irregularities can be reduced 30% through the use of biorhythm timing.

612.
Fruh, H. R. Sieg der Lebensrhythmen (Victory of the Life Rhythms). Freiburg: Hermann Bauer Verlag, 1971.

613.
Fuller, C. A., F. M. Sulzman, M. C. Moore-Ede. The effect of suprachiasmatic nucleus lesions on circadian rhythms in the squirrel monkey (Saimiri sciureus). Soc. Neuroscience Abstr. 3: 162, 1977.

Bilateral electrolytic (4 mA, 15 sec) hypothalamic lesions were located in the SCN using stereotaxic coordinates confirmed by x-ray visualization of the third ventricle using a radio-opaque dye (Conray)

infused into the ventricles. The mean level of the behavioral variables did not change after the lesion. In LD there was a less precise phase control of the rhythms. However, most activity was still confined to the lights-on portion of the cycle, with greater phase control than seen in similarly lesioned rodents. After 8-hr. phase-delays of the LD cycle the animals took approximately 3 times longer to resynchronize with the new LD phase than they did before the lesions. In LD and LL there was a sine wave fitting. Visual inspection of the record also showed a marked alteration in the circadian organization of these variables. This preliminary evidence indicates that the SCN plays a key role in the multioscillator circadian timing system of the squirrel monkey.

614.
Fuller, C. A., F. M. Sulzman, and M. C. Moore-Ede. Thermoregulatory homeostasis fails in constant environments when circadian oscillators desynchronize (abstract). Fed. Proc. 36: 423, 1977.

615.
Fuller, C. A., F. M. Sulzman, and M.C. Moore-Ede. Thermoregulation is impaired in an environment without circadian time cues. Science 199: 794-795, 1978.

Squirrel monkeys synchronized to a 24-hour light-dark cycle show a prominent circadian rhythm in body temperature which is regulated against mild environmental cold exposures throughout the 24-hour day. However, cold exposures produce significant decreases in core body temperature when the circadian rhythms of the animal are free-running in the absence of environmental time cues. Effective thermoregulation appears to require the precise internal synchronization of the circadian timekeeping system.

616.
Fuller, C. A., F. M. Sulzman, and M. C. Moore-Ede. Circadian control of thermoregulation in the squirrel monkey, Saimiri sciureus. Am. J. Physiol. 236: R153-R161, 1979.

The characteristics and control of the circadian rhythms of core body temperature (colonic) and skin temperature (tail) were studied in chair-acclimatized squirrel monkeys (Saimiri sciureus). When animals were entrained to a light-dark cycle (12 h 600 lx; 12 h $<$ 1 lx) these two temperatures displayed prominent, reproducible, tightly coupled circadian rhythms. In constant light of 600 lx, where no other effective circadian time cues were present, both temperature rhythms persisted with free-running periods. Within each animal, however, these rhythms were not as tightly coupled to one another as in LD. On occasion colonic and tail temperature rhythms free-ran with different circadian periods and some animals demonstrated "splitting" of the colonic temperature rhythm, with the colonic temperature rhythm displaying a bimodal pattern. These results suggest that the circadian rhythm of body temperature in primates is under the control of more than one potentially independent circadian oscillator.

617.
Fuller, C. A., F. M. Sulzman, and M. C. Moore-Ede. Effective thermoregulation in primates depends upon internal circadian synchronization. Comp. Biochem. Physiol. 63A: 207-212, 1979.

Squirrel monkeys display a prominent circadian rhythm in body temperature (T_{co}). When entrained to 24-hr light-dark (LD) cycles, T_{co} is is defended against mild 6-hr cold exposures at all circadian phases. In constant light (LL), however, the animals ability to defend T_{co} against similar cold exposures is impaired. We have examined the potential roles of internal circadian synchronization and other factors such as LL or chair -restraint in determining the animals' ability to thermoregulate in the cold. 3. Constant light and or chair- restraint were ruled out as being major contributions to this thermoregulatory response in experiments where an alternate circadian synchronizer (24-h cycles of food availability) was supplied to animals in LL. These animals were able to maintain T_{co} at the same levels as comparable controls when they were cold exposed at three different circadian phases. 4. The role of internal circadian synchronization was examined using an adrenalectomized squirrel monkey preparation. These animals, when supplied with replacement cortisol at 24-hr intervals, have the same circadian thermoregulatory characteristics as intact control animals, and when synchronized by LD cycles can maintain T_{co} during cold exposure. 5. In LL, the adrenalectomized animals, with 24-hr cortisol replacement, become internally desynchronized since a portion of the circadian system is entrained by cortisol and the rest free-runs. In this state, the cold exposures produce significant decreases in T_{co}. 6. The data indicate that for effective thermoregulation to occur, proper temporal synchronization of the circadian timekeeping system of the squirrel monkey is essential.

618.
Fuller, C. A., F. M. Sulzman, and M. C. Moore-Ede. Sound cycles exert circadian phase control after partial suprachiasmatic nucleus lesions in the squirrel monkey. The Physiologist 22: 41, 1979.

The circadian system of intact squirrel monkeys (Saimiri sciureus) can be entrained to a 24 hr period by light-dark and food availability cycles, but not by cycles of sound intensity, social cues, environmental temperature or drinking. In isolation chambers with constant light and food ad lib., the monkeys' circadian rhythms free-run with periods of approximately 25 hrs. However, after lesioning the suprachiasmatic nuclei (SCN) of 3 animals, we observed phase control of the circadian rhythm of drinking to a 24 hr period even in constant light and food ad lib. Another animal after SCN lesions showed relative coordination with a modulation of the circadian period at the same phase of the cycle at which entrainment occurred in the other animals. The temporal cue perceived by the SCN-lesioned monkeys was a 24 hr. cycle of sound intensity since when all sound cues-entering the chamber were obscured by countinous white noise, the circadian rhythm of drinking free-ran. Preliminary histology demonstrates that this occurs after subtotal destruction of the SCN. Thus when the integrity of the SCN is damaged, the circadian timing system of the squirrel monkey becomes sensitive to sound cycles.

619.
Fuller, C. A., F. M. Sulzman, and M. C. Moore-Ede. Variations in heat production cannot account for the circadian rhythm of body temperature in the squirrel monkey. Fed. Proc. 38: 1053, 1979.

620.
Fuller, C. A., F. M. Sulzman, and M. C. Moore-Ede. Circadian body temperature rhythms of primates in warm and cool environments (abstract). Fed. Proc. 39: 989, 1980.

621.
Fuller, R. W., and H. D. Snoddy. Feeding schedule alteration of daily rhythm in tyrosine alpha-ketoglutarate transaminase of rat liver. Science 159: 738, 1968.

Liver tyrosine alpha-ketoglutarate transaminase has a daily rhythm such that in rats fed on an unrestricted basis the activity is highest at approximately 11:00 p.m. In contrast, rats fed only from 8:00 a.m. to noon show a markedly different rhythm in the enzyme, with maximum activity at 11:00 a.m. Controlling the time of food intake seems to be a useful means of studying the mechanism of the daily changes in this enzyme.

622.
Furon, D., P. Frimat, J. F. Caillard, H. Labriffe, A. Thilliez, and F. Broussier. Aspects medicaux, sociaux et professionnels du travail en equipe chez les femmes. (Medical, social and professional aspects of shift working in women.) Arch. Mal. Prof. Med. 40: 370-375, 1979.

This article describes an inquiry into the working condition of women employed in shift work, in the course of which the authors interviewed (by questionnaire survey) 254 women employees in the textile industry in Northern France (2x8 work schedule). Results: nearly 75% of the interviewees preferred shift work: 42% complained about noise, 26% about air conditioning and long periods of standing; 16% about the repetitive nature of the work; 60% of the women showed signs of nervousness, 25% complained of insomnia, 59% of those under 40 years of age had an average absenteeism record of 1.5 days per year. Recommendations: reorganization of work-rest schedules; noise control, improvement of working environment (heat and humidity), better distribution of rest breaks, information and education of employees as part of in-plant training schemes.

623.
Furon, D. G., P. Frimat, and A. Cantineau. Les Problemes Medicaux Poses par le Travail Poste--Communication sur les Resultats d'une Enquete Relative au Travail Poste (Medical Problems of Shift Work.) Caisse Regionale d'Assurance Maladie due Nord de la France, Lille, France, May 1977, 23 pp.

These two communications were submitted to the Regional Joint Technical Committee for the Metal Trades (Lille, France). The first, devoted to medical aspects, covers: health effects of shift work; work design and medical supervision (careful supervision for the first year, long-term supervision, etc.) The second deals with the effects of shift work on occupational accidents, and reports three studies (personnel of an electrical engineering department, and iron and steel plant, and a metallurgical plant); accidents among shift workers were less frequent during the night shift than the day, but commoner at the beginning than at the end of the shift; it does not appear that shift work can be definitely incriminated as a cause of accidents for this would give too much weight to the human factor. The profitability of shiftwork is questionable.

624.
Fuxe, K., T. Hokfelt, G. Jonsson, S. Levine, P. Lidbrink, and A. Lofstrom. Brain and pituitary-adrenal interactions studied on central monoamine neurons. In: Brain-Pituitary-Adrenal Interrelationships, edited by A. Brodish and E. S. Redgate. Basel: S. Karger, 1973, pp. 239-269.

625.
Gadbois, C. Women on night shift: interdependance of sleep and off the job activities (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, Fr., 1980, p. IV-3.

626.
Gale, M. Biorhythm Compatibility. New York: Warner Books, 1978.

Following a short review of biorhythm theory, the author postulates the existence of a 4th biorhythm the 38 day "intuition"cycle. This cycle is presumed to result from endocrine system interactions and is based on unspecified mathematical and intuitive reasons. Extensive and elaborate biorhythm charts and interpretations are presented. The author modified biorhythm theory by using straight line instead of sinusoidal plots and extends the theory with the "Gale Biorhythm Plot" (biorhythm phase and time plots), energy level scale (a measure of amplitude), mode cycles (sum of 4 biorhythm cycles at critical days, and "zone analysis" (a measure of biorhythmic compatibility between two people at different biorhythm phases). The author advocates recording and plotting ones own mood cycles, noting that if the mood cycle represents a combination of biorhythm cycle interactions, the resultant additive cycle may not appear cyclic. The author does not indicate how to resolve this problem (e.g., time series analysis). The existence of a postulated 38 day intuition biorhythm might have been more convincing had it bee based on more evidence than the authors "unspecified mathematical and intuitive reasons".

627.
Gambashidze, G. M. The effect produced by the nature of occupational activity on the "sense of time" factors. Gig. Trud. Prof. Zabol. 4: 1-5, 1976.

628.
Gamberale, F., L. Strindberg, and I. Wahlberg. Female work capacity during the menstrual cycle physiological and psychological reactions. Scand. J. Work Environ. Health 1: 120-127, 1975.

629.
Gardner, A. W. and B. D. Dagnall. The effect of twelve-hour shift working on absence attributed to sickness. Br. J. Ind. Med. 34: 148-150, 1977.

630.
Gardner, M. Freud's friend Wilhelm Fliess and his theory of male and female life cycles. Sci. Am. 215: 108-109, 111-112, July 1966; 215: 99, Aug. 1966.

This article is a critical evaluation of the biorhythm theory of Wilhelm Fliess. Gardner appears to be the only person other than George Thommen (Is This Your Day?, Crown, New York, 1973) citing Fliess' work who actually read Fliess' original publications. The author states that Fliess was obsessed by the numbers 23 and 28 and believed all living phenomena manifested a male cycle of 23 days and a female cycle of 28 days. Fliess published a book in 1897 entitled "The Relations between the Nose and the Female Sex Organs from the Biological Aspect" in which he claims the male and female cycles are ultimately connected with the mucous lining of the nose. Fliess thought he had found a relation between nasal irritation, neurotic symptoms and sexual irregularities. He diagnosed these ills by inspecting the nose and treated them by applying cocaine to "genital cells" on the interior of the nose. The author then criticizes Fliess" major biorhythm book "Der Ablauf des Lebens (The Course of Life)" (for details, see Fliess 1906 bibl.) in which he finds that Fliess' claim that all natural processes reflect the interaction of multiples of 23 and 28 day cycles is numerological nonsense, since, using Fliess' formula, the occurrence of a biological event on a given day can be expressed as the combination of integral multiples of the numbers 23 and 28. A German physician, J. Aelby, published a book after the death of Fliess containing a complete refutation of the biorhythm theory. By then, however, the biorhythm cult was firmly established in Germany.

631.
Gardner, W., and P. Taylor. Health at Work. London: Associated Business Programmers Ltd., 1975, 170 pp.

The subject of this book, health and safety at work, is outlined in detail. It offers the lay reader a comprehensive and unprejudiced viewpoint of the philosophy and functions of modern occupational health practice. It stresses the importance of collaboration by specialists in scientific disciplines, of managerial attitudes, and of enlightened workers in the prevention of accidents and industrial diseases, in the provision of good working conditions and the promotion of mental and physical health. Some of the chapters (for instance, absence: sickness or malingering? Shift work and health; Safety at work - preventing injuries and damage; Mental health and motivation at work) are written by people who have established an international reputation for their expert knowledge of these problems. A list of books for further reading appears at the end of each chapter, from which authoritative references and scientific evidence can be obtained.

632.
Garfield, E. What do we know about jet lag? Current Contents 23(12): 5-11, 1980.

633.
Garg, S. K., G. S. China, and B. Singh. Factors influencing plasma cortisol (11-hydroxycorticoids) levels in Rhesus monkeys. Indian J. Exp. Biol. 16: 1184-1185, 1978.

Plasma cortisol levels have been studied in individually caged male Rhesus monkeys to determine day to day, seasonal, diurnal and intra-animal variations as well as chganges following brain surgery and induction of experimental diabetes. Both day to day as well as intra-animal variations depict a marked range of changes during winter as compared to those in summer. The values are significantly higher in winter in contrast to those in summer. Plasma cortisol levels are significantly higher in the morning in comparison to those in the evening. Implantation of electrodes in the brain causes insignificant differences in basal cortisol levels. Basal cortisol levels are significantly higher in diabetic animals as compared to non-diabetics. These observations point out a direct correlation amongst body rhythm, environmental stress and adrenocortical functions.

634.
Garnett, R. E. A Study of the Impact of Three Cycles of Biorhythms and Suggestibility on Behavior and Self-Reported Feelings (Ph.D. thesis). University of Miami, 1979. (Diss. Abstr. 39: 5551B, 1979.)

Biorhythm charts were prepared for 28 subjects and time periods were identified when all three biorhythms were either positive or negative. During these periods subjects were rated behaviorally and given a self-report measure of feelings (Profile of Mood States). All subjects were given an orientation to biorhythms. Half the subjects were told they were in a negative biorhythmic phase (accurate information, but the other half were told they were in a positive biorhythmic state (inaccurate inforamtion). Data were subjected to analysis of variance. A significant difference was found on 4/6 POMS variables between positive and negative phase groups, but no significant difference was found for the behavioral ratings. No significant differences were found between the two experimental groups (accurate, inaccurate feedback) for any parameters. The author concludes that certain mood parameters correlate to biorhythm cycles and that suggestion had no significant influence on the measurements. The results of this study, however, do not warrant a conclusion that mood is correlated with biorhythm cycles since no differences were found betwen behavior ratings or accurate/inaccurate groups and particularly due to the biased sampling procedure in which the population included only those periods in which subjects were high or low in all three biorhythms simultaneously.

635.
Gartner, W. B., and M. R. Murphy. Concepts of Fatigue. In: Survey of Methods to Assess Workload, edited by B. O. Hartman and R. E. McKenzie. Neuilly-Sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-AG-246, 1979, pp. 3-5.

636.
Garzino, S. J. Biorhythms and social work. Health & Social Work 1: 11-37, 1976.

Introduces the concepts and principles of biorhythms and suggests applications of such knowledge in the human services of casework, counseling, psychotherapy, and psychiatry. A history of biorhythmic theory is included along with explanations of biorhythmic cycles and biological clocks. The relationship between biorhythms and personality is discussed in addition to the effects of physiological rhythms. Periodic characteristics that may be observed in such everyday discomforts, psychopathologies, and major mental illnesses as premenstrual syndrome, suicide, sleep disturbances, ulcers, phobias, alcoholism, schizophrenia, catatonia, and manic-depressive psychosis are discussed. Numerous applications of a biorhythmic component in human behavior and illnesses are possible: service delivery, case histories, testing, biorhythm charts, planned intervention and individual counselin[illegible]

637.
Gasperoni, G. Recent medical advances and human aspirations inherent to space flights. Elementary concepts of chronobiology. Minerva Med. 64: 3563-3567, 1973.

638.
Gautherie, M. Circadian rhythm in vasomotor oscillations of skin temperature in man. Int. J. Chronobiol. 1: 103-139, 1973.

639.
Gautier, C. Pathologie Aquise au Cours du Travail Poste. (Health Impairment due to Shift Work). (M. D. thesis.) Universite de Bordeaux II, Unites d'Enseignement et de Recherche des Sciences Medicales, Bordeaux, France, 1977, 79 pp.

An introduction on the characteristics of shift work, the present situation and French regulations on this subject, and the consequences of shift work on physiological equilibrium, health, and family and working life, is followed by the results of a study of 1,000 motor industry workers performing shift work for at least three years: comparison of medical records with various shift works systems and a control group; comparison of shift workers in nine sectors of activity. Digestive disorders were the only significant parameter in the shift workers (8-hour 3 shift, semi-continuous). Significant changes according to sector of activity were however observed for disorders of the skin and locomotor apparatus, overweight, and pseudo-neuro psychopathic disorders. Ways of improving the situation of shiftworkers are briefly mentioned (design of working conditions and work schedule, improved sleeping and eating habits, medical supervision).

640.
Gavrikov, Y. I. Dynamics of human cardiac sinus rhythm in experiments with inversion of the work and rest schedule. Aktualnyye Voprosy Kosmicheskoy Biologii i Meditsiny. Moscow, 1971, pp 97-98. (English Translation in Current Problems in Space Biol. and Med. Arlington, VA: Joint Publications Research Service, 1972, pp 40-41.)

The collected data indicate that a study of cardiac sinus rhythm can be used as a criterion for evaluating the rate and nature of human adaptation to inversion of the work and rest schedule. It is evident that individuals retaining more slowly with a predominance of vagotonic reactions during this period. Individuals with predominantly sympathicotonic reactions, that is, more labile individuals, restructure more rapidly and, subjectively, the restructuring for them transpires more easily. The research data make it possible to recommend individuals with the first type of reaction to prolonged sleeplessness for work requiring the assimilation of different new work and rest schedules.

641.
Gazenko, O. G. "Predvaritel'nyye rezul'taty isseldovaniy na biosputnike 'Kosmos-782' (Fiziologischeskiy eksperiment s krysami)," Moscow: Ministry of Health USSR, Institute of Biomedical Problems and Academy of Sciences USSR, 1976, 156 pp. (Engl. transl. NASA TT F-17288, 144 pp.).

The program of physiological, morphological and biochemical studies on the Kosmos-782 was almost completely successful. This report is preliminary analysis of the results of the tests made on SPF rats in space flight and in the two control groups (simultaneous and low-fidelity controls). One of the primary goals of the experiment was to isolate the effect of weightlessness on different organs and tissues and on the organism as a whole. The Kosmos-782 used systems similar to those of the Kosmo-605 and 690 with improvements. The flight lasted for 20 days; laboratory tests started immediately upon recovery (within a few hours) and continued for 25 more days.

642.
Gerathewohl, S. J. Simple calculator for determining the physiological rest period after jet flights involving time zone shifts. Aerosp. Med. 45: 449-450, 1974.

A device is described for calculating the rest periods necessary for the physical and mental well-being of an air traveler after long-distance flights. The device is basically a pocket-sized calculator consisting of two concentric discs and a pointer. The larger disc is subdivided in an outer and an inner ring. The outer ring is marked in 10^{0} and 5^{0} intervals, which indicate the travel time in hours and half-hours respectively. The center ring is marked in 10^{0} intervals, which indicate the duration of the rest period in hours. The smaller disc, which is transparent in its center to allow for reading the rest-period times, bears the scales of the additional five factors which determine the duration of the rest period. The overlaying transparent pointer, which can be rotated about the center of the device, provides for the reference setting of each factor, for their addition, and for the reading of the final result.

643.
Gerathewohl, S. J. Definition and measurement of perceptual and mental workload in aircrews and operators of air force weapon systems: a status report. In: Higher Mental Functioning in Operational Environments, edited by B. O. Hartman. Neuilly-Sur-Seine: NATO, Advisory Group for Aerospace Research and Development AGARD-CP-181, 1976, pp C1-1-C1-7.

The definition and measurement of perceptual and mental workload in pilots and aircrews becomes increasingly important, because of the introduction of new and sophisticated equipment and procedures into aerial warfare. It is recognized that every mission places certain perceptual and mental demands on the pilot and the crew, which depend on a variety of variables and conditions. Moreover, every mission involves certain tasks, which are either flight oriented or combat oriented. This classification lends itself to a definition of activities as primary or secondary tasks, which as been successfully used in experiments for quantitative determinations of workload.

The determination of pilot and aircrew workload using psychological, physiological, and operational criteria has yielded valuable results. Methods used in civil aviation can be applied with appropriate modifications to military problems. However, workload measurements associated with high complex and demanding conditions are still difficult. Data are not available from actual combat missions. The results obtained by simulation are promising and may be improved by the standardization of methods and the application of statistical approaches and mathematical models.

644.
Gerathewohl, S. J., W. D. Chiles, and R. T. Thackray. Assessment of perceptual and mental performance in civil aviation personnel. In: Higher Mental Functioning in Operational Environments, edited by B. O. Hartman. Neuilly-Sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-181, 1976, pp. C7-1-C7-4.

Series of experiments were conducted at the Civil Aeromedical Institute of the FAA in Oklahoma City, Oklahoma, in order to study functions in relevance to aircrew, pilot, and ATC performance. They concerned the assessment of mental functions and complex performance on single operators and five-man crews while monitoring static and dynamic processes, of perceptual-motor tracking ability, as well as group problem solving. Operator proficiency was measured at various levels of demand induced by the simultanteous performance of different combinations of tasks, requiring the exercise of psychological and mental processes. It was found that multiple task performance varied significantly as a function of information input and group interaction. Substantial correlations were obtained between perceptual-motor type problem solving and mental ability tests. Moreover, the results obtained from two tracking tasks suggest that a central process exerts a regulatory influence on a variety of physiological variables during increased attention demand and, furthermore, a correlation exists between the ability to sustain attention and personality characteristics of the operator.

645.
Gerd, M. A. Man's capacity for work under a special regime in an isolation chamber. Vopr. Psikhol. 3: 123-128, 1975.

Studied the effect of changed day-night rhythm on work performance and nonwork activities of three Ss isolated in a 2x3x4m chamber inside a submarine. Ss were on a schedule of 6 hr of sleep, 6 hr of work, and 6 hr of other activities and rest. The 18-hr cycles continued to be the same for each S throughout the experimental period of 20 cycles, except that they were staggered so that one of the Ss was always asleep. Ss were tested throughout the experiment on work activity, reaction time, word associations, and mental arithmetic problems. Adjustment to the new sleep-waking schedule occurred after 11 to 12 cycles when deep and quiet sleep was re-established and sleepiness during the waking periods disappeared. Work performance, however, never reached pre-experimental level. It is suggested that emotional factors prevented Ss from working at their best.

646.
Gerke, R. J., C. E. Billings, and R. L. Wick. Diazepam effects on pilot performance in flight. Aerospace Med. Assoc., Preprints, 1975, p. 99.

647.
Gerner, R. H., R. M. Post, J. C. Gillin, and W. E. Bunney, Jr. Biological and behavioral effects of one night's sleep deprivation in depressed patients and normals. J. Psychiat. Res. 15: 21-40, 1979.

Twenty-five patients with major depressive illness and 20 normal volunteers were sleep deprived for one night in order to assess mood, physiology, and biochemistry. Fifteen patients showed mild to moderate improvement in depression, normally lasting one day, while volunteers tended to experience slight increases in dysphoria following sleep deprivation (SD). Prior to SD depressed patient responders tended to have decreases in CSF calcium and MHPG and increases in serum cortisol compared to nonresponders. Nonresponders also showed a flattened diurnal temperature rhythm following SD. Alterations in central neurotransmitters, circadian rhythms, and stress activation are discussed as possible mediators of the selective mood improvement in depressed patients compared to normal volunteer controls.

648
Gerritzen, F. Methods for the study of the behaviour of human circadian rhythms in kidney function before, during and after global flights. In: Recent Advances in Aerospace Medicine, edited by D. E. Busby, Dordrecht-Holland: D. Reidel, 1970, pp. 356-358.

649.
Gerritzen, F., and T. Strengers. Adaptation of circadian rhythms in urinary excretions to local time, after rapid air travel. In: Chronobiology, edited by L. E. Scheving, G. Halberg and J. Pauly. Tokyo: Igaku Shoin, Ltd., 1974, pp. 555-559.

650.
Gervais, M., and F. Halberg. La chronobiologie applique a l'hygiene de l' environnement. (Chronobiology applied to hygiene of the environment.) Arch. Mal. Prof. Med. 32: 395-396, 1971.

Summaries of four papers on variations in circadian rhythms experienced by subjects experiencing time zone changes. Three papers on the characteristics of workers working during various work shifts are summarized.

651.
Ghata, N. J., and A. Reinberg. Changes in the circadian acrophase and amplitude of urinary 17-OHCS and VMA resulting from transmeridian flight between Paris and Colombo (-5h) in December and April (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. VI-3.

652.
Ghata, N. J., and A. Reinberg. Circadian rhythms in oral temperature, urinary 17-OHCS and VMA: speed and mode of adjustment after transmeridian flights; special reference to aging and rhythm amplitude (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. VI-2.

653.
Ghata, J., A. Reinberg, M. Lagoguey, and Y. Touitou. Human circadian rhythms documented in May-June from three groups of young healthy males living respectively in Paris, Colombo, and Sydney. Chronobiologia 3: 181-190, 1977.

654.
Ghata, J., A. Reinburg, N. Virux, C. Abulker, and A. Nicolai. Adjustment of circadian rhythms of urinary 17-OHCS, 5-HIAA, catecholamines, and electrolytes in oil refinery operators to a rapidly rotating shift system. Ergonomics 21: 863, 1978.

Measurements taken from five selected workers on a rapidly-rotating shiftworking schedule showed that they were able to rapidly adjust the phasing of their circadian rhythms in certain urinary excretions to the changes in the timing of their work-rest schedule on the 24 h scale. The timing of physical and mental work per se (with reference to mid-work) was found to be a rather poor synchroniser of these rhythms in comparison with the socio-ecologic dependent activity-rest alternation (with reference to mid-sleep) with which it was in competition. The finding that a rapid rotation of shifts (changing every 3-4 days) seems to be well tolerated from a chronophysiological point of view is important, since sociality as well as psychologically, a rapidly rotating shift system is preferable to the conventional, more slowing rotating system, in which shifts change at weekly intervals,

655.
Giannetta, C. L. and S. V. Jayanthinathan. Circadian variations in renal excretion of magnesium, calcium, and phosphorus during a 3-day flight-on-board C-5 aircraft. Brooks Air Force Base TEX: USAF School of Aerospace Medicine (VNE), 1974, AD-787 661, 8 pp.

The effect of a 3-day flight on the excretion of calcium, magnesium, and inorganic phosphorus in the urine of C-5 crewmembers was studied. The excretion rate of the minerals was analyzed for evidence of circadian rhythm. Magnesium showed a signficant (p .05) day/time interaction during the flight and day-to-day variation (p 0.5) during the recovery. Phosphorus had a significant time-of-day variation (p .05). The day-to-time and day-to-day variations for calcium were of borderline significance.

656.
Gianotti, L. J. A Statistical Evaluation of the Theory of Biorhythms. (M.S. thesis) Naval Postgraduate, Monterey, CA, Report No. N75-17090, 75 pp., 1974.

In this thesis the author provides a detailed analysis of appropriate statistical methodology to applictions to the study of the relationship between biorhythm cycles and performance and accident data. He characterizes previous studies as reflecting the absence of a good methodological approach, justification for choosing sampling categories, the lack of acceptable mathematical tests resulting in quantifiable results. These deficiences lead to incomplete results and subjectively interpreted conclusions. Also, the three biorhythm cycles are vaguely defined: performance may involve physical and emotional responses, as well as intellectual. He advocates use of the chi-square contingency test and coefficient of contingency to determine if there is a correlation between the biorhythm cycle and the performance observation. The chi square goodness of fit test and the Kolmogorov-Smirnov test should be used to test the hypothesis that the data are uniformly distributed (not cyclical). In cases where sample size is small, the Fisher Test for exact probability should be used. These methods were used on academic grade scores from 4 subjects obtained from 15 courses over a 14 month period in relation to the 33 day intellectual biorhythm. A significant (.005) relation was demonstrated using the chi square test. Chi square goodness of fit, but not the Kolmogorov-Smirnov test, revealed non-uniform data distribution. Next the methods were applied to 66 accidents obtained from Canadian Forest Products, Ltd., with respect to the 23 day physical cycle. Chi square contingency test was not appropriate here since accidents represent exclusively below average performance.

Chi square goodness of fit and the Kolmogorov-Smirnov Test indicated non uniform data distribution. Distribution of accidents on critical days was significantly (.01) above chance. However, the author claims accident statistics are not appropriate for testing the biorhythm theory since they isolate the low performance phase of the biorhythm. He concludes that the results of these analyses are coincident with biorhythm theory and strongly support but not necessarily prove it. The authors methodological approach is the most sophisticated in the biorhythm literature and could not likely be improved upon since the non-equally spaced distribution of the data render it inappropriate for periodicity analysis. However, the small sample sizes used in his analysis (4 subjects, 66 accidents with only 4 occurrences on the critical day) compromise his support for the performance-biorhythm cycle relationship Also he has not taken into account the well-known circadian influences on intellectual performance and accidents. If the occurrence times of the examinations and accidents were not uniformly distributed throughout the day, then low-frequency periods could have resulted from an aliasing effect. Also, it is possible that significant correlations may have existed between the performance and accident data and non-biorhythmic period lengths but only the 23 or 33 day cycles were tested for correlation or goodness of fit in this study.

657.
Gibbs, F. P. Correlation of plasma corticosterone levels with running activity in the blinded rat. Am. J. Physiol. 231: 817-821, 1976.

658.
Gibbs, F. P. Fixed interval feeding (FIF) does not entrain the circadian pacemaker in blind rats (abstract). Fed. Proc. 37: 832, 1978.

659.
Giedke, H., M. Fatranska, P. Doerr, E. Hansert, D. Stamm, and H. Wisser. Tagesperiodik der Rectaltemperatur sowie der Ausscheidung von Electrolyten, Katecholaminmetaboliten und 17-Hydroxycorticosteroiden mit dem Harn beim Menschen mit und ohne Lichtzeitgeber (Circadian rhythms of rectal temperature and urinary excretion of 17-OH-corticosteroids in man with and without light-dark cycle). Int. Arch. Arbeitsmed. 32: 43-66, 1974.

During a continuous 8-day period, urine volume and urinary excretion of Na, K, Ca, dopamine, free total catecholamines, vanillin-mandelic-acid and 17-hydroxycorticosteroids were measured in 6 male subjects at 3-hour intervals. Gross motor activity (during daytime only) and rectal temperature were recorded continuously. During all 8 days there was a strict experimental routine with fixed sleeping-times. In the first 4 days the rhythm of wakefulness and sleep was accompanied by a simultaneous light-dark-cycle (LD); during the second 4 days, there was continuous darkness (DD). The phase-relationship of the 9 functions to the sleep-waking-rhythm was the same during LD as during DD. Since the social Zeitbebers, such as experimental routine and sleep-waking-rhythm were the same during LD as during DD, it is concluded that these are sufficient for the maintenance and the synchronization of human circadian rhythms under the experimental conditions cited, and that a light-dark-cycle is not needed. Motor activity, mean-level and range of Ca excretion were significantly lower in DD. Beyond it, the other functions showed a tendency for lower mean-level and range of Ca- excretion were significantly lower in DD. Beyond it, the other functions showed a tendency for lower mean-level and range in DD - with the exception of 17-hydroxycorticosteroids and rectal temperature which tended to higher ranges in DD.

660.
Gillberg, M., and T. Akerstedt. Catecholamines, cortisol and body temperature during unrestricted sleep at different times of day. Chronobiologia 6: 100, 1979.

661.
Gillberg, M., and T. Akerstedt. Possible measures of "sleepiness": for the evaluation of disturbed and displaced sleep (abstract). In: Int. Symp. on Night- and Shift-work, 4th, Rouen, FR., 1980, p. III-4.

662.
Gillette, P. J., Forecasting your ups and downs. True, Nov. 1973.

663.
Gillmann, H. Einfuhrung in das Thema: Zur klinischen Bedeutung biologischer Rhythmen. (Introduction to the subject: on the clinical importance of biological rhythms). Arzneim.-Forsch. 28: 1809-1810, 1978.

664.
Gingst, V. P. Funktsional'niye sdvigii v organisma cheloveka pre pereyezdye v mesta s 3-chasovoi poyasnoi raznidtei (Funtional displacement in the human organism during passage in place from a 3-hour displacement). Teoriya i Praktika Fizicheskoi Kul'tury 3: 39-40, 1970.

Movement of athletes to a place with a 3-hour time zone difference exerts a substantial influence on the functional state of the body, which can have a negative effect on sports results. On the first day of arrival, it was impossible to carry out training with a full load.

665.
Girard-Globa, A., G. Bourdel, and M. Forestier. Regulation of circadian rhythm in hepatic enzymes by schedule of food ingestion. Chronobiologia 3: 79, 1976.

This study show that the displacement of the protein meal and its dissociation from the energetic intake not only results in alterations in the circadian rhythmicity of the various enzymes responsible for amino-acid metabolism, but also desynchronizes their activities.

666.
Gittelson, B. Biorhythm: A Personal Science. New York: Arco Publishing, 1977, 202 pp.

This book provides a basic introduction to Fliess' biorhythm theory, along with discussion of scientific biological rhythms. He also discusses applications of biorhythm to sports performance and accident reduction. The author states that nothing in biorhythm theory contradicts scientific knowledge but then cites Dewans' work on the alteration of menstrual cycles by lighting schedules which violates the biorhythm axiom of period constancy. He notes the failure of menstrual cycles to correspond to the exact 28 day biorhythm period but claims this results from the interaction of biorhythm 23 and 28 day periods. He qualifies the biorhythm theory somewhat by noting that there are no physical correlates to the 23, 28 and 33 day cycles (except possibly lunar), by referring to a study by a Kosmos International Inc. indicating the existence of a "mini-critical" day at the center of biorhythm phase, by showing that there may be differences in biorhythm cycle amplitudes in individuals which are genetically determined, by indicating that the effects of biorhythm cycles may be masked except in situational encounters (accidents, challenging tests) and by questioning whether biorhythm cycles are constant in every individual. A number of studies, apparently largely unpublished, are cited, relating accidents and performance to biorhythm cycles: Dr. F. Pircher of Basel, Switzerland found 70% of 204 aviation accidents occurred on a critical day; Col. W. Kernach of the Swiss Cadet Training Center found 70% of 130 student pilot accidents occurred on a critical day; Dr. Sansouci, consultant to a state mental hospital in Rhode Island found that schizophrenic behavior cycles corresponded to emotional critical days; S. Kawahara, of the Japanese Military Police, found 59% of self-caused accidents occurred on critical days; the Tokyo Metropolitan Police found 82% of self-caused traffic accidents occurred on critical days; the Osaka Police found 70% of auto injuries to children occurred on critical days; B. Krause-Poray of Queensland, Australia, found that 54% of 100 auto deaths occurred on critical days; C. Newcomb found 53% of 100 accidents of the Edison Electric Inst. occurred on critical days; Dr. P. Costin of the Canadian Air Force found 81% of acts of heroism by Canadian soldiers took place on critical days; the National Lead Co. reduced accidents from 4-40% in two groups of workers where safety was emphasized on workers' critical days. In a third group, where safety was emphasized on days chosen at random, accidents increased 28%; United Air Lines distributed biorhythms plots to 2800 ground crew and maintenance workers and claimed accidents were halved. The author, however, criticizes the findings of the Canadian Workman's Compensation Board, who in analyzing 13 of 215 accidents, found no relation to biorhythm critical days, as including non-self-caused accidents and perhaps faulty calculation of critical days. He quotes the study by R. Hersey, who found 33-36 day cycles in mood cycles of industrial workers. This cycle corresponds to the 33 day intellectual cycle, not the 28 day emotional cycle, but Gittelson claims the mood testing communication may have involved an intellectual process. He claims that the Ohmi Railway found 59% of 331 accidents occurring on critical and adjacent days (but critical plus adjacent days of the 3 biorhythms constitute over 60% of the total days!). Finally, Gittelson claims (p. 31) that biorhythmic critical days occur once/year. But a simple calculation: (probability of 3 cycles intersecting at phase zero) = (2/23 x 2/28 x 2/33) = 0.00038 = 1/2656.5 days = 7.3 years!

667.
Gittelson, G. Biorhythm Sports Forecasting. New York: Arco Publishing Co., 1977, 238 pp.

This book provides a basic introduction to the biorhythm method of Fliess with particular emphasis on application to athletic performance. Most of this information can be found in Gittelson, B. Biorhythm. A Personal Science, Arco, New York, 1977. He cites innumerable examples of incidences relating individual and team performance to biorhythm phase, with the implication that individual and team performance can be predicted from biorhythm charts. The book also contains charting information and a comprehensive listing of celebrities and sports performers with birthdays for charting purposes. His approach is limited by use of selected anecdotal examples rather than valid statistical samples and tenuous rationalizations of why good or bad performance occurs at a particular biorhythm phase.

668.
Gittelson, B. The Gittelson Biorhythm Code Book. Charts and Compatibility Guides for 1978-1982. New York: Arco Publishing Co., 1978.

This is primarily an expanded set of biorhythm tables. The following anecdotal information for the efficacy of biorhythm scheduling was provided in an introduction: 100% successful surgical rate using biorhythmic scheduling (D. R. A. M. Lotter), increased pain tolerance in dental patients using biorhythm high phases, 41-73% of accident occurrences on critical days (G. R. Schwartz of U.S. Dept. of Interior), 40% drop in accidents following installation of biorhythm safety program (Armstrong Cork Co., Lancaster, Pa).

669.
Gittelson, B. Your Personal Biorhythm Daily Planner for 1980. Kansas City: Andrews and McMeel, 1980.

The author provides a book of charts so that the reader can chart daily biorhythm phases in diary style. Daily comments are provided in association with various biorhythm phases (high, low, critical) which resemble daily astrological horoscopes.

670.
Glaubman, H., I. Orbach, O. Aviram, et al. REM deprivation and divergent thinking. Psychophysiology 15: 75-79, 1978.

The contribution of REM sleep to divergent thinking was examined. Ten subjects were deprived of REM sleep and of equal length of NREM sleep. In both cases a divergent thinking task was assigned in the evening to be performed in the morning. The subjects' responses after NREM deprivation were numerically greater, included more positive reactions, and were more divergent and original than those produced after REM deprivation. The study thus reconfirms the hypothesis that

REM sleep contributes to divergent thinking and supports the claim that it encourages the individual's adaptation to new situations.

671.
Glenville, M. Examination of the factors influencing individual susceptibility to shiftwork. Chronobiologia 6: 101, 1979.

The results suggest that there is a peak in both mental and physical functions around the age of 26 which gives the 25-year-old subject an advantage with respect to disruptions in the circadian sleep cycle, and that familiarity with the job rather than length of experience is the important factor. No subjects rated themselves as being a definite or even moderate morning type and this is discussed in relation to previous findings concerning self-selection procedures.

672.
Glenville, M., R. Broughton, A. M. Wing and R. T. Wilkinson. Effects of sleep deprivation on short duration performance measures compared to the Wilkinson auditory vigilance task. Sleep 1: 169-176, 1978.

The effects of one night's total sleep deprivation were examined using the Wilkinson vigilance task and four 10 min duration performance tests. A repeated measures design was used in which eight male subjects experienced one night of sleep loss, the order of sleep loss being balanced across subjects. The four short duration performance tests consisted of choice reaction time, simple reaction time, short-term memory, and a motor task, handwriting. The results confirm the effects of one night's sleep deprivation on the vigilance task and also show that performance on the two reaction time tests was significantly impaired by the loss of sleep, but not at such a high level as for the vigilance. The short-term memory test failed to show any adverse effects of sleep loss and similarly for the handwriting. The experiment shows that two portable and brief (10 min) performance tests are sensitive indices of sleep loss and should be particularly useful for assessing levels of alertness in the field.

673.
Glenville M, and R. T. Wilkinson. Portable devices for measuring performance in the field: The effects of sleep deprivation and night shift on the performance of computer operators. Ergonomics 21: 865, 1978

674.
Glenville, M., and R. T. Wilkinson. Portable devices for measuring performance in the field: the effects of sleep deprivation and night shift on the performance of computer operators. Ergonomics 22: 927-933, 1979.

The performance of twelve computer operators was measured in the field, on two new portable tests of reaction time, during the first night of the night shift at 0400 h and at the beginning day shift (0800 h), over three successive three-week comparisons. The results were: (i) mean reaction time increased significantly on the night

shift as compared with the day; (ii) the adverse effect of the night shift was absent during the first comparison and became increasingly apparent on the second and third replications. These results: (i) provide evidence of inferior performance on the night as compared with the day shift in the field: (ii) show that data from previous studies of sleep deprivation in the laboratory are able to provide a good indication of what was to be expected in the field; (iii) emphasize the need for longitudinal studies in order to assess the true effects of stressful influences.

675.
Glines, C. V. Fatigue. *Air Line Pilot* 44: 6-10, 1975.

675a.
Glines, C. V. Probable cause: pilot fatigue? *Air Line Pilot* 45: 1947, 1976.

676.
Glines, C. V. Flight time/duty time. *Air Line Pilot* 48: 6-12, 55, 1979.

677.
Globus, G. G., E. C. Phoebus, and R. Boyd. Temporal organization of night workers' sleep. *Aerosp. Med.* 43: 266-268, 1972.

678.
Goertzen, C. Synchronization und Desynchronization verschiedener psychophysiologischer Variablen. *Kongr. Dtsch. Ges. Psychol.* Report 30, 1976, pp 387-388.

679.
Goetz, F., J. Bishop, F. Halberg, R. B. Sothern, R. Brunning, B. Senske, B. Greenberg, D. Minors, P. Stoney, I. D. Smith, G. D. Rosen, D. Cressey, E. Haus, and M. Apfelbaum. Timing of single daily meal influences relations among human circadian rhythms in urinary cyclic AMP and hemic glucagon, insulin and iron. *Experientia* 15: 1081-1084. 1976.

680.
Coldberg, V. Do body rhythms really make you tick? *New York* 10: 71-74, 1977

681.
Goldberg, V. What can we do about jet lag? *Psych. Today* 11: 68-72, 1977.

682.
Goncharenko, A. M. Elektrofiziologicheskoe issledovanie sna pri smennom rezhime raboty i proizvodstvenno obusiovlennom emotsional 'nom napriazhenii (Electrophysiological investigation of sleep during work-shift regime and production - induced emotion stress). *Fiziologia Cheloveka* 5: 641-649, 1979.

683.
Gonzales, L. Airline Safety. *Playboy* 27: 135-142, 268-290, 1980.

684.
Gonzalez, F. F., J. Zaplana, C. R. De Elvira, and J. M. R. Delgado. Nocturnal and diurnal sleep in Macaca sylvana. Electroencephal. Clin. Neurophysiol. 46: 13-28, 1979.

685.
Gordon, S. A., M. D. Challberg, and E. M. Buess. Light-phased circadian rhythms of hepatic tryptophan to auxin and tryptophan aminotransferase activities in the mouse. Int. J. Chronobiol. 1: 65-71, 1973.

686.
Gouars, M. Etude des possibilities d'adaptation de l'homme a un rythme de view impose de 30 heures. In: Ergonomie due travail de nuit et des horaires alternants, edited by P. Andlauer, et al. Paris: Editions Cujas (Education Permanent Univ. Paris I) Paris, 1977, pp. 57-60.

687.
Graeber, R. C. Alterations in performance following rapid transmeridian flight. Chronobiologia 6: 101-102, 1979.

Rapid transmeridian flight provides a unique opportunity to observe the chronobiologic effects of a sudden, dramatic shift in the timing of numerous geophysical and social external synchronizers. It value as a real-world experiment has not gone unnoticed by students of physiologic rhythms. However, it may have even greater value to those of us who emphasize the behavioral aspects of biological rhythms in that it challenges us with a practical test of the implications of circadian rhythms for human performance. A review of the current literature suggests that the extent and duration of post-flight performance deficits may not be as great as the concomitant disruptions in physiological-circadian rhythms. This conclusion must be considered tentative at best in view of the relatively few subjects in limited tasks which have been used. A more systematic cognitive and perceptual motor approach is suggested.

688.
Graeber, R. C., B. N. Cuthbert, H. C. Sing, R. J. Schneider, and G. R. Sessions. Rapid transmeridian deployment: I. Uses of the chronobiologic countermeasures to hasten time zone adjustment in soldiers. Chronobiologia 6: 102, 1979.

Altering the timing of certain synchronizers before flight departure may accelerate circadian phase adjustment to a new time zone. This study examined the effectiveness of such countermeasures by comparing 2 groups of 90 male soldiers (age 18-28) years) airlifted from Texas to W. Germany. Oral temperatures were measured at 4-h intervals during 4 working days prior to departure. Every 4 h throughout the 96-h span a subset of 15 subjects in each group maintained a circadian diary, had their temperatures taken, performed 2 simple behavioral tasks, and completed a subjective fatigue checklist. Countermeasures instituted on the morning of departure advanced the time (+6 h) of means, rest/activity, and social interaction. The experimental subjects ate lightly and avoided caffeine on the day of departure, took 100 mg of "Dramamine" before lights out at 1700, and ate a large high protein breakfast with coffee before landing at 0600. The control subjects underwent usual airlift procedures on a separate flight. Upon arrival all subjects were studied every 4 h for 6 days. The countermeasures significantly reduced sleeping and subjective fatigue during the first 2 days. Single digit addition was unaffected for both groups. The mean oral temperatures of both groups manifested appropriate circadian phase shifts within 24-48 h; however, the countermeasures produced a more rapid phase adjustment and recovery of amplitude for those subjects 30 years old. The use of chronobiologic countermeasures, even if limited to the day of departure, may help overcome the effects of transmeridian flight more rapidly.

689.
Graeber, R. C., R. Gatty, F. Halberg, and H. Levine. Human eating behavior: preferences, consumption patterns, and biorhythms. Natick, MA.: Food Sciences Laboratory, 1978, 287 pp.

690.
Graeber, R. C., H. C. Sing, and B. N. Cuthbert. The impact of transmeridian flight on deploying soldiers. In: The 24-Hour Workday. A Symposium on Variations in Work-Sleep Schedules. Edited by: L. C. Johnson, D. I. Tepas, W. P. Colquhoun, and M. J. Colligan. Washington, D.C.: National Institute for Occupational Safety and Health, in press., 1980, 30 pp.

691.
Graeber, R. C., et al. Circadian rhythm in tapping of subjects on a limited free-choice diet. Chronobiologia 2 (Suppl. 1): 24, 1975.

692.
Grandjean, E. Fatigue: It's physiological and psychological significance. Ergonomics 11: 427-436, 1968.

692a
Grandjean, E. P., G. Wotzka, R. Schaad, and A. Gilgen. Fatigue and stress in air traffic controllers. Ergonomics 14: 159-165, 1971.

Fatigue was measured on 68 air traffic controllers using the following methods: critical fusion frequency (CFF), tapping test, grid tapping test, self-rating. The measurements were taken 9 times within 24 hours over 3 weeks. Stress was measured on the basis of a questionnaire and of catecholamine excretion in urine. The four fatigue tests showed significant agreement. There was a marked decrease in the values after the 6th hour of work. During the night hours, the test values were lower, and the subjects stated they were more tired. For the first work hour and for the 9th and 11th work hour Spearman's correlation coefficients between the two sets of data were calculated. A signficant correlation was found (a) between CFF and grid tapping ($p < 0.02$); (b) between CFF and self-rating "refreshed-tired" ($p < 0.05$); (c) between grid tapping and self-rating "refreshed-tired" ($p < 0.02$). This means that subjects with a marked decrease in CFF or in grid tapping performance have a greater tendency to "tired" in the self-rating test. On the basis of this finding it might therefore be hypothesized that all measures are indicative of a common state of fatigue.

Results of the questionnaire (62 subjects): in difficult situations 60 subjects felt nervous, tense, irritated, 13 were anxious and trembling, 19 had increased perspiration, 14 had increased pulse rate and heart ache, 25 suffered from insomnia and chronic fatigue.

Urine samples from 6 subjects were taken after normal office work, easy ground control work, and radar air traffic control. There was a significant increase in the catecholamines in the last condition.

693.
Gratton, J. B. A Study in the Effects of Diurnal Variations upon Maximal Stress Performance, Resting Heart Rate, and Reaction Time. (Ph.D. thesis), East Texas State Univ., 1978.

The investigation was undertaken in an effort to determine the effects of diurnal variations upon maximal stress performance, resting heart rate, and reaction time. A second purpose included in the study was to determine the effects of fatigue upon reaction time.

694.
Grieg, M. They got Bio-Rhythm. San Francisco Chronicle, p. 4, March 26, 1975.

This article discusses the popular biorhythm surge in the San Francisco Bay area, discussing the use of coin operated Bio-Computers which provide biorhythm predictions. Literature from the Assoc. Coin Amusement Co. of Oakland which developed the machine claims the NASA authorities used biorhythm theory to chart the life cycles of the astronauts to set schedules ensuring optimum performance but no documentation exists for this claim.

695.
Groot Wesseldijk, A. T. The influence of shift work on health. Ergonomics 4: 281-282, 1961.

696.
Gross, H. M. Biorhythmik: die Auf und Ab unserer Lebenskraft: Einfluss and Anleitung (Biorhythmic: the up and down of our vitality: influence and introduction). Freiburg: Bauer, 1975, 236 pp.

The author claims that 80% of all accidents involving racing car drivers occur on biorhythmic critical days.

697.
Grossman, R. I got rhythm (and so do you). Family Health 11: 54-57, 1979.

In this popular discussion of biological rhythms, the author refers to the biorhythm method as a form of computerized astrology and recommends that people instead determine their own rhythms by keeping records of moods, sleep and physiological measurements and significant life events.

698.
Groza, P., V. Ionescu, L. Stoenescu, R. Vranclanu, and V. Filcescu. Circadian synchronization and desynchronization of some cardiodynamic parameters in reversed activity-rest cycle. Rev. Roum. Morphol. Embryol. Physiol. Physiol. 15: 23-27, 1978.

A comparative study of 23 turners on the first and fifth days ofthe weeks in which they worked in the morning shift and in the night shift respectively has shown that the vagal predominance of biorhythm influences mainly the heart rate and the total ejection. In the second part of night work, mobilization of the autonomic nervous system by ergorhythm brought about a shortening of the initial rapid systolic phase and an obviously smaller variation of electrical systole (QT) in relation to the heart rate (HR). Different and even opposite circadian changes were recorded in sportsmen. These findings might be of practical use in assessing the efficiency of adaptation to night work.

699.
Guignard, J. C. Noise in Combination with Other Stressors. In: Symposium on working Place Safety Proceedings, Bad Grund, Germany, 1974, 1 p.

The adverse effects of noise include temporary and permanent threshold shift in hearing; interference with communication (which can be dangerous, as well as affecting productivity); impairment of skilled performance in certain kinds of task; and physiological stress. Some of these responses can be modified by the simultaneous presence of other stressors, such as vibration, heat workload stress, sleep loss, and other biological or physical factors in the work situation. However, the interaction of other stressors with noise is varied and frequently complex, and cannot simply be summarized as always additive. In some circumstances, for instance, human performance appears paradoxically to be improved by the addition of noise when it is degraded by another stress (e.g., sleep loss). Again, temporary threshold shift due to intense broad-band noise is sometimes lessened by simultaneous whole-body vibration. The interaction between noise and other stressors can accordingly be specified only for particular combinations of factors, for it varies not only with the nature of the other stressors in the combination but also with time and with the level and the relative severity of the noise and other stressors.

700.
Guilleminault, C., and M. Carskadon. Relationships between sleep disorders and daytime complaints. In: Memory, Environment, Epilepsy, Sleep Staging, edited by W. P. Koella and P. Leum. New York: Karger Press, 1977, pp. 95-102.

701.
Guillerm, R., E. Radziszewski and A. Reinberg. Circadian rhythms of six healthy young men over a 4-week period with night-work every 48 hr and a 2% CO_2 atmosphere. Int. J. Chronobiol. 3: 14, 1975.

702.
Guillerm, R., E. Radziszewski, and A. Reinberg. Persisting and unaltered circadian rhythms of six healthy young men with a night-work shift every 48 hrs and a 2% CO_2 atmosphere during a 4-week span. Chronobiologia 2: 336-345, 1975.

Six apparently healthy young males (20 +/- 0.5 years of age) lived in a specially designed laboratory for a 1-week span in normal air, followed by 4 weeks in a 2% CO_2 atmosphere and thereafter 1 week again in normal air. Room temperature was 24°C +/- 1°C ; relative hygrometry 75% +/- 5%. With respect to socio-ecologic time clues and cues, the subjects were not isolated. The subjects' social synchronization was altered only by the shift-work schedule (light-on, 0700; light-off, 2230 on normal days). Every other day each subject had a 3-h night task, located between 2300 and 0700. Once a week, during 48 hrs (Saturday and Sunday) a set of physiologic variables was documented every 4 hrs in order to study their circadian changes: oral temperature, peak expiratory flow, grip strength, arterial blood pressure, tempo, and urinary pH, volume and potassium excretion. As far as rhythms are detectable (cosinor method) the most striking result is that both rhythm acrophases and amplitudes do not show any statistically significant changes when comparing either night-work versus day-work and/or normal air versus air with 2% CO_2. Both 3 hrs. of night-work every other day and an unusual amount of CO_2 do not alter the parameters characterizing the circadian rhythms considered. The absence of desynchronization during night-work could be related to: 1) the speed of rotation in the shift-work; 2) the short duration of night-work; and 3) the youth of the subjects.

703.
Guisset, J. L., T. Vanden Driessche, and R. Detrie. Conceiving microprocessor- based data gathering and processing (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. I-2.

704.
Gunther, E. Die Veranderungen Tagesperiodischer Schwankungen von Atmung und Sauerstoffaufnahme nach Transmeridianen Flugen. (Ph.D. Thesis), Univ. Bonn, 1972.

705.
Gwinner, E. Entrainment of a circadian rhythm in birds by species-specific song titles. Experientia 22: 765, 1966.

706.
Gwinner, E. Testosterone induces "splitting" of circadian locomotor activity rhythms in birds. Science 185: 72-74, 1974.

Under the influence of testosterone, the free-running circadian rhythm of locomotor activity of the starling, Sturnus vulgaris, tends to "split" into two components which temporarily run with different circadian frequencies: "splitting" occurred in intact birds whose testes grew, and in castrated birds that were injected with testosterone. Since "splitting" most probably reflects the temporal separation of two (or two groups of) circadian oscillators, these results suggest that testosterone affects the mutual coupling of circadian oscillators controlling locomotor activity.

707.
Hadjilova, J., and M. Daleva. Daily variations of the urinary excretion of some corticosteroids and catecholamines in workers under different working conditions. Ergonomics 21: 866, 1978.

Daily variations of urinary excretions of free 11-oxycorticosteroids, total 17-oxycorticosteroids, adrenaline and nonadrenaline were studied in various groups under resting conditions, and with different work loads. In resting conditions urinary 11-oxycorticosteroid concentrations showed an early morning rise and a subsequent decline over the 24 h sampling period. Peak values for both free and conjugated adrenaline and nonadrenaline were found between 1100 h and 1300 h. The excretion patterns of the 11-oxycorticosteroids were found to be relatively unaffected by variations in work load up to moderate levels. However, higher work loading extensions of working hours beyond normal length, and unfavourable working conditions altered the measured corticosteroid and catecholamine excretions, notably by reducing the amplitude of their circadian variations.

708.
Haggard, D. F. HUMRRO studies in continuous operations. Alexandria, Va; Human Resources Research Organization, HUMRRO Professional Paper-7-70, 1970, 15 p.

709.
Hagino, N., O. Nakamoto, H. Saito, and R. King. Effect of lighting on maturation of neural elements controlling biorhythm of sleep, wakefulness and paradoxical sleep in rats. Brain Res. 166: 359-368, 1979.

710.
Hak, A., and R. Kampan. Working irregular hours: complaints and state of fitness of railway-personnel (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. IV-4.

711.
Hakkinen, S. Adaptability to shift work. In: Night and Shift Work. Edited by A. Swensson. Stockholm: Inst. Occup. Health, 1969, pp. 68-80.

712
Halberg, E., J. Halberg, F. Halberg, and F. Halberg. Is there a "menstrual" component in oral temperature series prior to menarche? Chronobiologia 4: 113, 1977.

Self-measurements of body temperature in two girls revealed period lengths of 27.9 and 28.1 days, respectively, prior to menarche.

713.
Halberg, E., W. Nelson, L. E. Scheving, M. Stupfel, F. Halberg, J. E. Pauly, J. E. Bouquot, R. A. Vickers, and R. J. Gorlin. Interactions of meal-scheduling, lighting and housing influence the timing of circadian rhythms to a different extent at different levels of murine organization. Int. J. Chronobiol. 1: 327-328, 1973.

714.
Halberg, F. Biological rhythms. Adv. Exp. Med. Biol. 54: 1-41, 1975.

715.
Halberg, F. Some aspects of chronobiology relating to the optimization of shift work. In: Shift Work and Health: A Symposium. 1975, U. S. Department of Health, Education, and Welfare, 1976. pp. 13-47.

716.
Halberg, F. Implications of biological rhythms for clinical practice. Hosp. Pract. 12: 139-149, 1977.

717.
Halberg, F. Naito International Symposium on biorhythm and its central mechanism. In: Biological Rhythms and their Central Mechanism (A Naito Symposium), edited by M. Suda, O. Hayaishi, and H. Nakagawa. New York: Elsevier/North-Holland, 1978, pp. 328-334. (A summary of the symposium)

718.
Halberg, F. Survival affected by meal-timing. Chronobiologia 5: 343-344, 1978.

719.
Halberg, F. Naito Foundation Symposium on 'Biorhythm and its central mechanism (Tokyo, 1978.) Waking Sleeping 3: 93-99, 1979.

720.
Halberg, F. et al. Increased mortality in mice exposed to weekly 180^{0} shifts of lighting regimen LD12:12 beginning at one year of age. Chronobiologia 2 (Suppl.) 1: 26, 1975.

721.
Halberg, F., C. P. Barnum, R. H. Silber, and J. J. Bittner. Twenty four hour rhythms at several levels of integration in mice on different lighting regimens. Proc. Soc. Exp. Biol. Med. 97: 897-900, 1958.

722.
Halberg, F., F. Carandente, G. Cornelissen, and S. G. Katinas. Glossary of Chronobiology. Chronobiologia 4(Supplement 1): 1-189, 1977.

723.
Halberg, F., M. Engeli, C. Hamburger, and D. Hillman. Spectral resolution of low-frequency, small amplitude rhythms in excreted 17-ketosteroids; probable androgen-induced circaseptan desynchronization. Acta Endorinol. Suppl 103: 5-54, 1965.

Least squares spectral analysis of 24-hour urinary 17-ketosteroids collected from one man for over 16 years revealed small amplitude circaseptan, 20 day (17.6-20.5), monthly (29.5-30-7) and circannual rhythms.

724
Halberg, F., E. Halberg, and J. Halberg. Collateral-interacting hierarchy of rhythm coordination at different organization levels, changing schedules and aging. In: Biological Rhythms and Their Central Mechanism (A Naito Foundation Symposium), edited by M. Suda, O. Hayaishi, and H. Nakagawa. New York: Elsevier/North-Holland, 1979, pp. 421-434.

725.
Halberg, F., E. Haus, W. Nelson, and R. B. Sothern. Klinische Aspekte der Chronobiologie (Chronopharmacology, chronodietetics, and eventually clinical chronotherapy). Nova Acta Leopold. 46: 307-336, 1977.

726.
Halberg, F., D. K. Hayes, E. Halberg, F. Carandente, J. Halberg, R. B. Sothern and D. Dubey. Shift schedules in relation to ulcergenesis, carcinogenesis, and lifespan modelled in the laboratory with and without shift-modifying drugs. Ergonomics 2: 864, 1978.

Lifespans of the codling moth, pink boll worm and tobacco bud worm may be influenced by -90 (=6 h) shifts, at certain regular intervals of the temporal placement along the 24 h scale of a schedule of light (L) alternating with darkness (D) every 12 h, just as the lifespan of inbred C mice can be affected by varying (1) the frequency with which such shifts in lighting regimen are repeated or (2) the age at which such shifts are initiated, under conditions standardized for rhythm assessment (Halberg 1976). Further work has shown that codling moths subjected to -90 delays of a regimen of LD 16:8 every fifth day have higher mortality ($p<0.5$) than non-shifted control insects.
While lifespan studies in relation to shiftwork may be coordinated in a 3-pronged approach on insects, rodents, and human beings, rodents such as spontaneously hypertensive rats constitute, in turn, documented models for a scrutiny of factors influencing circadian stage-dependent sarcoma growth and ulcerogenesis, in addition to blood pressure disease and life span (Julie Halberg, this symposium). The probability of affecting schedule shifting by anti-depressant drugs, first reported for imipramine, and under study by us with nomifensine (8 amino-1,2,3,4-tetrahydro-2-methyl-4-phenyl-isoquinoline) indicates that further work on rodents (and human beings) would be of value (though it must be recognized that handling in itself can bring about some extent of rhythm-shift, and that any enhancement of rhythm shifts in the rodent by nomifensine is circadian stage dependent).

727.
Halberg, F., W. A. Lubanovic, R. B. Sothern, B. Brockway, E. W. Powell, J. N. Pasley, and L. E. Scheving. Nomifensine chronopharmacology, schedule-shifts and circadian temperature rhythms in di-suprachiasmatically lesioned rats - modeling emotional chronopathology and chronotherapy. Chronobiologia 6: 405-421.

728.
Halberg, F., and W. Nelson. Chronobiologic optimization of aging. In: Aging and Biological Rhythms, edited by H. F. Samis and S. Capobianco. New York: Plenum Press, 1978, p. 5-55.

729.
Halberg, F., W. L. Nelson, and L. Cadotte. Living routine shifts simulated on mice by weekly or twice-weekly manipulation of light-dark cycle. In: Proc. XII Intern. Conf. Intern. Soc. Chronobiology, Milan: Il Ponte, 1977, pp. 133-138.

730.
Halberg, F., W. Nelson, W. J. Runge, O. H. Schmitt, G. C. Pitts, J. Tremor and O. E. Reynolds. Plans for orbital study of rat biorhythms results of interest beyond the biosatellite program. Space Life Sci. 2: 437-471, 1971.

731.
Halberg, F., E. W. Powell, W. Lubanovic, L. E. Scheving, J. N. Pasley, P. R. Ernsberger, R. B. Sothern, and B. Brockway. Chronopharmacologic approach to vigilance: models and methods for anti-circadian dyschronic drug tests based on different kinds of murine thermodyschronism following unilateral or bilateral suprachiasmatic lesions. Adv. Biosci. 21: 39- 48, 1978.

Histologically validated unilateral removal of a suprachiasmatic nucleus in inbred Fisher rats kept in light and darkness alternating at 12-hour intervals (LD 12:12) leads to an increase in the average amplitude (A) of the circadian rhythm in telemetered intraperitoneal temperature, without a change in average acrophase (ø) of rhythm. Rats with such unilateral lesions complement those with histologically validated bilateral lesions exhibiting a circadian thermal A-reduction and ø advance. Models thus are available for use in the search for drugs that may correct (normalize) experimentally altered circadian rhythm characteristics, i.e., lower an increase A or raise a lowered A and/or delay and advanced ø of the circadian rhythm in body temperature.

732.
Halberg, F., E. W. Powell, W. Lubanovic, R. B. Sothern, B. Brockway, J. N. Pasley, and L. E. Scheving. The chronopathology and experimental as well as clinical chronotherapy of emotional disorders. In: Glossary of Chronobiology, edited by F. F. Halberg, F. Carandente, G. Cornelissen, and G.S. Katinas. Chronobiologia 4: 1-189, 1977.

733.
Halberg F., and A. Reinberg. Rythmes circadiens et rythmes de bases frequences en physiologie humaine. J. Physiol. (Paris) 59: 117-200, 1967.

Circadian rhythms were examined by chronobiologic serial sections applied to self-measurements of oral temperature, peak expiratory

flow, vital capacity, eye-hand skill and heart rate, as well as urinary volume, sodium and potassium, by a presumably healthy young woman before and after 2 transmeridian flights across 6 time zones. Polarity characterized the adjustment rate after the homeward flight (from west to east). Adjustment rates differ among variables and the variables themselves differ in the prominence of their circadian rhythmicity. Noisiness notwithstanding, chronobiologic serial sections represent useful tools in the hands of a physiologist interested in the extent of coupling among circadian rhythms , in the hands of an ecologist wishing to exploit predictable physiologic variability for environmental monitoring or in the hands of the physician assessing the shift-behavior of pathologic as well as physiologic rhythms (metarhythmometry) for diagnosis and therapy.

734.
Halberg, F., A. Reinberg, and A. Reinberg. Chronobiologic serial sections guage circadian rhythm adjustments following transmeridian flight and life in novel environment. *Waking and Sleeping* 1: 259-270, 1977.

735.
Halberg, F., and B. Sullivan. Chairperson's remarks: meal schedules and their interaction with the body's schedules. *Chronobiologia* 3: 75, 1976.

736.
Halberg, F., and M. B. Visscher. Some physiologic effects of lighting. In: *Proceedings of the 1st international photobiology congress* (4th international light congress), Amsterdam 1954, pp. 396-398.

737.
Halberg, F., H. W. Wendt, E. Haus, D. J. Lakatua. Steps toward physiologically validated manility (earliness) versus serality (lateness) for use in specific applications. Shift-work and treatment scheduling. *Chronobiologia* 4: 115, 1977.

738.
Halberg, J. Fixed or changing lighting schedules simulating shift-work and systolic blood pressure of adult Okamoto SH and SP rats. *Chronobiologia* 4: 116, 1977.

739.
Halberg, J. Shift schedules, blood pressure disease, and lifespan of genetically mesor-hypertensive rats. *Ergonomics* 2: 866-867, 1978.

The question of whether certain shift schedules imposed from birth without added loads lead to an elevated blood pressure was examined in inbred "spontaneously hypertensive" (SH) or "stroke-prone" (SP) rats, known to develop an overall increase in blood pressure mesor (rhythm-adjusted mean), 37 SH and SP rats were maintained in light from 0600 h to 1800 h alternating with darkness from 1800 h to 0600 h, beginning at birth. After weaning (at approximately 4 weeks of age)

they were stratified by strain, age and weight and divided into three groups. Group 1 remained on the same lighting schedule as before, while Groups 2 and 3 were subjected to schedule-shifts (changes in the temporal placement along the 24 h scale) every third or every sixth day, respectively. In each case the shift was made as an advance, i.e., as a shortening of a single light span from 12 to 6 h. The increase in mesor was slightly less steep in rats subjected to shifts in schedule than in controls ($p<0.05$), and lifespan did not differ bewtween shifted and control SP rats. Certain schedule shifts need not be "bad" and might even be beneficial.

740.
Halberg, J., E. Halberg, and F. Halberg. Nonobese mammals pair-fed or on free-choice diets may be what they eat but body weight and internal circadian timing are rhythmometrically specifiable functions of when they eat. Chronobiologia 3: 77-78, 1978.

741.
Halberg, J., E. Halberg, F. Halberg, and P. Regal. Circadian desynchronization of blood pressure and core temperature variation in Mesor-hypertensive rats compatible with unabridged life-span (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. II-3.

742.
Halberg, J., E. Halberg, D. K. Hayes, R. D. Smith, F. Halberg, C. S. Delea, R. S. Danielson, and F. C. Bartter. Schedule shifts, life quality and quantity - modeled by murine blood pressure elevation and arthropod life span. Int. J. Chronobiol. 7: 17-64, 1980.

743.
Hale, H. B., B. O. Hartman, D. A. Harris, R. O. Miranda, and E. W. Williams. Physiologic cost of prolonged double-crew flights in C-5 aircraft. Aerosp. Med. 44: 999-1008, 1973.

One double crew was studied during four standardized trans-oceanic flying missions in C-5 aircraft during the first year of its use by the USAF Military Airlift Command. All four flights went from Delaware, U.S.A., to South Vietnam and back, and each included short stops in Alaska, Japan, and Okinawa. Urine specimens collected at 4-hr intervals were analyzed for epinephrine., norepinephrine, 17-hydroxycorticosteroids, potassium, sodium urea, and creatinine. In general, the results confirm and extend the findings for a double crew which flew long-duration missions in C-141 aircraft, indicating that physiologic entrainment remains at all times the principal determinant of endocrine-metabolic responsiveness to factors in the flying environment, including the work itself. Recovery from these long missions (average duration = 65 hrs) involved differential reversal among the flight-affected endocrine-metabolic functions. Extrapolations of postflight data suggest that the time for complete recovery exceeded the flight time.

744.
Hale, H. B., B. O. Hartman, D. A. Harris, E. W. Williams R. E. Miranda, and J. M. Hosenfeld. Time zone entrainment and flight stressors as interactants. Aerosp. Med. 43: 1089-1094, 1972.

Physiologic responsiveness to flying was studied, using the members of a double-crew of a C-141 aircraft during six flights, each of which lasted 54 hours and involved bi- or tri-directional transmeridian flying. Responsiveness was quantified by means of endocrine-metabolic indices (urinary epinephrine, norepinephrine, 17-hydroxycorticosteroids, urea, sodium and potassium), using urine specimens which were collected at 4-hour intervals during the flights. Physiologic entrainment was shown to be a factor contributing to responsiveness, for there was rhythmic variability which related to time of day at the crews' home base. The wave-forms, amplitudes, time relations and overall levels, however, did not agree with those of unstressed persons. Preflight factors had carryover influence, acting as intensifiers of flight induced elevations at first, but gradually becoming less influential. As judged by epinephrine, norepinephrine and 17-OHCS, refractoriness toward flight stressors consistently developed at 2200 hours (Eastern Standard Time), even after the crew had crossed many time zones (flying either eastward or westward). These hormones indicated hyper-responsiveness was shown (by these same indices) to be moderate in grade. Potassium, on the first day, indicated low responsiveness at 2200 hours and transient hyper-responsiveness at 0200 hours. On the second day, in association with sustained subjective fatigue of moderate degree, potassium indicated persistent noncyclic hyper-responsiveness. At the same time 17-OHCS indicated persistent hyper-responsiveness, although the factor of entrainment had modifying influence. Urinary sodium indicated cyclic change in responsiveness to flight, as did urea, but these two metabolic indices were out of phase with the hormones and potassium.

745.
Hale, H. B., B. O. Hartman, D. A. Harris, E. W. Williams, R. E. Miranda, M. M. Hosenfeld, and B. N. Smith. Physiologic stress during 50-hour double-crew missions in C-141 aircraft. Aerosp. Med. 43: 293-299, 1972.

746.
Hale, H. B., R. C. McNee, J. P. Ellis, R. R. Bollinger, and B. O. Hartman. Endocrine-metabolic indices of aircrew workload: an analysis across studies. In: Simulation & Study of High Workload Operations, edited by A. N. Nicholson. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-146, 1974, A10-1 - A10-6.

Endocrine-metabolic measures have been used at the USAF School of Aerospace Medicine in a series of field and laboratory studies performed during the past decade. The field studies involved different kinds of military aircraft as well as missions of varying nature and length. Certain aspects were studied in simulated flights conducted under laboratory conditions. The data accumulated in the ten-year period have now been subjected to a cross-sectional analysis in an effort to ascertain the basic relation of endocrine-metabolic activity to the workload in either actual or simulated flights. For the present purpose, load represents degree of flight difficulty multiplied by duration. Difficulty was based upon USAF expert rankings, and duration was based upon reactions of a day. Multiple linear regression analysis was performed on data for urinary epinephrine, norepinephrine, 17-OHCS, urea, Na, K, and the Na/K ratio. This report presents the findings in the first phase of the cross-sectional study. Definition of the utility of endocrine-metabolic assessments of workload in the flight situation is expected to emerge ultimately from additional analyses.

747.
Hale, H. B., W. F. Storm, J. W. Goldzieher, B. O. Hartman, R. E. Miranda, and J. M. Hosenfeld. Physiological cost in 36- and 48-hour simulated flights. Aerosp. Med. 44: 871-881, 1973.

Groups of young healthy men were studied during 36- and 48-hr simulated flights in which they performed on psychomotor measuring devices, using a 2-hour work/rest schedule. Physiologic cost was assessed by use of a battery of urinary techniques, including potassium, sodium, urea, 17-OHCS, and, in some cases, individual 17-ketosteroids. Comparison was made of responses to (a) uncomplicated flight, (b) flight complicated by environmental dryness, (c) flight complicated by 8,000-ft pressure altitude, and (d) flight complicated by dryness and altitude. The prolonged psychomotor effort (and attendant sleep deprivation) acted as a nonspecific stressor. Altitude had intensifying influence, but dryness tended to conteract some phases of the stress response. In combination altitude and dryness in certain physiologic respects acted in a depressant manner. Completed recovery from such prolonged effort required more than 2 days.

748.
Hall, D. A., R. F. Townsend, and J. Knippa. Stress, fatigue, and work-rest cycles associated with deep submergence rescue vehicle fly-away evolution. Naval Health Research Ctr., 1979, 16 p.

To obtain information on stress, fatigue, and work-rest cycles of both submersible operators and surface support crew members during an actual submarine rescue fly-away mission, six operators and seven surface support personnel (SSP) were monitored during the conduct of a six day trial open-sea submarine rescrue evolution using the Deep Submergence Rescure Vehicle (DSRV), "Mystic". Operators and crew members lived aboard the mother submarine which carried the DSPV from port to the site of the downed submarine and return. Demographic information, psychological measures, performance measures, and environmental data were obtained during pre-deployment, transit-out, at dive site, and transit-in periods. The overall results suggested that a DSRV mission of the present duration and difficulty can be accomplished without exceeding the capabilities of the crew and support personnel. The trend of the changes does, however, suggest that missions of longer duration may require scheduling of regular sleep periods for personnel to maintain performance.

749
Hamilton, P., R. T. Wilkinson, and R. S. Edwards. A study of four days partial sleep deprivation. In: Aspects of human efficiency: Diurnal rhythm and loss of sleep.(Proceedings of the Symposium, Strasbourg, Fr. 1970), edited by W.P. Colquhoun. London: English Univ. Press, 1972, pp. 101-113.

Investigation of the effects of cumulative partial sleep deprivation over a period of four days, and discussion of the implications of the findings both for general theories of human information processing and for hypotheses concerning the effects of sleep deprivation. Under the described experimental procedure vigilance, routine-addition, and running digit span tests were administered to three groups of enlisted men. The obtained results are presented in diagrams, and the significance of the levels of comparisons between each sleep ration on each day and for all four days is reviewed.

750.
Handyside, J. Biorhythms in Man. Dayton, Ohio: Dayton Labs, 1978.

751.
Harkness, R. A. Variations in testosterone excretion by man. In: Biorhythms and Human Reproduction, edited by M. Ferin, F. Halberg, R. M. Richart, and R. L. Vandewiele New York: John Wiley, 1974, pp. 469-478.

Twelve serial studies of testosterone secretion from nine normal men lasting from 10-45 days revealed two groups of principal rhythms, one group with an average period length of 3-5 days and another group of 12-18 days period length.

752.
Harner, R. N. Neural control of circadian rhythms. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J. E. Pauly. Tokyo: Igaku Shoin Ltd., 1974, pp. 551-554.

753.
Harper, C. R., and G. Kidera. Aviator performance and the use of hypnotic drugs. Aerosp. Med. 43: 197-199, 1972.

754.
Harper, C. R., and G. J. Kidera. Hypoglycemia in airline pilots. Aerosp. Med. 44: 769-771, 1973.

755.
Harper, R. Air travel and your health. Mainliner: p. 172, 1979.

756.
Harris, D. A., G. V. Pegram, and B. O. Hartman. Performance and fatigue in experimental double-crew transport missions. Aerosp. Med. 42: 980-986, 1971.

Six experimental transport missions using a double crew were flown in a C-141 on routes generating various combinations of long and short legs. Crews followed a 4/4 of 16/16 work/rest schedule within operation constrains. On-board crew-rest facilities were provided so that the plane could fly through the airlift system without crew changes or crew delays. The missions required approximaely 55-60 hours to complete. The flying time averaged around 43 hours. Crew performance was evaluated by ratings made by an on-board flight examiner. There were no significant differences in flight examiner ratings. Subjective fatigue was measured by a rating scale. There were not significant differences related to work/rest cycles. There were significant differences related to mission profile and crew position. Sleep EEGs were recorded on the two navigators and were supplemented by self-reports from all crewmembers. There was a marked reduction in total sleep as well as stage 1-REM and deep sleep. Findings are discussed in relation to the demands of flying transport missions.

757.
Harris, W., Fatigue, circadian rhythm and truck accidents. In: Vigilance: Theory, Operational Performance, and Physiological Correlates, edited by R. R. Mackie, New York: Plenum Press, 1977, pp. 133-146.

758.
Harris, W., and J. F. O'Hanlon. A Study of Recovery Functions in Man. U.S. Army Human Engineering Laboratory Tech. Memo. No. 10-72. Santa Barbara Research Park, CA.: Human Factors Research, Inc., 1972.

759.
Harrison, E. A. Stress Factors on Pilot Performance (A Bibliography with Abstracts). Government Reports Announcements (report No. NTIS/PS-77/1160/9GA), 1977, 168 pp.

The selected abstracts of research reports cover acceleration, circadian rhythms, physiology, psychology, neurology, man-machine systems, high altitude effects, noise effects, and vibration effects as related to stress factors on pilot performance. (This updated bibliography contains 163 abstracts, 31 of which are new entries to the previous edition).

760.
DeHart, R.D. Work-rest cycle in air crewmen fatigue. Aerospace Med. 38: 1174-1179, 1967.

761.
Hartley, L. R. A comparison of continuous and distributed reduced sleep schedules. Quart. J. Exp. Psychol. 26: 8-14, 1974.

After a night of normal sleep, 36 subjects were divided into three groups of 12. One groups was allowed to continue sleeping normally, one group had four hours continuous sleep and the third group had three 80-min. periods of sleep distributed throughout the 24-h period, for the next four days. Subjects were given a visual vigilance test on each day. Overall performance was rather better following distributed thatn following continuous reduced sleep, but rather worse than following 8 h of sleep. The main difference between the reduced sleep groups was in their decision criterion. It was suggested that this difference mainly reflected the difference in time since the two groups had last slept.

762.
Hartman, B. O, (editor), Higher Mental Functioning in Operational Environments. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-181, 1976, 88 pp.

763.
Hartman, B. O. Management of irregular rest and activity. In: Sleep, Wakefulness and Circadian Rhythm. Neuilly-Sur-Seine: NATO, Advisory Group for Aerospace Research and Development. AGARD-LS-105, 1979, pp. A13-1 - A13-15.

764.
Hartman, B. O., and J. P. Ellis, Arousal and sleep distrubance: biochemical considerations. In: Sleep, Wakefulness and Circadian Rhythm. Neuilly-Sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-LS-105, 1979, pp. 6-3 - 6-34.

765.
Hartman, B. O., J. P. Ellis, Jr., J. B. Garcia, JR., and R. R. Bollinger. Human amino acid excretion during and following and extended airborne alert. Aviat. Space Environ. Med. 48: 395-398, 1977.

766.
Hartman, B. O., and H. B. Hale. Findings on the cost of flying transport missions (human stress expenditures in operational airlift mision flights). In: Performance in Biodynamics: Stress-influence of Interaction Stresses on Performance. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development AGARD-CP-101, 1972, 7 pp.

767.
Hartman, B. O., H. B. Hale, D. A. Harris, and J. F. Sanford, III. Psychobiologic aspects of double-crew long-duration missions in C-5 aircraft. Aerosp. Med. 45: 1149-1154, 1974.

Subjective fatigue and oral temperature were used as biomedical indices in a study in which two C-5 jet transport crews alternately operated the aircraft. Data collected at 4-h intervals during and following four 66-h missions (each a roundtrip inter-contontinental flight) clearly established that a. these dissimilar functions were rhythmic and b. flight factors exerted modifying influence on both rhythms. Particularly significant was the finding that subjective fatigue on the average showed a. initial latency, b. an intensification phase, and c. a reversal phase. The
finding that subjective fatigue on the average showed a. initial latency, b. an intensification phase, and c. a reversal phase. The
last phase apparently represents a state in which there is endocrine-metabolic and sympathetic nervous system hyperactivity (compensation). Oral temperature and subjective fatigue responses to prolonged flight tended to run parallel courses. Recovery rates for subjective fatigue and oral temperature tended to be similar, and at least 3 d were needed for elimination of residual flight effects.

768.
Hartman, B. O., H. B. Hale, and W. A. Johnson. Fatigue in FB-111 crewmembers. Aerosp. Med. 45: 1026-1029, 1974.

769.
Hartman, B. O. and D. Langdon. A second study on performance upon sudden awakening. U.S. Air Force Sch. Aerosp. Med., Report No. SAM-TR-65-61, pp. 1-10, 1965.

770.
Hartman, B. O., D. Langdon, and R. E. McKenzie. A third study on performance upon sudden awakening. U.S. Air Force Sch. Aerosp. Med., Report No. SAM-TR-65-63, pp. 1-4, 1965.

771.
Hartman, B. O. and R. E. McKenzie, (editors). Survey of Methods to Assess Workload. Neuilly-Sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-AG-246, 1979, 172 pp.

772.
Hartman, B. O., W. F. Storm, J. E. Vanderveen, E. Vanderveen, H. B. Hale, and R. R. Bollinger. Operational Aspects of Variations in Alertness. Neuilly-sur- Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-AG-189, 1974, 38 pp.

Vigilance performance, waking EEG patterns and mood were studied before and after one night of sleep deprivation in normal males. The effects of of d-amphetamine 10 mg, 1-amphetamine 10 mg and placebo on these measures were compared. Changes were found in all three measures after one night of sleep-deprivation. d-Amphetamine was more powerful than 1-amphetamine in reversing sleep deprivation effects on vigilance and on waking EEG.

773.
Hartmann, E., and W. C. Stern. Desynchronized sleep deprivation: learning deficit and its reversal by increased catecholamines. Physiol. Behav. 8: 585-587, 1972.

Four days of desynchronized sleep (DP) deprivation (island technique) produced a significant deficit in subsequent acquisition of an active avoidance task in the rat. Four days of repeated stress resulting in similar adrenal and thymus changes had no effect on acquisition. L-dopa 200 mg/kg in normals produced a signficant deficit in acquisiton, bu L-dopa after four days of D-deprivation results in normal acquisition. (Thus L-dopa reversed the learning deficits produced by D-deprivation, an effect we have shown previously for MAO inhibitors and imiprimine.) Alpha-methylparatyrosine also produced a deficit in avoidance acquisition, and L-dopa signficantly reduced this deficit, suggesting that the catecholamine increase produced by L-dopa is involved. We suggest that D-deprivation produces defects in the functioning of central catecholaminergic neuronal systems, and that the defects are reversible by increasing the availability of catecholamines.

774.
Haske, R. Das verhalten der Tagesrhythmik von Korpertemperatur and Leistung nach zwei Transatlantikflugen in rascher Folge (Behavior of circadian rhythm of temperature and performance after two subsequent transatlantic flights). Bonn-Bad-Godesberg: Deutsche Forschungs - und Versuchsantalt fur Luft und Raumfahrt. Institut fur Flugmedizin, DLR-FB 74-55, 1974, 52 pp.

Circadian rhythms of temperature and performance were studied in 8 students in 3-hour-intervals during periods of 24 hours after a jet flight from Germany to USA and vice versa with a stay of 24 hours in the USA. Two 24-hour preflight periods revealed the basic normal daily rhythm of temperature and performance. The effects of a 6 hour time shift after the 24-hour stay in the USA were evaluated by determining temperature and performance parameters on day 1, 3, and 5 following the flights. A considerable desynchronization with the local time was observed after flights. The resynchronization-time amounted up to 3-5 days in Germany afterwards.

775.
Hastings, W., and H. G. Schweiger (editors). The molecular basis of circadian rhythms (Dahlen Konferenzen). Berlin: Abakon Verlag, 1976.

776.
Hauke, P., H. Kittler, and R. Moog. Interindividual differences in tolerance to shift-work related to morningness-eveningness. Chronobiologia 6: 109, 1979.

Eight-eight 3-shift workers and 64 workers, who had given up night-shift because of health reasons, filled out a new German morningness-eveningness questionnaire, which gives a score for the subjective phase position (SCP) and for the stability of circadian phases (PSCP). Both groups of subjects were comparable in age, family circumstances, and housing standards. Three-shift workers gave significant higher rating for the SCP and the PSCP. There was only a tendency for higher scores in extroversion, but a signficant lower score for neutroticism. No differences were found for "neurotic" introverts and "neurotic" extroverts. These sub-groups did not corresond to morningness-eveningness as suggested by Colquhoun and Folkard (1978). It is concluded, the morning-types are less tolerant to shiftwork than evening-types.

777.
Hauri, P. Sleep disorders. Current Concepts: 76 pp.

778.
Haus, E. Pharmacological and toxicological correlates of circadian synchronisation and desynchronisation. In: Shiftwork and Health: A Symposium, edited by R. G. Rentos and R. D. Shepard, DHEW Publication No (NIOSH) 76-203. Washington D.C.: U.S. Government Printing Office, Department of Health, Education, and Welfare, 1976, pp. 87-117.

779.
Haus, E., and F. Halberg. Phase-shifting of circadian rhythms in rectal temperature, serum corticosterone and liver glycogen of the male C-mouse. Rass. Neurol. Veg. 23: 83-112, 1969.

This phase-shift of the circadian rhythms of rectal temperature, serum corticosterone and liver glycogen concentration after a 180° shift in synchronizer schedule ($LD_{12:12}$; 180° phase shift from D 0600-1800, D 1800-0600 to L 1800-0600, D 0600-1800) is evaluated in two experiments on a total of 2052 inbred male C-mice.

Differences in shift time are found by inferential statistical methods as a function of exprimental technique--and under certain experimental techniques and experimental conditions as a function of the synchronizer manipulation i.e., the modification of single spans of light or darkness.

The time course of the phase shift of the circadian rhythms studied apparently involves changes in rate of adjustment to a new schedule. Rather than occurring necessarily with a uniform "speed", slow and fast stages alternate throughout the time span of phase adjustment in a fashion which apparently is characteristic for each rhythmic physiologic function studied.

780.
Haus, E., and F. Halberg. Circannual rhythm in level and timing of serum corticosterone in standardized inbred mature c-mice. Environ. Res. 3: 81-106, 1970.

Circannual variations in serum corticosterone levels in Balb/C mice are demonstrated in pooled data of profiles involving at least 6 time points of sampling per 24-hour span. High values are found during the winter months and low values in late spring and summer.

Cosinor analysis of the circadian rhythm of serum corticosterone during different times of the year shows a change in the circadian acrophase (crest) from about 43° in February to 95° in May. This change is evident after a seven-day standardization span at relatively constant temperatures and regimen of $LD_{12:12}$ with light from 0600 to 1800 (for mice kept previously under largely natural lighting conditions). This circannual variation in circadian acrophase is compared with the time required for phase shift after an abrupt change in lighting regimen: after a 180° shift of the lighting regimen, the change in the serum corticosterone acrophase reaches 45° in less than three days, over 100° in 4 days and almost a full 180° in 7 days. Therefore, the circannual variation in circadian system phase of the adrenal cycle shown in this study cannot be regarded as an incomplete phase shift such as occurs shortly after an abrupt shift of the lighting regimen. The underlying mechanisms of this presumably partly intrinsic circannual biorhythm await further study.

781.
Haus, E., D. I. Lakatua, and F. Halberg. The internal timing of several circadian rhythms in the blinded mouse. Exp. Med. Surg., 23: 7-45, 1967.

782.
Haus, E., L. S. Sackett, M. Haus, Sr., W. K. Rabb, and E. K. Bixky. Cardiovascular and temperature adaptation to phase shift by intercontinental flight (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. VII-4.

783.
Hauty, G. T. and T. Adams. Phase shifts of the human circadian system and performance deficit during the periods of transition: III. North-South flight. Aerosp. Med. 73: 1257-1262, 1966.

783a.
Hauty, G. T., and F. L. Smith. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep (Proceedings of the Symposium, Strasbourg, Fr. 1970). Edited by W.P. Colquhoun. London: English Univ. Press, 1972, pp. 59-73.

Phase shifts of the human circadian system and performance deficits during periods of transition were investigated experimentally for east-west and west-east transitions. In these studies, psychological and physiological functions were assessed at periodic intervals for two or four alternate days throughout the accustomed waking day, to provide a base of reference, whereupon the subjects were transported by jet aircraft across 7-10 time zones to destinations where they remained for 8-12 days, during which they were subjected to the same test schedule, which was repeated for a last time after their return to the origin of the flight. The obtained results indicate, in essence, that phase shifts of the various physiological functions occurred at greatly differing rates and that the psychological functions were only minimally affected and, relative to the time lags of the phsiological phase shifts, for an exceedingly short duration only.

784.
Hauty, G. T., and F. L. Smith. Psychological Correlates of Physiological Circadian Periodicity. Washington, D.C.: Office of Naval Research, N71-23281, 1971, 14 pp.

Numerous psychological and physiological assessments were made on adult male, human subjects five times a day at four-hour intervals beginning at 0700 hours. Except for these periods of assessment (approx. 30 minutes duration) no other change was imposed upon their accustomed daily routine of activity nor upon their habits of sleep. Circadian periodicity was found to be clearly manifested by physiological functions; however, little or no corresponding periodicity was demonstrated by the psychological functions assessed.

785.
Hauty, G. T., D. K. Trites, and W. J. Berkley. Frequency of Shift Rotation at Air Traffic Control Facilities and Incidence of Stress-related Symptoms. Washington, D.C.: F.A.A., 1965, 7 pp.

From six enroute and six terminal air traffic control facilities selected on the basis of differences between shift rotation schedules and high traffic volume, 300 journeymen and assistant controllers were selected as volunteer subjects to complete a biomedical inventory daily for a period of 90 consecutive days. The inventory elicited information relating to health, morale, behavioral habits, and side effects of medications. Of the 300 subjects, 209 fulfilled the reporting requirements of the 90 days. For one of the indices of information--stress-related symptoms--analyses of the data revealed that: (1) facilities did differ to a statistically significant degree in the incidence of reported symptoms but these differences could not be attributed to shift rotation schedules and (2) eight hours or less between two successive shifts occasioned the highest incidence of reported symptoms and more than 24 hours between shifts the next highest.

786.
Haward, L. R. C. Emotional stress and flying efficiency. In: Higher Mental Functioning in Operational Environments, edited by B. O. Hartman. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-181, 1976, pp. C8-1 - C8-5.

A comparative study of the effects of "emotional" and "intellectual" stress upon flying performance is described. Ten pilots with self-confessed emotional problems but certified medically fit to fly were matched approximately for age and flying experience with ten pilots confessing to no emotional problems. Emotional stress was induced by a clinical abreactive technique and measured in terms of

psychophysiological concomitants. Intellectual stress was induced by the PASAT technique which is an automated numerical task designed to produce mental overload. Flying skill was measured in the presence and absence of both types of stress separately by means of a cross-over design, using especially modified D4 Link Trainer. The results show significantly differences in flying performance between the two groups and the two types of stress. It is demonstrated that "intellectual" stress produces impaired flying skill which is predictable both in degree and duration whereas "emotional" stress produces substantially more severe but fluctuating degress of impairment of unpredictable duration. The use of psychometric technique using personnel keywords and physiological monitoring clearly diffferentiates the two groups of pilots and indicates the orgin of emotional stress. Its possible use for screening aircraft captains before important missions is examined.

787.
Hawkins, F. Sleep in the long-range aviation environment. Shell Aviation News 434: 8-16, 1976.

788.
Hawkins, F. H. Sleep and Body Rhythm Disturbance in Long-Range Aviation. F. H. Hawkins, P. O. Box No. 75577, Schiphol Airport (c), Holland, 1978, 90 pp.

789.
Hawkins, L. H. Circadian rhythms and shiftworking. Occup. Health 32: 86-90, 1980.

790.
Hawkins, L. H., and C. A. Armstrong-Esther. Circadian rhythms and night shift working in nurses. Nursing Times 734: 49-52, 1978.

791.
Hawkins, L. H., and T. Barker. Air ions and human performance. Ergonomics 21: 273-278, 1978.

792.
Hayes, D. K. , S. Baylis, K. J. Lee, and F. Halberg. Codling moth development and aging in different lighting regimens. Chronobiologia 4: 118, 1977.

We investigated in each of an insect's growth stages (larva, pupa and adult) whether the manipulation of schedules, i.e., of lighting regimens affects an insect's development and longevity. Apples containing 6-day-old codling moth larvae, Laspeyresia pomonella L., were placed in biological oxygen demand (BOD) boxes in 1 gallon glass jars covered with cheesecloth. Larvae exiting from the apples were placed in polystyrene Petri dishes and held until they pupated, emerged as adults and died. Time until death was recorded for each insect. The temperature in the boxes was maintained at $25 \pm 1.5^{\circ}C$, relative humidity was $60 \pm 5\%$. Each box was equipped with 14 W cool white fluorescent light tubes: 24-h timers were used to adjust time schedules. A control groups of insects (no. 1) was a fixed schedule of light of 16 h alternating with darkness for 8 h. A 90° delay was achieved by lengthening the photofraction to 22 h, every 3rd, 4th, 5th, 6th or 7th day for groups 2, 3, 4, 5 and 6, respectively. Two added groups were kept in continuous light (7) or continuous darkness (8). For each growth stage a cumulative number of deaths for consecutive days, during the total span of 43 days, from 2-16-1977 to 3-31-1977 was obtained on each of the 8 different lighting regimens. Data were analyzed separately for each stage and for the whole study as soon as one half of the insects in the control grup had died, in the span being analyzed. The cumulative numbers of dead and live insects on this date were then tabulated for each lighting regimens. The total number of observations was taken to be the actual number of deaths at the end of the span analyzed. A contingency table was thus constructed and a X^2 test applied to test the null hypothesis that the proportions of dead and surviving insects on the 8 lighting regimens were equal. This test revealed a difference signficant at the 5% level for the case of deaths analyzed separately for the larvae and for the adults and also for the pooled data, but it failed to indicate statistical significance for the case of the pupae analyzed separately. Mortality was highest on the "5th day shift" regimen ($p<0.001$).

793.
Hayes, D. K., L. Cadotte, J. Halberg, E. Radha, and F. Halberg. Longevity studies of mice, rats, and colding moths on simulated shift-schedules. Proc. Minn. Acad. Sci., 1978, p. 21.

In simulating shiftwork, age at institution of synchronizer shifts, varying frequencies of shifts and directions (advances versus delays) instituted for mice, codling moths and rats, all affect longevity or mesorhypertension. 30 BALB/c female mice, retired breeders 17 months old, were housed 5/cage with food and water freely available, 10 on a fixed regimen of light and darkness alternating at 12-h intervals, the others on shifts of this regimen instituted as advances of 6 h (+90^0) for 10 mice every 3 day, for another 10 every 6 days. These shift schedules were continued for 35 wks. Survival times differed between the 20 mice all shifted late in life and controls ($t=1.90$; $P<.05$, 1-tail). Schedules may be optimized in several animal species (in terms of life duration and quality) and perhaps in human beings.

794.
Hayes, D. K., and B. M. Cawley. Phase shifting and life span in the codling moth, Laspeyrisia pomenella. In: Aging and Biological Rhythms, edited by H. V. Samis and S. Capobianco. New York: Plenum Press, 1978, p. 97-99.

795.
Haywood, K. M. Skill performance on biorhythm theory's physically critical day. Percept. Mot. Skills 48: 373-374, 1979.

The archery performance of 6 women and 11 men, unaware of supposed biorhythm-performance relationships, were recorded once/week for 10-29 weeks and compaared to biorhythm physical critical days. The sample proportion of performances above average was not significantly different from the population proportion. On two instances of "double critical" and one "triple critical" day, the archers shot above average. Note that Thommen (Is This Your Day?, Crown Publishers, New York, p. 95) reports that 9/11 no-hit pitching performances occurred on critical days, although in general biorhythm theory predicts poor or accident prone performance on critical days and many examples are given to support this claim. Thommen rationalizes this apparent inconsistency by claiming the pitchers were "charged up" and disregard caution, which resulted in superior performance.

796.
Hecht, K. and M. Poppei. Chronomedizinische Aspekte der Psychonervalen und Physischen Leistungsfahigkeit (Chronomedical aspects of psychoneural and physical performance capacity). Med. Sport 17: 377-386, 1977.

797.
Heckert, H. Entwicklung, Grundlagen and Aussagewert der Lehre einer endogenen sogenannten "Biorythmic" (Development, foundation and stated value of the theory of the endogenous so-called "biorhythmic"). In: Proceedings of the Society for Biological Rhythm, 7th Conference, Siena, Italy, edited by G. Dell'Aqua, A. Jores, A. Canniggia and A. Sollberger, Turin: Panminerva Medica, p. 70, 1962.

798.
Hegge, F. W. Biorhythm Studies in Drug Abuse. MDRC Walter Reed Army Institute of Research, July 1973.

This reference is to an unpublished study being conducted by the Walter Reed Army Institute of Research on biorhythms and drug abuse, using time series analysis of physiological and behavioral data.

799.
Helmers, C. Is pseudoscience done by computer pseudo-computer-science? Byte 4: 6,8,10, Nov., 1979.

This editorial states that BYTE magazine, a popular computer periodical, refuses to publish articles dealing with biorhythm theory since there is a general belief that if a computer program exists, that its computations are a valid representation or model of the real world, which the author claims biorhythm theory is not. He maintains the biorhythm constants (23, 28, 33 day cycles) do not reflect the non-integral nature of biological constants and that biorhythm proponents ignore contrary data and purport that its premises describe and predict reality. He suggests instead, that data be collected over several hundred days and analyzed by Fourier analysis to isolate periodic effects.

800.
Hendrick, H. W., and H. E. Jones. Physiological biorhythm as a correlate of pilot error and accidents. Proceedings of the Annual Meeting of the Human Factors Society, 22nd, Detroit, Michigan, 1978, pp. 498-501.

Aircraft accidents and incidents attributed to pilot error were hypothesized to have occurred while the pilot was in a critical phase for one or more biorhythms. From screening accident and incident reports for a large military unit, two groups of 25 pilots who had been involved in pilot error accidents and one group of 50 pilots who had been involved in pilot error incidents were identified. 13 of the accident validation group and 12 of the cross validation group were found to have been in a critical physiological phase at the time of accident, or twice the number expected by chance. For the incident group, 20 of the 50 pilots were in a critical physiological phase at the time of incident. Results for all three groups exceeded chance at the 0.25 level. Results for emotional and intellectual biorhythms, found for double critical phases were found not significant.

801
Herbert, M. Performance measures in varied sleep patterns. In: Memory, Environment, Epilepsy, Sleep Staging, edited by W. P. Koella and P. Leum. New York: Karger Press, 1977, pp. 91-95.

802.
Herrero Aldama, P. Fatiga de vuelo. Datos neurofisiologicos de interes diagnostico. (Flight fatigue. Neurophysiological data of diagonostic interest.) Arch. Neurobiol. 40: 197-216, 1977.

803.
Hersey, R. B. Periodic emotional changes in male workers. Personnel J. 7: 459-464, 1929.

This is a preliminary report to Hersey's 1931 study (J. Mental Sci. 77: 151-169). Daily measures of overt behavior, emotional behavior, dominant trends of thought, blood pressure, hours of sleep, weight, and fatigue were recorded daily in 17 workers by an observer throughout several months to a years. Periodic cycles ranging from 3-9 weeks were found with variation of a week or less in a given individual. Note: Hersey's studies have been often cited by biorhythm proponents as evidence for the 33-day intellectual biorhythm. However, Hersey states in this paper "this cyclical movement varied characteristically for each man in regard to length, amplitude and nature of the emotional and objective changes involved" which certainly does not coincide with the biorhythm period constancy hypothesis.

804.

Hersey, R. B. Emotional cycles in man. J. Mental Sci. 77: 151-169, 1931.

In this study 25 industrial workers were given a mood evaluation by means of an oral interview 4 times/day for several months to a year. Cycles were found in mood state data from weekly averages and period lengths were determined by visual inspection. Period lengths range from 4-9 weeks (28-63 days) among individuals and cycle lengths varied within 7 days of a given individuals average period length. The cycles of different workers were not in phase. Note: The average cycle length in this study, cited as 33-36 days, has been presented as evidence for the 33 day biorhythm intellectual cycle by biorhythm proponents (Thommen 1973, Is This Your Day?, Crown, New York; Gittelson, 1977, Biorhythm. A Personal Science, Arco, New York; and Tatai, 1977, Biorhythm for Health Design, Japan Publ., Tokyo). However, analysis of this paper reveals a mean cycle period of 35.7 days with a standard deviation of 10.6 days, a considerably larger variability than that expressed by Thommen et al. Periodogram analysis of data extracted from a graph containing 67 consecutive weeks of mood data revealed a mean period of 6.1 weeks (43 days), in close agreement with Hersey's estimate of 6 weeks. Thus Hersey's period estimates appear reasonably accurate despite the lack of periodicity analysis. The variability observed in these periods violates the biorhythm theory axiom of invariant period length. Also, from biorhythm theory, mood states should be associated with the 28 day or emotional biorhythm rather than the 33 day cycle. Gittelson attempts to resolve this inconsistency by claiming that the interviews given in this study involved an intellectual rather than emotional process. Gittelson also quotes Fliess as stating that measured physiological cycles (menstrual cycle) represent the interaction between the 23 and 28 day biorhythm cycles. However, this rationalization makes it impossible to rigorously test the biorhythm theory since any deviation from biorhythm periods could be justified in this manner.

805.
Hetherington, N. W., L.S . Rosenblatt, E. A. Higgins, and C. M. Winget. Quantification of the rates of reschronization of heart rate with body temperature rhythms in man following a photoperiod shift. In: International Congress on Aviation and Space Medicine, 21st, Munich, West Germany, 1973, Preprints, 1973, pp. 225-226.

A mathematical model previously presented by Rosenblatt et al. (1973) for estimating the rates of resynchronization of individual biorhythms following transmeridian flights or photoperiod shifts is extended to estimation of rates at which two biorhythms resynchronize with respect to each other. Such quantification of the rate of restoration of the initial phase relationship of the two biorhythms is pointed out as a valuable tool in the study of internal desynchronosis.

806.
Heybach, J. P., and J. Vernikos-Dannellis. Inhibition of the pituitary-adrenal response to stress during deprivation-induced feeding. Endocrinology 104: 967-978, 1979.

807.
Higgins, E. A., W. D. Chiles, J. M. McKenzie, G. E. Funkhouser, M. J. Burr, A. E. Jennings, and J. A. Vaughan. Physiological, Biochemical, and Multiple-task-performance Responses to Different Alterations of The Wake-Sleep Cycle. Washington D.C.: FAA Office of Aviation Medicine, FAA-AM-76-11, 1976, 20 p.

Three groups, each comprising five healthy, male, paid volunteers (ages 21 to 30), were studied for 11 days. Baseline data were collected for 3 days, during which subjects adhered to a day/night routine; i.e., sleeping from 2230 to 0600. On the fourth day each group took a "flight" in the altitude chamber. Following the flight day, subjects in the first group (Group I) slept from only 0230 to 0600 and then returned to the baseline routine; subjects in the next group (Group II) had their day extended by 6 hours and began a new routine of sleeping from 0430 to 1200 for the remainder of the study; subjects in the third group (Group III) had their day compressed by 6 hours and slept from 2030 to 2400 only that fourth night and then began a new routine of sleeping from 1630 to 2400 for the final 7 days of the study. According to the physiological and biochemical measurements, there was little difference between the two 6-hour-change groups (Groups II and III), both of which required longer rephasal times than did the group that experienced sleep loss but no time change (Group I). The psychomotor performance test indicated the greatest change in the group whose day was shortened by 6 hours (Group III). The Multiple Task Performance Battery (MTPB) indicated the greatest deficit in performance for Group III and the best postshift performance for Group II. Therefore, if performance of the type represented by the MTPB is the most important consideration, then travel from west to east (or "quick turnarounds" for shift workers) appears to be more deleterious than changes in the opposite direction. However, this effect cannot be predicted on the basis of the physiological and biochemical determinations made in this study.

808.
Higgins, E. A., W. D. Chiles, J. M. McKenzie, P. F. Iampietro, J. A. Vaughan, Higgins, E. A., G. E. Funkhouser, M. Burr, A. E. Jennings, and G. West. The Effects of Dextroamphetamine on Physiological Responses and Complex Performance during Sleep Loss. Washington D. C.: FAA Office of Aviation Medicine, FAA-AM-75-14, 1975, 9 p.

On two separate occasions, performance of ten male subjects was measured on the Civil Aeromedical Institute Multiple Task Performance Battery at 4-hour intervals for a period of 24 hours without sleep. Each subject received a capsule at 4-hour intervals beginning at 2000. On one occasion, the first three doses contained 5 mg each of dextroamphetamine sulphate followed by placebos for the remaining three capsules. On the other occasion, all capsules were placebos.

Results of experiment demonstrated that the dextroamphetamine sulphate sustained a high level of proficiency and altertness and delayed the effects of fatigue for 8 to 12 hours after the ingestion of the third and final drug capsule. Heart rate, rectal temperature, and urinary excretion rates of catecholamines were elevated with this drug. These increases could support the enhancement of proficiency and alertness demonstrated with amphetamines. Neither the subjects' feelings of fatigue nor the accuracy of their estimates of performance capabilities differed significantly in these two test conditions.

809.
Higgins, E. A., W. D. Chiles, J. M. McKenzie, P. F. Iampietro, C. M. Winget, G. E. Funkhouser, M. J. Burr, J. A. Vaughan, and A. E. Jennings. The Effects of a 12-hour Shift in the Wake-Sleep Cycle on Physiological and Biochemical Responses and on Multiple-task-performance. Washington, D. C.: FAA Office of Aviation Medicine, 1975, FAA-AM-75-10, 24 pp.

810.
Higgins, E. A., P. F. Iampietro, J. A. Vaughan, G. E. Funkhouser, and M. J. Burr. Effects of altered wake-sleep cycle in biorhythms. Aerosp. Med. Assoc., Preprints, 1973, pp. 227-228.

811.
Higgins, E. A., J. M. McKenzie, J. A. Vaughan, G. E. Funkhouser, and M. J. Burr. Physiological responses to different alternations of the wake-sleep cycle. Aerospace Med. Assoc., Preprints, 1975, pp. 37-38.

812.
Hildebrandt, W. Untersuchung zur Berucksichtigung der Menschlichen Tagesrhythmik durch eine Variable Arbeitszeitregelung (Investigation Concerning a Consideration of the Human Circadian Rhythm by Means of a Variable Working Time). (Doctoral Thesis) Fakultat fur Maschinenwesen, Aachen: Rheinisch-Westfalische Technische Hochschule, 1972, 182 pp.

Studies of the human circadian rhythm are considered together with approaches to adapt working schedules to this rhythm. The adaptations can include operational adjustments within the framework of a fixed working time and an adoption of a variable working-time schedule. The original of variable working-time arrangements are discussed along with details concerning working-time schedules, advantages and drawbacks of a variable working time, the present use of a variable working time in the economy, and problems connected with the introduction of a variable working time. The employment of the Pauli test in a modified form provides information in investigations regarding a quantification of the circadian rhythm. Results obtained regarding fixed and variable working-time schedules are compared, taking into account data obtained in a statistical analysis.

813.
Hildebrandt, G. Chronobiologische Grundlagen der Leistungsfahigkeit und Chronohygiene. In: Biologische Rhythmen and Arbeit., edited by G. Hildebrandt, Wien-New York: Springer-Verlag, 1976, pp 1-19.

814.
Hildebrandt, G. Outline of Chronohygiene. Chronobiologia: 3: 113-127, 1976.

Since chronotherapy already manipulates rhythmical functions, it is the important task of chronohygiene to outline the object of therapy, i.e., health, from chronobiological points of view. Only on such a basis can chronohygiene be extended to the prevention provisions of health care and health education in regard to the biological time structure. Health can be characterized as an optimal state of harmonious time structure and its integration into the temporal orders of the environment.

The circannual variations of an organism establish a seasonal risk cycle changing the inner preconditions of therapy as well. Moreover, chronohygiene must raise the question of whether the biological circannual rhythm is an integrating component of the human time organization, or if it may be levelled by civilization.

Circadian variations of the organism not only modify the preconditions of therapy, but in particular those of activity and efficiency. The nocturnal maximum of functional economy normally is protected against exploitation by a simultaneous minimum of vigilance, which provides the nightly recovery. Therefore the destruction of this phase relationship by night-work must worsen recovery conditions.

The disturbance of the time structure in the organism by night-work not only affects the circadian system, but faster rhythms as well. The phase position of the circadian rhythms is closely related to the individual responsiveness of the autonomous system as well as to the pulse-respiration-ratio. The latter can serve as a chronobiological criterion for evaluating suitability of risk of night- and shift-work. The effort of chronohygiene is based on the fact that disturbances of the time structure represent just a complementary aspect to disturbances of the spatial structure of the organism.

815.
Hildebrandt, G., and P. Engel. The relation between diurnal variations in psychic and physical performance. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep. (Proceedings of the Symposium, Strasbourg, Fr. 1970), edited by W.P. Colquhoun, London: English Univ. Press, 1972, pp. 231-240.

Investigation of an individual's ability to carry out a given task at a given point of time, which is determined by the performance characteristics of various functional levels or systems in the organism. These consist essentially of motivation, precision, economy, and capacity. Various studies are cited which indicate that in the central nervous system the degree of automatic coordination or synchronization of physiological rhythmic functions generally increases greatly during the nocturnal recuperation phase, and can be taken as a common basis for the decrease in psychic performance and

the simultaneous increase in physical performance at this time. Thus the 180 - deg phase-difference in the diurnal rhythms of the two kinds of performance can be thought of as a consequence of the varying effect of automatic coordinations on the specific performance characteristics of various functional levels in the organism.

816.
Hildebrandt, G., and E. M. Lowes. Tagesrhythmische Schwankungeen der vegetative Lichtreaktionen beim Menschen. J. Interdiscip. Cycle Res. 3: 289-301, 1972.

817.
Hildebrandt, G., W. Rohmert, and J. Rutenfranz. Daily variations of the frequency of errors by shift working railway operators and the influence of fatigue. Int. J. Chronobiol. 1: 331-332, 1973.

818. Hildebrandt, G., W. Rohmert, and J. Rutenfranz. Twelve and twenty-four rhythms in error frequency of locomotive drivers and the influence of tiredness. Int. J. Chronobiol. 2: 175-180, 1974.

819.
Hildebrandt, G., W. Rohmert and J. Rutenfranz. The influence of fatigue and rest period on the circadian variation of error frequency in shift workers (engine drivers). Int. J. Chronobiol. 3: 6, 1975.

820.
Hildebrandt, G., and I. Siratmann. Circadian rhythms and shift work--implications and findings. Circadian system response to night work, in relation to the individual's circadian phase position. Ergonomics 21: 861, 1978.

Daily rhythms of body temperature and pulse rate were measured in six night-nurses under strict resting conditions immediately after 7 18 days of night work, and subsequently after 10 days of recovery under normal living conditions. Scores on the Horne-Osberg Questionnaire indicated that three of the subjects were moirning types, and three evening types.

A "flattening-index" and a "disturbance-index" were used in order to quantify the changes in amplitude, phase position and high frequency modulation of the rhythms. While the rhythms of the morning types exhibited an increase in amplitude, leading to a greater value of the disturbance-index, those of the evening types showed a flattening. Ratings of subjective vigilance during the day also indicated that evening types were less affected by the night work. It is concluded that this greater tolerance of evening types to night work stems from the lower responsiveness of their vegetative functions to changes in the external environment.

821.
Hildebrandt, G. and I. Siratmann. Circadian system response to night work in relation to the individual circadian phase position. Int. Arch. Occup. Environ. Health 43: 73-83, 1979.

In 6 night nurses the daily course of body temperature and pulse rate was measured under strict resting conditions immediately after a 7 to 18-day period with night work as well as after a 10-day period of recovery under normal life conditions. Three of the subjects were morning types and three evening types according to the Horne-Ostberg-Questionnaire as well as to the phase position of the body temperature cycle. In order to quantify the changes in amplitude, phase position, and frequency a "flattening index", a "circadian deformation index" were used. While the evening types reacted with a flattening of their circadian amplitude and thus gained a greater tolerance, the morning types hyperreacted when exposed to the inverse life pattern, developing an increased amplitude and adding to the circadian deformation by ultradian periods. No significant differences could be detected in phase shift. Higher amounts of subjective complaints and deficit of sleep as well as differences in the additionally controlled vigilance functions demonstrated the lower tolerance of the morning types to night work. The discussion concerns the methological basis of a quantitative evaluation of disturbance of the circadian system, and shows that the greater tolerance of evening types to night work is based on a lower reagibility of the vegetative functions to changes in the outer environment.

822.
Hildebrandt, G., and Strempel, H. Chronobiological problems of performance and adaptational capacity. Proc. Intern. Conf. Inter. Soc. Chronobiol., 12th, Milan: Il Ponte, 1977, p. 103-115.

823.
Hildebrandt, G., and H. Strempel. Chronobiologische Grundlagen der Leistungs- und Anpassungsfahigkeit. (Chronobiological foundation of performance and adaptability.) Nova Acta Leopold. 46: 337-350, 1977.

824.
Hilfenhaus, M. Circadian rhythm of plasma renin activity, plasma aldosterone and plasma corticosterone in rats. Int. J. Chronobiol. 3: 213-229, 1976.

825.
Hilfenhaus, M., and T. Hertig. Effects of inverting the light dark cycle on the circadian rhythm of urinary excretion of aldosterone, corticosterone and electrolytes in the rat. In: Advances in the Biosciences, vol. 19: Chronopharmacology, edited by A. Reinberg and F. Halberg. New York: Pergamon Press, 1979, pp. 49-55.

The influence of a 180°-light shift on the circadian rhythm of urinary excretion of sodium, potassium, corticosterone and aldosterone was investigated in rats to analyze the interrelationship between the rhythms of corticosteroids and electrolyte metabolism. Male Sprague-Dawley rats were kept in individual metabolic cages with a standard rat food (Na^+ 96 moles/kg; K^+ 143 moles/kg) and tap water ad libitum. The animals were adapted to a lighting regime of

L(6.00-18.00): D(18.00-6.00) for two weeks prior to inversion of the light dark cycle to L(18.00-6.00): D(6.00-18.00). Spontaneously discharged urine sampled continuously in 7h-portions was analyzed for free aldosterone, free corticosterone and electrolytes. The peaks of aldosterone, corticosterone and potassium shifted day by day, by which a complete inversion of the rhythmic patterns was found 9 days after the 180°-light shift. Sodium excretion behaved differently: The nomal pattern was modified by the light shift but was found not completely inverted even 19 days after inversion of the light dark cycle. From the parallel shifting of the rhythms of urinary excretion of aldosterone, corticosterone and potassium and the different behaviour of the sodium rhythm it can be concluded that: (1) the circadian rhythm of corticosterone as well as of aldosterne seems to be controlled by a common regulatory mechanism, presumably by the rhythm of ACTH secretion. (2) the circadian rhythm of potassium excretion may be controlled by the rhythm of corticosterone and /or aldosterone. (3) the circadian rhythmm of sodium excretion man be controlled by mechanisms not related to adrenal cortical function.

826.
Hill, B., and G. O. Williamms. An investigation of landing accidents in relation to fatigue. In: Aircrew Stress in Wartime Operaations, edited by E. J. Dearnaley and P. B. Warr. London: Academic Press, 1979, ch. 6, pp. 89-108.

827.
Hillestad, et al. Diazepam metabolism in normal man. Clin. Pharm. Ther. 16: 485-489, 1974.

828.
Hindmarch, I. A repeated dose comparison of 3 benzodiazepine derivatives nitrazepam, flurazepam, and flunitrazepam on subjective appraisals of sleep and measures of psycho-motor performance the morning following night time medication. Acta Psychiatrica Scandinavica 56: 373-381, 1977.

829.
Hiroshige, T., and K. Honma. Factors entraining circadian rhythms in mammals: internal and external synchronization of endogenous rhythms in the rat and involvment of brain biogenic amines. In: Biological Rhythms and Their Central Mechanism, edited by M. Suda, O. Hayaishi, and H. Nakagawa. New York: Elsevier/North-Holland Biomedical Press, 1979, pp 233-246.

830.
Hirsch, E. et al. Body weight change during 1 week on a single daily 2000 calorie meal consumed as breakfast (B) or dinner (D). Chronobiologia 2: 31-32, 1975.

831.
Hirsch, T. Biorhythm-Or, is it a critical day? National Safety News 113: 41-44, 1976.

A review article in which are considered both accident occurrrence as correlated to the biorhythm theory and the use of the theory in accident prevent. National Safety News, after contacting dozens of companies, scientists and biorhythm proponents found that only a handful of organizations will admit to using the theory, despite claims by proponents. H. Willis, Director of the Biorhythm Clinic, defends the theory, but compromises the theory by claiming that there may be individual variability in biorhythm cycles due to psychological or physical trauma. He claims 60-75% of the population conforms to the theory. They cite a study by K. Tyler of the Truck Underwriters Assoc. which studied 18,000 accidents and found that the pattern of accidents was the same as would be expected from chance. National Safety News has been unable to substantiate claims that biorhythm theory is widely used in occupational safety and quote a statement from United Air Lines, which has been widely quoted as using biorhythm theory: "we do not have any hard data that will indicate that the biorhythm program had any direct effect on our ground safety performance, and the program has been discontinued".

832.
Hockey, G. R. J., and W. P. Colquhoun. Diurnal variation in human performance - a review. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep. (Proc. of a Symp., Strasbourg, FR., 1970), edited by W.P. Colquhoun. London: English Universities Press, 1972, pp. 1-23.

Review of published findings on human performance as a function of time of day including the relation of the circadian rhythm of human performance to physiological rhythms and their alteration as a result of exposure to changes in living routines or to otherwise unusual conditions. Emphasis in the review is on variations in performance efficiency, rather than on physiological processes. Some of the conclusions drawn from the reviewed findings indicate that: (1) there is a marked rhythm in the efficiency of human performance, both in normal and in many unusual environmental conditions; (2) this rhythm has a primary period of 24 hours, and its effects appear not only when tests are made during the normal waking day, but also when they are carried out through the night; and (3) there is a high degree of correspondence between diurnal changes in performance and body temperature.

833.
Hockey G. R., S. Davies, and M. M. Gray. Forgetting as a function of sleep at different times of the day. Quart. J. Exp. Psychol. 24: 386-393, 1972.

The experiment studied the separate effects of sleep and time period of retention interval on forgetting. A free recall task was given to independent groups of subjects either at night or in the morning, and a second recall demanded 45 h later, after an intervening period of sleeping or waking activity. Oral body temperatures (BT) were measured at each session. The data were analysed in terms of (a) immediate recall at test 1, and (b) amount forgotten from test 1 to test 2. Immediate recall was higher for morning groups, in agreement with previous findings, serial position analysis indicating that the effect is confined to enhancement of the primary memory component. Long-term retention was higher over the night interval, irrespective of sleeping conditions, though having slept at night produced better retention than having stayed awake. Sleep during the morning was not effective in reducing forgetting. BT showed a marked drop for both night groups and rise for day groups over the retention interval. Alternative explanations for the classical sleep/memory findings are suggested in terms of (a) differential effects of sleep stages on memory, and (b) the underlying diurnal variation in BT and other processes.

834.
Hodge, D. C. Environmental quality considerations for continuous operations. Conf. on Military Requirements for Research on Continuous Operations (Human Engineering Labs.), Lubbock, TX., 1971, pp. 39-50.

835.
Hodges, J. R., and S. Mitchley. The effect of betamethasone on circadian and stress-induced pituitary-adrenocortical function in the rat. Br. J. Pharmacol. 38: 719-724, 1970.

836.
Hoecken, H. Die Biorhythmik als Helfer der Menschheit, aus Bleib gesund. (The biorhythmic as a helper of mankind, to remain healthy). Braunschweig: Zeitschrift des Volksgesundheitsvereines e. V., 1957.

837.
Hoffman, K. Overt circadian frequencies and the circadian rule. In: Circadian Clocks, edited by J. Aschoff. Amersterdam: North-Holland Publ. Co., 1965, pp. 87-94.

838.
Hoffmann, K. Die relative Wirksamkeit von Zeitgebern, Oecologia (Berlin) 3: 184-206, 1969.

Amongst others, masking effects are discussed, that is, the direct action of the light-dark cycle, evoking activity or suppressing activity, as distinct from entraining effects underlying biological oscillation.

839.
Hoffmann, K. Zum Einfluss der Zeitgeberstaerke auf die Phasenlage der synchronisierten circadianen Periodik. Z. vergl. Physiol., 62:93-110, 1969.

After a phase-shift of the light-dark cycle, activity rhythms of birds are found to become resynchronized faster than those of mammals. In addition, the minimum amplitude of the light-dark cycle necessary for entrainment is found to be smaller in birds than in mammals.

840.
Hoffman, K., M. Gonderoth-Palmowski, G. Wiedenmann, and W. Engelmann. Further evidence for period lengthening effect of Li+ on circadian rhythms. Z. Naturforsch. 33C: 231-234, 1978.

841.
Holley, D. C., D. A. Bechman, and J. W. Evans. Effect of confinement on the circadian rhythm of ovine cortisol. J. Endocr. 65: 147-148, 1975.

842.
Holley, D. C., and J. W. Evans. Effect of confinement on ovine glucose and immunoreactive insulin circadian rhythms. Am. J. Physiol. 226: 1457-1461, 1974.

843.
Hollmann, W., and T. Hettinger. Sportmedizin - Arbeits- und Trainingsgrundlagen. Stuttgart-New York: F. K. Schattauer Verlag, 1976, p. 67.

844.
Hollwich, F. The Influence of Ocular Light Perception on Metabolism in Man and in Animal. (H. Hannum and H. Hannum, transl.) N. Y., Heidelberg, Berlin: Springer-Verlag, 1979, 130 pp.

845.
Holmes, D. S., C. A. Curtright, K. D. Mccaul, and D. Thissen. Biorhythms: Their utility for predicting postoperative recuperative time, death, and athletic performance. J. Appl. Psychol. 65: 223-236, 1980.

In three studies the relationship between biorhythm phase and postoperative recuperative phase, death times, and athletic performance were studied using analysis of variance, chi square analysis or multiple regression. Neither analysis of variance or multiple regression revealed any significant correlations between phase of any of the 3 biorhythm cycles and postoperative recuperative times. Chi square analysis of 148 obituary notices selected at random revealed no significant relationships between biorhythm critical days or negative days and date of death. Multiple regression analysis of 20 golf tournament scores from 22 male members of the Professional Golfers Assoc. revealed no significant evidence the biorhythms could reliably predict golf performance since only one significant correlation was found out of 22 samples.

846.
Honjo, S., T. Fujiwara, M. Takasaka, Y. Sauzuk, and I. Imaizumi. Observations on the diurnal temperature variation of cynomolgus monkeys (Macaca irus) and on the effect of changes in the routine lighting upon this variation. Jpn J. Med. Sci. Biol. 16: 189-198, 1963.

Cynomolgus monkeys which were kept one per cage in an animal room which the sun-light could freely enter, exhibited a distinct diurnal rhythm of body temperature taken from the rectum. The maximum temperature (mean=38.84° C) was recorded at 4 p. m. and the minimum (mean=37.42° C) was at 4 a. m. The range of d. t. v. (diurnal temperature variation) was 1.42° C. The pattern of d.t.v. of cynomolgus monkey, that was kept one per cage in the room which was artificially illuminated by fluorescent lamps during 10 a. m. - 5 p. m. each day preceeded and followed by an entire darkness, was not essentially different from the pattern which was observed under the sun-light condition (the control pattern). The inversion of the pattern of d. t. v. was induced one to two weeks after the inversion of routine lighting. In this case, lights were on during 5 p. m. - 10 p. m. The maximum temperature was obtained at 10 a. m. and the minimum was at 4 p. m. in the inverted pattern. When monkeys were continuously left in an entire darkness or in artificial light, the d. t. v. seemed to lose the normal control pattern, and the range of d. t. v. evidently decreased. With changing the experimental conditions of lighting again to the same one as that of the control, the altered patterns of d. t. v. returned to the same pattern as the control in every experimental group. Although the pattern of d. t. v. of cynomolgus monkeys was undoubtedly dependent upon the given condition of lighting, the after-effect of pre-existing condition remained for some time.

847.
Homma, K. The mechanism of synchronization of endogenous biological rhythms. 1. Analysis on the mode of synchronization of circadian rhythms of locomotor activity, body temperature and plasma corticosterone in the rat. Hokkaido Igaku Zasshi 52: 213-236, 1977.

Circadian rhythms of locomotor activity, body temperature and plasma corticosterone level were determined simultaneously from individual rats (longitudinal study) in order to know the nature of these rhythms and the interrelationships among them. Periodicity analysis by least squares spectra was used. Characteristics of the underlying mechanism by which these rhythms are regulated were examined in relations to light-dark cycle and light intensity. The circadian rhythms studied in the rat ran freely with a period of more than 24 h (free-running rhythm) in the absence of light-dark cycle (Zeitgeber). During 12 days under continuous light (200 lx) these rhythms did not desynchronize each other, but showed paralllel phase shifts of similar size. Prolonged illumination (200 lx over a period of 3 mon.) abolished the circadian rhythm of all parameters used. These animals showed ultradian rhythms having a 4-6 h period. Similar ultradian components were identified by the periodicity analysis in locomotor activity of prepuberal rats in which no circadian rhythm was established yet. Correlation analysis revealed that increment of locomotor activity was significantly related to subsequent elevation of body temperature. But circadian rhythm per se of body temperature is not induced by increments of locomotor activity. The Aschoff Rule apparently was valid for the circadian rhythm of plasma corticosterone level and locomootor activity. Cervical ganglionectomy that abolished circadian rhythm of pineal serotonin content affected neither free-running rhythm of locomotor activity nor of body temperature, nor plasma corticosterone level. Apparently circadian rhythms of locomotor activity, body temperature and plasma corticosterone are all endogenous. Since these rhythms always showed a parallel phase shift under various experimental conditions used, they are assumed to be tightly coupled with each other, most probably with a common regulating mechanism (the biological clock). Periodicity analysis revealed that an ultradian component with a 4-6 h period is the basic unit of circadian rhythms. Apparently the principal role of the biological clock is to cluster these ultradian rhythms within a certain period during 24 h.

848.
Homma, K., and T. Hiroshige. Endogenous ultradian rhythms in rats exposed to prolonged continuous light. Am. J. Physiol. 235: R250-R256, 1978.

Circadian rhythms of locomotor activity, body temperature, and plasma corticosterone were determined simultaneously in individual rats that were exposed to 200 lx continuous light for over 3 mo. Free-running circadian rhythms of locomotor activity persisted for about 2 mo under continuous light and then the rhythms gradually decomposed. After 3 mo. of exposure, circadian rhythms disappeared and several times during a 24-hr period. Body temperature also exhibited several bursts of fluctuation and these bursts were closely correlated in their temporal sequence with those of locomotor activity. A least-squares spectrum analysis revealed that the burst had regular 4- to 7-h periods. Plasma corticosterone, determine by serial sampling at 2-h intervals from individual rats, also exhibited several secretion episodes in a day. Those episodic secretions synchronized with bursts of locomotor activity. These results suggest that the ultradian component, manifested under prolonged continuous light, is a fundamental unit of the circadian rhythm and an oscillator for the ultradian rhythm is common to the three functions examined.

849.
Homma, K., and T. Hiroshige. Internal synchronization among several circadian rhythms in rats under constant light. Am. J. Physiol. 235: R243-249, 1978.

Three biological rhythms (locomotor activity, body temperature, and plasma corticosterone) were measured simultaneously in individual rats under light-dark cycles and continuous light. Spontaneous locomotor activity was recorded on an Animex and body temperature was telemetrically monitored throughout the experiments. Blood samples were obtained serially at 2-h intervals on the experimental days. Phase angles of these rhythms were calculated by a least squares spectrum analysis. Under light-dark cycles, the acrophases of locomotor activity, body temperature, and plasma corticosterone were found at 0029, 0106, and 1940 h, respectively. When rats were exposed to 200 lx continuous light, locomotor activity and body temperature showed free-running rhythms with a period of 25.2 h on the average.

Plasma corticosterone levels determined at 12 days after exposure to continuous light exhibited a circadian rhythm with the acrophase shifted to 0720. The acrophases of locomotor activity and body temperature, determined simultaneously on the same day, were found to be located at 1303 and 1358 h, respectively. Phase-angle differences among the three rhythms on the 12th day of continuous light were essentially the same with those under the light-dark cycle. These results suggest that circadian rhythms of locomotor activity, body temperature, and plasma corticosterone are most probably coupled to a common internal oscillator in the rat.

850.
Honma, K. and T. Hiroshige. Simultaneous determination of circadian rhythms of locomotor activity and body temperature in the rat. Jpn J. Physiol. 28: 159-169,1978.

Simultaneous determination of the circadian rhythms of locomotor activity and body temperature weas carried out in the rat. Deep body temperature was monitored continuously using a telemetric device. The circadian rhythm of locomotor activity was characterized by clustering of several bursts of activity during the dark period. THe circadian rhythm of body temperature was also characterized by bursts of small fluctuations which were well correlated with those of locomotor activity. Correlation between the two functions was such that the regression line expressing body temperature as a function of locomotor activity had approximately the same slope for dark and light periods, but a body temperature for a given amount of locomotor activity was significantly higher during the dark period than during the light one. After a prolonged exposure to constant light, the circadian rhythm disappeared in both functions. Both showed bursts of fluctuations which were correlated with each other. These results indicate that the bursts of body temperature increment were dependent on those of the locomotor activity. However, manifestation of the circadian rhythm per se of body temperature could not be explained as resulting exclusively from the circadian fluctuation of locomotor activity.

851.
Honma, K., and T. Hiroshige. Decomposition of circadian rhythm of plasma corticosterone into several secretion episodes by prolonged exposure to 200 lux LL or by 6-OHDA treatment (abstract). Chronobiologia 6: 111-112, 1979.

Circadian rhythms of plasma corticosterone (Cpd. B) and locomotor activity were observed simultaneously and longitudinally in individual rats. To know a fluctuation pattern of plasma Cpd. B, a serial blood sampling from the tail was performed at 2 h intervals for 24 h. Locomotor activity was monitored by a non-stress type of actograph (Farad Animex). Circadian rhythm of locomotor activity free-ran with a period of 25.1 ± 0.1 h under 200 lux LL. After 3 months in LL, the circadian rhythm became obscure and instead several bursts of locomotor activity were observed over a 24 h period. A least-squares spectrum analysis revealed that occurrence of the burst had a regular cyclicity with a 4-6 h period. Free-running circadian rhythm of plasma Cpd. B, which was measured 2 weeks after exposure to

LL, synchronized well with that of locomotor activity. But fluctuation of plasma CPd. B measured after 3 months in LL was characterized by secretion episodes, which showed good correlation in their phase-relation with burst of locomotor activity. This decomposition of the circadian rhythms was reversible when the animal was returned to LD. Intraventricular injection of 6-OHDA did not affect the circadian rhythms of both functions in LD. But when 6-OHDA treated animal was exposed to 200 lux LL, the circadian rhythm of plasma Cpd. B. decomposed into 3 to 4 secretion episodes in only 2 weeks. On the other hand, the circadian rhythm of locomotor activity continued to free-run under such conditions. These results indicated that a fundamental unit of circadian rhythm of plasma Cpd. B was an episodic secretion, a regulary mechanism which had a different biochemical background from that of circadian rhythm and also suggested that brain catecholaminergic neurons were indispensable for circadian rhythm of plasma Cpd. B in 200 lux LL.

852.
Honma, K., and T. Hiroshige. Participation of brain catecholaminergic neurons in a self-sustained circadian oscillation of plasma corticosterone in the rat. Brain Res. 1980 (submitted for publ.).

853.
Honma, K. F. Katabami, and T. Hiroshige. A phase response curve for the locomotor activity rhythm of the rat. Experientia 34: 1602-1603, 1978.

854.
Honma, K., K. Watanabe, and T. Hiroshige. Effects of parachlorophenylalanine and 5,6-dihydroxytryptamine on the free-running rhythms of locomotor activity and plasma corticosterone in the rat exposed to continuous light. Brain Res. 169: 531-544, 1979.

Parachlorophenylalanine (PCPA) and 5,6-dihydroxytryptamine (5,6-DHT), depletors of brain serotonin, were administered to the rat and circadian rhythms of locomotor activity and plasma corticosterone were determined simultaneously in individual rats in light-dark cycles (LD) and in 200 lux continuous light(LL). Free-running periods and acrophases on the 12th day in LL (LL12) were calculated by a least squares spectrum method. In PCPA-treated rats which showed 70% depletion of brain serotonin, circadian rhythms of locomotor activity in LL and of plasma corticosterone and ACTH in LD disappeared for several days after the drug injection. Circadian rhythms of locomotor activity reappeared after the LL7 day and free-ran with a phase shift. Free-running periods of these rats did not differ significantly from that of control rats. However, the acrophase of PCPA-treated group on the LL11 day was 5 h advanced as compared to that of control.

Circadian rhythm of plasma corticosterone in the PCPA-treated rats was detected on the LL12 day but their peak times were distributed around 24:00 h instead of 08:00 h observed in control rats. The 4,6-DHT-treated rats which showed only 40% depletion of brain serotonin exhibited normal free-running rhythms in both locomotor activity and plasma corticosterone in LL and no difference in the acrophases of these functions on the LL12 day as conpared to controls. These results suggest that PCPA affects the circadian clock (or clocks) itself in such a way that it blocks the clock to free-run or at least it effectively shortens the free-running periods of locomotor activity and plasma corticosterone in the rat.

855.
Hopkins, H. A. et al. Food and light as separate entrainment signals for rat liver enzymes. Adv. Enzyme Regul. 11: 169-189, 1972.

856.
Hord, D. J., A. Lubin, M. L. Tracy, et al. Feedback for high EEG alpha does not maintain performance or mood during sleep loss. Psychophysiology 13: 58-61, 1976.

857.
Hord, D. J. M. L. Tracy, A. Lubin and L. C. Johnson. Effect of self enhanced EEG alpha on performance and mood after two nights of sleep loss. Psychophysiol. 12: 585-590, 1975.

Can the deleterious effects of acute sleep loss on performance and mood be ameliorated by self enhanced alpha activity? Fourteen Naval volunteers were divided equally into an experimental (alpha contingent auditory feedback) group and a yoked control (pseudofeedback) group. All subjects received feedback plus performance and mood tests during 3 baseline days and following 2 days and 2 nights without sleep. Feedback was given 45 min in the morning and 45 min in the afternoon, preceding performance and mood tests. The self enhanced alpha (experimental) subjects did produce more alpha than the yoked controls during all feedback sessions except for one pair that was discarded. Of eleven measures that were sensitive to sleep loss, two performance scores and one mood score showed significantly less sleep loss decrement for the self enahanced alpha group (at the usual univariate .05 level). Two recall scores and an anxiety score showed more impairment for the self enhanced alpha group following sleep loss. The differences were not significant, however, by the conservative Dunn Bonferroni multivariate criiterion, so our results are not conclusive. Alpha enhancement may help maintain performance that requires continuous attention, such as counting and auditory discrimination, but does not ameliorate the sleep loss effect for anxiety, memory, and addition.

Can performance and mood during sleep loss be maintained by self induced high EEG alpha activity? In a previous study, most of the performance and mood measures showed sleep loss impairment regardless of EEG alpha level, but attention and reported sleepiness were less impaired for the high alpha group (although the differences were of doubtful significance). A constructive replication was carried out. In Group A (N-10) auditory feedback was contingent on high alpha, and in Group B (N-10) auditory feedback was contingent on low alpha and low theta. All subjects were repeatedly mesured on auditory vigilance, addition, immediate recall, and feelings of sleepiness for 40 hrs during which no sleep was permitted. Sixty min of EEG feeback were given during each block of 220 min. Group A did produce significantly more alpha for the first 24 hrs but this difference as not maintained. Both groups had significant sleep loss impairment on all measures. There were no significant differences between the groups in the amount of impairment. Self enhanced EEG alpha activity does not prevent impairment of performance or mood during sleep loss.

858.
Horne, J. A. Binocular convergence in man during total sleep deprivation. Biol. Psychol 3: 309-19, 1975.

It was proposed that binocular convergence (lateral phoria) for near and far vision would reflect the states of visual function and that ther would be a progressive reduction in phoria during sleep deprivation. Six young male subjects underwent two conditions of sleep deprivation on separate occasions. One condition incorporated a high visual load and the other a low load. Exercise and sound were balanced. Lateral phoria for near and far vision was carefully measured, regularly, before, during and after sleep deprivation. It was found that a reduction inconvergence (exophoria) for both near and far vision became increasingly apparent with progressive sleep deprivation, especially with near vision and under high visual load. The near vision measure, which included accommodation convergence, appeared to be more sensitive to sleep deprivation generally, whereas far vision tended to produce a greater differentiation between the conditions. The implications of these findings for REM sleep and oculomotor innervation are discussed.

859.
Horne, J. A. Recovery sleep following different visual conditions during total sleep deprivation in man. Biol. Psychol. 4: 107-118, 1976.

The findings of visual impairment during total sleep deprivation were used as a basis for a possible link between vision and sleep. It was proposed that the level of visual load imposed during sleep deprivation was an important variable, and would have a substantial effect upon recovery sleep. Six young male subjects underwent two conditions of 64 h of sleep deprivation on separate occasions. One conditions incorporated a high visual load, and the other a low load Exercise and sound were balanced. All night sleep EEGs were taken for two baseline nights, and also for two recovery nights following each condition. there was a significant increase of stage 4 on all recovery nights and a REM rebound on the second recovery night, SWS, particularly stage 4, TST and REM density, were significantly greater following the high load. Implications of these findings for sleep theories and for sleep deprivation research are discussed.

860.
Horne, J. A. A review of the biological effects of total sleep deprivation in man. Biol. Psychol. 7: 55-102, 1978.

861.
Horne, J. A., C. G. Brass, and A. N. Pettitt. Circadian performance differences between morning and evening "types". Ergonomics 23: 29-36, 1980.

Two groups of subjects identified as either morning (M) or evening(E) types, determined by a self-assessment questionnaire, were measured for performance efficiency at a simulated prooduction-line inspection task given for 15 sessions at different times of the waking day. Systematic fatigue and practice effects were minimised by a random presentation of these sessions over a series of days. Although there were no significant within- or between-group changes with circadian trends for items erroneously rejected, significant differences were apparent with the number of items correctly rejected. M types' correct rejection levels were significantly better than E types' in the morning, whereas they were worse during the evening. Whilst E types showed a steady improvement throughout the day, M types showed a general decline. A post-lunch dip in performance was quite evident for M types, but not for E types. In addition, the circadian trends in correct rejection levels and body temperature were highly positively correlated for E types, but a significant negative relationship between these parameters was found for M types. These findings are discussed.

862.
Horne, J. A., and I. Coyne. Seasonal changes in the circadian variation of oral temperature during wakefulness. Experientia 31: 1296-1298, 1975.

863.
Horne, J. A., and O. Ostberg. A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. Int. J. Chronobiol. 4: 97-110, 1976.

Research into individual differences in circadian rhythms is reviesed, particularly morningness-eveningness. It was hypothesised that extraverts would be inclined towards eveningness and introverts towards morningness. Forty eight subjects took regularly their oral temperature. Peak times were identified from smoothed temperature curves. Results showed that extraverts had a peak time insignificantly later than extroverts. Re-grouping of the data into the morningness-eveningness dimension, based upon the results of a self assessment questionnaire, showed that evening types had significantly later peak times than morning types. Morningness-eveningness was not significantly correlated with extraversion-introversion, although there was a trend. No significant differences were found for sleep lengths with either groupings, or of sleep-wake habits within extraversion-introversion. Morning types retired and arose significantly earlier than evening types. Although sleep-wake habits and extraversion-introversion help to determine peak times there are either contributory factors to peak time which appear to be partly covered by the questionnaire.

864
Horne, J. A. and O. Ostberg. Individual differences in human circadian rhythms. Biol. Psychol. 5: 179-190, 1977.

865.
Horne, J. A. and O. Ostberg. A self-assessment questionaire to determine morningness-eveningness in human circadian rhythms (abstract). Sleep Res. 7: 474-475, 1978.

866.
Horne, J. A., and J. M. Porter. Time of day effects with standardized exercise upon subsequent sleep. Electroenceph. Clin. Neurophysiol. 40: 178-184, 1976.

The effect standardized exercise had upon sleep was studied with eight subjects. A pilot study assessed individual work capacity by the sub-maximal estimation of VO_2 max. In the main study each subject performed the exercise, once a.m. and once p.m., on different days. Sleep was scored into stages and an additional sub-division of stage 2 containing 10-20% by time of delta. Comparison with baseline showed no significant whole night changes with any criteria following either a.m. or p.m. exercise. After p.m. exercise there was a significent increase in stage 3 for the first half of the night. It was concluded that ensuing wakefulness following early daytime exercise is sufficient for recovery, but late daytime exercise may result in an intrusion of recovery into initial sleep. Sleep is not seen to be necessary for recovery from muscular fatigue.

867.
Horton, B. J., and C. E. West. Shifting phase analysis correlation in the determination of reproducibility of biological rhythms. Its use in the study of patterns of rabbit and rat feeding. J. Interdiscipl. Cycle Res. 8: 65-76, 1977.

The diurnal feeding pattern of rabbits has been analysed using a shifting phase analysis correlation. Measurements of feed intake were made at regular intervals (hourly) throughout a cycle (24 hrs). Measurements were repeated 8 days later at exactly the same times, then again after retarding the lighting cycle by 6 hrs. The data for any cycle are compared with another by calculating correlation coefficients comparing the measurements during one cycle with those at the corresponding times during another. The data for the second cycle were all moved forward by one hour and a new correlation coefficient calculated. This process was repeated until a shift of 24 hrs was obtained. Using this procedure it was shown that rabbits have a regular diurnal pattern of eating, which requires from 8 to 15 days to adjust to a changed lighting cycle. A study of the individual rabbits shows that all had approximately the same pattern of eating, though one was 3 hrs out of phase with the others. However, several had lost their original feeding patterns after the change in light conditions and failed to adapt to the new cycle within 15 days.

868.
Hoshizaki, T. Biorhythms of a nonhuman primate in space. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J. E. Pauly. Tokyo: Igaku Shoin, Ltd., 1974, pp. 424-428.

A significant circadian rhythm of catecholamine excretion in man, with associated alterations in myocardial contractility, blood pressure and heart rate, has been demonstrated. During the 6 a. m,. to 9 p. m. period there was an increase in catecholamine excretion, contractility, and heart rate. During the 9 p. m. to 6 a. m. period, there was a marked decrease in catecholamine excretion, with concomitant decrease in cardiac contractility, blood pressure, and heart rate. These observations suggest that the response to stress of the cardiovascular system in man may be significantly altered by the phase of the circadian rhythm. Knowledge of these rhythmic changes may be of great importance in the understanding and proper treatment of the patient with cardiovascular disease.

869.
Hoshizaki, T., J.M. McNew, I. Sabbot, and L. R. Adey. Micturition patterns of an unrestrained chimpanzee under entrained and free running conditions. Aerosp. Med. 43: 149-154, 1972.

870.
Howitt, J. S. A. E. Hay, G. R. Shergold and H. M. Ferres. Workload and fatigue - in-flight EEG changes. Aviat. Space Environ. Med. 49:1197-1202, 1978.

Continuous recordings were made of the EEG and ECG of one pilot during a series of instrument flights in a feeder-type transport aircraft. The flights were arranged to contain epochs of distinctly differing levels of workload. In addition, some flights were made after a night of sleep deprivation and others were made as the second and third flights of the day. Subjectively, there appeared to be marked differencs in performance between the two types of tired flight. the EEG analyses showed changes that correlated well with differences in workload. In the highest workload areas during fresh flights, EEG activity increased by approximately a factor of 4 over that of the preflight resting values. This large increase did not occur in the tired flights. Further experiments are planned using flights in aircraft and in simulators using several subjects.

871.
Huff, D. The biorhythm question. In: Cycles in Your Life, New York: Norton, Chapter 9, 1964, pp. 104-108.

In a short review of the biorhythm theory, the author, although skeptical about a theory that demands precise cycles with arbitrary periods, cites application of the theory to medical practice and accident prevention.

872.
Hughes, D. G., S. Folkard, and R. Cifelli. Adaptation to an 8-h shift in living routine by members of a socially isolated community. Nature 264: 432-434, 1976.

The conclusions to be drawn from these results are, in general, very similar to those based on studies where the subjects have not been members of a socially isolated community. Even after ten successive days of an 8-h shift, complete adaptation had not occurred in either temperature or visual search performance. Although the other performance measures showed no significant lack of adaptation, it is generally accepted that different rhythms adapt to a time shift at different rates, and the adaptation of performance rhythms may well be quicker than that of the physiological ones. The lack of complete adaptation could be due to the social influences of the six members of the camp who did not shift their routine, and/or to the opposing light-dark cycle. Although it has recently been suggested that the light-dark cycle is relatively unimportant for man, this is based on results using only an artivicial light-dark cycle. It is quite possible that the natural cycle is a rather stronger Zeitbeber than these studies would suggest, especially since in the present study the contact between the shifted and unshifted members of the camp was minimal.

873.
Hume, I. I. Some Electrophysiological Studies of Sleep from Subjects on Varying Sleep-wakefulness Schedules. (Doctoral Dissertation) Victoria Univ. of Manchester, England, 1978.

874.
Hume, K. I., and J. N. Mills. A split sleep investigation of the relative effects of time of day and duration of prior wakefulness on the sleep process (abstract). Sleep Res. 4: 266, 1975.

875.
Hume, K. I., and J. N. Mills. The circadian rhythm of REM sleep (abstract). J. Physiol. 270: 32P, 1977.

876.
Hume, K. I., and J. N. Mills, REM sleep during simulated circumglobal flight. J. Physiol. 271: 52P-53P, 1977.

We have recorded and scored by conventional means (Rechtschaffer & Kales, 1968) the sleep stages of an air pilot who, in an isolation unit, first spent 4 days on a normal schedule and was then subjected to a series of time shifts simulating a long circumglobal flight. His temperature rhythm appeared to be free-running (Mills, Minors & Waterhouse, 1977) with a period of 25.1 hr. Two of his sleeps were of only 4 hr but the others (2 controls and 8 during time shifting) were of 8 hr, and we have calculated the amount of REM in each 4 hr of sleep. this followed a circadian rhythm. The data points are insufficient to define the period with precision, but are well described by an oscillation of amplitude 17 min and mean 40 min which, in controls and during time shifting, leads the temperature rhythm by 9.5 hr. The amount of REM in the second half of an 8 hr sleep corresponds to this rhythm as closely as that in the first half. The amount of REM thus seemed to depend upon an endogenous rhythm, perhaps linked to that of temperature, and not upon the habits of the subject.

877.
Hume, K. I., and J. N. Mills. Rhythms of REM and slow-wave sleep in subjects living on abnormal time schedules. Waking and Sleeping 1: 291-296, 1977.

Polygraphic records have been obtained upon 9 subjects who took 4 hours of sleep from midnight and a second 4 hours at different times of day and upon 3 subjects who for a fortnight lived on a 21-hour day. The amount of REM showed a clear circadian rhythm, with maximum shortly before noon and minimum shortly after midnight, and a weak negative correlation with the duration of prior wakefulness. The amount of slow-wave sleep was largely dependent upon the duration of prior wakefulness but also showed a circadian rhythm of low amplitude, with maximum in the afternoon.

878.
Humphrey, N. K., and G. R. Keeble. Do monkeys' subjective clocks run faster in red light than in blue? Perception 6: 7-14, 1977.

When monkeys are given control of the illumination in a testing chamber, it has been found, under three conditions, that they spend less time with red light than with blue. But the results cannot easily be explained in terms of 'preference'. Rather, the results suggest that monkeys judge 'subjective time' to pass nearly twice as fast in red light as in blue.

879.
Hunter, J. E. Beware of your critical days. Management World 8: 3-6, 1975.

880.
Hunter, K. I., and R. H. Shane. Time of death and biorhythmic cycles. Percept. Mot. Skills 48: 220, 1979.

Chi square analysis of birth and death records from 144 male veterans revealed no frequencies of death dates above chance expectation levels on biorhythm positive, negative, or critical days.

881.
Hunter, S. R. Schraer, D. M. Landers, E. R. Buskirk, and D. V. Harris. The effects of total estrogen concentration and menstrual cycle phase on reaction time performance. Ergonomics 22: 263-268, 1979.

882.
Hyndman, B. W. The role of rhythms in homeostasis. Kybernetik 15: 227-236, 1974.

883.
Iglesias, R. A. Terres, and A. Chavarria. Disorders of the menstrual cycle in airline stewardesses. Aviat. Space and Environ. Med. 51: 518-520, 1980.

Of 200 airline stewardesses, 39% underwent unfavourable changes in the menstrual cycle after commencing aeronautical activities while 11% who had previous disorders healed soon after joining the company. Although 48% of the stewardesses underwent changes in menstruation during flight, in about half of these the menstrual flow increased an in the other half it decreased or disappeared, only to reappear with greater intensity after the flight; 38% of the stewardesses manifested suffering from pelvic discomfort after long flights. Sufficient research in this field has not been done. Therefore, it is difficult to trace the exact origin and mechanism of these changes in the menstrual cycle. Stress and internal desynchronization due to disruption of circadian rhythm may intervene in generating these disorders.

884.
Ikemi, Y. T. Nakagawa, H. Suematsu and W. Luthe. The biological wisdom of self-regulatory mechanism of normalization in autogenic and oriental approaches in psychotherapy. Psychotherapy and Psychosomatics 25: 99-108, 1975.

885.
Ilmarinen, J., R. Ilmarinen, O. Korhonen, and M. Nurminen. Circadian variation of physiological functions and their relation to oral temperature (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. II-4.

886.
Ilmarinen, J., J. Rutenfranz, H. Kylian, und F. Klimt. Untersuchungen zur Tagesperiodik verschiedener Kreislauf- und Atemgrossen bei submaximalen und maximalen Leistungen am Fahrradergometer. Europ. J. Appl. Physiol. 34: 255-267, 1975.

887.
Indira, C. V. R., and V. Gopal. Interaction of light schedule with meal timing in the regulation of circadian variation of body temperature rhythm in the rat. Indian J. Physiol. Pharmacol. 22: 223-224, 1978.

Groups of healthy male albino rats of same age in their prepuberty stage were selected and maintained under standardized conditions. One group of rats were kept ad libitum feeding, the food being available around 24 hours during natural day light (06.00 to 18.00 hrs) and darkness (18.00 to 06.00). These rats showed a series of temperature oscillation in tune with the feeding times. From a morning-minima of 98.6° F during 02.00 to 04.00 hrs and a minima of 98.6°F during 09.00 to 11.00 hrs to a peak of 100.5° F around 19.00 to 20.00 hrs after which, it gradually came down to follow the cycle again to form a rhythm. Thus the interval between the minima and maxima extended for a fairly long period of 8 to 10 hrs. The rats kept under reversed light conditions (opposite of first group) and fed for 12 hours during artificial light (18.30 to 06.00) and kept unfed during artificial dark (06.00 to 18.00) condition; thus the light schedule was coupled simultaneously to feeding schedule. These rats showed an abrupt rise of temperature and high amplitude, shortening the maxima and minima interval to 2 to 3 hrs from a minima of 97.2°F at about 16.00 hrs to a maxima of 100.5°F at 18.00 hrs. Thus coupling of light schedule with feeding schedule seems to influence the body temperature rhythm.

888.
Inoue, K., et al. Influence of change in feeding regimen on circadian rhythm of adrenal cortical activity in rats under various lighting conditions. Nippon Naibunpi Gakkai Zasshi 53: 1054-1064, 1977.

889.
Ishibashi, T., and M. Kitagawa. Driving work and effects of sleeping time. J. Hum. Ergol. 6: 101, 1977.

890.
Ismail, A. A. A., and R. A. Harkness. Urinary testosterone excretion in men in normal and pathological conditions. Acta Endocrinol. 56: 469-480, 1967.

Urine samples were collected from 6 men every 24 hours for 14-26 days. Visual inspection of the data revealed a testosterone cycle of 4-6 and 12 days.

891.
Jackson, D. Dysrhythmia. TWA Ambassador 6: 32-33, 1973.

892.
Jacoby, J. H., E. Smith, J. Sassin, M. Greenstein, and E. D. Weitzman. Effects of sleep deprivation on the episodic release of cortisol and growth hormone in Macaca mulatta (abstract). Fed. Proc. 31: 235, 1972.

Recently we reported that plasma cortisol in Macaca mulatta is secreted episodically, with multiple major secretory episodes occurring during the latter half of the nocturnal sleep and continuing into the morning waking period (Neurology 21, 431, 1971). Growth hormone is also secreted episodically, but unlike previous findings in man, these episodes could not be correlated with the onset of sleep.

Monkeys were well acclimated to a chair on a 12 hour light-dark cycle with constant temperature and white noise. The animals were implanted with a chronic indwelling right atrial catheter and with EEG, EOG and EMG electrodes. Each monkey was subjected to sleep deprivation for 76 hours. Blood samples were obtained every 15 minutes for 12 hours beginning 4 hours prior to the termination of sleep deprivation. Following sleep deprivation there was a marked elevation of plasma cortisol concentration after sleep onset and persisting through 8 hours of recovery sleep in 3 of the 4 monkeys. The pattern of growth hormone release was unchanged.

These findings suggest that sleep deprivation may have a different hypothalamic-pituitary response for two different hormonal systems.

893.
Jensen, N. J. J. Human performance, physiological rhythms, and circadian time relations (thesis). Texas Tech. University, 1975, 199 pp.

894.
Jerison, H. J. Vigilance: biology, psychology, theory and practice. In: Vigilance Theory, Operational Performance, and Physiological Correlates, edited by R. R. Mackie. N. Y.: Plenum Press, 1977, pp.27-40.

895.
Johns, M. W., D. W. Bruce, J. P. Masterton. Psychological correlates of sleep habits reported by healthy young adults. Br. J. Med. Psychol. 47: 181-187, 1974.

896.
Johnson, D. A Relationship of Selected Biological Rhythms to Football Injuries (Ph. D. Thesis). University of Utah.

Chi square analysis was performed on the relationship between the 3 biorhythm cycles and 164 football injuries, randomly divided into two groups. A significant relationship (.05) was found between the physical biorhythm and injuries in group A but not group B. No significant relationship between football injuries and the emotional or intellectual cycles in either group. The author concludes there may be a possible relationship between football injuries and the physical injuries, but this relationship was found in only one of the two groups. Chi square analysis of the total injury population or multiple regression to detect the possible presence of cycles in the injuries would have shed more light on the claimed injury-physical biorhythm cycle relationship.

897.
Johnson, J. T., and S. Levine. Influence of water deprivation on adrenocortical rhythms. Neuroendocrinology 11: 268-273, 1973.

898.
Johnson, L. Are stages of sleep related to waking behavior? American Scientist 61: 326-338, 1973.

In this article, I would like first to review our work, and that of others, detailing some of the electrophysiological, autonomic, and endocrine activity during sleep, and second, to describe our efforts to determine whether each stage of sleep meets a unique need or has specific recuperative values. As this review will be oriented around work from our own laboratory, many areas of sleep research will not be covered - e. g. the extensive research in the areas of biochemistry, neurophysiology, and neuroanatomy (for the current status of theses and other areas of sleep research see Chase 1972).

899.
Johnson, L. C. Psychological and physiological changes following total sleep deprivation. Government Reports, Announcements (Report No. AD-737 757, 1972, 18 pp.

A review of the literature on effects of total sleep deprivation is presented. Cognitive and motor tasks of long duration, of low subject interest and without knowledge of results, are highly susceptible to the effects of sleep loss. While marked behavioural and personality changes may occur during prolonged sleep loss (after 150 hours), these changes are usually transient and disappear with sleep in subjects who were emotionally stable before onset of sleep loss. Sleep loss per se does not appear to always result in chronic psychotic behaviour. Reports of chemical and physiological changes were inconsistent and no clear cut pattern of change has been found.

900.
Johnson, L. C. The effect of total, partial, and stage sleep deprivation on EEG patterns and performance. In: Behavior and Brain Electrical Activity, edited by N. Burch and H. L. Altschuler. New York: Plenum, 1973, pp. 1-30.

901.
Johnson, L. C. Sleep loss and sleep deprivation as an operational problem. Government Reports Announcements (Report No. AD- Ao15-640/6GA)., 1974, 10 pp.

Effects of total sleep loss, partial sleep loss, and sleep stage deprivation are reviewed with particular attention to performance decrement and operational consequences. Within the 36-48 hour range of total sleep loss most likely to be experienced by aircrew personnel, no consistent or uniform performance decrement has been found in operational studies even though laboratory studies have found decrement on certain types of tasks, but marked increase in fatigue is a common problem. Sleep loss, both total and partial, tends to potentiate the circadian influence on performance and interact with other stressors to enhance the stress-induced physiological responses. Deprivation of sleep stage REM or sleep stage 4 produces no behavioural changes of operational consequence.

902.
Johnson, L. C. Sleep disturbance and performance. In: Sleep, Wakefulness and Circadian Rhythm. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development. AGARD-LS-105, 1979, pp. 8-1 - 8-17.

While the type of sleep obtained does not appear to be an important factor in performance, the time of day the sleep is obtained and when the performance occurs are very important. Time-of-day effects may be a more crucial factor in performance than the preceding sleep patterns. While the effect of total sleep loss becomes pronounced after 48 to 60 hours, consistent performance decrement following reduced sleep or fragmented sleep has not been found. Feelings of fatigue, however, are a consistent finding in all sleep-loss studies. A significant relation between sleep quality (good vs. poor sleep) and performance is not easily found. The deleterious effect of hypersomnia, especially that due to narcolepsy, has been documented.

903.
Johnson, L. C. Sleep disturbance in humans. In: Sleep, Wakefulness and Circadian Rhythm. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-LS-105, 1979, pp. 4-1 - 4-16.

Disturbed sleep results in feelings of fatigue and, usually, in impaired performance regardless of whether the disturbed sleep is due to excessive noise or a chronic sleep disorder. In addition to noise some other environmental factors that disturb sleep are temperature, unscheduled operational demands that fragment sleep time, rotating shift-work schedules, and operational requirements that result in air travel across several time zones. While appropriate attention to sleep logistics may minimize the environmental causes of disturbed sleep, resolution of the disturbed sleep of those with sleep disorders is more difficult. The focus in sleep disorders must be on the individual. The major sleep complaint is insomnia, not enough sleep, usually due to prolonged sleep latency. A more serious medical problem, however, may be the complaint of excessive daytime sleep or hypersomnia. Most patients with complaints of hypersomnia are usually diagnosed as having narcolepsy or sleep apnea. Relative to narcolopsy, sleep apnea (episodes of respiratory arrest during sleep) has only recently received attention. In addition to a sleep problem, sleep apneic patients may have hypertension and/or cardiac arrhythmia.

904.
Johnson, L. C., and W. L. Macleod. Sleep and awake behavior during gradual sleep reduction. Percept. Mot. Skills 36: 87-97, 1973.

Two young adults, 1 male and 1 female, reduced their total sleep time by 30 min. every 2 wk. from an initial 7.5 hr. to 4 hr. The 4-hr. regimen was maintained for 3 wk. and then ad lib. sleep was permitted. A third S withdrew from the study at the 4.5-hr. period. Daily sleep and nap logs reflected the difficulty in maintaining the restricted sleep schedule after the 6-hr. period. EEG sleep records indicated earlier onset of REM sleep at 5.5 hr. but there were no changes in other measures. At 4 hr., a marked increase in stages 3 and 4 was present with a decrease in REM and stage 2 sleep. Mood and performance measures showed changes beginning at the 4.4-hr. sleep regimen. Follow-up reports indicate both Ss have maintained a sleep schedule 1 to 2 hr. below their baselines.

905.
Johnson, L. C., and P. Naitoh. The Operational Consequences of Sleep Deprivation and Sleep Deficit. Neuilly-Sur-Seine, FR.: NATO, Advisory Group for Aerospace Research and Development, AGARD-AG-193, 1974, 44pp.

Effects of total sleep loss, partial sleep loss, and sleep stage deprivation are reviewed with particular attention to performance decrement and operational consequences. Within the 36-48 hour range of total sleep loss most likely to be experienced by aircrew personnel, no consistent or uniform performance decrement has been found in operational studies even though laboratory studies have found decrement on certain types of tasks. Of major importance are the type of task, the setting in which the task is to be performed, and the individual. Physiological changes are minimal during moderate sleep loss, but mood changes are clearly noticeable. The most likely sleep problems for aircrew members are those associated with disruption of sleep-wakefulness cycles and partial sleep loss. Consistent performance decrement is difficult to find, but marked increase in fatigue is a common problem. Sleep loss, both total and partial, tends to potentiate the circadian influence on performance and interact with other stressors to enhance the stress-induced physiological responses. Deprivation of sleep stage REM or sleep stage 4 produces no behavioral changes supportive of earlier beliefs that these two stages, especially stage REM, were necessary for effective waking behavior.

906.
Johnson, L., P.L. Naitoh, A. Lubin, and J. Moses. Sleep stages and performance. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep, edited by W. P. Colquhoun. Proc. of a symposium, Strasbourg, Fr., 1970. London: English Univ. Press, 1972, pp. 81-100.

907.
Johnson, L. C., P. Naitoh, J. M. Moses, and A. Lubin. Variations in sleep schedules. Waking and Sleeping 1: 133-137, 1977.

908.
Johnson, L. C., H. L. Williams, J. A. Stern. Motivation, cognition, and sleep work factors: central and autonomic nervous system indices. Repr. from Human Factors in Long Duration Space Flight. Washington: Natl. Acad. of Sci., Rpt. #NMRU-72-13, 1972, pp. 108-130.

Possible problems for human performance in relation to three factors, motivation, cognition, and sleep, are discussed. Of particular concern in the discussion are possible alterations in cycles of sleeping and waking, and in physiological patterns of sleep and the potential effects of such changes on vigilance, memory, problem solving, and motivation. An attempt is also made to anticipate the effects of prolonged spaceflights on the central and autonomic nervous systems.

909.
Johnson, P. C., W. R. Carpenter, T. B. Driscoll, C. K. LaPinta, J. A. Rummel, and C. F. Sawin. Passenger fluid volumes measured before and after a prolonged commercial jet flight. Aerosp. Med. 43: 6-7, 1972.

Interstitial and intracellular fluid volumes were calculated from measured plasma volume, extracellular volume and total body water of six subjects before and after a 24-hour commercial overseas flighty. No change occurred in these spaces or in peripheral hematocrit or total serum protein concentration. The subjective feeling of dehydration and the actual swelling of the lower extremities characteristically found among passengers at the end of a long trip of this type seems to represent a shift in body fluids to the dependent portions of the body rather than water retention or a decrease in the intravascular water volume.

910.
Johnsson, A., and J. M. Froberg. Work schedules and biological clocks. Ambio. 4: 46-50, 1975.

The relationship between internal, 24-hour rhythms (so-called biological clocks) and external work schedules is now attracting increased attention. The article gives a brief survey of the field. Lowered performance and other difficulties for the individual occur when the internal rhythms, normally synchronized to the rhythms of the society, experience a change of the external working conditions. Such a change is imposed on persons who should work after a jet flight across time zones or on shift workers. These changing working conditions and their effects on body and mental functions are surveyed. Some fields which urgently need to be investigated are listed.

911.
Jones, B. J. The Effects of Fifty-three Hours of Continuous Wakefulness on the Performance of Balance, Strength, and Psychomotor Tasks by College Females (thesis). Florida State University, 1972, 116 pp.

An investigation of performances of selected tasks during a period of prolonged wakefulness was conducted. The tests utilized were as follows: One Foot Lengthwise Balance Test for static balance, Maximal Grip Strength Test for static strength, Vertical Jump Test for auditory reaction time, and Purdue Pegboard Both-Hands Test for finger dexterity. Also included were three paper-pencil tests: Large Tapping Test for wrist-finger speed, Pursuit Aiming Test for coordination, and Minnesota Clerical Number Comparison Test for perception.

Female college undergraduates volunteered to particiate. The experimental group subjects (N=10) remained awake for fifty-three continuous hours while the control group subjects (N=10) followed their normal living routines. The subjects were familiarized with tests and procedures prior to the actual testing periods. All subjects were tested at twelve-hour intervals beginning at 12:00 n. on Friday and ending at 12:00 n. on Sunday. Experimental group subjects also took the tests at 6:00 a.m. on Saturday and Sunday and at 6:00 p.m. on Saturday.

912.
Jones, B. M., Circadian variation in the effects of alcohol on cognitive performance. Quart. J. Stud. Alcohol 35: 1212-1219, 1974.

Alcohol impaired cognitive performance more when subjects were tested in the afternoon than it did in the evening; the alcohol metabolism rate was also faster in the afternoon.

913.
Jones, G. M. Some aviation medical aspects of flight crew fatigue. Ottawa, Ontario: Defence Research Board. DRS Aviation Med. Res. Unit Rept. 1: 158-170, 1971.

Quantitative measurements on the time course of decrement in skilled pilot performance for a specific environment as a result of performing that task are reported. Numerical data specify how decrement takes place, and on the basis of results obtained from an adequately representative population it is possible to predict the human operator function and to set time limits for the particular circumstances of the specific conditions. It is shown that subjective changes go hand in hand with objectively demonstrated performance decay. Sensible criteria for rest periods, aircrew accomodations in low noise environments, physiological observations of body responses are all measures to control operator fatigue.

914.
Jones, J. K., L. L. Graves, and J. R. Bradford. University interdisciplinary research panel. Conf. Military Requirements for Research on Continuous Operations (Human Engineering Labs), Lubbock, TX., 1971, pp. 20-38.

915.
Jones, W. L. Habitability in long-duration space missions. Environ. Biol. Med. 2: 29-45, 1973.

916.
Jouvet, M., J. Mouret, G. Chouvet, and M. Siffre. Towards a 48 hour day in man. In: The Neurosciences - Third Study Program, edited by F.O. Schmitt and F.G. Worden. Cambridge, Mass.: MIT Press, 1974, pp. 491-497.

917.
Jovanovic, U. J. The sleep waking cycle in healthy test subjects. Waking and Sleeping 1: 7-26, 1976.

918.
Jovanovic, U. J. Chronobiologic aspects of psychiatry. Waking and Sleeping 1: 335-341, 1977.

Our own experiences and those of other authors are discussed with respect to the infradian, circadian and ultradian biorhythm in schizophrenic manic-depressive, exogenous-psychotic and neurotic patients. A consequence of the results is the newly founded Center for Chronomedicine which enables a simultaneous control of all diagnostic and therapeutic approaches in psychic, psycho-psychic, psycho-somatic and somato-psychic patients.

919.
Jovanovic, U. J. Chronobiology and sleep-waking-cycle. Waking and Sleeping 1: 225-226, 1977.

920.
Juro, E. How transit firms cut crash risks. Pittsburgh Press., April 28, 1964.

921.
Kallina, H. Ergebnis einer Prufung des Einflusses des sog. Biorhythmus auf Unfalldisponiertheit. (Results of test of the influence of so-called biorhythms on accident disposition). Die Med. Welt 27: 1423-1424, 1961.

From birth-dates of 100 drivers who caused accidents, the Austrian Society for Biorhythm calculated biorhythm phases; the authors then correlated expected and actual frequency distributions of accidents and found that there were no significant differences; they concluded that there was no influence of biorhythm phases on the disposition to cause an accident.

922.
Kamimura, K., and A. Endo. Diurnal rhythm of body temperature in night-shift workers. Jap. J. Hyg. 24: 497-501, 1970.

Ten employees working in three shifts at an iron foundry were under survey. Workers were engaged in each shift for five days. Diurnal change of the sublingual temperature was determined for a successive 20 days in summer as well as in winter. Regardless of season, diurnal change of body temperature in workers on the first shift (7:30-15:30) revealed a similar pattern to that of men in an ordinary routine. In the second (15:30-22) and the third (22:30-7:30) shifts, however, body temperatures rose at night. Body temperature was higher at 7 a. m. on the third shift, compared to other shifts. It was subsequently striking that an amplitude of the diurnal change was narrow in this shift. Under the circumstances, there were some working for more than 8 years, whose body temperature was lower in the afternoon than in the morning. It can therefore be inferred that biological rhythm is lower in the afternoon than in the morning. It can therefore be inferred that biological rhythm is prone to synchronize with the rhythmic pattern of the mode of living of these particular workers. For the most part, however, no inversion of the rhythmic change was seen on night-shift work. On each shift, the mean temperature on a day tended to be higher in summer than in winter, and, especially, a significant difference between seasons was observed on the third shift. In its mean and variance, an amplitude of diurnal change had the tendency to lessen on the third shift compared to other shifts regardless of season.

923.
Kapen, S., R. M. Boyar, J. W. Finkelstein, L. Hellman, and E. D. Weitzman. Effect of sleep-wake cycle reversal on luteinizing hormone secretory pattern in puberty. J. Clin. Endocrinol Metab. 39: 293-299, 1974.

924.
Kapen, S., R. M. Boyar, L. Hellman, and E. D. Weitzman. The relationship of LH secretion to sleep in women during the early follicular phase: effects of sleep reversal and a 3-hour ultradian sleep-wake rhythm (abstract). Sleep Res. 3: 169, 1974.

925.
Kapen, S., R. M. Boyar, L. Hellman, E. D. Weitzman. The relationship of luteinizing hormone secretion to sleep in women during the early follicular phase: efects of sleep reversal and a prolonged three-hour sleep-wake schedule. J. Clin. Endocrinol. Metab. 42: 1031-1040, 1976.

926.
Karacan, I., et al. The effect of caffeinated and de-caffeinated coffee on nocturnal sleep in young adult males (abstract). Sleep Res. 2: 64, 1973.

927.
Karcher, A. Biorhythmikdokumentation zur Biorhythmik-Tagung. (Biorhythmic documentation to the biorhythm day). Boblingen, Sept. 12-15, 1975.

928.
Karcher, A. Biorhythmic-Wiederentdeckung und Bestatigung der Fliess'schen Periodenlehre. (Biorhythmic rediscovery and verification of the Fliess' periodic theory). Paper presented at the Interdisciplinary Cycle Research Symposium, 7th Germany, 1976.

The author recorded his physical condition for 4 years. Out of 1461 days he was in poor physical condition on 59 of which 43 or 79% occurred on physical or emotional critical biorhythm critical days (27% expected by chance). Since the author apparently was aware of biorhythm theory, the possibility of psychosomatic illness induced by suggestibility form biorhythm awareness cannot be ruled out here.

929.
Karpov, Y., and V. Bodrov. Rezhim Truda i Otdykha Kosmonavtov. (The work and rest regime of cosmonauts.) Aviatsiya i Kosmonavtika 5: 38-39, 1973. (transl. in Engl. by NASA, NASA TT F-14, 990., 1973.)

The cosmonauts work-rest regime is discussed as a major problem to be overcome in spaceflight. The authors cite the essential phytclogical and physiological problems encountered (disruptions of the sleep-wakefulness cycle, poor quality sleep, loss of appetite) and possible ways to overcome them. They provide a chart for a crew regime for crews consisting in various numbers of persons. They state that the schedule in the chart does not provide optimum results.

930.
Kass, D. A., F. M. Sulzman, C. A. Fuller, and M. C. Moore-Ede. Interrelationship of ultradian and circadian periodicities in excretion (abstract). Fed. Proc. 37: 832, 1978.

931.
Katz, S. Biorhythm: guide to life or a fad for "numerical nuts". The Toronto Star, p. A3, April 2, 1977.

932.
Kawakami, M., K. Seto, and F. Kimura. Influence of repeated immobilization stress upon the circadian rhythmicity of adrenocorticoid biosynthesis. Neuroendocrinology 9: 207-214, 1972.

Experiments were carried out to elucidate the influence of stress on the diurnal change in adrenal biosynthetic activity during controlled 24 h light-dark cycles. Groups of 10 rabbits were decapitated at 3 h intervals and the adrenal glands were rapidly removed for measurement of incorporation of ^{14}C-1 acetate into corticosterone and 17-hydroxycorticosterone in their homogenates. Immobilization stress was applied for 6 h a day. The influence of repeated stress was studied in the rabbits after exposure to 7 immobilization stresses. A diurnal rhythm was observed in the activity of adrenocorticoid biosynthesis in non-stressed ribbits, with a maximum of 18:00 and a minimum at midnight. When the animals were exposed to 6 h of immobilization, the adrenocortical biosynthetic activity showed an 80% increase at 3 h and a 40% increase at 6 h; the normal rhythmicity was thus disturbed by exposure to this stressor. The lowest level was observed at 9:00 on the next morning, with a 9 h delay. Where rabbits were repeatedly exposed to immobilization for 7 days, the 7th immobilization did not affect the diurnal rhythmicity of adrenal biosynthetic activity or induce its facilitation.

933.
Kawamura, H., and N. Ibuka. The search for circadian rhythm pacemakers in the light of lesion experiments. Chronobiologia 5: 69-88, 1978.

934.
Keating, R. J., and R. K. Tcholakian. In vivo patterns of circulating steroids in adult male rats. I. Variations in Testosterone during 24- and 48-hour standard and reverse light/dark cycles. Endocrinology 104: 184-188, 1979.

The in vivo pattern of circulating testosterone (T) was investigated in unrestrained, conscious, individual male rats during 24 and 48 h. Each rat exhibited its own characteristic in vivo diurnal rhythm. When these individual patterns of T were grouped, the mean values also showed a diurnal rhythm. Although T concentrations peaked during the dark and light periods, the most pronounced elevations were observed during the dark periods (2200-2330 h). Lowest T concentrations were noted during the late dark and early light hours (0400-0700 h). The pattern of T was further investigated by extending the experimental period to 48 h. The pattern of T observed during the first 24 h repeated itself on the second day, thus demonstrating the authenticity of this diurnal rhythm. Rats were exposed to a reversed light/dark regimen which resulted in an inversion of the rhythm of circulating T. These data indicate that the pattern of circulating T is not intrinsically regulated.

935.
Keesey, R. F. , and T. L. Powley. Hypothalamic regulation of body weight. Am. Sci.: 63: 558, 1979.

936.
Keil, T. U. Chronotherapy: unused opportunities. Muench Med. Wochenschr. 120: 880-881, 1978.

937.
K nedy, R. S., and R. A. Bruns. Some practical considerations for p rmance testing in exotic environments. In: Higher Mental Functioning in Op ational Environments, edited by B. O. Hartman. Neuilly-Sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-181, 1976, pp. C4-1 - C4-6.

Correlations and normative data for six different versions of an auditory vigilance task are presented for approximately 100 college graduate males each. In addition, other findings about effects on performances of (a) practice, (b) distractions, (c) threat stress, and (4) aircraft turbulence are discussed. Instructions for apparatus construction, scoring, and administration are reported.

938.
Kerkhof, G. A., H. J. Korving, H. M. M. Willemse, V. D. Geest. Diurnal differences between norning-type and evening-type subjects (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. VIII-4.

939.
Kerkhof, G. A., H. J. Korving, V. D. Willemse, H. M. M. Geest, W. J. Rietveld. Diurnal differences between morning-type and evening-type subjects in self-rated alertness, body temperature, and the visual and auditory evoked potential. Neurosci. Lett. 16: 11-15, 1980.

On the basis of their score on a morningness/eveningness questionnaire 9 extreme morning-type (M-type) and 9 extreme evening-type (E-type) subjects were selected. During a morning and an evening session both groups performed a reaction-time task with a visual and an auditory warning signal. The results showed the (i) M-types have a higher self-rated activation level in the morning than in the evening, while E-types show the reverse; (ii) M-types do not differ in oral temperature between the two sessions, while E-types show an increased temperature in the evening; (iii) M-types have a larger N1-P2 amplitude of the visual and auditory AEP in the morning than in the evening, while E-types show the reverse.

940.
Kess, E., Aktivitatzeit, Zeitschatzung, subjektive vigilanz and akustische Reaktionzeit bei frei laufender Circadian rhythmik unter Zeitgeberausschluss. (Ph.D. Dissertation), Marburg, Germany, 1972.

941.
Khaleque, A., and P. Verhaegen. Circadian effects in short cycled repetitive work in a two shift system. In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. VII-7.

The work activity of 15 high and 12 low performance cigar making machine operators was studied. The number and duration of machine stoppages were registered with a precision of 0.1 s during an entire morning (6-14 h) and an entire afternoon (14-22 h) shift. Low performance workers stop their machines nearly 3 times more and 2 times longer than high performance workers. In the high performance group the number of stoppages and still more their duration display a circadian variation. This is not the case in the low performance group. This difference may be explained by assuming that high performance subjects are almost always functioning at their maximum capacities. Other data supporting this explanation are briefly discussed.

942.
Khalil, T. M., and C. N. Kurucz. The influence of "biorhythm" on accident occurrence and performance. Ergonomics 20: 389-398, 1977.

The authors studied 63 FAA aircraft accidents with pilot at fault, 105 unscreened death dates from the Alachua County Health Dept., 181 traffic accidents with driver at fault from the State Public Safety Dept., worst and best performance event times for 23 college swimmers, and 12-16 weekly bowling scores from 25 student/faculty bowlers in relation to the three biorhythm cycles coded to phase (low = -3, high = +3). Frequencies of observed and expected events or performances were analyzed by chi square. Out of 12 single event categories (aircraft accident, auto accident, death dates, total events for each of 3 biorhythm cycles), only one showed a significant difference (auto accident, intellectual critical). No significant differences were obtained between expected and observed event frequencies and biorhythm phases or combination of biorhythm phases. Swimming performance levels were opposite of biorhythm theory prediction (e.g., high performance, low physical cycle) but no significant differences were obtained between expected and observed event frequencies and biorhythm phases or phase combinations. No significant differences were obtained between bolwing scores and biorhythm phases or combination of phases. The authors conclude that no evidence obtained in this study favors the biorhythm theory. Previously obtained favorable results may have resulted from psychological factors (e.g., suggestion).
Note: selection of only best and worst swimming performances represents a biased statistical sample.

943.
Khoe, W. H. Treatment of jet lag syndrome by acupuncture. Am. J. Acupuncture, 6: 135-137, 1978.

Jet lag, meaning the disruption of circadian daily rhythm, is by now a recognized air travel syndrome that tourists, business executives and government officials alike must confront when flying across more than a few time zones. The most familiar rhythm is sleep and wakefulness. But the body has many biological "clocks," some daily, some on other schedules. Body temperature, the digestive process, the liver, and secretions of hormones such as adrenalin all have their own timetables. Some rhythms are triggered by external signals such as the dark-light cycle; others are triggered internally. So complex is the problem, it appears unlikely that medical science will soon devise an effective drug to stave off or redress jet lag. However, it was found that a few well-chosen acupuncture points will cause 90% of the patients suffering from jet lag to become asymptomatic within 5 to 10 minutes after a brief treatment, while the remaining 10% of patients will invariably lose all their symptoms within 24 hours.

944
Khokhlova, O. S., Investigation of the state of human lipid metabolism in sealed chambers. Kosm. Biol. Aviakosm. Med. 8(3): 69-73, 1974.

A study was made of lipid metabolism (the content of total lipids, total, esterified and free cholesterol and the percentage of its esterification, the content of phosphorus and phospholipids, percentate of α- and β-lipoproteins) in the blood serum of 16 healthy male subjects in the age group 23-24 years. The test subjects were confined to pressurized chambers and consumed diets designed for one-month space missions. These conditions did not bring about noticeable changes in the mentioned parameters of lipid metabolism. An altered diurnal rhythm caused a significant increase in the content of total lipids, cholesterol and beta-lipoproteins.

945.
Kidera, G. Does anybody know what time it is? Mainliner: 152, 1978.

946.
Kiesswetter, E., P. Knauth, R. Weirer, W. Theissen, and J. Rutenfranz. Reentrainment of rectal temperature and heart frequency during days with experimental night shifts and morning or afternoon sleep (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. II-5.

947.
Kihlstrom, J. E. A monthly variation in beard growth in one man. Life Sci. 10, part II: 321-324, 1971.

Beard growth was measured in one man for 6 months. Serial chi square analysis revealed a significant 33 day period. This study is limited by the use of one subject and the lack of periodicity analysis which might have revealed the extent of variability in the period.

948.
Kikuchi, M., M. Katayama, S. Tsukidate, and K. Fujita. Influence of phase shift in light-dark cycle on immune response of mice (abstract). Int. J. Biometeorol. 243: 168, 1979.

We have reported that primary immunization with sheep red blood cells on the 4th day after inversion of light-dark cycle caused a marked suppression of circulating antibody level in mice, antibody production being suppressed only in the initial phase of immune response. In the present study secondary immune response after inversion of the lighting regimen was observed. Materials and methods were similar as that of previous report. Seven days after the primary immunization with sheep red blood cells ($6.6x10^7$/gBW) the secondary immunization (3.3x107/gBW) was carried out, and the time course of the immune response thereafter was investigated by hemagglutination reaction, hemolytic reaction and number of plaque forming cells in the spleen. The results indicate that light-inversion exerts little influence on the immune response after secondary immunization. By treatment of the serum with 2-mercaptoethanol it was revealed tht 19S antibody, not 7S was suppressed after the inversion of light-dark cycle in the primary immunization.

949.
Kimball, K. A., and D. B. Anderson. Aviator performance: biochemical, physiological, and psychological assessment of pilots during extended helicopter flight. In: The Role of the Clinical Laboratory in Aerospace Medicine, edited by R. G. Roxler. Neuilly-Sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-180, 1976, pp. A8-1 - A8-15.

This investigation was conducted to provide information on the psychological and performance effects of extended helicopter flight. Measurements of biochemical, physiological and psychological parameters were obtained and compared with inflight performance measures obtained by the USAARL Helicopter Inflight Monitoring System. Six rotary wing aviators performed extended daily flight missions for a period of five days. In addition, when not flying, various psychological tests were administered. Physiological and biochemical monitoring were conducted throughout the five day period. Ss were on a controlled diet and slept approximately three hours each night. This paper presents preliminary findings with regard to performance, biochemical, physiological and psychological parameters.

950.
Kitay, D. S. Workload and aviation safety. Presentation to the Aerospace Medical Association, Washington D.C., 1979, 14 pp.

951.
Kjellander, C. G. Skiftgang vallar problem: storsatsning pa utbildning. (Health care in a large company: shiftwork causes problems.) Lakartioningen 72: 3632-3634, 1975.

952.
Kjellberg, A. Effects of sleep deprivation on performance of a problem-solving task. Psychol. Rep. 37: 479-485, 1975.

The effects of sleep deprivation on problem-solving performance was tested. It was hypothesized that sleep deprivation could affect this kind of performance by lowering S's standard of performance, provided that the task was such that S found failures acceptable. S would then spend less time on task and leave more items unsolved. In two experiments one group informed that there were insoluble items was compared with a group who did not get this information. The results from Exp. 1 indicated a lowered standard of performance in both groups after sleep deprivation. This was interpreted as a result of the extreme difficulty of the task was made easier and only the group who knew about the insoluble items spent less time on the task after deprivation.

953.
Kjellberg, A. Sleep deprivation and some aspects of performance: I. problems of arousal changes. Waking and Sleeping 1: 139-143, 1977.

The aim of the author's three papers (see also the next two abstracts) is to provide a theoretical framework within which the performance effects of sleep deprivation (SD) can be interpreted. Primarily, the possibilities and limitation of interpretations in terms of dearousal are evaluated. An interactional view of the relation between SD and arousal is proposed, implicating that the effect of SD is to potentiate the dearousing effect of situational variables. The habituation of the orienting response is suggested as one possible mediator of this effect. The reported attentional effects of SD are shown to be interpretable within this framework. The effects of motivational factors on the SD effects the SD effect on motivation are discussed, leading to the conclusion that habituation cannot be the only mediator of the dearousing influence of the situation, and that an analysis in operant terms must be added. Furthermore, the motivational effects of SD demonstrate the limitations of the present arousal analysis of the effects. The implications for future SD research are discussed.

954.
Kjellberg, A. Sleep deprivation and some aspects of performance: II. Lapses and other attentional effects. Waking and Sleeping 1: 145-148, 1977.

In the first part of the author's review he has discussed the problems of arousal, arousal changes, physiological, behavioral and subjective effects of sleep deprivation. There, theoretical points of view of sleep deprivation has been explained. At the end of the paper he has tried to comment on the above mentioned problems and to draw conclusions from the material obtained. This part deals with the problems of lapses, the lapse hypothesis and some other attentional effects of sleep deprivation. In the next article he passes on the motivation in connection with sleep deprivation.

955.
Kjellberg, A. Sleep deprivation and some aspects of performance: III. motivation, comment and conclusions. Waking and Sleeping 1: 149-195, 1977.

While in the first part of the author's review the problem of arousal and arousal changes after sleep deprivation have been discussed, the second part has dealt with lapses and other attentional effects. The present part reviews the problems of motivation and performance in connection with sleep deprivation. All three parts of the review are commented and conclusions are drawn from the complete material. The references for all three parts are given.

956.
Kjellberg, A. Sleep deprivation, arousal, and performance. In: Vigilance Theory, Operational Performance, and Physiological Correlates, edited by R. R. Mackie. New York: Plenum Press, 1977, pp. 529-535.

The aim of this paper is to provide a theoretical framework within which the performance effects of sleep deprivation (SD) can be interpreted. Primarily, the possibilities and limitations of interpretations in terms of dearousal are evaluated. An interactional view of the relation between SD and arousal is proposed, suggesting that the effect of SD is to potentiate the dearousing effect of situational variables. The habituation of the orienting response is suggested as one possible mediator of this effect. The reported performance effects of SD are shown to be interpretable within this framework. The effects of motivational factors on the SD effects and the SD effect on motivation are discussed, leading to the conclusion that habituation cannot be the only mediator of the dearousing influence of the situation, and that an analysis in operant terms must be added.

957.
Klein, K. E. Prediction of flight safety hazards from drug induced performance decrements with alcohol as reference substance. Aerosp. Med. 43: 1207-1214, 1972.

958.
Klein, K. E. The prediction of flight safety hazards from drug induced performance decrements with alcohol as reference substance. In: In Use of Medication and Drugs in Flying Personnel. NATO, Advisory Group for Aerospace Research & Development, AGARD-CP-108, 1972, pp. A9-1 - A9-12.

A modification of CNS activity resulting in a decrement of performance is the most unwanted side effect of drugs in active flying personnel. To make use of the benefits of neuro-pharmacological agents for crew members, or estimate the hazard of drug self-administration it is necessary to predict the maximum allowable concentrations compatible with flight safety. This is usually done from laboratory experiments; however, different laboratories using different techniques often come to divergent results. Moreover, there is practically no change that these results will ever be validated in terms of a dose-hazard-relationship derived from operational conditions. It is consequently desirable to introduce a reference substance for which a quantitative validation of its operational meaning has already been made. Such a substance is ethanol. - Therefore a procedure is described where hazard prediction is accomplished with ethanol as reference substance through the following steps: (a) Evaluation of dose-effect-relationship for ethanol with the performance test to be applied in toxicological drug studies; (b) Examination of drugs with the "alcohol calibrated" test method; estimation of the alcohol intoxication level equipotential in its performance decrement to the drug-dose studied ("alcohol-equivalent); definition of the operational significance of the drug induced performance changes by reference to the intoxication-hazard-relationship established for alcohol; prediction of the "critical" drug-dose through extrapolation. - The technique is applicable to quantitative test methods; it allows a direct comparison of toxicological studies performed with different methods. - Results with sedative, neuroleptic, tranquilizing and stimulating drugs are demonstrated and the advantage and limitations of the reference procedure discussed.

959.
Klein, K. E. Current scientific papers from the Aerospace Medical Institute. Deutsch Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Bad Godesberg (West Germany): Report No. DLR-FB-73-15, 1973, 253 pp.

Results of experimental research are reported. The following topics are dealt with: selection and work load of air crews, effects of transmeridian flights on circadian rhythms, vibrations, acceleration, and weightlessness, effects, and hyperbaric and underwater medicine and technology.

960.
Klein, K. E. The resynchronization of dian performance rhythms following transmeridian flights -- observed in two groups of students. Aktuelle Forschungsarle, aus dem Inst. fuer Flugmed., 1973, pp. 117-132. (English Translation - Paris: European Space Agency. In: Current Res. Work at the Inst. for Aerospace Med., 1974, pp. 123-139.).

The phase shifts in diurnal performance rhythms were observed in two groups of 8 students after transmeridian flights. It was found that the phase resynchronization takes between 4 to 5 days, and is of an exponential character. Its speed is determined by the following factors: the direction of the flight (west-east resynchronization took longer than vice-versa), the nature of the tested biologic functions, and activity modes of the subject after the flight.

961.
Klein, K. E. Spacelab and beyond - Bioscience problems in the use of space. Deutscher Luft- und Raumfahrtkongress, Darmstadt, West Germany: DGLR Paper 78-129, 1978, 23 pp.

The paper defines some of the new goals for bioscience research in view of man's entering upon a stage of utilization of space. There is need for studies on the mechanisms of disturbance factors in space: development of protective and auxillary equipment for long stays in space and readjustment to terrestrial conditions; and research into techniques for production of biological material in space. The new type of astronaut will be the payload expert, performing medical and psychological experiments in space.

962.
Klein, K. E., H. Bruner, E. Gunther, D. Jovy, J. Mertens, A. Rimpler, and H. M. Wegmann. Psychological and physiological changes caused by desychronization following transzonal air travel. In: Aspects of Human Efficiency: Diurnal rhythm and loss of sleep. (Proc. of the Symposium, Strasbourg, FR, 1970) Edited by W.P. Colquhoun. London: English Universities Press, 1972, pp. 295-305.

963.
Klein, K. E., H. Bruner, H. Holtmann, H. Rehme, J. Stolze, W. D. Steinfoff, and H. M. Wegmann. Circadian rhythm of pilots' efficiency and effects of multiple time zone travel. Aerosp. Med. 41: 125-132, 1970.

964.
Klein, K. E., R. Herrmann, P. Kuklinski, and H. M. Wegmann. Circadian performance rhythms: Experimental studies in air operations. In: Vigilance: Theory, Operational Performance and Physiological Correlates, edited by R. R. Mackie, New York: Plenum Press, 1977, pp. 111-132.

The significance of circadian performance rhythms in air operations is discussed. This is done mainly by presenting results from seven experimental studies in which behavioural and physiological variables were evaluated before and after transmeridian flights.

In general, performance was assessed every second post-flight day in three hourly intervals round the clock. Between midnight and 0900 hours subjects were allowed to sleep but were aroused twice for testing for a period of 45 minutes. In all but one study eight healthy male students in the range of 23 to 28 years of age served as subjects; in one experiment ten pilots participated in flight simulator tests.

The results confirmed the idea that alertness, or the readiness to be mentally active, belongs to these biological properties of the living organism which are subject to circadian variation. This rhythm persists after transmeridian flights and is de- and resynchronized with with the environmental time cues similar to other biological cycles. It so happens that a low performance output temporarily occurs in the local daylight phase instead of, as usual, during the dark phase. Results given in the pertinent literature reveal an alternating effect on performance of operationally induced fatigue and the circadian rhythm; this interference is of operational significance. Recommendations are given for flight scheduling considering circadian rhythm effects.

965.
Klein, K. E., and H. M. Wagmann. Die Resynchronization dianer Leistungs rhythmen nach transmeridianen Flugen. (The resynchronization of dian performance rhythms following transmeridian flights - observed in two groups of students). Bon-Bad Godesberg: Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt. Institute fur Flugmedizin, DLR-FB 73-15, 1973, p. 117-132. (transl. in Engl. by European Space Research Organisation, ERSO-TT-35, p. 123-139, 1974.)

The phase shifts in diurnal performance rhythms were observed in two groups of 8 students after transmeridian flights. It was found that the phase resynchronization takes between 4 to 5 days, and is of an exponential character. Its speed is determined by the following factors: the direction of the flight (west-east resynchronization took longer than vice-versa), the nature of the tested biologic functions, and activity modes of the subject after the flight.

966.
Klein, K. E., and H. Wegmann. The resynchronization of human circadian rhythms after transmeridian flights as a result of flight direction and mode of activity. In: Chronobiology, edited by L. E. Scheving, F. Halberg and J. Pauly. Tokyo: Igaku Shoin, Ltd., 1974, pp. 564-570.

Translongitudinal air travel is followed by an instant desynchronization of human circadian rhythm and periodic time cues in the environment. The abnormal phase relationship involves physiological and psychological processes. Times given in literature for the normalization of dysrhythmic changes are discordant, and experiments conducted in the more recent past have also failed to reveal consistent trends in human response pattern.

Flight direction, number of time zones crossed, specific nature of biological functions, stress of travelling and the mode of post-flight activity are factors which have been said to influence intensity and duration of sysrhythmic symptoms. However, so far we are still lacking data showing the exact time course of circadian rhythms resynchronization under the different conditions. Therefore, from the data of transatlantic flight studies we have computed the postflight course of adaptation of body temperature and performance rhythm as it was observed with differences in flight direction (East versus West) and mode of activity (indoor versus outdoor).

967
Klein, K, E., and H. M. Wegnamm. Das Verhalten des menschlichen Organismus beim Zeitzonenflug. 1. Die circadiane Rhythmik und ihre Desynchronization 2. Die Folgen der Desynchronization. Fortschr. Med. 93: 1407-1414, 1497-1502, 1975.

The responses of the human organism to time zone flights are reviewed. The physical and biological principles which are connected with dysrhythmic phenomena following shifts of environmental time cues are demonstrated. Quantity and quality of desynchronotic symptoms of psychophysiological functions are described and their significance for performance ability and health of the air traveler, in particular with respect to the possibility of pathogeneous effects, are discussed.

Indications are given for a chronobiologically appropriate behavior and prophylactic measures for the prevention of dysrhythmic symptoms are presented.

968.
Klein, K. E., and H. M. Wegmann. Das Verhalten des menschlichen Organismus beim Langstreckenflug uber mehrere Zeitzonen (The behavior of the human organism in long distance flights over many time zones). Der Kassenarzt 23: 4280-4290, 1977.

Daily biological rhythms are disturbed in long distance flights over many time zones. This results in the endogenous rhythm not being able to follow the sudden change of environemental periodicity with the same speed. The inner clock precedes a western flight and follows an eastern flight; it is desynchronized with reference to the Zeitgeber of external conditions. Body functions and behavior are concerned with these changes. There can be transient changes in hormone secretion and body temperature aand deviations in performance capability to unusual times of day and indications of sleep disturbances. The length and extent of desynchronization depends upon different factors such as the number of time zones crossed, the direction of flight, postshift behavior, individual adaptability and, in this connection, age and personality. The transposition to the new destination results in a dissociation of biological rhythms in these different bodily functions which are carried out with different rates of change: noradrenaline, adrenaline and the 7-hydroxycorticosteroid, which need, on the average, from 3.5 to 11 days to normalize after a flight across 6 time zones.

The resynchronization of the circadian rhythm after time zone flights is a physiological adaptation process to the altered envirnoment. Residual detrimental consequences have not been found. There is therefore no specific contraindication. It should be considered that the time zone change presents an additional stress for the organism which can be of importance for all patients and older passengers.

969.
Klein, K. E., and H. M. Wegmann. The "biorhythm" theory. In: Sleep, Wakefulness and Circadian Rhythm. Neuilly-Sur-Seine: NATO, Advisory Group for Aerospace Research and Development AGARD-LS-105, pp. 2-10 to 2-17, 1979.

The authors provide a short but excellent review of the biorhythm theory from a scientific point of view. The point out that the biorhythm theory was commercialized before it had been tested seriously for its biological and mathematical foundations and cite summaries from 15 investigative papers which refute claims of biorhythm proponents that biorhythm cycles can be used to predict performance and reduce accidents. Reported successful application of biorhythm theory to accident reduction is criticized as possibly resulting from the power of suggestion in people who believe in the method. The suggestion that biorhythm theory could be used to reduce accidents in flying personnel is potentially dangerous: "It could bring about a psychosis by association that, indeed, might make pilots reluctant to fly on a critical day, especially a multiply critical day".

970
Klein, K. E., and H. M. Wegmann. Circadian rhythms in air operations. In: Sleep, Wakefulness and Circadian Rhythm. Neuilly-Sur-Seine: NATO, Advisory Group for Aerospace Research and Development AGARD-LS-105, 1979, pp. 10-1 - 10-25.

After a brief introduction into the principles of environmental and biological timing systems, the phenomenology of post-transmeridian de- and resynchronization of circadian rhythms is presented, its control and modification through external and internal factors described, and the consequences for human efficiency and health discussed. There are conclusions drawn as to possible relief measures, and formulas and models reviewed which try to define the physiological processes and predict work loads occurring in transmeridian flight operations. Finally, the incorporation of circadian rhythm's aspects into rest/duty regulations is described.

971.
Klein, K. E., and H. M. Wegmann. Circadian rhythms of human performance and rpesistance: operational aspects. In: Sleep, Wakefulness and Circadian Rhythm. Neuilly-Sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-LS-105, 1979, pp. 2-1 - 2-17.

972.
Klein, K. E., H. M. Wegmann, G. Athanassenas, H. Hohlweck, and P. Kuklinski. Air operations and circadian performance rhythms. Aviat. Space Environ. Med. 47: 221-230, 1976.

This paper reviews experimental results and pertinent data from the literature on circadian behavioural rhythms and their modifications through various factors, including many of the authors own studies. If time zones are crossed, waking activity is imposed on circadian sleep time. Thus, the natural depression of alertness transiently coincides with the high demand of the operator's mental functioning during the day. At the same time, subjective experiences of travelers on time zone flights show a general degradation of performance efficiency as a consequence of circadian desynchronization. The circadian effect upon performance levels is then reviewed. The range of oscillation in performance rhythms is between 12 and 25% of the 24 hr. mean. The task load also determines size and significiance of circadian performance oscillations. Pilots with higher performance levels in a flight simulator were also those with smaller circadian amplitudes. Practice results in circadian mean increases while the amplitude decreases. Motivation may reduce amplitude through "extra effort". Performance maxima and minima occur at different times in the circadian cycle in extraverts (evening types) and introverts (morning types). The sleep-wake cycle modifies the rhythm so that nocturnal performance decrement is less pronounced if subjects in the laboratory are kept awake instead of aroused for testing. Transmeridian flights result in reduced rhythm amplitude and often reduced 24 hr. means in performance. Significant performance degredation occurs at one part of the day but overall significant performance decrements occurs after east-bound travel. These results, otained from passengers, imply that performance changes in aircrews, subject to fatigue, could be even greater. Amount of performance decrement and duration of rephasal is proportional to the number of time zones crossed. Differences between east and west bound travel are not due to scheduling since variation in waking periods does not affect the course of de and re-synchronization as long as a sleep period of normal length precedes the following duty period. About 25-30% of transmeridian travellers have no or few difficulties adjusting to time zone change. In the author's studies, rephasal took 0-6 days in the westward direction and 2.9-17.9 days in the eastward direction after crossing 6 time zones. Social interaction can reduce rephasal from 11-12 days to 6-7 days. The authors recommend taht aircrews should commence night duty only well-rested and that maximum efficiency should not be demanded at the time of maximal behavioral depression. A short layover between outgoing and homegoing flights is recommended, to avoid rhythm adaptation to the new environment. After return to home base, prolonged rest time should be granted for normalization of the circadian system. Sleep time should be provided within the natural depression of the circadian rhythm. Aircrews sensitive to rhythm phase shifts and sleep-wake cycle alternations should perhaps be excluded by selection. Since adjustment to time cue shifts becomes more difficult with age, operating on transmeridian routes should be restricted in pilots older than 45-50 years.

973.
Klein, K. E., H. M. Wegmann, and B. I. Hunt: Desynchronization of body temperature and performance circadian rhythm as a result of outgoing and homegoing transmeridian flights. Aerosp. Med. 43: 119-132, 1972.

974.
Klein, K. E., H. M. Wegmann, and P. Kuklinski. Athletic endurance training - advantage for space flight?: The significance of physical fitness for selection and training of spacelab crews. Aviat. Space Environ. Med. 48: 215-222, 1977.

975.
Klein, K. E., H. E. Wegmann, J. Vernikos-Danellis, and C. M. Winget. The effects of transmeridian flight on human performance and physiological rhythms. DFVLR Aerospace Medical Institute Report. NASA-Ames Research Center, Moffett Field, Ca., 1977, 22 pp.

976.
Klein, M. Biorhythm in the Prediction of Heart Attacks Suffered by American Business Men. Joplin, Mo.: Missouri State Southern College, 1973.

977.
Kleitman, N. Studies on the physiology of sleep. VIII. Diurnal variation in performance, Am. J. Physiol. 104: 449-456, 1933.

978.
Kleitman, N. Sunset, night and day shifts for "round-the-clock" production, Steel, 2: 72, 1942.

Amongst others, it is proposed that the shifts of work starting at the hours 4-12-20 should be standard as this conforms to the body temperature cycles of the workers.

979.
Klinker, L, and D. Weiss. Model concept concerning some control principles of the human organism. III - Seasonal adaptation. Zeitschrift fuer Meteorologie 23: 170-173, 1972.

The system of the human diurnal cycles goes through a stable phase at the beginning of the year. The length of the performance phase is about 12 hours. The effects of an increase in the stimulation intensity of daylight with the advancing seasonal cycle are considered, giving attention to the damping mechanism in the human control cycle. A performance maximum is reached during the summer months.

980.
Knauth, P. Kriterien fur die Beurteilung verschiedener Schichtwechselformen. (Ph.D. Thesis). Technich Horchschule Darmstadt, 1975.

981.
Knauth, P., and J. Ilmarinen. Continuous measurement of body temperature during a three-week experiment with inverted working and sleeping hours (abstract). Int. J. Chronobiol. 3: 3, 1975.

This paper deals with the question of whether a complete inversion of the circadian rhythm in body temperature takes place during 3 weeks of experimental nightwork. The body temperature of 4 subjects was recorded continously. Even after 21 days of continuous nightwork the body temperature curve was not completely inverted. In the first few days of nightwork the amplitude decreased but by the end of the first week it had increased again and had reached nearly the same amplitude

C-4

as in a period of daywork. While the body temperature maximum was hardly phase-shifted at all during the 21 days of nightwork, the minimum phase-shifted to the period of daysleep after the first week.

982.
Knauth, P. W. Rohmert, and J. Rutenfranz. Systematic selection of shift plans for continuous production with the aid of work-physiological criteria. Applied Ergonomics 101: 9-15, 1979.

Taking into account the numerous theoretically possible shift systems, we chose sensible shift systems with the aid of objective work-physiological criteria, e. g., the duration of the daily working time, the positioning and duration of sleep and recreation time. With an agreed 40 h week shift, systems with a weekly working time of 24 h the following shift systems are recommended: when you have 8 shifts the relation between the number of working days and the number of free days should be "3 n/n", whereby n must be larger than 1, within one shift rota. In the exceptional case of a 12 h shift the corresponding relation should be "2 n/n". Further unsuitable and recommended shift plan examples are demonstrated for these shift systems.

983.
Knauth, P., and J. Rutenfranz. Utersuchungen uber die Beziehungen zwischen Schichtform und Tagesaufteilung. Int. Arch. Arbeitsmed. 30: 173-191, 1972.

984.
Knauth, P. and J. Rutenfranz. Untersuchungen zum Problem des Schlafverhaltens bei experimenteller Schichtarbeit. (Investigations of the problems of sleep in connection with experimental shiftwork.) Int. Arch. Arbeitsmed. 30: 1-22, 1972.

The sleep of 5 subjects aged from 21 to 24 years was studied by polygraphic methods for a total of 40 days and nights during experimental shiftwork. Undisturbed day-time sleep was significantly shorter than undisturbed nocturnal sleep and we found a distinct reduction in the duration of paradoxal sleep in comparison with nocturnal sleep. Disturbances due to noise caused a shorter duration of sleep, a reduction in stage IV and REM steep of sleep and an increased number of changes from one stage of sleep to the other in both day-time and nocturnal sleep. After sleep was interrupted for lunch we found a proportion of deep sleep which was above the average.

985.
Knauth, P. and J. Rutenfranz. Arbeitsphysiologiscne und Arbeitspsychologische Hinweise zur Gestaltung von Schichtplanen (Physiological and psychological recommendations for planning shift work). Arbeitsmedizin-Sozialmedizin-Praventivmedizin: 10: 197-200, 1975.,

There is no ideal organizational scheme for shift work adapated to every type of undertaking. The article contains recommendations intended to eliminate unnecessary constraint and stresses in shift workers. Principal aspects covered: length of working day; duration of shift cycle; number of successive shifts (especially night shifts), changeover from a 42- to a 40-h week in continuous work systems.

986.
Knauth P., and J. Rutenfranz. The effects of noise on the sleep of night-workers. In: Experimental studies of shiftwork, edited by P. Colquhoun, S. Folkard, P. Knauth, and J. Rutenfranz. Opladen: Westdeutscher Verlag, 1975, pp. 57-65.

987.
Knauth, P., and J. Rutenfranz. Experimental shift work studies of permanent night, and rapidly rotating, shift systems. 1. Circadian rhythm of body temperature and re-entrainment at shift change. Int. Arch. Occup. Environ. Health 37: 125-137, 1976.

The effects of permanent night and rapidly rotating shift systems on the daily course of body temperature were examined in an experimental situation.

In the first series of test 4 subjects worked on night shift for 3 successive weeks. A further 4 subjects worked on rapidly rotating shift systems; 2 subjects on a 1 - 1 - 1 - system (first day early shift, 2nd day late shift, 3rd day night shift, 4 day free), and 2 subjects on a 2 - 2 - 2 - system ("metropolitan rota").

Only slight changes in the daily course of rectal temperature were found with single night shifts. The greatest changes in the circadian rhythm occurred during the first week of night shifts.

Even after 21 consecutive night shifts we failed to find complete inversion of the daily course of body temperature.

In view of these test results rapidly rotating shift systems would seem to be advisable.

988.
Knauth, R., and J. Rutenfranz. Re-entrainment of body temperature in experimental shift systems with different numbers of consecutive night-shift (1-21 nights) (abstract). Chronobiologia. 4: 124, 1977.

The re-entrainment of body temperature after a phase-shifting of the waking and sleeping hours was investigated in three experiments. In the first experiment 6 subjects stayed at the Institute for 5 weeks. A period of day-work (0900 to 1700) was followed by a period of 3 weeks of continuous night-work (2200 to 0600) and a period of recovery without work. In addition 4 subjects worked on a 1-1-1 system (1st day early shift, 2nd day late shift, 3rd day night-shift 4th day free) and 2 subjects on a 2-2-2 system ('metropolitan rota'). After a change from day-work to the night-shift period of 3 weeks the minima of body temperature of 3 subjects shifted towards the first third of day-sleep after the first night-shift. The minima of body temperature of the other subjects needed 2 to 4 days to shift towards the day-sleep. During the following night-shifts the minima were in general situated within the day-sleep. During the following night-shifts the minima were in general situated within the day-sleep and preferably in the second half of the sleep. After the first and respectively the second night-shift in the experiments with rapidly rotating shift systems the minima of the body temperature of 3 of the 6 subjects were phase-shifted towards the day-sleep.

989.
Knauth, P., and J. Rutenfranz. Duration of sleep related to the type of shift-work (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. III-5.

990.
Knauth, P., J. Rutenfranz, G. Herrmann, and S. J. Poeppl. Re-entrainment of body temperature in experimental shift-work studies. Ergonomics 21: 775-783, 1978.

In a series of experimental shift work studies six subjects worked on continuous night shift for three weeks, four subjects worked on a 1-1-1 shift system (1st day morning shift, 2nd day afternoon shift, 3rd day night shift, 4th day off), and two subjects worked on an 2-2-2 shift system (the 'metropolitan rota"). Rectal temperature was continuously recorded in each experiment.

The greatest changes in the circadian rhythm of body temperature occurred on the second night shift day, and during the first week of continuous night shift working. The changes involved both shifts in the phasing of the rhythm, and alterations in its form. The re-entrainment of the rhythm to its normal phasing took two or more days after two or more successive night shifts, but only one day after a single night shift. Considerable individual differences in the rhythm adjustment ot night work were observed.

In a field validation of these findings, 34 shiftworkers in municipal gas and water supply undertakings measured their oral temperature even 2 h both on and off duty. Although only very few temperature readings were obtained during sleep periods, the results confirmed, in general, those of the experimental studies.

991.
Knoerchen, R., E. M. Gundlach, and G. Hildebrandt. Circadian variations of visual sensitivity and vegetative responsiveness to light in man (abstract). Int. J. Chronobiol. 3: 13, 1975.

The rate of vegetative reactions to light exposure following an exposure to darkness (decrease of eosinophils, increase of cortisol-excretion and heart rate) exhibits a circadian variation, the maximum of which occurring after exposure at 0800, i. e. at the time of the natural "light on" - signal, and the minimum occurring at 2000. This could be shown at different durations of light exposure ranging from 10 sec up to 4 hours. The phase position of the cycle of responsiveness deviates about 90^{0} from that of the circadian variation of the initial values of the parameters measured during the exposure to darkness. From this can be concluded that the rate of vegetative light response depends in a dynamic manner on the phase direction and slope of the circadian rhythm. Contrary to this finding, the circadian variation of the visual sensitivity to light which was followed up by the course of dark adaptation after a given light exposure shows its maximum around 0300 and its minimum around 1500 to 1800. This phase position indicates a different steering mechanism of the circadian cycle of visual sensitivity.

The significance of these findings for the circadian problems of night and shift-work is discussed.

992.
Knowles, J. B., J. Cairns, and A. W. MacLean. Acute shifts in the sleep-wakefulness cycle: 1. effects on sleep (abstract). Sleep Res. 7: 158, 1978.

993.
Knowles, J. B., J. Cairns, and A. W. MacLean. Acute shifts in the sleep-wakefulness cycle: 2. effects on performance (abstract). Sleep Res. 7: 159, 1978.

994.
Knowles, L., and R. Jones. Police altercations and the ups and downs of life. The Police Chief 40: 51-54, 1974.

Relationships between 184 incidences of physical altercations between police officers and suspects being apprehended and biorhythm cycle phases were studied. Chi square analysis indicated frequency of altercations was not significantly above expected levels during biorhythmic critical days or low cycle periods for police officers or their suspects. It is possible that in this study the interactions involved too many complex variables to be amenable to simple statistical analysis.

995.
Kobayashi, K., and K. Takahashi. Prolonged food deprivation abolishes the circadian adrenocortical rhythm, but not the endogenous rhythm in rats. Neuroendocrinol. 29: 207-214, 1979.

An abolishment of 24 h periodicity of the adrenocortical activity was observed in rats subjected to a prolonged food deprivation of 7-8 days. Total locomotor activity progressively decreased and its circadian rhythm faded out in a similar fashion as the adrenocortical rhythm. The circadian rhythms of both locomotor and adrenocortical activities were recovered after the rats were blinded and allowed free access to food. At the end of the first week, a peak elevation of blood corticosterone levels took place at the time corresponding to the light-dark transition before blinding. Similar patterns of locomotor activity and food intake were also noticed. THe recovered rhythm of these activities free-run throughout the observation period of 5 weeks. This fact indicates that the endogenous time-keeping system (clock) remained intact and synchronized with light-dark alternation during the period of prolonged food deprivation.

996.
Koch, C., and F. Monesi. Evaluation of aircrew fatigue during operational helicopter flight mission. In: Operational Helicopter Aviation Med. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, 1978, 2 pp.

Monitoring of physiological paramters for the assessment of successive phases of an operational flight mission, the latter being more demanding. The crucial question is which physiological parameters prove of practical value in revealing the onset of a state of acute fatigue. Undoubtedly, breathing rate and amplitude show relatively early changes with the increase in workload during helicopter flying (Petyjohn) as well as EMG and EOG. However, adequate computerized analysis of other physiological and behavioral parameters is necessary to provide the investigator with more subtle tools for the identification of fatigue.

997.
Kogi, K. Estimation of sleep deficit during a period of shift rotation basis for evaluating various shift systems (abstract). Ergonomics 21: 873, 1979.

Field investigations of various forms of shift working confirm that adaptation to shift rotation is hampered not only by phase shifts in the circadian cycle but by the sleep deficiency resulting from these shifts. A recent survey by the Committee on Shift Work of the Japan Association of Industrial Health revealed that a large majority of industrial shift workers suffer from frequency shortages of sleep. Insufficiently long inter-shift intervals, relatively large numbers of consecutive days on night or on other phase-shifted duties, and rest periods which are too short to allow home night sleeps of adequate duration immediately following these duties, are all factors which can impair sleep in both quality and quantity. When shift systems are compared, all of these factors producing shortened sleep should be considered, because it seems that none of them can be counterbalanced by a simple increase in the total amount of sleep taken. On the basis of actual time budgets of shift workers, comparisons were made of the amount of sleep lost during a complete rotation cycle of 14 different shift systems. In each case a sleep deficit index was estimated as the sume of the daily shortage of night sleep (compared with the normal) and the balance between this shortage and compensatory sleep taking during day hours. The results show that sleep deficit assessed in this way was lower for shift systems with a small number of consecutive night shift and for those with opportunities for intra-shift sleep. Greater deficit was observed in alternate-day, day, night and continuous 3 shift systems.

998.
Kogi, K. Comparison of resting conditions between various shift rotation systems for industrial workers (abstract). In: Int. Symp. on Night- and Shift-work. 5th, Rouen, FR., 1980, p. VII-8.

999.
Kogi, K., M. Takahashi, and N. Onishi. Experimental evaluation of frequent eight-hour versus less frequent longer night shifts. Int. J. Chronobiol. 3: 14-15, 1975.

1000.
Kokkoris, C. P., E. D. Weitzman, C. P. Pollak, A. J. Spielman, C. A. Czeisler, and H. Bradlow. Long term ambulatory temperature monitoring in a subject witn a hypernychthemeral sleep-wake cycle disturbance. Sleep 1: 177-190, 1978.

A portable temperature data logger was used for prolonged rectal temperature monitoring in an ambulatory subject with a longer than 24 hr (hypernychthemeral) sleep-wake cycle. The mean period of the sleep-wake and circadian temperature cycles was 24.8 hr. However, the period of the sleep-wake cycle fluctuated considerably, being less than 24.8 hr when he slept during the socially desirable sleep hours and more than 24. 8 hr when he slept during the day. In the first instance, the daily temperature fall occurred later than, and the second earlier than, sleep onset. During the times of desynchronization of the two cycles, he complained of insomnia, fatigue, and reduced performance. We postulate that his hypernychthemeral cycles were the result of either a primary defect in the mechanism of entrainment or "weakened" social zeitgebers due to a personality disorder. These concepts are supported by a sleep-wake pattern resembling that of relative coordination. We therefore raise the possibility that 24 hr was beyond the range of entrainment of the subject's circadian temperature cycle during the study.

1001.
Kollar, E. J., R. D. Pasnau, R. T. Rubin, P. Naitoh, G. G. Slater, A. Kales. Psychological psychophysiological, and biochemical correlate of prolonged sleep deprivation. Am. J. Psychiatry 126: 488-497, 1969.

A study in which four healthy adult males underwent 205 hours of sleep deprivation indicated that although they suffered transient ego disruptive phenomena, they did not appear to undergo psychopathological reactions extending beyond the period of sleep deprivation. Detailed psychological, physiological, and biochemical findings are reported.

1002.
Koller, M., M. Haider, M. Kundi, R. Cervinka, and H. Katschnig. Possible relations of irregular working hours to psychiatric and psychosomatic disorders (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. VIII-5.

1003.
Koller, M., M. Kundi, and R. Cervinka. Field studies of shift work at an Austrian oil refinery. I. Health and psychosocial wellbeing of workers who drop out of shiftwork. Ergonomics 21: 835-847, 1978.

Most of the problems that arise in shift workers prove to be social or family-bound rather than strictly medical, though health may in fact be affected seriously by these problems. The present study was concerned with the question whether, and in what way, men giving up shift work ('drop-outs") differ from those who stay on shift work, and from those on permanent day work. A questionnaire containing items about personal, family, and social life, and health, working conditions, and sleep was given to 270 workers in an oil refinery. All respondents were subsequently interviewed. Taking all the results together it is concluded that shift and night work leads, in a proportion of cases, to difficulties with regard to work and family life, as well as in social and health matters. The results from the "drop-outs" group indicate that in certain individuals very long lasting "psychosomatic", pseudoneurotic" or "sensitisation" reactions may develop.

1004.
Kolmodin-Hedman, B., and A. Swensson. Problems related to shift work. A field study of Swedish railroad workers with irregular work hours. Scand. J. Work. Environ. Health 1: 254-262, 1975.

A group of 132 engineers from the north of Sweden was included in the study. A subsample of about 50 subjects was selected for further laboratory investigations during a light and warm summer period and a dark and cold winter period. The mean for the hours of sleep noted on the sleep records was significantly lower for night work than for day work. The amount of sleep during night work was signficantly less during the light period than during the dark period as was the amount of sleep during the day off. Body temperature measured during work followed a daytime pattern and had a low amplitude. Potassium excretion and the blood levels of cortisol displayed a stable circadian rhythm with a daytime pattern. Many environmental factors made the results of catecholamine data difficult to interpret. The frequency of reported peptic ulcers was higher in the engineer group than in some other groups.

1004a.
Kong, H. Atmospherics geringster Frequenzen Z. Angew. Physik 11: 264-274, 1959.

1005.
Kononenko, A. A., and V. V. Derkac. Issledovanie Vnimanija i Pamjati u Operatorov Vyeisliltel'nyh Centrov v Ustovijah Trehsmennogo Rezima Raboty (Research in Vigilance and Short-Time Memory of Data Processing Centre Operators Working the 3-Shift 8-Hour System). Gig. i Sanit. 8: 102-104, 1975.

Results of several tests carried out at various times during and after three 8-h shifts to assess vigilance and short-time memory of data processing center operators. There was a falling-off in vigilance and memory during the second shift; this tendency was more pronounced during the third (night) shift. The article recommends special work/rest arrangements for this category of worker, and a change of work during the day shift to relieve monotony after 3-4 h of the same kind of work.

1006.
Kopozy'nska, B., L. Narojek, E. Albinowska, E. Swiechowska, J. Wojtczak-Jaroszowa, E. Kochman, and A. Tucholka. Dietary pattern of workers employed in a 3-shift system,. Med. Pr. 29: 173-183, 1978.

1007.
Koreshkov, A. A. Diurnal rhythms of the electroencephalogram (EEG) during a period of 72 hours sleeplessness. Kosm. Bio. Med. 6(1): 58-62, 1972.

The author studied EEG diurnal rhythms during a period of 72 hours sleeplessness to which ten healthy individuals were subjected. These and further studies have shown that test subjects with a stable rhythm of cerebral bioelectric activity can adapt less well and those with an unstable rhythm of activity can adapt better to altered work and rest schedules.

1008.
Koreshkov, A. A. The dynamics of ECG changes caused by altered work-rest patterns. Int. Cong. Aviat. Space Med., 21st, Munich, 1973, preprint, p. 83.

1009.
Koreshkov, A. A. Issledovanie bioelektricheskoi aktivnosti mozga v usloviiakh izmenennogo sutochnogo rezhima. (Investigation of the bioelectrical activity of the brain under conditions of varied 24 hour lifecycle.) In: Optimization of the Professional Activity of a Cosmonaut. Moscow: Izdatel'stvo Nauka, 1977, pp. 169-172.

Experiments were conducted to evaluate the functional state of the human organism in an inverted sleep/wakefulness regime under conditions of total isolation from external illumination and noise. The evaluation concerned the circadian dynamics of heart rate, arterial blood pressure, respiration rate, body temperature, and EEG indicators. It is shown that inversion of the circadian rhythm is accompanied by characteristic changes in the parameters examined. During the first three days after rhythm inversion, it is observed that the alpha-wave frequency is reduced and that the slow wave activity during wakefulness is enhanced. It is concluded that the study of the bioelectrical activity of the human brain is suitable for estimating the speed of human adaptation to the inversion of the work/rest order.

1010.
Koroleva-Munts, V. M. Sutochnyy ritm fiziologicheskikh funktsiy pri klinostaticheskoy gipokinezii (Circadian rhythm of physiological functions in clinostatic hypokinesia). Fiziologicheskiy Zhurnal SSSR 8: 1145-1149, 1974. (Eng. transl. NASA TT F-16, 308, 1975).

In the first 10 days of a strict bed regime (for medical reasons) changes were noted in the circadian rhythm of the heart rate, body temperature, minute volume of respiration and openness of the bronchial passages. By the 19-21st day in bed, initial rhythms of the first three indices reappeared. Changes in the character of individual rhythm curves and correlations between rhythms of heart rate and body temperature were statistically significant while no significant differences were found for mean values of sinusoid amplitude and phase with which empirical curves of rhythms were approximated.

1011.
Koulack, D., and K. J. Schultz. Task performance after awakenings from different stages of sleep. Percept. Mot. Skills 39: 792-794, 1974.

1012.
Kovacevic-Ristanovic, R., J. Spire, E. Van Cauter, D. Desir, C. Jadot, and P. Noel. Time shift (jet lag) and sleep (abstract). Sleep Res. 7: 306, 1978.

1013.
Kramm, K. R. Circadian activity of the red squirrel, Tamiasciurus judsomicus, in continuous darkness and continuous illumination. Int. J. Biometeor. 19: 232-245, 1975.

Fifty-eight red squirrels (Tamiasciurus hudsonicus) were taken directly from the field and placed in either total darkness (DD) or continuous illumination (LL) 500 lux, for up to 70 days. The squirrels were sampled at various times of the year so that seasonal changes in the endogenous rhythm could be examined. The initial phasing of activity correlated with the photoperiod in the field and had a free-running period (T) close to 24 hours. However, T increased in a nearly linear fashion, averaging about 0.19 min/day for squirrels in DD and about 0.87 min/day for squirrels in LL. All animals in LL had rhythms which eventually became dissociated into two or more components. On the other hand, squirrels kept in DD had running patterns which usually remained intact. After being in constant conditions for between 10 and 70 days, 28 squirrels were subjected to step transitions in illumination from DD to LL (500, 350 or 200 lux) 200 and 350 lux. The free-running period was directly correlated with the entrainment phase-angle difference. This relationship was compared to the red squirrel's light-pulse response curve. These data support Pittendrigh's (1965) entrainment model. or vice versa. An increase in illumination level generally resulted in a phase advance and a decreased T. A decrease in illumination level generally resulted in a phase delay and increased T.

1014.
Kratochvil, C. H. Biological rhythms. In: Use of Medication and Drugs in Flying Personnel, edited by H. S. Fuchs. Neuilly sur Seine, France: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-108, 1973, p. 4-1-4-9.

1015.
Krause-Poray, B. I Wish I had Known: Biorhythmic Living, a Fascinating New Way for You to Live. Brisbane, Australia: Biorhythm Research Information Centre, 1974, 57 pp.

1016.
Krause-Poray, B. Basic Biorhythms: Natures Biological Master Clock. Brisbane, Australia: Biorhythms Research Information Centre, 1976, 164 pp.

1017.
Krebs, J. Clocks, pineals and compasses. Nature 274: 115-116, 1978.

1018.
Krefft, S. Sicherheit Beim Fliegen Aus Flugmedizinischer Sicht; Folia Traumatologica Geigy (Safe Flying from the Viewpoint of Aviation Medicine; Folia traumatologica Geigy). Basel: Geigy, Basel, 1974, 20 pp.

The physiological (psychophysiological) aspects of flying are reviewed. The duties and working environment of pilots are discussed disturbance of the circadian rhythm, mental load, ergonomics of the cockpit, microclimate, noise, vibrations, acceleration, altitude, hypoxia, safety, etc.

1019.
Kriebel, J. Circadiane Periodik der Nebennieremark- und Nebennierenrindenhormone beim Menschen mit und ohne Zeitgeber. Dissertation, Munich, 1971.

1020.
Kriebel, J. Exogenous modifications of circadian rhythms of adrenal hormones in man. J. Interdiscipl. Cycle Res. 3: 233-241, 1972.

Circadian rhythms of activity, rest, body temperature, urine volume, urine excretion of adrenaline (A), noradrenaline (NA), 17-hydroxycorticosteroids (17-OHCS) and 17-ketosteroids (17-KS) have been measured during a 37-day experiment, including 17 days in isolation with a young male subject. The phase relationship between the periods of activity and vegetative functions were different in isolation and synchronisation. All maxima were moving toward begin of activity in isolation. According to the multioscillatory theory the amount of change was different: 180° for the catecholamines; 60° for the steroids; 90° for the body temperature. For the same reason the shape of the curves changed during isolation. Furthermore, the data suggest that social stimuli are important factors determining the shape of circadian funtion curves. Evidences for this hypothesis are: (1) the relative late maxima of the catecholamines in synchronization; (2) the increased amplitude during social activity; (3) abrupt

increase in the level of urinary catecholamine excretion at the conclusion of isolation.

1021.
Kriebel, J. Changes in internal phase relationships during isolation. In: Chronobiology, edited by L. E. Scheving, F. Halberg and J. Pauly. Tokyo: Igaku Shoin, Ltd., 1974, pp. 451-459.

Circadian rhythms are endogenous and persist under constant conditions with periods which deviate to some extent from 24 hours Under constant conditions the rhythmic functions tend towards a new phase-relationship different from that under conditions of entrainment with normal social environment.

1022.
Krieger, D. T. Effect of ocular enucleation and altered lighting regimens at various ages on the circadian periodicity of plasma corticosteroid levels in the rat. Endocrinol. 93: 1077-1091, 1973..

1023.
Krieger, D. T. Food and water restiriction shifts corcicosterone, temperature, activity and brain amine periodicity. Endocrinol. 95: 1194-1201, 1974.

The circadian periodicity of plasma corticosteroid levels was determined in individual adult male and female rats, sampled every 4 hr over a 48-hr period. Access of these rats to food and water was then restricted to 9:30 AM-11:30 AM for a 15-day period, the animals being kept under normal laboratory lighting conditions (lights on 8:00 AM, off 8:00 PM). At the end of this period, such animals had a 12-hr shift in the time of the circadian peak of plasma corticosteroid levels. A similar alteration in the time of the peak of body temperature levels was also seen in these animals. Alteration of patterns of running activity, with a marked increase in daytime running activity was also present in such food and water restricted animals. There was also a reversal of AM/PM ratios of hippocampal norepinephrine and of serotonin levels in these animals. These findings demonstrate that presence of normal light-dark alteration is not sufficient for the maintenance of normal circadian periodicity of plasma corticosteroid levels. It is suggested that disruption of the sleep-wake pattern induced by food restriction may be a factor responsible for the observed changes.

1024.
Krieger, D. T. Circadian pituitary adrenal rhythms. Adv. Exp. Med. Biol. 54: 169-189, 1975.

1025.
Krieger, D. T. Regulation of circadian periodicity of plasma ACTH levels. Ann. N. Y. Acad. Sci. 297: 561-567, 1977.

1026.
Krieger, D. T. Rhythms in CRF, ACTH and corticosteriods. In: Comprehensive Endocrinology, edited by D. T. Krieger. New York: Raven Press, 1979, pp. 123-142.

1027.
Krieger, D. T. Ventromedial hypothalamic lesions abolish food-shifted circadian adrenal and temperature rhythmicity. Endocrinol. 106: 649-654, 1980.

1028.
Krieger, D. T., and J. Aschoff. Endocrine and other biological rhythms. In: Endocrinology, edited by L. J. DeGroot, et al. New York: Grune and Stratton, 1979, pp. 2079-2109.

1029.
Krieger, D. T., and H. Hauser. Suprachiasmatic nuclear lesions do not abolish food-shifted circadian adrenal and temperature rhythmicity. Science 197: 398-399, 1977.

Daytime restriction of food and water availability in nocturnal animals phase shifts the circadian periodicity of plasma corticosteroid concentrations and body temperature. These shifted rhythms persist in animals with lesions of the suprachiasmatic nuclei who are arrhythmic under normal conditions. These findings suggest the existence of an additional "clock" that may be involved in the generation of the rhythm.

1030.
Krieger, D. T., and H. Hauser. Comparison of synchronization of circadian corticosteroid rhythms by photoperiod and food. Proc. Natl. Acad. Sci. 75: 1577-1581, 1978.

1031.
Kripke, D. F. An ultradian biologic rhythm associated with perceptual deprivation and REM sleep. Psychosom. Med. 34: 221-234, 1972.

To demonstrate that the 10 to 20 cycle/day oscillations expressed during sleep by the cyclic occurrence of rapid-eye-movement periods may be present during wakefulness, 6 normal subjects were isolated for 36 hours. The electroencephalogram and several physiologic and behavioral indices were continuously recorded. After 8 hours of sleep, subjects attempted to remain awake and perform consistent behavioral tasks for 27 hours, but no subject could remain awake this entire interval. Data were analyzed with spectral analyses. Both during sleep and when the subjects were almost continuously awake, the 10 to 20 cycle/day frequency range was the predominant source of variance, indicating that a discrete 10 to 20 cycle/day oscillatory mechanism may modulate physiologic systems and behavior throughout the 24 hours.

1032.
Kripke, D. F., B. Cook, and O. F. Lewis. Sleep of night workers: EEG recordings. Psychophysiology 7: 377-384, 1970.

1033.
Kripke, D. F., L. L. Judd, B. Hubbard, D. S. Janowsky, and L. Y. Huey. The effect of lithium carbonate on the circadian rhythm of sleep in normal human subjects. Biol. Psychiatry 14: 545-548, 1979.

1034.
Kripke, D. F., D. J. Mullaney, . L. Atkinson, L. Y. Huey, and B. Hubbard. Circadian rhythm phases in affective illnesses. Chronobiologia 6: 365-375, 1979.

Four patient groups (manic, bipolar depressed, unipolar endogenous depressed, and unipolar reactive depressed) were studied for 24 days after admission to the hospital for acute affective illnesses. A few patients without affective illness were used as controls. Oral body temperatures were measured 4-6 time daily. All voided urine samples were collected, and volume, sodium content, and potassium content were determined. Activity was monitored 24-h a day with a wrist activity transducer and a portable tape recorder. 24-h rhythm phases, amplitudes, and mesors were imputed with a least-squares cosine fitting technique. The mean phases, amplitudes, and mesors of the 24-h rhythms generally did not differ significantly among groups; however, the bipolars (both manic and depressed) showed significantly more phase variability. These results give only equivocal support to our hypothesis that bipolars have a fast free-running circadian oscillator. If it exists in all patients, the free-running oscillator must have only weak coupling with activity, temperature, and urine water and electrolytes.

1035.
Kripke, D. F., D. J. Mullaney, M. Atkinson, and S. Wolf. Circadian rhythm disorders in manic-depressives. Biol. Psychiatr. 13: 335-351, 1978.

1036.
Kripke, D. F., and V. G. Wyborney. Lithium slows rat circadian activity rhythms. Life Sci. 26: 1319-1321, 1980.

1037.
Kroll, P. Contribution of the Anticipation Stress to Total Flight Stress and its Dependence on Diurnal Rhythm, Measured by Phsyiological Parameters. Bad Godesberg: Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmedizin, 1972, 69 pp.

The rating of anticipation reaction before flight was compared with flight stress. An evaluation was also made of whether the anticipation reaction depends on daytime oscillation and whether it differs from the diurnal pattern of flight stress. Eighteen pilots had to perform a standardized instrument flight in a flight simulator in order to determine pulse rate, ventilation rate, respiratory minute volume, oxygen uptake, and carbon dioxide output before and during a given flight task. The result showed that anticipation reaction coincides with flight stress.

1038.
Kronauer, R. E., C. A. Czeisler, E. D. Weitzman, S. F. Pilat, and M. C. Moore-Ede. A mathematical model of the human circadian system: use of two interacting oscillators to stimulate free-running and entrained sleep-wake patterns. (Unpublished abstract, personal communication), 1980.

1039.
Krueger, G. P., and Y. F. Jones. U.S. Army aviation fatigue-related accidents, 1971-1977. Army Aeromedical Research Lab., Fort Rucker, Ala. Avail. NTIS Sap: HC A99/MF A01. In: Operational Helicopter Aviation Med. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, 1978, 11 p (See N79-19605 1051).

An accident data survey was made to determine how frequently aviator crew fatigue may have contributed to US Army aviation accidents from 1971 to 1977. All accident reports in the US Army Agency for Aviation Safety (USAAAVS) data base were reviewed. Aviator fatigue was deemed to be a contributing factor in 42 rotary wing accidents which resulted in a total of 51 fatalities and five injuries. These fatigue related accidents are categorized by aircraft and mission type and by time of day and day of week of the accident. Pilots activities prior to the accidents which promote the likelihood of pilot fatigue contributions are described. The personnel and equipment costs of these accidents to the Army are estimated, and the relative importance of such accidents to the total US Army aviation accident picture is assessed.

1040.
Kucherov, I. S., V. G. Tkachuk, A. V. Volkov, N. N. Shabatura, and I. M. Zimin. Dlitel'niye biologicheskiye ritmi v dinamike mishechnoi rabotosnosobnosti cheloveka (Long term biological rhythms in the dynamic of human muscular activity). Kibernetika i Vycheslitel'naya Tekhhnika 7: 71-79, 1970.

Periodogram and autocorrelogram analysis revealed a rhythm in muscular activity in males with a period of 12-20 days.

1041.
Kuhl, J. K. Lee, F. Halberg, E. Haus, K. Gunther, and E. Knapp. Circadian and lower frequency rhythms in male grip strength and body weight. In: Biorhythms and Human Reproduction, edited by M. Ferin, F. Halberg, R. M. Richart, and R. L. Vandewiele. New York: John Wiley & Sons, 1974, pp. 529-548.

Least squares cosinor analysis of hand grip strength from 10 medical students over 56 days revealed a significant rhythm of about 13 days (range 2-25 days).

1042.
Kuhn, R. I. Control Your Destiny With Biorhythms. Boca Raton, Fla.: Fiesta de Florida Publishing Co., 1975.

1043.
Kuklinski, P., K. E. Klein, and H. M. Wegmann. Untersuchungen zum problem der circadianen rhythmus - storungen beim fliegenden personal. (Investigations regarding the problem of circadian rhythm disturbances involving flying personnel.) Int. Cong. Aviat. Space Med., 21st, Munich, 1973, preprint, pp. 338-339.

1044.
Kuklinski, P., and H. M. Wegmann. Biomedical investigations on payload specialists during spacelab simulation ASSESS II. Aerospace Med. Assoc. Preprints, 1979, pp. 93-94.

Summarizing the results, it can be concluded that a Spacelab environment, as simulated in ASSESS II, will affect well-being and performance of Payload Specialists through factors as rhythm disturbances, sleep difficulties, and stressful workload. These effects are most pronounced during the first three days and in real Spacelab missions will probably occur to a greater degree with the added requirement for adjustment to weightlessness. Therefore, a pre-mission system simulation is proposed. First, this would permit an estimation of the stress load to be expected, and secondly, it will give the opportunity of training and adaption, thus reducing the impairing conditions and improving Payload Specialists' effectiveness.

1045.
Kulesov, V. I. Problem of physiologic shifts in ship-borne helicopter pilots. Voenno-Med. Zh. No. 2, pp. 60-62, 1977.

Two flight crews of ship helicopters were tested for pulse at rest, arterial pressure, maximum muscular exertion, and static muscular endurance during hydrodynamometry, and critical flicker fusion frequency. The results of the investigation reveal a definite development of fatigue among the flight crews during training flights.

1046.
Kumar, V., P. C. Chatterjee, N. Ramachandran, and J. K. Gupta. Effects of partial sleep deprivation on psychological performance and behavior. Aviat. Med. 22: 1-7, 1978.

Ten healthy male volunteers (21-29 yr.) were deprived of sleep during the second half of the night so that maximum REM sleep deprivation could be produced. The subjects were allowed only 4-hr.

sleep (10 p.m. to 2 a.m.) every night for three consecutive nights and days. The effects of this partial sleep deprivation on task performance and behavior were studied. The task performance was assessed on the following tests: critical fusion frequency, stability of attention test, flight-oriented psychomotor test, choice reaction time test, spatial orientation test, and pursuit rotor test. The results indicated an increase in deterioration in performance on certain tests with further partial sleep deprivation on two successive nights. The deterioration in performance on sudden awakening was significant. The testees developed subjective complaints such as increased desire to sleep, lack of concentration, increased appetite, etc. These subjective complaints disappeared with one night recovery sleep and 2-3 hours of sleep next afternoon.

1047.
Kundi, M., M. Haider, M. Koller, and R. Cervinka. Job satisfaction in shift-workers and its relation to family situation and health (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. IV-5.

1048.
Kupriianov, A. A., and V. V. Dudnikov. Evaluation of physiological indices during preflight medical examination of pilots. Voenno-Med. Zh. (2): 49-51, 1979.

Results are presented for a one-year study of the circadian rhythm of basic physiological functions in 50 flying-personnel members aged 24-38. The investigation is carried out during the period of preflight medical examinations at different times of the day. The results suggest that the use of data on the normal limits of basic physiological indices will contribute to the timely detection of various deviations in the functional state of flight personnel, due to fatigue, initial symptoms of diseases, several emotional responses, and unfavorable impact of flight factors.

1049.
Kurth, H. Mit Biorhythmik zum Erfolg (With biorhythm to success). Stuttgart, Vienna: Rüschlikon-Zurich, 1972, 104 pp.

1050.
Kurucz, C. N., and T. M. Khalil. Probability models for analyzing the effects of biorhythms on accident occurrence. J. Safety Res. 9: 150-158, 1977.

This paper examines the biorhythm theory from a theoretical probability point of view and provides a method for determining critical days and comparing expected and actual results with the biorhythm theory is applied. The implications for analysis of several different defintions of critical days are noted, especially with regard to changes in the probabilities used for calculations. The authors recommend that observed accident frequencies be compared to frequencies expected if biorhythm cycles did not affect accident occurrence and tested using chi square analysis. A problem arises since the zero crossing of the 23 day physical cycle and the 33 day intellectual cycle occurs at midnight, assuming the individual was born at noon, and therefore one must decide which is the critical day, the one before or the one after midnight. If time of birth is not known, the exact position of these cycles can not be calculated and it may be necessary to calculate the expected cycle position based on population probabilities of being born before or after noon. The authors note that some biorhythm proponents also define days adjacent to the critical day as critical days. The authors provide tables for accurately calculating critical day probabilities given time of birth (or unknown time of birth) and assuming single or multiple critical days. They caution that given these problems, definitional probability of critical physical days can vary from .09 to .3 and that observed data should be interpreted consistent with a particular definition and compared with expected results calculated using the corresponding theoretical probabilities. These methods were applied to 63 FAA pilot error aircraft accidents (see Khalil and Kurucz 1977, Ergonomics 20: 389) with no significant findings of a relationship between biorhythm phase and accident times. The authors conclude the reported success of biorhythm accident reduction programs may not be due to the biorhythm effects. They cite accident statistics related to critical days from a paper by Willis (Proc. 16th Ann. Meet. Human Factors Soc., pp. 272-282, 1972) in which they recalculated critical day probabilities and found that there was no significant difference betwen observed and expected accident rates on critical days, thereby refuting the results of this paper.

1051.
Kuznetsov, O. N., A. N. Litsov. Psychoneurological problems in man's adaptation to modified diurnal regimes. Kosm. Biol. Med. 7(4): 69-75, 1973.

This paper discusses theoretical and practical aspects of the psychoneurologic and personality problems involved in human adaptation to an altered diurnal regime (circadian cycle). It describes stages and levels discriminated in clinical and experimental desynchronosis. The paper demonstrates the role of anticipation, emotions, personality relationships and self-dependence in assimilating general experience for successful adaptation to an altered circadian cycle. It interprets an individual biorhythmological adaptive style as a derivative of endogenous and exogenous processes in the course of personality development. The paper demonstrates the significance of the exterior phase for the development of biorhythmological adaptive capabilities. It covers the main characteristics of the personality which may favor or impede adaptation to an altered circadian cycle.

1052.
Kwarecki, K. Some aspects of chronobiology and their significance in aviation medicine. Artificial Satellites 11: 71-83, 1976.

Problems concerning chronobiology and biorhythms are reviewed along with their relation to aerospace medicine and biology. The main groups of human biorhythms are identified, examples of each group are presented, and properties of selected human biorhythms are described. Studies of chronobiology in aviation medicine are discussed with reference to factors which may disturb the natural course of biorhythms in flight personnel. Effects of space flight on biorhythms are examined, particularly the effects of a lack of natural synchronizers in orbital and interplanetary space flights. It is shown that a catabolic effect of thyroid-gland hormones and glicocorticosteroids may be the reason for the bone demineralization and changes in the characteristic structural and functional features of the muscle system during prolonged space flight.

1053.
Kwarecki, K., and G. Szmigielski. Selected problems concerning biological rhythms. Postepy Astronautyki 5: 23-28, 1972.

Survey of current medical views on the origins of biological rhythms and on mechanisms and effects of disruptions in these rhythms. Factors producing the 24-hr biological cycle in man are described, with emphasis on the modern concept of biological clock localized at the cellular level. Effects of disrupted rhythms observed in speleologists, astronauts, and airline pilots are discussed.

1054.
LaDou, J. Circadian rhythms and athletic performance. The Physician and Sportsmedicine 7:6pp., 1979.

The competitive athlete who understands circadian rhythms will be able to perform more effectively. If a person's circadian rhythms are not synchronized with the time zone he or she has traveled to, athletic performance will be below par.

1055.
Lahtinen, U., A. Lahtinen, and P. Pekkola. The effect of nitrazepam on manual skill, grip strength, and reaction time with special reference to subjective evaluation of effects on sleep. Acta Pharmacologica et Toxicologica 42: 130-134, 1978.

1056.
Lakatua, D. J., F. Halberg, E. Hause, E. Halberg, H. Levine, J. K. Sackett, M. Thompson, L. L. Sackett, C. Graeber, and H. Jacobs. Timing of single daily meal serves to manipulate relations among human circadian plasma growth hormone, cortisol, insulin and cardiovascular rhythms (abstract). Annual Meeting of the Endocrine Soc., 58th, 1976, p. 285.

It is demonstrated that (1) a method of separating hormonal and other physiologic rhythms by different extent of adjustment following the manipulation of an environmental synchronizer-mealtime. (2) the fact that three circadian rhythms intimately related to carbohydrate metabolism adjust differently on different meal times. The latter observation may serve for optimizing food utilization.

1057.
Lakatua, D. J., E. Haus, L. Sackett-Boche, and J. Swoyer. Phase-shift of endocrine and metabolic circadian rhythms following a single prolongation of the wakefulness span from 16 to 24 h(-120). Chronobiologia 4: 127, 1977.

1058.
Landau-Ferey, J., et al. Night sleep patterns in post-operative intensive care patients. Rev. Electroencephalogr. Neurophysiol. Clin. 7: 467-472, 1977.

1059.
Lanuza, D. M. Circadian rhythms of mental efficiency and performance. Nurs. Clin. North Am. 11: 583-594, 1976.

1060.
Lapaev, I. I., V. F. Ivanov, and V. F. Vasil'chenkov. Effect of the circadian rhythm of body activities on the work capacity of drivers. Voenno-Med. Zh. No. 2, pp. 43-44, 1949.

1061.
Lapointe, F. Biorythmie: Comment Prevoir Vos Bons et Mauvais Jour. (Biorhythm: How to predict our good and bad days). Montreal: Distributions Eclair, 1976, 108 pp.

1062.
Laties, V. G. Modification of affect, social behavior and performance by sleep deprivation and drugs. J. Psychiatr. Res. 1: 12-35, 1961.

A 37-hour period of sleep deprivation proved sufficient to induce reliable changes in how men working together in small groups felt and how they acted. These changes generally reflected both more negative affect and more negative behavior. However, while verbal reports of hostility increased, overt aggressive behavior did not. The subjects worked on both group and individual performance tasks, none of which showed effects of sleep loss. A combination of amphetamine and secobarbital moved reports of affect in a "positive" direction, with effects usually greater with sleep deprived subjects. Task performance was improved by the drugs while overt social behavior usually was unchanged. No evidence was found that the group performance changes were mediated by changes in interpersonal affect.

1063.
Latman, N. Human sensitivity, intelligence and physical cycles and motor vehicles accidents. Accid. Anal. & Prev. 9: 109-112, 1977.

Tested a hypothesis describing the effect of possible cycle fluctuations of 23, 28, and 33 day biorhythm cycles on motor vehicle accidents. Study I examined 260 traffic accidents recorded in a midwestern city over a 1-yr period. Study II included all the accidents of a taxicab company in the same city over a 1-yr period. For the general driving public, a higher rate of accidents (37%) was found to occur on days termed critical. Although the positive half-period of these cycles reflected no significant difference from that predicted, the negative half-period of the 28 day cycle had fewer accidents (37%) as compared with the predicted rate (46%). Results suggest that there appears to be a good correlation betwen the proposed cyclces and motor vehicle accident occurrences. Note: this contradicts biorhythm theory, which predicts higher accident rates at the low biorhythm phase.

1064.
Lavie, P. Rhythms in human performance. Catalog of Selected Documents in Psychology 4: 39, 1974.

The study of human cyclic performance stems from three independent research concerns. First, studies rooted in the early days of Educational and Experimental Psychology searched for daily trends in mental fatigue. These studies focused on the possible existence of independent rhythms in performance during the day and reported-different courses for mental and motor performance during the waking hours. While mental performance tended to show an increase from morning to early noon, a decline around midday, followed by subsequent increase, motor performances tended to peak during the afternoon hours

and early evening. The second area of research leading to the exploration of human cyclic performance was the study of biological rhythms. Researchers such as Kleitman, Aschoff, and others have studied the relationships between biological rhythms and performance during the day and night and reported on close relations between performance indexes and biorhythms. The biorhythmic- behavioral research has been catalyzed by problems stemming from the newly adquired ability of man to cross multiple time zones in a short time and the increasing necessity of shift work.
A third area of research has attempted to identify ultradian behavioral rhythms, that is, rhythms shorter in periodocity than one day. These studies have emerged primarily from the extensive study of sleep over the last two decades. Sleep has been shown to display 90 to 110 minute cycles of active (REM) and quiet (NONREM) sleep. This cycle was hypothesized by Kleitman in 1961 to be the nightly manifestation of a 90 to 110 minute biological rhythm that continues around the 24 hours. During the last decade, evidence has accumulated that supports the existence of such a rhythm during the waking state in performance, drive-related behavior, perception, and general acitivity level.

1065.
Lavie, P., and W. B. Webb. Time estimates in a long-term time-free environment. Am. J. Psychol. 88: 177-186, 1975.

Subjects in a time-free environment for 14 days estimated the hour and day several times a day. Half of the subjects were under a heavy exercise regime. During the waking hours, the no-exercise group showed no difference between estimated and real time, whereas the exercise group showed significantly shorter estimated than real time. Neither group showed a difference after the sleeping periods. However, the mean accumulated error for the two groups was 48.73 hours and was strongly related to the displacements of sleep/waking behavior. It is concluded that behavioral cues are the primary determinants of time estimates in time-free environments.

1066.
Lawrence, G. H. Brain waves and the enhancement of pilot performance. In: Survey of Methods to Assess Workload, edited by B. O. Hartman, and R. E. McKenzie. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-AG-246, pp. 93-102.

The use of brainwaves (EEG) for the enhancement of the performance of aircraft pilots is an idea which requires, for its development, the integration of two previously independent lines of research endeavor: human performance assessment and central nervous system neurophysiology. A human performance research paradigm specifically relevant to the study of pilot performance, in the context of which the use of brain waves may feasibly be studied, will be discussed later. Attention is now directed to the state of the art of brain wave research and brain-behavior relationships, specifically those aspects

which are considered to be feasibly and usefully applicable for potential use in simulated aircraft crew stations or eventually in a real-world environment.

1067.
Layne, J. N. Activity responses of two species of Peromyscus (Rodentia, Muridae) to varying light cycles. Oecologia (Berl.) 7: 223-241, 1971.

1068.
Leach, C. S., and J. A. Rummel. Temporal relationships of urinary constituents before and after long duration space flight. In: Chronobiological Aspects of Endocrinology, edited by J. Aschoff, et al. Stuttgart: Schattauer: 1974, pp. 81-89.

1069.
Lebedev, V. I. and B. A. Leonov. Cosmic flight-watch-standing and psycho-physiological rhythms. In: Perception of Space and Time in Outer Space. Washington D.C.: Joint Publications Research Service, 1968, pp. 8-15.

1070.
Lecocq, J. Au sujet de quelques facteurs suseptibles d'influencer l'action pathologique des horaires de travail en equipes tournant 3 x 8. Arch. Mal. Prof. Med. 24: 214-218, 1963.

1071.
Leddy, S. Sleep and phase shifting of biological rhythms. Int. J. Nurs. Stud. 14: 137-150, 1977.

1072.
Leeks, R. C. The Influence of Biorhythms in Traffic Accidents. (M.S. thesis) Arizona State University, 1976.

1073.
Lees, M. A., K. A. Kimball, and L. W. Stone. The assessment of rotary wing aviator precision performance during extended helicopter flights. Ft. Rucker, Ala.: Army Aeromedical Research Lab. In: Studies of Pilot Workload, Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development. 1977, 13 pp.

Man machine system performance during a five day extended flight was evaluated with emphasis on the changes in pilot performance and aircraft stability during the stabilized 3-ft precision hover maneuver. Changes in subjective reactions of fatigue and flight performance and in the measurement of auditory reaction time are also discussed. Data obtained suggest the occurrence of a learning effect across the first day of extended flight. The most stable hover performance was observed during the second flight day. By the third flight day, pilots attempted to maintain high quality precision hovers through an increase in the number of control inputs. On the fourth day of flight the pilots have shifted their control technique from active control of the helicopter to a more passive strategy of

responding to observed error. The subjective rating scales demonstrate a progressive increase in the rated levels of fatigue between and within flight days. This increase in the level of fatigue corresponds to a general decrease in the ratings of flight performance.

1074.
Leff, D. N. Biorhythm fans have charts too-but little scientific support. Medical World News 20: 46, 1979.

This short review article on the biorhythm theory reports that Dr. H. Levine of the New Britain, Conn. General Hospital has been recording his personal physical, emotional, and intellectual rhythms for 10 years and reports that this data has no relation to the cycles of a commercial biorhythm chart.

1075.
Leff, D. N. Chronobiologists tell clinicians - think circadian. Medical World News 20: 44-53, 1979.

1076.
Lehwess-Litzmann, I. Leitstung und Zeitzonenfluge (Performance and time zone flights). Techisch-Okonomische Informationen der Zivilen Luftfahrt 10: 50-54, 1974.

The body of man is governed by various biological cycles which are disrupted when he travels across many time zones in a short period of time, as is done by aircraft crews on long distance flights. This results in a decrease of performance ability unless extra resting time is granted before making another flight. An ICAO formula is discussed according to which the minimum necessary resting time is calculated as a function of the flight time, the number of time zones crossed, and the local times of departure and arrival. For a flight from New York to Tokyo, this resting time would come to two and a half days.

1077.
Leibowitz, S. F. Brain catecholaminergic mechanisms for control of hunger. In: Hunger: Basic Mechanisms and Clinical Implications, edited by D. Novin, W. Wyrwicka, and G. Bray. New York: Raven Press, 1976, pp. 1-18.

1078.
Lekhan, V. M. Comparative assessment of physiological functions in female workers engaged in different shifts. Gig. Trud. Prof. Zabol. 16: 38-40, 1972.

1079.
Lekhan, V. M. Characteristics of body functioning while performing work of varying severity, taking into account its shifts. Fiziol. Zh. 20: 553-555, 1974.

1080.
Leonard, R. Amplitude of the temperature circadian rhythm and tolerance of night- and shift-work (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. VI-4.

1081.
Leonov, A. A., and V. I. Lebedev. Psikhologicheskiye problemy mezhplanetnego poleta (Psychological problems of interplanetary flight). Moscow: Izdatel'stvo Nauka, 1975, pp. 4-248. (English translation NASA TT F-16536, 1975.)

The monograph examines the questions of psychological compatibility among crew members of and interplanetary ship under the conditions of group isolation, the extended effect of weightlessness on human mental processes, the effect of sensory and information starvation on the appearance of unusual mental states, emotional stress, and the rhythm of working and rest.

1082
LePage, W. A., R. F. Thatcher, and P. J. Dean. A conceptual model for the effects of operational stress. In: Higher Mental Functioning in Operational Environments, edited by B. O. Hartman. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-181, 1976, pp. C9-1 - C9-5.

1083.
Lester, J., T. M. Knapp, and R. Roessler. Personality, physiology, performance, and sleep deprivation. Psychophysiol. 13: 180, 1976.

Groups formed from subjects selected for extreme scores on the Barron Ego Strength Scale (ES) and on the Barratt Impulsiveness Scale (BIS) differed in the number of signals correctly detected in a visual monitoring task during a 72-hr sleep deprivation experiment. Subjects who scored high on the ES scale detected more signals than did normal or low Es subjects. Subjects who scored low on the BIS also performed significantly better on the vigilance task. Sleep deprivation produced substantial decrements in heart rate and in four performance measures (ommission errors, interrogation rate, reaction time, and word forgetting). There was significant covariation of heart rate and two performance measures, omission errors and interrogation rate, in particular for the low ego strength/high impulsiveness group, the personality group which showed the greated deterioration of performance over the sleep deprivation period. Skin conductance was found to be lower for those subjects with high ego strength. The results are discussed in relation to the effects of personality types and physiological arousal on performance during sleep deprivation.

1084.
Lester, J., T. M. Knapp, and R. Roessler. Sleep deprivation, personality, and performance on a complex vigilance task. Waking and Sleeping 1: 61-65, 1976.

Groups formed from subjects selected for extreme scores on the Barron Ego Strength Scale (Es) and on the Barratt Impulsiveness Scale (BIS) differed in the number of signals correctly detected in a visual monitoring task during a 72-hour sleep deprivation experiment. Subjects who scored high on the Es scale detected more signals than did normal or low Es subjects. Subjects who scored low on the BIS also performed significantly better on the vigilance task. Sleep deprivation produced substantial decrements in four performance measures. The results are discussed in relation to the effects of personality types on performance during sleep deprivation.

1085.
LeVere, T. E., R. T. Bartus, and F. D. Hart. Electroencephalographic and behavioral effects of nocturnally occurring jet aircraft sounds. Aerospace Med. 43: 384-389, 1972.

The present research presents data relative to the objective evaluation of the effects of a specific complex auditory stimulus presented during sleep. The auditory stimulus was a jet aircraft flyover of approximately 20-sec duration and a peak intensity level of approximately 80 db (A). Our specific interests were in terms of how this stimulus would interact with the frequency pattern of the sleeping EEG and whether there would be any carry-over effects of the nocturnally presented stimuli to the waking state. The results indicated that the physiological effects (changes in electroencephalographic activity) produced by the jet aircraft stimuli outlasted the physical presence of the auditory stimuli by a considerable degree. Further, it was possible to note both behavioral and electroencephalographic changes during waking performances subsequent to nights disturbed by the jet aircraft flyovers which were not apparent during performances subsequent to undisturbed nights. The results then suggest that even limited exposure to nocturnal stimuli which do not necessarily produce behavioral awakening can nonetheless produce significant changes in an individual's pattern of sleeping and waking EEG and overt waking performance.

1086.
LeVere, T. E., G. W. Morlock, and F. D. Hart. Waking performance decrements following minimal sleep disruption: The effects of habituation during sleep. Physiol. Psychol. 3: 147-154, 1975.

The present research was concerned with whether the occurrence of habituation to auditory stimuli during sleep might attenuate the disruptive effects these stimuli can have on waking performance. Human subjects were exposed on different nights to either 0, 6, or 24 presentations of a 15 sec. burst of filtered auditory noise, and their morning waking performance was measured by a reaction time task previously shown to be sensitive to minimal sleep disturbances. The results indicated that on nights when 24 stimuli were presented, the subjects' average arousal response was significantly less as compared to the nights when 6 stimuli were presented, thus demonstrating the occurrence of habituation. However, the decreased average arousal when 24 stimuli occurred was not associated with superior morning performance. On the contrary, the subjects performed significantly better following the nights when only 6 stimuli occurrred even though the average arousal associated with the stimulus presentations were significantly greater. The data thus suggest that the relation between sleep disruption and waking performance is a function of not only the arousal produced by the individual stimulus occurrences but also, and perhaps more importantly, the number of stimuli occurring during the night.

1087.
Levi, L. Psychological and physiological reactions to and psychomotor performance during prolonged and complex stressor exposure. In: Stress and Distress in Response to Psychosocial Stimuli, edited by L. Levi. Oxford: Pergamon Press, 1972, pp. 119-142.

1088.
Levin, H. Health and work shifts. In: Shift Work and Health, edited by P. G. Rentos, and R. D. Shepard. Washington D.C.: U.S. Department of Health, Education, and Welfare, 1976, pp. 57-69.

1089.
Levine, H., E. Halberg, F. Halberg, M.E. Thompson, R. C. Graeber, D. Thompson, and H. L. Jacobs. Changes in internal timing of heart rate, diastolic blood pressure and certain aspects of physical and mental performance in presumably healthy subjects on different meal schedules. Proc. Int. Cong. Int. Soc. Chronobiol., 12th, Milan: Il Ponte, 1977, pp. 139-148.

Good agreement - relative in step synchronization - with near zero differences in circadian group acrophases is found for rhythms in right and left grip strength, finger counting, adding speed, vigor and mood of presumably healthy adult human volunteers under conditions of ad libitum eating. The timing of these same rhythms is also in good agreement with that reported earlier for similar functions of other groups of healthy volunteers. Moreover, the timing of these particular performance acrophases was roughly similar when the subjects ate but one single meal, as breakfast only or as dinner only. By contrast to such psycho-physiological performance rhythms, heart rate exhibited an advance in acrophase on breakfast only and a delay on dinner only. The circadian acrophase of diastolic blood pressure was delayed by breakfast rather than by dinner.

1090.
Levine, H., G. Halberg, R. B. Sothern, F. C. Bartter, W. J. Meyer, and C. Delea. Circadian phase-shifting with and without geographic displacement. In: Biorhythms and Human Reproduction, edited by M. Ferin, F. Halberg, R.M. Richart, and R. L. Vande Wiele. New York: Wiley and Sons, 1974, pp. 557-573.

Changes in the sleep/wakefulness routine and consequent phase-shifting of physiologic functions at different rates have provided an important means for studying circadian rhythms in particular. However, phase-shifting promises to become a biologic tool of even broader scope and may well serve in the future for scrutinizing interactions between circadian rhythms and reproductive cycles, among others.

1091.
Lewis, S. A. Sleep after shift in synchronisers. Int. Cong. Aviat. Space Med., 21st, Munich, 1974, preprints, p. 264.

1092.
Lewis, S. A., G. A. Christie, J. R. Daly, J. I. Evans, and M. Moore-Robinson. Preliminary results of the vigilance tests from "Project Pegasus". In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep, Proc. of the Symposium., Strasbourg, FR., 1970, edited by W. P. Colquhoun. London: English Universities Press, 1972, pp. 307-315.

Discussion of the vigilance tests results forming an integral part of Project Pegasus, an interdisciplinary study of the biochemical, physiological, and behavioral aspects of the time zone 'syndrome'. A team of 14 subjects were administered vigilance tests when assembled in London on November 4th, after being flown to San Francisco on November 10th, and following the return flight to London on November 21st, 1969. The results indicate that some of the subjects were relatively unaffected by the flight while others were considerably affected. THe very large individual differences were the most striking feature of all the results.

1093.
Lewy, A. J., T. A. Wehr, and F. K. Goodwin. Sunlight and artificial light have different effects on melatonin secretion in humans (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. II-6.

1094.
Lille F., D. Sens-Salis, P. Ullsperger, F. Cheliout, L. Borodulin, and Y. Burnod. Heart rate variations in air traffic controllers during day and night-work (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. VII-5.

1095.
Lindberg, R. G., E. Halberg, F. Halberg, and P. Hayden. Inversion of lighting regimen alters acrophase relations of circadian rhythms in body temperature, heart rate and movement of pocket mice. Space Life Sci. 4: 240-248, 1973.

A biotelemeter capable of simultaneously monitoring body temperature, heart rate, and animal movement was used to determine (1), whether those three parameters could be uncoupled or made to change their circadian phase relationship in response to reversal of the photoperiod (2), if measuring the three parameters could improve our understanding of circadian phenomenon in pocket mice, and (3), whether a cosinor form of time series analysis could be applied meaningfully to pocket mice data which appear as high amplitude square waves. All three questions were answered affirmatively although considerable individual variability was observed between the three mice studied.

1096.
Lindsley, D. F., R. H. Wendt, R. Fugett, D. B. Lindsley, and W. R. Adey. Diurnal activity cycles in monkeys under prolonged visual-pattern deprivation. J. Comp. Physiol. Psychol. 55: 633-640, 1962.

Two macaque monkeys, one rhesus and one cynomolgus, were raised from 3 weeks of age for 1 year, in an environment isolated from patterned auditory stimulation by white noise and deprived of light except for 1 hr. of unpatterned light stimulation each day. The activity of the two monkeys was continuously monitored by a stabilmeter system. Analysis of the records revealed intrinsic diurnal activity cycles which were anchored to the period of light stimulation and shifted position on an absolute time scale when the light-stimulation period was shifted. Dropping of feeding periods or shifting the feeding schedule had no such effect on the activity cycle. With each shift in the light schedule a transition period of 3 to 5 weeks was required before the activity cycle stabilized in a new location relative to the light.

1097.
Lindsley, D. B., R. H. Wendt, D. F. Lindsley, S. S. Fox, J. Howell, and W. R. Adey. Diurnal activity behavior and EEG responses in visually deprived monkeys. Ann. N. Y. Acad. Sci. 117: 564-588, 1964.

1098.
Lisper, H. O., I. Dureman, S. Ericsson, and N. G. Karlsson. Effects of sleep deprivation and prolonged driving on a subsidiary auditory reaction time. Accid. Anal. Prev. 2: 335-341, 1971.

1099.
Lisper, H. O., B. Eriksson, K. O. Fagerstrom, and J. Lindholm. Diurnal variation in subsidiary reaction time in a long-term driving task. Accid. Anal. Prev. 11:1-6, 1979.

Traffic accidents show a marked diurnal rhythm, which is a seldom investigated phenomenon. One possible background factor examined in the present study is the biological circadian rhythm. Eight subjects drove for 3 hr, beginning at 0300, 0900, 1500, and 2100. During each session a subsidiary reaction time task was used as an indirect measure of driving performance. Critical confounding factors, such as lighting conditions, traffic intensity, amount of sleep preceding the session and temperature in the car were considered. The results showed that there were small differences in the level of performance among the four sessions. However, differences in the rate of performance deterioration were not observed. From these results it was concluded that biological rhythm as a single variable has only a minor influence on this type of performance. Consequently the diurnal rhythm of traffic accidents must be attributed to other factors such as long hours of driving and/or sleep deprivation which culminate during the morning hours.

1100.
Lisper, H. O., and A. Kjellberg. Effects of 24-hour sleep deprivation on rate of decrement in a 10-minute auditory reaction time task. J. Exp. Psychol. 96: 287-290, 1972.

A reaction time (RT) task of short duration, characterized by a high signal rate (16 signals/minute) was used to examine if 1 night of sleep deprivation (SD) in interaction with task duration did transfer and/or change the RT distribution. Eight Ss participated on two occasions; after SD and after normal sleep. From a significant interaction between SD and task duration for 25th, 50th, and 75th percentiles, it was concluded that there was a general increase in RT. Strengthening of the interaction for the 75th percentile values and significantly more blockings for the last minutes in SD also did confirm an increased skewness found by other researchers. Since these effects are a function of interaction, it is suggested that one of the effects of SD can be an accentuation of the decrement found in vigilance.

1101.
Litsov, A. N. Experimental study of the diurnal rhythm of physiological functions, performance and sleep in man modified regimes with double alternations of sleep and wakefulness. Kosm. Biol. Med. 7(5): 78-85, 1973.

The dynamics of diurnal rhythm of physiological functions, work performance and sleep of test subjects exposed to two schedules with a double alternation of work and rest exhibited the same three stages (latent, apparent, and deep) which were observed under other schedules. The adaptation of these subjects to this alternation of sleep and wakefulness may adher to a fractioned (4+4 hours and 6+2 hours), displaced (4 + 0.6 + 0 hours) or mixed (fractioned, disturbed, and refractioned) schedules. The best schedule was a cycle with 6+2 hours of sleep. A schedule with two equal sleep cycles can be used temporarily to solve operational or emergency problems as well as an immediate one.

1102.
Litsov, A. N. Investigation of the rhythm of sleep and wakefulness in crews of the spaceships Soyuz 3-9 before, during and after exposure to spaceflight. In: Izd. Akad Nauk SSR. Sci. Biol. 6: 836-845, 1972 (Engl. transl. in: Washington D.C.: National Aeronautics & Space Administration, NASA-II-F-15103, 1973 16 pp.).

During the course of preparations for space flight and during its execution, the crews of the Soyuz-3-9 exhibited similar disturbances in the rhythms of sleep and wakefulness associated, on the one hand, with the influence of modified daily schedules and on the other hand, neuropsychic stress and weighlessness. The dynamics of higher nervous activity of these cosmonauts during space flight revealed four stages: (1) deterioration in the general feeling of well being, performance and sleep, (2) recovery and retention of functional state and performance of the cosmonauts to a high level, (3) gradual decline in functional state and performance of the cosmonauts, and (4) brief increase in functional state and performance of the cosmonauts immediately before landing. During the postflight period there was a general slowing in the rate of resynchronization of the sleep and wakefulness rhythms.

1103
Litsov, A. N. Rhythm of Sleep and Wakefulness in Crews of the Spaceships Soyuz 3-9 before, during and after Exposure to Spaceflight. Report No. JPRS-58, 1973, 17 pp.

The report contains data on the work and rest regimes of crew members of the Soyuz 3-9 space ships in the course of preparations for and implementation of space flight.

1104.
Litsov, A. N. Principles in formulating optimum sleep and wakefulness regimes for man during prolonged space flights. Kosm. Biol. Aviakosm. Med. 8(2): 71-75, 1974.

The main steps which can be taken to prevent unfavorable responses of cosmonauts to changes in work-rest schedules are as follows: development of optimum schedules, their good agreement with the biorhythmological peculiarities of every crew member, and preliminary adaptation of cosmonauts to the new cycle under favorable conditions on the earth. The optimum regimes are the routine regimes to which man normally adheres. Relatively optimum regimes are those which provide a rapid but incomplete rearrangement of the cycle. Non-optimum regimes are those which are not followed by a synchronization of the basic functions of the human body and the altered environment. The optimum level of the diurnal cycle is dependent to a certain extent on the duration of sleep and wakefulness periods, their change and fractionation, distribution of work and rest, etc. During space flight static 24-hour cycles seem to be the best; there may or may not be a transition to a new daily regime.

1105.
Litsov, A. N. Effects of prolonged unidirectional shift of sleeping-waking cycle on physiological functions, mental productivity and sleep of man. Kosm. Biol. Aviakosm. Med. 13(1): 53-58, 1979.

The paper gives the results of three 30-day experiments carried out to study the effect of migration of the sleep-alertness cycle on physiological functions, psychic productivity and sleep of man. The migration was aggravated by the initial change of the cycle which varied from 7 to 11 hours. All test subjects showed a counter-clockwise migration which amounted to a 1.5 hour shift every - 5 days. All test subjects demonstrated functional cerebral changes, decline of psychic productivity and sleep disorders. The level of those disturbances depended on the value of the initial shift of the sleep - alertness cycle and on the cumulation of the migration effect. Those disorders were noted even when the prechanged sleep - alertness cycle approximated the normal pattern as a result of migration. The results indicate that the migrating day - night pattern, particularly in combination with the initial shift of the sleep - alertness cycle, cannot be recommended for manned space missions. Good health condition and high work capacity of cosmonauts can be maintained, only if a 24-hour sleep - alertness cycle with a normal sleep pattern is provided.

1106.
Litsov, A. N. The peculiarities of human sleep under double alternation of cycles sleep-waking. Izv. Akad. Nauk. SSSR Ser. Biol. 4: 505-511, 1979.

The long-term experiments with double alternation of cycles "sleep-waking" cause the expressed disturbances in sleep both in quality (prolonged falling asleep, perfunctory sleep, frequently awakening) and in quantity (decreasing of sleep duration). Under two four-hours' regime of sleep four periods were distinguished:
-initial (the first day) period with good sleep for the two intervals;
-the second (2-6 days) period with sleep disturbances for the two intervals;
-the third (5-8 days) period with improvement and worsening of sleep by turn for the two intervals;
-the fourth day (8-10 days) period with sleep improvement and its prolongation to 6 hours at day time and its decreasing to 2 hours at night.

Under two unequal intervals of sleep regime three periods were noted:
-initial (1-3 days) with sleep disturbances for the two intervals;
-intermediate (3-5 days) period with sleep improvement at day time;
-the third (5-8 days) period with sleep improvement at night;

The sleep improvement was coming quicker under the regime with unequal distribution of intervals then that under two four hours regime.

1107.
Litsov, A. N., and I. F. Sarayav. Effects of unusual schedules of daily activity and sleep deprivation on man's functional state and work fitness. Kosm. Biol. Aviakosm. Med. 14(1): 17-23, 1980.

Physiological functions, work capacity and sleep characteristics of six healthy test subjects were studied for 30 days. The test subjects adhered to one of the three different regimens (1 - sleep from 2:00 a. m. to 10:00 a. m., 2 - sleep from 7:00 p. m. to 2:00 a. m. and 3 - sleep from 10:00 a. m. to 6:00 p. m.) which were aggravated by 64 hr or 72 hr vigilance during the experiment. The studies demonstrated general and specific changes in physiological functions, work capacity and sleep closely associated with the fact how far work-rest cycles were shifted and how long they were applied. Prolonged vigilance caused similar changes in physiological functions, work capacity and sleep. The test subjects showed very poor tolerance to an alteration in the work-rest cycle combined with sleep deprivation.

1108.
Lobban, M. C. Physiological circadian rhythms in shift-workers in the high arctic (abstract). Int. J. Chronobiol. 3: 12, 1975.

1109.
Lobban, M. C. Circadian rhythms of renal excretion in nurses on night duty (abstract). Egonomics 21: 865, 1978

Nurses who are permanently employed on night duty provide a population of experienced night workers in which physiological adaptation to their unusual hours of work may be investigated (Folkard and Haines 1977, Lobban and Nessling 1977). In two recent studies on full-time (working four successive nights per week) and part-time (two nights) night nurses their circadian rhythms of renal excretion of water, potassium, sodium and chloride have been compared with those of nurses working the normal day shift.

The rhythms of both full-time and part-time night nurses showed considerable disorganization on the first night shift, with low relative amplitudes; this disruption was most marked in potassium, although this is normally the most rhythmically stable of the urinary constituents studied. Some degree of reorganization was observed in most of the nurses on subsequent working nights, with a tendency of the rhythms to approximate to the temporal phase of the subjects' "night-oriented" activity patterns. In the full-time group, the rhythms of potassium, water, and chloride showed satisfactory temporal phasing and higher relative amplitudes on the fourth night. These findings indicated both long-term physiological adjustment to working at night and futher improvement in rhythmicity within each weekly period of night shifts. In both studies it would appear that the full-time group of night nurses attained a greater degree of physiological adjustment to night-work than did the part-time group.

1110.
Loeb, M., and E. A. Alluisi. An update of findings regarding vigilance and a reconsideration of underlying mechanism. In: Vigilance: Theory, Operational Performance, and Physiological Correlates, edited by R. R. Mackie. New York: Plenum Press, 1977, pp. 719-749.

The effects of numerous display, task, and organismic variables known to influence monitoring behaviors are reviewed, and the principal models or theories to explain such behaviors are assessed in light of the empirical findings. The current status of vigilance theories in the mid-1970s is summarized as follows: (1) Recent research, like previous research, has failed to confirm any one theory exclusively, (2) the data available continue to cast doubt on the prospect of any current theories being able to account adequately for all established vigilance phenomena, (3) the differentiation of "cortical arousal" may provide a basis for a useful advance in an arousal-theory explanation of some monitoring phenomena, especially as related to certain brain-wave activities, and (4) other factors not encompassed by any of the theories are known to affect vigilance, some of them to appreciable extent.

1111.
Lomonaco, T. Ritmi biologici in medicina aerospaziale. (Biological rhythms in aerospace medicine.) Minerva Med. 63: 430-433, 1972.

Biological rhythms tied to local times persist after rapid air transportation to a different time zone. The ensuing physiopsychic conflicts are not resolved until a number of days have passed.

1112.
Lomonaco, T. Human factors as the cause of aviation accidents, and their prevention. Minerva Med. 65: 1552-1556, 1974.

The human factor in air accidents and their prevention. - Psychological and physiological causes likely to be responsible for air accidents are listed, together with aeromedical means for their prevention. Stress is laid on strict medical examination when signing-on aircrew and during periodic checkups. Airports should employ aerospace mechine specialists devoted to the prevention diseases arising from flying and holding of courses for pilots in fundamental principles of aeronautical medicine.

1113.
Lortie, M., J. Foret, C. Teiger, and A. Laville. Circadian rhythms and behavior of permanent night workers. Int. Arch. Occup. Environ. Health 44: 1-11, 1979.

This paper describes rest/activity rhythms of permanent shift-workers: rotary printers. They reported during one week the hours of their sleep onset and of their meals, and their subjective appreciation of tiredness and mood. The average sleep duration (7.84 h) can be compared with that of day workers and is fairly longer than the duration of day sleep of shift-workers when they are on nightshift. This long sleep can be accounted for by: (1) the early bedtime (around 05.00 h), (2) an adjustment of biological rhythms to the schedule inversion. Other evidence (naps, meal time) supports the hypothesis of a physiological adjustment. It is pointed out that this adjustment is fragile: the printers must have very rigid life habits and schedules (sleep, meals). Each time they change this strategy (especially during week-end) it is subjectively felt as detrimental.

1114.
Loskant, H. Der Einfluss verschiedener Schichtformen auf die Gesundheit und das Wohlbefinden des Wechselschichtarbeiters (The influence of different kinds of shift on the health and physical fitness of alternating shift workers). Zbl. Arbeitsmed. 20: 133-144, 1970.

1115.
Loskant, H., and P. Knauth. Kriterien zur Gestaltung der Schichtarbeit. In: Ergonomische Aspekte der Arbeitsmedizin, edited by W. Brenner, W. Rohmert, and J. Rutenfranz. Bericht uber die 15, Jahrestagung der Deutsche Gesellschaft fur Arbeitsmedizin in Munchen, 1975. Stuttgart: A. W. Gentner Verlag, 1976, pp. 231-240.

1116.
Lotz, W. G. Physiological response to acute microwave exposure depends on the circadian rhythm (abstract). Fed. Proc. 39: 989, 1980.

1117.
Louis, A. M. Should you buy biorhythms? Psychology Today 11: 93, 95-96, 1978.

The author claims that anecdotal reports of biorhythm cycle phase-performance relationships are largely selected after the fact to support the theory. In two studies he compared observed and expected frequencies of positive, negative, and critical phases of the 3 biorhythm cycles on individual baseball pitches of 100 no hit games from 1934 to 1975, and found no significant differences. He also analyzed biorhythmic cycle phases in 100 heavyweight boxing title fights between 1889 and 1976 under the hypothesis that the winner would have a "biorhythmic advantage" (i.e., winners biorhythms in a positive phase, losers biorhythms in a negative or critical phase. No significant correlation was found between biorhythm phase and boxing performance.

1118.
Lubin, A., D. J. Hord, M. L. Tracy, and L. C. Johnson. Effects of exercise, bedrest and napping on performance decrement during 40 hours. Psychophysiology 13: 334-339, 1976.

1119.
Lubin A., J. M. Moses, L. C. Johnson, and P. Naitoh. The recuperative effects of REM sleep and stage 4 sleep on human performance after complete sleep loss: experiment 1. Psychophysiology 11: 133-146, 1974.

Twelve young (17-21 yr.) male Navy recruits volunteered for a sleep loss study. After 4 baseline days, the subjects were completely deprived of sleep for 2 days and nights. Next followed an experimental phase of 2 days and nights after which all subjects received 2 nights of uninterrupted sleep. During the experimental phase, the 4 subjects in the rapid eye movement (REM) deprived group were aroused whenever they showed signs of REM sleep. The 4 subjects of the stage 4 deprived group were aroused whenever they showed signs of entering stage 4 sleep, and the 4 subjects of the Control group had uninterrupted sleep. All tests (speed and accuracy of addition, speed and accuracy of self paced vigilance, errors of omission in experimenter paced vigilance, immediate recall of word lists, and mood) showed significant impairment after the first night of complete sleep loss. But during the experiment (sleep stage deprivation) and recovery phases, all 3 groups showed equal rates of recovery. Depriving the subject of stage REM or stage 4 during recovery sleep does not affect the recuperation rate. Frequent arousals (50-100 per night) also do not impair recovery. The amount of sleep is probably more important then the kind of sleep.

1120.
Lubin, A., C. Nute, P. Naitoh, and W. B. Martin. EEG delta activity during human sleep as a damped ultradian rhythm. Psychophysiology 10: 27-35, 1973.

1121.
Lucas, E. A. Effects of five to seven days of sleep deprivation produced by electrical stimulation of midbrain reticular information. Exp. Neurol 49: 554-568, 1975.

1122.
Lucas, E. A. Effects of short light-dark cycle on the sleep-wake patterns of the cat. Sleep 1: 299-317, 1979.

1123.
Lucas, R. Untersuchungen uber den Nachtschlaf des Menschen bei circadian freilaufendem Schlaf-Wachzyklus. Dissertation, Marburg, 1973.

1124.
Luce, G. G. Look what they're doing for jet fatigue! Travel & Leisure 2: 42-43, 90, 1972.

1125.
Luce, G. G., D. McGinty, and J. Segal. Current research on sleep and dreams. Washington D.C.: U. S. Dept. H.E.W., Public Health Service Publication No. 1389, 1971, 125 pp.

1126.
Lund, R. Circadiane Periode physiologischer und psychologischer Variablen bei 7 blinden Vpn mit und ohne Zeitgeber. (Ph.D. thesis). Munich, 1974.

1127.
Lund, R. Personality factors and desynchronization of circadian rhythms. Psychosom. Med. 36: 224-228, 1974.

About 20% of human subjects, living under constant conditions (without time cues) showed rhythms of activity and temperature with greatly different periods ("internal desynchronization"). Psychological testing indicated that these physiologically internally desynchronized subjects had a significantly greater tendency for neuroticism and showed a significantly greater tendency to complain of physical ailments than the other 80% of the subjects, which were not internally desynchronized with regard to rhythm of activity and temperature.

1128.
Lund, R. Instability of circadian rhythms and personality factors (abstract). Ergonomics 21: 863, 1978.

Subjects aged 20-35y with high neuroticism scores and complaints of physical ailments show a greater tendency for "internal desychronisation" of the rest-activity and body temperature rhythms under constant conditions without Zeitgeber than "stable" subjects (Lund 1974). Several recent isolation experiments have confirmed this finding, which has been interpreted as a weakness of the coupling betwen these rhythms. Wever (1975) also found a correlation between age and internal desynchronisation; however, his subjects had low neuroticism scores.

There are four possible factors which could account for this internal desynchronisation: (1) Sleep, since there is a correlation between poor sleep and both neuroticism and age; (2) Low Amplitude Rhythms, since these are sometimes seen in the aged and in patients with psychopathological disturbances; (3) Abnormal Periodicity, since the free-running period of the rhythms of those Ss who show internal desynchronisation has been found to differ from those who do not; and (4) Response to Stress, which is greater in emotionally labile and older subjects.

In experiments where "forced internal desynchronisation" was achieved by exposing subjects to 30 days of LD-schedules ranging from 20 to 32 h, post-trial neuroticism scores were significantly increased. It is hypothesised that the conflict between intrinsic rhythms and the demands of the new environmental and social conditions created by shift work will be exacerbated by personality factors like neuroticism, since this seemed to be the case in these experiments, where most of the subjects were aware that the LD-schedules were changing. Thus, the disadvantages of shift work can be expected to be particularly marked for people with high neuroticism scores, who, in any case, may exhibit desynchronisation in their circadian rhythms in such circumstances.

1129.
Lutz, T., T. M. Kramer, and T. Roth. The relationship between mood and performance (abstract). Sleep Res. 4: 152, 1975.

1130.
Lutz, T., T. Roth, M. Kramer, and J. Felson. The relationship between sleepiness and performance (abstract). Sleep Res. 5: 104, 1976.

1131.
Lynch, H. J., D. C. Jimerson, Y. Ozaki, R. M. Post, W. E. Bunny, Jr., and R. J. Wurtman. Entrainment of rhythmic melatonin secretion in man to a 12-hour phase shift in the light/dark cycle. Life Sci. 23: 1557-1564, 1978.

Daily rhythms in melatonin secretion were monitored in four healthy adult males by measuring the melatonin contents of sequential 4-hour urine specimens and of plasma samples collected at 12-hour intervals, or, in one subject, continuously for 24 hours. All subjects exhibited similar diurnal rhythms, with peak urinary melatonin excretion rates and blood melatonin levels occurring during the daily period of darkness and sleep. When the daily light/dark regimen was phase-shifted by 180°, the plasma and urinary melatonin rhythms required 5-7 days (depending on the subject) to re-entrain to the new schedule. Simultaneous measurements of plasma melatonin levels and melatonin excretion rates indicate that urinary melatonin reflects, with remarkable fidelity, circulating melatonin levels.

1132.
Lynch, H. J., Y. Ozaki, D. Shakal, and R. J. Wurtman. Melatonin excretion of man and rats: effect of time of day, sleep, pinealectomy and food consumption. Int. J. Biometeor 19: 267-279, 1975.

1133.
Lynch, H. J., and R. J. Wurtman. Physiological significance and control mechanism of pineal hormone rhythm in mammals: Control of rhythms in the secretion of pineal hormones in humans and experimental animals. In: Biological Rhythms and Their Central Mechanism, edited by M. Suda, O. Hayaishi, and H. Nakagawa. New York: Elsevier/North-Holland Biomedical Press, 1979, pp. 117-132.

1134.
Lyon, W. S. F. F. Dyer, and D. C. Gary. Biorhythm: imitation of science. Chemistry 51: 5-7, 1978.

Analysis was made of 112 lost time accidents from Oak Ridge National Laboratory with respect to biorhythm cycle critical days. Observed accident frequencies did not exceed expected frequencies for any of the 3 biorhythm cycles. Also, no significant differences were found when accidents were broken down into categories of victim at fault, victim not at fault, and indeterminate fault.

1135.
Lysaght, R., T. Roth, M. Kramer, and P. Salis. Variations in subjective and body temperature across the day (abstract). Sleep Res. 7: 308, 1978.

1136.
Maasen, A., A. Miers, and P. Virhaegen. Quantitative and qualitative aspects of sleep in four-shift workers. Ergonomics 21: 874, 1978.

Over a 25 week period, 27 shift-workers (mean age 28 y) made daily recordings of their sleep and waking times, together with notes of sleep interruptions, difficulties in getting to sleep, and pre-sleep consumption of sleeping pills and coffee. The subjects had followed, for a 4 y, a semi-continuous four-shift system, comprising six morning shifts (0800-1600 h), six afternoon shifts (1600-2400 h), six night shifts (2400 - 0800 h) and six free days. The six-day shift periods were from Monday till Saturday, and were always followed by a free Sunday. The mean sleep duration (including the post-shift Sunday) was 8 h 15 min on the morning shift, 7 h 56 min on the afternoon shift, 7 h 26 min on the night shift, and 8 h 18 min on the free week. The overall mean sleep duration over the four weeks was exactly 8 h. Within each of the four shifts there were substantial interindividual differences. The amount of sleeep was significantly greater during the free week, and significantly smaller during the night-shift week, than the amount of sleep in each of the other three weeks. Difficulties in getting to sleep were not very common, but were significantly more frequent on the afternoon and night shifts than on the morning shift or on the free week. Sleep interruptions were more common on the night shift, their mean number per sleeping period and subject amounting to 0.35. However, correcting for these sleep interruptions did not noticably change the sleep duration values. These results suggest that the duration and quality of sleep in these shift workers was quite satisfactory. This may be due to the particular time schedules used in the shift-system, to the compensation for partial loss of sleep made possible by the free week, to the occurrence of some (self-) selection, and, finally, to the relative youth of the subjects.

1137.
Maasen, A., et al. Quantitative and qualitative aspects of sleep in young self-selected four-shift workers. Int. Arch. Occup. Environ. Health 45: 81-86, 1980.

1138.
MacFarlane, W. V. Night light and human functions. IES Lighting Review 36: 35-41, 1974.

Changes of lighting and work patterns are important in shift working, in time-zone displacement and in military types of operations. The disruption of the circadian rhythm which results, is discussed in relation to a number of physiological functions. The body eventually adjusts itself to these abnormal living patterns but at different rates for different people.

1139.
MacKenzie, J. How biorhythms affect your life. Science Digest, Aug. 1973, pp. 18-22.

This is a general review article on biorhythm theory which is generally supportive of the theory. It cites the meager scientific evidence supporting the theory, including a claim that R, Hersey discovered the 33 day intellectual cycle (for a critique of this claim, see Hersey 1931 J. Mental Scil 77: 151 in bibliography). It also cites a 1971 paper by Sandia Laboratories in which lab accidents over a 20 years were analyzed. They reported the possibility of heightened accident susceptibility during a phase similar to that in which the individual was born.

1140.
Mackie, R. R., editor. Vigilance: Theory, Operational Performance, and Physiological Correlates. New York: Plenum Press, 1977, 862 pp.

1141.
Mahoney, R. P. A Test of the Natal Biorhythm Theory (Ph.D. Thesis), California School of Professional Psychology, 1979

This study examined biorhythm cycle phase and critical day relations with persons seeking inpatient psychiatric services during a critical day, and measurements of manual dexterity self-congruence, multiplication abilities and electromyograph recordings in 98 students. Little relationship was found between any of the measures and the critical day hypothesis. However, manual dexterity was positively correlated with the physical cycle, self-reported ideal vs. actual activity levels were negatively correlated with the emotional cycle and math scores were positively correlated with the intellectual cycle. A 7.66 day sub-cycle of the physical cycle was found to significantly correlate with performance on the manual dexterity. Psychiatric inpatient admissions were also found to negatively correlate with the emotional cycle. The electromyograph data demonstrated no significant relationships to the biorhythmic cycles. Insufficient information on sampling and statistical methods is available in this abstract to evaluate the authors' findings.

1142.
Makarov, V. I. Effect of the physical load on human biorhythms - relating to space flight. In: Optimization of the Professional Activity of a Cosmonaut. Moscow: Izdastel'stvo Nauka, 1977, pp. 130-135.

The effects of increased physical load on the biorhythms of healthy untrained humans were studied for the purpose of determining the upper limit of physical loading to which people can adapt without disruption of the inherent rhythms of their physiological functions. The stress caused by physical loading is considered with attention to the desynchronization it causes and the lowering of the general adaptative capability of the organism. Physical load is a negative effect of prolonged weightlessness, as would be caused by a voyage in space.

1143.
Makowsaka, Z. Night and shift work. Preference of a working shift and shift systems. Sleep time and fatigue of women employed in three shift systems in the textile industry. Med. Pracy 25: 321-332, 1974.

1144.
Malaviya, P. and K. Ganesh. Individual differences in productivity across types of work shift. J. Appl. Psychol. 62: 527-528, 1977.

Productivity measures from 60 weavers who alternately worked day and swing shifts under similar environmental conditions were compared to check the validity of the conclusions of an earlier study. Once again, the results showed that although day-shift productivity as a whole was significantly higher than that of the swing shift, weavers differed in their relative productivity between the two shifts. Some weavers produce more during the day shift whereas others produced more during the swing shift.

1145.
Malbecq, W., G. Cornelissen, and J. De Prins. Some methods for the assessment of phase shift (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. I-3.

The nonstationary nature of a time series affected by phase shift makes analysis difficult. The authors suggest that for conditions in which phase and amplitude slowly varies, that complex demodulation or chronobiological serial sections would be appropriate. Cosinor analysis is limited in value unless adjustments are made (time series decimation). Discrete spectral analysis is less sensitive to correlated noise and rhythm shape.

1146.
Mallardi, V. Biorhythms and Your Behavior. Bethlehem, Pa: Media America, Inc., 1975.

1147.
Mallardi, V. Biocycles: You Can Use Biorhythms to Forecast Your Future and That of Your Favorite New-Makers. Dell, 1978.

1148.
Mallardi, V. Biorhythms and Your Behavior: A Personal Diary and Planning Program for Time and Life Objectives. Philadelphia: Running Press, 1978, 80 pp.

This book provides an elementary discussion of biological rhythms, chronotherapy and Fliess' biorhythm theory. The author often confuses the biorhythm theory with biological rhythm research. In a foreword, he dismisses commercial biorhythm charting as nonsense, yet later discusses the Fliess' 23 and 28 day cycles (from which biorhythm charting was derived) along with biological rhythm research as if there were no distinction. He mentions that biological rhythms can be phase shifted or altered but fails to see how this conflicts with the theory of immutable biorhythm cycles of constant period length. The author discounts the results of statistical studies in which no relation between accidents and biorhythm cycles was found by stating that biorhythm effects a tendency for performance but is not a guarantee of performance levels (and thereby implies that biorhythm tendencies are not statistically significant!). He believes biorhythm will be useful for the future scheduling of physical exertion, sexual relations, group activities, decision making and vacations.

1149.
Mangina, D. V. The physiological cost of flight work. Voenno-Med. Zh. No. 6, pp. 61-64, 1971.

1150.
Mann, H., E. Poppel, and J. Rutenfranz. Untersuchungen zur Tagesperiodik der Reaktionszeit bei Nachtarbeit. (Circadian rhythm of reaction time during night work. III. Correlations between body temperature and reaction time.) Int. Arch. Arbeitsmed. 29: 269-284, 1972.

Body temperature and reaction time werre investigated in 7 subjects during 5 periods of investigation. Simultaneous measurement of both variables were taken every 4 hrs. In each period of investigation body temperature and reaction time showed clear 24 hr-rhythms. During the course of the day reaction time decreased when body temperature increased and vice versa. There was a significant negative correlation of all pairs of data of both variables which were measured at different times of the day. No significant correlation between body temperature and reaction time was obtained when values of the same time of day from several days or average values from successive days were compared.

It is concluded that the negative correlation of body temperature and reaction time is based on the phase-relationship of their circadian rhythms and not on a direct causal connection. Therefore, body temperature cannot be regarded as an indicator of performance.

1151.
Mann, H., J. Rutenfranz, and S. Stiller. Untersuchungen zur Tagesperiodik der Reaktionzeit bei Nachtarbeit - IV Tagesperiodische Anderungen der Parameter Empirischer Reaktionszeitverteilungen. (Circadian rhythm of reaction time during night work. II. Diurnal variations in the parameters of empirical histograms of reaction times.) Arch. of Occupational Health 31: 193-207, 1973.

The parameters of empirical frequency distributions of reaction times were investigated at different times of the day in 12 Ss by measurements of multiple choice reaction time with visual signals. The reaction times used as the basis for the frequency distributions were measured every 4 hrs at 6 different times of day. Each 4-minute examination involved the recording of 24 reaction times. No changes in reaction time occurred during individual examinations. The arithmetic mean and standard deviation of the frequency distributions measured at different times of day revealed clear circadian changes, the phases bearing the same relationship to the time of day in each case. There was no circadian variation in the variation coefficients or the skewness of the frequency distributions. It is concluded that lengthening of reaction time during the night is caused by a general diminution of reaction velocity while the shape of the frequency distributions remains constant.

1152.
Mann, H., J. Rutenfranz, and R. Wever. Circadian rhythn of reaction time during night work. II. Relation between mean and range of oscillation. Int. Arch. Arbeitsmed. 29: 175-187, 1972.

1153.
Manson, J. C. Cyclic variations of the frequency of neutrophil leucocytes with "androgen-induced" nucleus appendages in man. Life Sciences 4: 329-334, 1965.

Smears of capillary blood from one man collected over 5 months revealed a period of 27.2 days (range 25-30, counted from minima to minima) in the frequency of leucocytes having one or more c-appendages.

1154.
Martel, P. J., G. W. G. Sharp, S. A. Slorach, and H. J. Vipond. A study of the roles of adrenocortical steroids and glomerular filtration rate in the mechanism of the diurnal rhythm of water and electrolyte excretion. J. Endocrinol. 24: 159-169, 1962.

1155.
Martin, D. E., J. L. Elliot, and B. S. Garcha. Can highs and lows be predicted? Runners World 12: 40-41, 1977.

The authors obtained information on 1395 track races from 23 runners along with a self-graded impression of each race. A set of criteria were applied to the sample: run on a flat surface of uniform composition, a precisely measured course, and run with sufficient frequency to give statistically valid conclusions. Correlations between graded and actual performance and biorhythm cycle phases were performed. No significant relationship was found between biorhythm physical or intellectual cycles and performance but there was a significant correlation between graded performance and the emotional biorhythm. Graded performance scores did not differ on critical days from non critical days. Only 10/38 race dropouts occurred on a critical day.

1156.
Martin, J. L. Relationship of Selected Biological Rhythms to Performance of Competitive Swimmers (Ph. D. Thesis). University of Utah, 1974.

The relationship between biorhythm cycle phases and the performance times of 31 college swimmers collected over 2 months was anlyzed by chi square. A significant (.05) relationship between performance and the emotional, but not the physical or intellectual cycles was demonstrated. When the physical and emotional cycles were in oscillation synchronization, a close relationship between performance and biological rhythms occurred. The critical day factor seemed to have no definite relationship to performance. The author, in using the term "biological rhythm" to describe what is clearly the Fliess' biorhythm cycles, perhaps does not understand the important distinctions between them. The reputed significant relationship between performance and the emotional cycle whould have been more convincing if the actual performance data had been used instead of coded + or - values (with respect to the mean) and if a multiple regression had been performed. There is no indication in the abstract of number of performance times/swimmer or if circadian effects were controlled.

1157.
Martin, L. Biorhythm Handbook, Work Book and Forecaster. B & N Books, 1978.

1158.
Martinet, P. Le cout humain du travail en equipes alternantes dans une fabrique de fils et fibres synthetiques de province (Human cost of alternating shift work in a provincial synthetic yarn and fibre plant). In: Service Medical du Travail. France: Rhone-Poulic-Textile, 1975, 192 pp.

After a number of general considerations on the '4-8' shift work system (4 teams: three 8-h shifts per day, one team off duty) used in the plant under study, the staff concerned and the working conditions, this doctoral thesis presents the results of a questionnaire survey, carried out among the staff, covering the following points: assessment of working hours in relation to length of service; advantages and disadvantages of the system; health impairment (nervousness, fatigue, digestive disorders); variations in frequency of digestive disorders related to working conditions; breakdown of occupational accidents according to time of day or night; workers' body-weight charts; duration and quality of sleep; evaluation of continuous shift work in relation to family and home life, commuting problems, age, etc; leisure activities. On the whole the advantages tended to outweigh the disadvantages and the limited health hazard was more than compensated by a number of satisfactions (high wages, free time). However, the author is against the principle of paying higher rates for shift work and would prefer to see compensatory time off granted. He also recommends reducing the number of shifts in the continuous system.

1159.
Martinez, J. L. Effects of selected illumination levels on circadian periodicity in the rhesus monkey (Macaca mulatta). J. Interdiscipl. Cycle Res. 3: 47-59, 1972.

1160.
Mason, K. An Investigation of the Biorhythm Theory. Workmans's Compensation Board of British Columbia, 5255 Heather St., 13, B. C., 1971.

Studied expected and observed frequencies of 13285 industrial accidents with respect to biorhythm cycle critical days. Accidents tended to occur no more frequently on critical days than on noncritical days. Occurrence of accidents on multicritical days did not exceed chance expectancy.

1161.
Matinyan, L. A., et al. Quantitative evaluation of biorhythms. (Russian). Biologicheskiy Zhurnal Armenii 30: 31-35, 1977.

The authors propose to diagnose pathology of an organ from the nature of the deviation of its biological rhythms from the norm and to restore its normal function by applying vibrations with frequencies corresponding to the natural biological rhythm.

1162.
Matlina, E. A., V. N. Vasilev, and S. D. Galimov. Circadian rhythms of the activity of the sympatho-adrenal system in the healthy man. Fiziol. Chri. 2: 970-985, 1976.

Available published materials are reviewed concerning the circadian rhythms for the release of catecholamines, their precursors, and metabolites in the healthy man in the resting state, under neuro-emotional stress, during exercise, and during change of time zones. It is shown that release of the cited substances in healthy young individuals varies in a definite circadian rhythm, and that the resulting changes are due to the diurnal dynamics of the activity of the sympatho-adrenal system. Elderly persons are found to exhibit rhythm disturbance consisting of the absence of nighttime reduction in the release of catecholamines. THe changes are more pronounced when working at night than working in the daytime. THe higher amplitude of epinephrine release fluctuation in athletes as compared to untrained persons points to permanent stress on the adrenal medulla in modern high-level sports activities. Change disordered circadian rhythm for release of catecholamines.

1163.
Matsumoto, K. Sleep patterns in hospital nurses due to shift work: an electroencephalographic study. Waking and Sleeping 2: 169-173, 1978.

Daytime sleep after night duty (00.30 08.30 h) and nocturnal sleep after day duty (08.30 16.30) was recorded on 5 hospital nurses working under a three-shift-system. The two recordings on the same subjects were compared with each other. The comparisons revealed that: a) time in bed and total sleeping time were significantly shorter in daytime than in nocturnal sleep, but there was no difference between the two with regard to sleep latency; b) in daytyime sleep, 2 of the 5 subjects were characterized by appearance of REM sleep immediately after falling asleep, and by significant shorening of REM latency; c) stage I was significantly greater in proportion to total sleep in daytime sleep than in nocturnal sleep, and percent time in stage 2 was smaller in the former. Stages 3 and 4, and REM sleep, did not differ in nocturnal and diurnal sleep; d; when the total sleeping time of each subject was divided into three equal parts. REM sleep in daytime sleep was greatest in the middle third, followed by the first and last third in the descending order. This distribution differed from that in nocturnal sleep. NREM sleep of stages 3 and 4 during daytime sleep had the largest proportion in the first third, followed by the middle and last third. The same distribution was observed in nocturnal sleep except that stage 4 occurred proportionately more in the last third of daytime sleep.

1164.
Matsumoto, K. N. Sasagawa, and M. Kawamori. Studies on fatigue of hospital nurses due to shift work. Japanese Journal of Industrial Health 20: 81-93, 1978.

Report on a study in 115 nurses working either a 3-shift system (day, evening and night shifts), a 2-shift or a permanent night shift system. Complaints of fatigue after a shift were greatest for the night shift, followed by evening and day shift. Symptoms of drowsiness, etc., were more frequent after a shift following an off-duty period of 8 h than one of 16 h. Flicker fusion frequency and body temperature were extremely low during night shifts, especially between 0400 and 0600 h. Conclusions: nurses are adversely affected by short off-duty periods and consecutive night shifts, and the shift system should be corrected so as to avoid these conditions.

1165.
Matyukhin, V. A. Bioritmologiya permeshcheniy cheloveka (Biorhythmology of human travel). Novosibirsk: Nauka Press, 1976.

This book discuses biological rhythms in people travelling in latitudinal directions with time-zone changes. Data were presented on the biological rhythms of people such as pilots, who systematically shifted location and of people who made a single long distance flight. From these data, the authors determined normalization of synchronization periods for rhythms during long flights.

1166.
Matyukhin, V. A., D. V. Demin, and A. V. Yevtsikhevich. Biorhythmology of human movements. Novosibirsk: Nauka, 1976. Fiziol. Chel. 3: 560-561, 1977. (Book review by N. A. Agadzhanyan.)

1167.
Matyukhin, V. A., and N. O. Nedbaeva. Seasonal and diurnal dynamics of skin temperature and heat loss in adolescents during adaptation. Fiziol. Chel. 4: 742-747, 1978.

1168.
Maurice, M. Shift Work: Economic Advantages and Social Costs. Geneva: International Labour Office. 1975, 146 pp.

In this general introduction to a question which is the concern not only of ergonomists, economists and production engineers, but also of sociologists and industrial medical officers, emphasis is placed on the great variety of approaches to shift work and on the diversity of the work schedules that now exist. Their respective advantages and drawbacks from the differing points of view of employers, workers and the public authorities are examined, and attention is drawn to a number of possible improvements. The study also includes several appendices; in addition to a selected bibliography of the main publications used in its preparation, the appendices give further information on the labour legislation on shift work, examples of the reasons for the adoption of this method of working in various branches of economic activity, examples of different arrangements of hours of work, a number of case studies of the introduction of new systems of continuous working, and statistics.

1169.
Maurice, M., and C. Monteil. Vie quotidiene et horaires de travail. Enquete psychophysiologique sur le travail en equipes successives. Institut des Sciences Sociales due Travail, Centre de Recherches. Paris: Universite de Paris, 1965.

1170.
May, R. R. Mood shifts and the menstrual cycle. J. Psychosom. Res. 20: 125-130, 1976.

This study used the reports of 30 healthy young women to examine the relation between mood changes and the menstrual cycle. One of the more important findings, from the standpoint of the research methods used in this area, is that there was no correspondence between one-time retrospective reports of menstrual mood variations and the actual reports of mood at different points in the menstrual cycle. Mood changes were not significantly related to physical symptoms or to the degree of physiological distress experience during the menstrual cycle. Dividing the cycle into 3 phases, 50% of this group had their lowest, their most depressed, mood at the premenstrual phase while 40% felt worst at the menstrual phase (the remaining 10% have a low at midcycle). Interview and psychological test information suggested that these 2 major groups may differ in some important attitudes and feelings.

1171.
Mayer, W., and I. Scherer. Phase shifting effect of caffeine in the circadian rhythm of _Phaseolus coccineus L._ _Z. Naturforschung_ 30C: 855-856, 1975.

1172.
McCabe, C. Carter, Jet lag. _San Francisco Chronicle_, 22 March 1979.

1173.
McCally, M. The use of period analysis to evaluate human physiological and psychomotor performance. Report No. AD-730 539, 1967, 9 pp.

Data have been presented as a demonstration of a new tool and a new point of view for the environmental physiologist; and to suggest new directions for research. The information needed to answer physiological questions includes: (1) detailed mapping of the spectrum of a variety of physiological and performance variables over a wide band, perhaps from one second to one month, at rest and during various levels of environmental stress; (2) the development of meaningful statistical procedures for defining confidence limits for changes in period, amplitude, and phase of the observed oscillations; and finally (3) the definition of the specific physiologic control systems of which the observed oscillations are an expression.

1174.
McCally, M., and P. Rieger. The REM sleep rhythm - its relationship to sleep onset (abstract). _Fed. Proc._ 33: 369, 1974.

There are two hypothesis concerning the REM rhythm: (1) the near sleep and is triggered by sleep onset (SO). (2) there is a continuous, day-long near 90 minute rhythm not peculiar to sleep which may be correlated with time of day. We examined the relationship between SO and RO while systematically varying the independent variable SO. Sleep EEC, EMC and actogram were recorded by conventional techniques from 8 young adults.

Three control nights with recording were followed by three nights in time of going to bed was delayed by 30 minutes. As a result, SP was shifted 30 minutes and a clear, approximately 30 minute delay in RO was seen. In a similar protocol, after three control nights SO was delayed 20 minutes each night for 4 nights and then advanced 20 minutes for 4 nights. Again there is a strong temporal correlation between the onset of sleep and the onset of the first REM period. This correlation is not so clear for the second, third, and fourth periods. These results demostrate that when SO is experimentally controlled and systematically shifted, the subsequent RO is highly correlated with SO. We concluded that the two hypotheses are not mutually exclusive and are both, in part, correct.

1175.
McCally, M., H. M. Wegmann, R. Lund, and J. Howard. Effects of simulated time zone shifts on human circadian rhythms. _Proc. Int. Congr. Aviat. Space Med._, 21st, Munich, 1973, pp. 260-263.

1176.
McConnell, J. V. Biorhythms: A report and analysis. J. Biol. Psychol. 20: 13-24, 1978.

Biorhythm theory predicts that in addition to the different psychophysiological rhythms, all individuals experience a 23-day physical cycle, a 28-day emotional cycle and a 33-day intellectual cycle. These cycles are presumed to be set at birth and hence are said to be unchangeable. It is argued, however, that there is no reliable evidence that these cycles exist as described; if they do exist, they are probably much more flexible and capable of alteration than current biorhythm theory allows. The strongest objection that can be made to current biorhythm theory is that it has too often been used to blame an individual's genes for his/her poor performance that might be caused by improper training, lack of psychological knowledge, and inefficient management.

1177.
McFarland, R. A. Understanding fatigue in modern life. In: Methodology in Human Fatigue Assessment, edited by K. Hashimoto, K. Kogi, and E. Grandjean. London:Taylor & Francis Ltd., sec. 1, 1979, pp. 1-10.

Since fatigue in its many forms can result from a variety of causes acting singly or in combination, it is difficult to give clear-cut rules or principles for its control or prevention. Each case must be evaluated according to its own peculiar characteristics. For the individual suffering from chronic fatigue, the most logical first step would be an examination by a physician to determine whether or not any organic basis for the condition exists. Where it does not, attention must be directed towards finding the most likely cause, and making the necessary changes in one's life and schedule of living. A few recommedations of general applicability would include: adequate sleep; the establishment of a daily work-rest cycle acceptable to the individual; the elimination of conditions resulting in excessive stress, anxiety, or boredom; the institution of a definite, adhered-to schedule of physical exercise or sports; the possible use of stimulants or medications. For the organizational control of fatigue, as in industry, the coordinated efforts of the medical and administrative departments are needed. The medical department should be concerned with the maintenance of fitness through adequate physical and mental hygiene programmes, and, in industries where it is appropriate, with the selection of emotionally stable and fatigue-resistant personnel. Finally, those in charge of administration can contribute most by seeing that work schedules, working conditions, and personnel relations are all maintained at levels consistent with the interests and well being of the employee, as well as of the company.

1178.
McFarland,R. A. Influence of changing time zones on air crews and passengers. Aerosp. Med. 45: 648-658, 1974.

The introduction of jet aircraft into general use has resulted in a technological revolution for both air crews and passengers. Although safe and comfortable, they have introduced a physiological stress for passengers flying east or west, known as the problem of "circadian rhythm", which is essentially induced by the rapid time changes over four or more time zones. Certain intrinsic physiological mechanisms, cyclic in nature, and regulated by stimuli from the day-night cycle of the environment, appear to be disturbed. In the first part of the paper brief analysis is presented of the basic physiological rhythms of the body in both man and animals. The findings are then related to air crews and passengers. The specialized studies simulating air transport schedules are then discussed from the point of view of suggested solutions. An example is "Project Pegasus", carried out by Christie and associates, on the effects of air travel across nine time zones. Emphasis is then placed on various factors which may influence or accentuate the effects of rapid flights across time zones. The application of in-flight studies are reviewed and recommendations are made for air crews and passengers. An additional extensive bibliography has been completed by the author, and is available on request.

1179.
McFarland, R. A. Air travel across time zones. Am. Sci. 63: 23-30, 1975.

The primary objective of this paper is to highlight some of the more than 200 recent studies that throw light on the problems encountered by the modern jet air traveler. Studies carried out in the 1930s and 40s by the author in the early, long-range flights at slower speeds provide some background data on the physiologic reactions to air travel then and now. Some of the most important information comes from an analysis of the following questions: (1) What is known about the physiology of the circadian rhythms? (2) How much of the effect on the rhythm is determined by the external environment, and how much internally by the organic or body processes? (3) To what extent can the 24-hour physiological cycle be altered and in what ways? (4) What factors - such as alcohol, carbon monoxide, diet, and drugs - accentuate the fatiguing effects? and (5) Practically, how can the modern air traveler make better adjustments to the geographical and physiological disruptions?

1180.
McGovern, J., M. Smolensky, and A. Reinberg. Chronobiology in Allergy and Immunology. Springfield, ILL.: Charles C. Thomas, 1977.

1181.
McGuire, R. A. W. M. Rand, and R. J. Wurtmand. Entrainment of the body temperature rhythm in rats: effect of color and intensity of environmental light. Science 181: 956-957, 1973.

1182.
McKenzie, R. E. Assessment correlates of workload and performance. In: Survey of Methods to Assess Workload, edited by B. O. Hartman, and R. E. McKenzie. Neuilly-sur Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-AG-246, 1979, pp. 145-161.

1183.
McKenzie, R. E. Concepts of stress. In: Survey of Methods to Assess Workload, edited by B. O. Hartman and R. E. McKenzie. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-AG-246, 1979, pp. 7-9.

1184.
McKenzie, R. E., and B. O. Hartman. Some insights relative to the man-machine system: an overview of the ten years of research. In: Survey of Methods to Assess Workload, edited by B. O. Hartman and R. E. McKenzie. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-AG-246, 1979, pp. 17-18.

1185.
McKissick, T. L. A Study of the Effects of the Biorhythm Cycles Upon Physical and Mental Performance (abstract). Ph.D. Thesis, East Texas State University.

Measurements of endurance (mile run), agility (4 step hop time), power (vertical jump), emotional state (IPAT self-analysis form) and intellectual performance (Otis Quick-Scoring Mental Ability Test) were administered daily at the same time for 9 phases of the 3 biorhythm cycles in 38 female students. Analysis by t-test and analysis of variance revealed no significant changes in any of thexe scores with respect to plus, critical or minus phases of the 3 biorhythm cycles. It would have been intersting if the author had utilized multiple regression or periodicity analysis to determine if any low-frequency biological rhythms were present in this data.

1186.
McNee, R. C., R. A. Albanese, W. G. Jackson, W. F. Storm, and B. O. Hartman. The correlational structure of traditional task measures and engineering analogues of performance in the cognitive domain. In: Higher Mental Functioning in Operational Environments, edited by B. O. Hartman. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-181, 1976, pp. C2-1 - C2-6.

Standard performance measures from a traditional battery of tasks (the Neptune battery) were compared with simulated antiaircraft gunnery activities under several configurations. These measures were found to correlate only to a moderate degree, with the highest canonical correlation between the two sets being .72. Preliminary modeling of the subject reactions on the simulation, a compensatory tracking task, has been accomplished using control theory methods. A tentative conclusion from this work is that the transfer functions associated with random inputs are reasonable to use for this compensatory tracking task, which involves both deterministic and random inputs.

1187.
McNew, J. J., R. C. Burson, T. Hoshizaki, and W. R. Adey. Sleep-wake cycle of an unrestrained isolated chimpanzee under entrained and free-running conditions. Aerosp. Med. 43: 155-161, 1972.

1188.
McPhail, H. The Relationship of Biorhythm Cycles to Performance on Selected Skill Tests (abstract). Ph. D. Thesis, University of Southern Mississippi. Diss. Abstr. 37: 5682A-5683A, 1977.

Determination of performance in the shuttle run, standing long jump and basketball free throw was made on 100 male students during a five month period, once when biorhythm cycles were in a high phase and once when biorhythm cycles were in a low phase. Data were analyzed by correlated t statistical test. There were no significant differences in performance between biorhythm cycle high or low phases. THe use of only two samples/variable/subject is questionable in this study. Selection of only high and low biorhythm phases biases the sample population in favor of the biorhythm theory-performance relationship but since no relationship was found, the use of the biased sample population tends to give added weight to the authors' findings.

1189.
Medd, A., E. Taggart, J. Kuiack, C. Rountree, P. Ridgeout, N. Hubbard, O. Pawlus, D. Rubenstein, J. Price, R. Lutz, G. Glavin, and R. Obilvie. Sleep deprivation and circadian mood and performance measures. Sleep Res. 7: 273, 1978.

Subjective health scores were obtained from 104 workers who were re-examined six months later, at which time a decrease in their health scores was evident. Four years and four months after they started working in the new plant, 95 workers out of the original 104 were studied a third time. Subjective health had further decreased in the 64 subjects who were still working in the plant, but in the 31 subjects who had left it had stabilized approximately at the level recorded after six months.

1190.
Meers, A. Performance on different turns of duty within a three-shift system and its relation to body temperature-two field studies (abstract). Int. J. Chronobiol. 3 : 10, 1975.

1191.
Meers, A., A. Maasen, and P. Verhaegen. Subjective Health after four years of shift work. Ergonomics 21: 857-859, 1978.

1192.
Mellersup, E. T. Lithium effect on temperature rhythm in psychiatric patients. Acta Pharmacol. Toxicol. 42: 125-129, 1978.

The diurnal rhythm of oral temperature was studied in 55 lithium treated patients, 51 other psychiatric patients, and 58 healthy subjects. The lithium treated patients had a higher temperature than the normal controls during the 24-hour period and their temperature maximum was shifted towards an earlier time. When the lithium intake was postponed for 12 hours, temperature temporarily decreased to control values, but returned to the higher level after the lithium dose. The temperature results are discussed in relation to lithium induced changes in electrolyte metabolism.

1193.
Melton, C. E., and J. M. McKenzie. Physiological Responses in Air Traffic Control Personnel at O'Hare Tower. TRC Report No. P-177082, 1971, 15 pp.

Physiological and biochemical measurements were made on twenty-two air traffic controllers at O'Hare tower during five days of the heavy traffic evening shift (1600-2400) and five days of the light traffic morning shift (0000-0800). Pulse rates were higher on the evening shift than on the morning shift. Converging approaching traffic was more excitatory than departing diverging traffic on the evening shift there was no differential response on the morning shift. Galvanic skin response indicated that adaptation to the morning shift was incomplete in five days. Fibrinogen levels in controllers' blood was not elevated above the expected level for their age group. Controllers had a higher total plasma phospholipid concentration than populations of normal people, schizophrenics and combat pilots. Phosphatidyl glycerol was significantly higher in controllers' plasma than in the normal population, but less than in the combat and schizophrenic populations. Finding from urine analyses that are reported separately by Hale et al., have been summarized in this report.

1194.
Melton, C. E., J. M. McKenzie, J. T. Saldivar, and M. Hoffmann. Studies of stress in aviation personnel: analysis and presentation of data derived from a battery of measurements. In: The Role of the Clinical Laboratory in Aerospace Medicine, edited by R. G. Troxler. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-180, 1976, pp. A9-1 - A9-6.

Total stress in working people can be understood only through a battery of measurements that give insights into the function of several systems. When personnel are piloting aircraft or controlling air traffic, the measurements must be made on easily obtainable fluid, usually urine, so that the task is not compromised. Adrenal steroids are primarily reflective of chronic stress, whereas the catecholamines are related to acute stressors. Narrative descriptions of changes in excretion of stress indicators are difficult to follow. Because of complexity of data from batteries of measurements, the usefulness of stress studies is largely denied to managers.

1195.
Melton, C. E., J. M. McKenzie, R. C. Smith, B. D. Polis, E. A. Higgins, S. M. Hoffmann, G. E. Funkhouser, J. T. Saldivar. Physiological, Biochemical, and Psychological Responses in Air Traffic Control Personnel: Comparison of the 5-day and 2-2-1 shift rotation patterns. Civil Aeromedical Institute. Federal Aviation Administration, Oklahoma City, Okla. December, 1973. 17 pp. Report #FAA-AM-73-22.

1196.
Melton, C. E., J. T. Saldivar, and S. M. Hoffmann. Sleep patterns in air traffic control personnel on different shift rotation patterns. Aerospace Med. Assoc., Preprints, 1977, pp. 179-180.

1197.
Melton, C. E., and R. Smith. Stress in Air Traffic Controllers: Comparison of Two Air Route Traffic Control Centers on Different Shift Rotation Patterns (Final Report). TRC Report No. T76-3194, 1975, 12 pp.

Stress in 23 air traffic controllers (ATCS) at Atlanta (ATL) on the straight 5-day shift rotation schedule was compared with stess in 23 ATCS on the 2-2-1 shift rotation schedule at Frot Worth (FTW). Stress estimates were made from urinary levels of 17-ketogenic steroids (st), epinephrine (e) and norepinephrine(ne). There were no statistically significant between-group differences in e excretion. Levels of st and ne were significantly higher for ATL ATCS under all conditions. Mean scores for neither anxiety trait (A-trait) nor anxiety state (A-state) were significantly different at FTW and ATL and the scores of controllers at both facilities were low compared to those of other normative groups.

1198.
Membach, H. Use of medication and drugs, especially alcohol, by flying personnel. In: AGARD Conf. Proc., AGARD-CP-108, Bonn, 1972, p. A21-1 - A21-5.

Alcohol is the most common and most dangerous drug used by our pilots. The use of other medication or drugs is practically negligible. Three simple methods are described by which the blood alcohol can be determined.

1199.
Mendelson, W., R. D. Guthrie, R. Guynn, R. L. Harris, and R. J. Wyatt. Rapid eye movement (REM) sleep deprivation, stress and intermediary metabolism. J. Neurochem. 22: 1157-1159, 1974.

1200.
Menzel, W. Gesundheitliche Fragen der Tages- und Nachtarbeit. J. Medizinishe Wochenschrift 19: 242-245, 1965.

1201.
Mertens, J. Die Veranderung Tagesperiodischer Schwankungen der Korpertemperatur nach transmeridianer Flugen (Changes in the circadian rhythm of the body temperature after transmeridian flights). Bonn-Bad Godesberg: Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt. Institut for Flugmedizin, DLR-FB 73-01, 64 pp. (transl. in Engl. by European Space Research Organisation, ERSO TT-16, 1974.)

The oral body temperature of 12 pilots was measured at 2-hour intervals over 24-hour periods. In two test periods prior to the Transmeridian flights the normal body temperature rhythm was established. The effects of a time displacement of eight hours were investigated by determining the body temperature after flights between Germany and the U. S. A., the measurements taking place in each case on the first, third, fifth and eighth day after the flight. Desynchronisation relative to the new local time was observed after flights in both directions, but the changes after the West-East flight were more pronounced than after the one in the opposite direction. THe adaptation time after an East-West flight was five days, and after a West-East flight at least eight days. Large individual differences both in the degree of the changes and the duration of adaptation were noted.

1202.
Metz, B. Principes physiologiques d'organisation du travail en zone saharienne. (Ier congres de physiologie saharienne.) J. Med. de Dakar, 1960.

1203.
Michel-Briand, C., J. L. Chopard, A. Guiot, M. Paulmier, and G. Studer. The pathological consequences of shift-work in retired workers (abstract). In: Int. Symp. on Night- and Shift- work, 5th Rouen, FR., 1980, p. VII-6.

1204.
Michel-Briand, C., and P. Dischaseaux. Enquete Realisee dans un Service de Chirurgie aupres du Personnel Travaillant en Deux Equipes Successives (Survey in a Surger Service among Staff Working in Two Successive Shifts). Arch. Mal. Prof. Med. 39: 537-538, 1979.

1205.
Migraine, C., A. Reinberg, and C. Migraine. Persistence of circadian rhythms of wakefulness-sleep alternation and feeding behavior in a 20-year-old man during his underground isolation, with and without a clock. C. R. Acad. Sci. 279: 331-334, 1974.

1206.
Miksl, R. and Kostanecka K. Influence of workshift and biorhythm upon critical fusion frequency. Acta Univ. Palacki. Olomuc. Fac. Med. 68: 169-179, 1974.

Critical flicker fusion frequency (CFF) decreases at an increasing brightness of the flickering target background. The relation between the brightness of a flickering target background and the CFF level is logarithmical. CFF decreases from the beginning to the end of the shift. The highest CFF decrease is to be seen at the nightshift. A circadian CFF course shows a characteristic effect of biorhythm. The regressive declination of decreasing CFF values with an increasing background intensity shows the highest drop at night hours and the lowest during the morning. 19 rescuers aged 24-74 were put to a test of CFF at an interval of 1 hr during 24 hr at 3 shifts. CFF was measured at 5 degrees of increasing intensity of flickering target background. CFF fluctuated significantly during the course of separate shifts in such a way, that the highest measurement of CFF was at the beginning of the new shift (the first shift from 6 p. m.) and the lowest one always at the end of the shift. The CFF measurement was lowest during the night.. By the interpolation of CFF values leaving out the last shift hour of the preceding shift and the first hour of the following shift a circadian curve was shown on which the effect of the biorhythm was discovered. The regressive declination at the course of CFF values with an increasing intensity of flickering target background lighting showed the largest slope during the night measurement and the lowest during the morning.

1207.
Miles, L., R. Cutler, K. Drake, B. Rule, and W. Dement. Use of a temperature monitor to investigate chronobiological dysfunction in patients presenting to a sleep disorder clinc (abstract). Sleep Res. 7: 293, 1978.

1208.
Miles, L. E. M., D. M. Raynal, M. R. Wilson. Blind man living in normal society has circadian rhythms of 24.9 hours. Science 198: 421-423, 1977.

The patient was investigated under three conditions: 1) Over 32 days in his home environment, his bedtime actigraph displayed a fragmented pattern with both 24.0-hr and 24.9-hr components (that is, there was a slow free-running component); 2) allowed to sleep ad lib. in a hospital for 26 days, he displayed only a free-runing 24.9-hr sleep-wake pattern, and his symtoms of insomnia and EDS remitted; 3) during a 10-day attempt to entrain strictly the patient's free-running rhythms with a strict 2300-0700 sleep regimen, the patient displayed insomnia and a pattern of EDS consistent with a residual free-running component. Measures of cortisol in plasma and K, Na, Cl, Ca, and PO4 in urine, as well as free-running rhythm whether the sleep pattern was strictly entrained to 24 hr or allowed to free-run by the ad lib. sleep schedule. Growth hormone was said to be entrained by the sleep patterns to 24.9 in the ad lib. and to 24.0 in the entrained condition. Metabolic and hormonal data were not reported in detail.

The authors state that they have found sleep-wake disorders in 338 of 50 blind subjects surveyed, including 20 with episodic or cyclic complaints. therefore, they believe the free-running circadian rhythms may be common source of sleep pathology in the blind, and perhaps in other people as well. They believe their data are consistent with entrainment of the 24.9 hr rhythm to the lunar day, in which case it would not actually be free-running.

1209.
Miller, C. O. Human factors in accident investigation. Forum - Int. Soc. Air Safety Investigators 13: 16-25, 1980.

1210.
Mills, J. N. Human circadian rhythns. Physiol. Rev. 46: 128-171, 1966.

1211.
Mills, J. N. Air travel and circadian rhythm. J. Roy. Coll. Physicians Lond. 7: 122-131, 1973.

1212.
Mills, J. N. Biological Aspects of Circadian Rhythms. London: Plenum Press, 1973, 319 pp.

1213.
Mills, J. N. Transmission processes between clocks and manifestations. In: Biological Aspects of Circadian Rhythms, edited by J. N. Mills, London: Plenum Press, 1973, pp. 27-84.

1214.
Mills, J. N. Phase relations between components of human circadian rhythms. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J.E. Pauly. Tokyo: Igaku Shoin, Ltd., 1974, pp. 560-563.

A series of experiments upon the effect of simulated time zone shifts upon human circadian rhythms ´1, has provided control observations from which circadian maps may be drawn. Groups of three to five subjects spent around 10 days in an isolation unit from which obvious Zeitgebers such as light and external noise were excluded. They spent two or three control days on a regular routine of sleep, meals and activity, timed by a clock which was then advanced or retarded by 6 or 8 hours to simulate a time zone shift. Among other physiological variables, oral temperature and urinary excretion rate of electrolytes were measured. Sine curves were fitted to each successive nychthemeron, using a conventional least-squares method for the temperature data, and the method of Fort and Mills for the urinary excretion. Significance was assessed from the ratio of variance due to the fitted sine to residual variance, and 161 cycles whose fit fell within 95% confidence limits were analysed; 97 fell within the 99% confidence limit.

1215.
Mills, J. N., and A. Fort. Relative effects of sleep disturbance and persistent endogenous rhythm after experimental phase shift. In: Experimental Studies of Shift Work, edited by W. P. Colquhoun, S. Folkard, P. Knauth, and J. Rutenfranz. Opladen: Wesdeutscher Verlag, 1975.

1216.
Mills, J. N., and K. I. Hume. The circadian rhythm of sleep stages. Chronobiologia 4: 132, 1977.

1217.
Mills, J. N., Minors, D. S., and J. M. Waterhouse. Periods of different components of human circadian rhythms in free-running experiments (abstract). Int. J. Chronobiol. 1: 344, 1973.

Fifteen subjects have spent from 5 to 13 d in an isolation unit without any indication of time. Seven were alone, and the others were in groups of 4.

Four of the solitary subjects and one of the groups of 4 adopted activity cycles with a period of 25 to 27 h, similar to those reported elsewhere. One subject adopted an abnormally long period of around 30 h. Two solitary subjects followed an unusual pattern with alternately long sleeps of 12-17 h and short sleeps of 5-8 h, separated by spans of 24-29 h awake. One group of 4 also alternated long and short sleeps, but supposed the short sleeps to be naps after lunch, although the time elapsed between waking from a long sleep and from a 'nap' was around 24 h and the 'naps' were of 3 to 7 h.

Temperature rhythm was more regular, following in all subjects a rhythm with a period of 24-26 h, which in 6 of the 15 subjects was clearly distinct from the activity rhythm.

The period of the urinary sodium chloride and potassium rhythms was usually similar to that of temperature, but in 2 subjects it was clearly distinct; and in one subject sodium and chloride excretion followed a similar period to temperature, while potassium followed a shorter period.

1218.
Mills, J. N., D. S. Minors, and J. M. Waterhouse. The circadian rhythms of human subjects without timepieces or indication of the alternation of day and night. J. Physiol. 240: 567-594, 1974.

1219.
Mills, J. N., D. S. Minors, and J. M. Waterhouse. Dissociation between different components of circadian rhythms of human subjects deprived of knowledge of time. J. Physiol. 236: 51P-52P, 1974.

Fifteen subjects, two groups of four and seven singly, have spent from 5 to 13 days in isolation in a unit from which all indication of the alternation of day and night was excluded. A few spent some days in the unit with a clock beforehand or afterwards. In only one group of four, and three solitary subjects, did the habits of sleep and activity follow an approximately regular circadian rhythm with period 25-27 hr. In all except one of the 15 subjects deep temperature followed a regular rhythm with a period of 24-26 hr., which was usually distinct from the pattern of activity.

In most subjects the rhythm of urinary sodium and potassium was also distinct from the pattern of activity, though sometimes spectral analysis showed the existence of two periods, one corresponding to activity and the other nearer to 24 hr. In two subjects the urinary electrolyte rhythms were clearly distinct from both the temperature and activity rhythms. In one of these the period of the temperature rhythm was 26 hr, and of the potassium excretory rhythms 24 hr, while activity was 27 hr. In the other the periods of the rhythms of activity, temperature and urinary electrolytes all changed during 13 days of isolation in such a way that their phase relationships became grossly abnormal. We conclude that separate timing mechanisms may control the rhythms of temperature and of electrolyte excretion; and if activity habits result from an endogenous rhythm this is also distinct.

1220.
Mills, J. N., D. S. Minors, and J. M. Waterhouse. Circadian rhythms and irregular sleep schedules. J. Physiol. 270: 31P, 1977.

1221.
Mills, J. N., D. S. Minors, and J. M. Waterhouse. The physiological rhythms of subjects living on a day of abnormal length. J. Physiol. 268: 803-826, 1977.

1222.
Mills, J. N., D. S. Minors, and J. M. Waterhouse. Adaptation to abrupt time shifts of the oscillator(s) controlling human circadian rhythms. J. Physiol. 285: 455-470, 1978.

1223.
Mills, J. N., D. S. Minors, and J. M. Waterhouse. The effects of sleep upon human circadian rhythms. Chronobiologia 5: 14-27, 1978.

Subjects who slept for 4 h from 0000, and for a second 4 h variously distributed over the day, have provided values for rectal temperature and for urinary excretion of water, potassium, sodium, chloride, phosphate, creatinine, calcium and urate in the sleeping subject at all hours of the 24. These are compared with similar values in the wakeful subject. Temperature was lower during sleep at all hours except 1000 and 1200, and the difference was maximal shortly before 0000. At all hours potassium excretion was lower and phosphate excretion higher during sleep. Cosinor analysis of the different variables in the sleeping subject is compared with that in subjects following nycthemeral habits, and the interaction between endogenous rhythms and external influences such as sleep is discussed.

The phasing of the temperature and urinary rhythms was essentially normal by the end of the observations. By contrast, in a subject who slept at irregular hours mimicking the habits of an air pilot a free-running rhythm unrelated to the habits of sleep emerged. When he was finally living again on normal time his temperature and urinary acrophases had moved to the middle of the night. Phosphate excretion was largely exogenous, falling consistently when subjects rose after 8 h, but not after 4 h of sleep.

1224.
Mills, J. N., D. S. Minors, and J. M. Waterhouse. Endogenous rhythms after living on 21 hr. days. J. Physiol. 281: 22P-23P, 1978.

1225.
Mills, J. N., D. S. Minors, and J. M. Waterhouse. Exogenous and endogenous influences on rhythms after sudden time shift. Ergonomics 21: 755-762, 1978.

When subjects are following their usual nychthemeral habits, the observed rhythms result from the interaction of a circadian 'clock' with rhythmic external influences. These major external influences can be removed by spending 24 h under constant conditions. The endogenous rhythms thus revealed, in temperature and urinary excretion, have mostly an earlier phasing than nychthemeral rhythms and adapt more slowly to time shift, usually by a phase delay. It appears undesirable for the rhythms of shift workers to be entrained to time shifts, and means of retaining the usual phasing are discussed.

1226.
Mills J. N., R. Morgan, D. S. Minors, and J. M. Waterhouse. The free-running circadian rhythms of two schizophrenics. Chronobiologia 4: 353-360, 1977.

Two chronic schizophrenic patients and a psychiatrist spent 21 days in an isolation unit. For the first 4 days they lived on normal time but thereafter the clock was removed and they were free-running. The psychiatrist followed the schedule set by the schizophrenics, one of whom spontaneously decided the times of retiring and rising while the other followed passsively. The psychiatrist commonly retired some time later but without disturbing the schizophrenics, the mean duration of whose days was 23.7 h, distinctly shorter than is usual in healthy subjects.

1227.
Mills, N. H., and A. N. Nicholson. Long-range air to air refuelling a study of duty and sleep patterns. In: Simulation and Study of High Workload Operations, edited by A. N. Nicholson. Neuilly-sur-Seine, NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-146, 1974, pp. A14-1 - A14-9.

The sleep patterns of ground crew, pilots and tanker crews involved in a long range air-to-air refuelling mission have been related to their duty hours. During such complex operations workload may vary considerably and the demands placed on some aircrew may be very high. It is suggested that the duty hours demanded of individual aircrew should be realted to their overall workload. In this way it may be possible to maintain an acceptable sleep pattern in all aircrew and ensure that no individual pilot or crew member is subjected to excessive duty hours.

1228
Milosevic, S. A. Milosavljevic, and S. Savic. Psihofizioloske Sposobnosti Operatora U Toku Rada (Psychophysiological abilities of operators during work). Arh. Hig. Rad. Toksikol. 27: 191-202, 1976.

The psychophysiological abilities of a group of operators working at a control panel in a power station were tested with a battery of tests. The battery included biochemical tests (adrenaline, noradrenaline and 17-OHCS), physiological test (arterial blood pressure) visual tests (accomodation, convergence, phoria and dark adaptation), psychological tests (visual and auditory, reaction time) and subjective estimation of fatigue. Workers from three different work shifts, with a constant change of the shift system every two days, were tested before and after work (at 6 a. m. and at 2 and 10 p. m.). Characteristic changes were found after work in all the three shifts, but the changes were significant only after work in the night shift. A significant change in dark adaptation was also noticed after work in the afternoon shift. A lack of sleep and night work increased arterial blood presure and prolonged the period of dark

1229.
Minors, D. S., J. N. Mills, and J. M. Waterhouse. The nature of the "adaptation" of human circadian rhythmicity to an altered time schedule (abstract). Chronobiologia 4: 133, 1977.

1230.
Minors, D. S., and J. M. Waterhouse. How do rhythms adjust to time shifts? J. Physiol. 265: 23P-24P, 1977.

1231.
Minors, D. S., and J. M. Waterhouse. The effects of times of meals and sleep on circadian rhythms. J. Physiol. 290: 18P, 1979

1232.
Minors, D. S., and J. M. Waterhouse. Stable rhythms on irregular schedules. Chronobiologia 6: 133, 1979.

One problem associated with irregular schedules, whether caused by shift work or circumglobal travel, is the attendant instability of circadian rhythms. Using our Isolation Unit we have investigated is the rhythms of rectal temperature and urinary constituents can be stabilized in humans undergoing irregular schedules.

In the first experimental design, after a control phase with normal hours of sleep and meals, subjects took their sleep in two 4h periods. One, the 'anchor sleep', was regularly taken at 0000-0400 and the other, the 'variable sleep', was distributed randomly throughout the other 20 h. During this experimental phase, meals were still taken at times as near as possible to those during the control phase.

Cosine curves were fitted to the data for each variable and consideration of both the acrophases and periods indicated that there were no significant differences between rhythmns during the control and experimental phases.

In 2 further experimental designs, during the experimental phase, the 'variable sleep' was taken at the same times as before but there was no 'anchor sleep'; it was replaced by a 4h sleep taken either 12 h before the variable sleep or by one continuous with the variable sleep. Meals were still taken at times as constant as possible.

Since cosinor analysis indicated that the rhythms now free-ran during the experimental phase, it is concluded that some factor associated with the anchor sleep rather than the regular mealtimes stabilized the circadian rhythms.

1233.
Minors, D. S., and J. M. Waterhouse. Endogenous rhythms during anchor sleep experiments (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. III-6.

1234.
Mitchell, M. A. Circadian rhythm and its effects on people working rotating shifts. Aerospace Med. Assoc., Preprints, 1977, p. 21.

1235.
Mitkova, N. Improvement of alertness in sailors during night watches by means of food and drinking regimens, including biologically active concentrates. Bull. Inst. Marit. Trop. Med. Gdynia 27: 17-24, 1976.

It is stated that by food and drinking intervention (including biologically active food and drinking concentrates) we are able to help the sailor's body to a certain extent, to adapt itself to work under especially aggravated occupational conditions. THis is extremely important for the peak moments of strain, esp., during night watches. This fact must not be underestimated in the complex of measures in fatigue prophylaxis, in the improvement of alertness to maximal working capacity with a view to ensure safe ship voyages.

1236.
Mitler, M. M., R. Lund, P. G. Sokolove, A. S. Pittendrigh and W. C. Dement. Sleep and activity rhythms in mice: a description of circadian patterns and unexpected disruptions in sleep. Brain Res. 131: 129-145, 1977.

Studies on daily and circadian rhythms in wheel running and electrographically defined wakefulness, NREM sleep, and REM sleep in M. musculus were done to gather data on the temporal distribution of activity and sleep. Generally, peaks in NREM and sleep tended to coincide and to alternate with the coincident peaks of wakefulness and wheel running. However, during the active phase of the circadian wheel running cycle some NREM and REM sleep did occur; conversely, during its rest phase, wakefulness was often present. The most striking finding was that in mice with clearly entrained or free-running activity onsets, the circadian peak-through patterns in wakefulness, NREM, and REM sleep were not always distinct - they could be damped and /or polyphasic. Several explanations of these phenomena are considered.

1237.
Mitler, M. M., P. G. Sokolove, R. Lund, C. S. Pittendrigh, and W. C. Dement. Activity-inactivity and wakefulness-sleep in mice: induced changes in cyclic relationships by prolonged exposure to constant conditions (abstract). Sleep Res. 4: 267, 1975.

1238.
Miyasita, A. The effects of sleep time shortening on long sleeper sleep. J. Psychiatr. Neurol. Jpn. 78: 435-450, 1976.

1239.
Mohler, S. R. Circadian Rhythm Medical Facts for Pilots. Proceedings of the 16th Annual Corporate Aircraft Safety Seminar, Washington, D. C., Apr. 19-20, 1971, pp. 55-57.

Aviation activities require a high state of alertness for safe aircrew performance. Alertness varies with respect to the sleep-wake cycle. Medical evidence shows that the probability of making mistakes significantly increases during those times when the individual is accustomed to sleeping but for various reasons elected to undertake certain duties. In order that the individual may adjust to the time of destination, the International Civil Aviation Organization has perfected a formula which for transmeridional flights takes into consideration the number of time zones traversed. It is recommended that aviation personnel and passengers should plan to avoid undertaking challenging duties for at least 24 hours following lengthy east-west trips.

1240.
Mohler, S. R. Physiological index as an aid in developing airline pilot scheduling patterns. Aviat. Space Environ. Med. 47: 238-247, 1976.

1241.
Mohler, S. R. Mental function in safe pilot performance. Part I; Jan-Feb, 1979; Part II: Mar-Apr, 1979. Arlington, Va.: Flight Safety Found. inc., 1979, 6 pp.

1242.
Mohler, S. R., and C. F. Booze. U. S. fatal general aviation accidents due to cardiovascular incapacitation: 1974-75. Aviat. Space. Environ. Med. 49: 1224-1228, 1978.

A study was undertaken to determine the relative impact of inflight cardiovascular incapacitation among general aviation pilots with respect to general aviation flight safety. During calendar years 1974-75, the National Transportation Safety Board reports reveal that 13 U. S. general aviation pilots died of cardiovascular incapacitation during flight. The analysis of these accidents will bear on any suggested changes in pilot medical screening procedures for cardiovascular disease, as well as on pilot safety education programs. Of the 13 cases noted above, nine pilots were flying alone. Of the remaining multiple occupant cases, the nonpilot wife of one deceased victim managed to land the aircraft. Eighteen deaths resulted from the inflight incapacitations. The ages of the pilots ranged from

33-68 years, with both a mean and a median of 52. Postmortem examinations revealed extensive coronary disease (atherosclerosis) in 12 cases (no pilot autopsy data is available in the case where the passenger landed the aircraft). Of these 12 cases, five demonstrated recent occlusions. In four more, evidence of old infarcts was revealed by the postmortem examination. It is concluded that these 13 inflight cardiovascular incapacitations, occuring among a total of 1,404 fatal general aviation accidents in the 1974-75 period, constitute such a small proportion (0.98%) of the documented fatal general aviation accidents that extensive additional cardiovascular screening procedures are not justified at present on cost/yield basis.

1243.
Mohler, S. R., and A. Cierebiej. Human factors in long-distance flights. Ind. Med. Surg. 41: 11-17, 1972

1244.
Mohler, S. R., J. R. Dille, and H. L. Gibbons. The time zone and circadian rhythms in relation to aircraft occupants taking long distance flights. Am. J. Public Health 558: 1404-1409, 1968.

1245.
Mohr, B. Feeling down? Might be your biocurve. San Francisco Examiner, Aug. 20, 1973.

This article discusses the "Bio-curve" (another name for biorhythm) of Wallerstein and Roberts 1973 All together on the Bio-curve. Human Behavior 2: 8-15, 1973.)

1246.
Moiseyeva, N. I. Effect of sudden change in temporal environment on some human circadian rhythms. Fiziol. Zh. 61: 1798-1804, 1975. (English Translation in: Human Circadian Rhythms. Washington, D. C.: U. S. Joint Publications Research Service JPRS L/5601, 1976, 9 pp.)

Changes in circadian rhythm of the indices of the cardiovascular system and sleep were revealed in practically healthy individuals taking transmeridional flights, particularly when crossing nine time zones. The nature of the changes depends on the direction of flight. After an eastward flight the reactions arise immediately, sleeping time decreases, arterial pressure drops; and daily fluctuations in indices of the cardiovascular system become smoothed. After a westward flight the alterations begin on the second day, sleeping time decreases, change in sleeping pattern occurs, the range of EEG frequency changes grows, and the pattern of fluctuations in cerebrovascular tone changes. Disturbances in sleeping rhythm caused by flying in both directions disappear in about a week, while changes in cardiovascular indices disappear in 2 weeks when flying westward and in over 1 month when flying eastward. Use of soporifics during the flying time accelerates adaptation to the new temporal conditions.

1247
Moiseyeva, N. I. The structure of biorhythms as one of the criteria of the organism's ability for physiological adaptation (author's translation). Fiziol. Zh. . 64: 1632-1640, 1978.

In order to establish the organism's ability for adaptation, we examined 16 healthy subjects, 10 of whom were able to very well adapt themselves to changes in environment, whereas 6 subjects could not do that well enough. In the background examinations (and for the well-adapting subjects in examinations made after meridian crossing in flight), the blood pressure, heart rate, and capillaroscopic picture were recorded during 3 days 5 times a day. Apart from that, the biorhythmic structure of the noatural nocturnal sleep EEG was analysed. THe data obtained showed that the well-adapting subjects had these characteristics of the biorhythms structure: relatively highter mean values of the parameters under study, a major dispersion of these values over different hours of the day and night, and a clear temporal structure of the 24-hr curve as expressed by occurrence of the maximal and the minimal values of the functions at the same hours.

1248.
Moiseyeva, N. I., M. M. Boboslovsky, M. Y. Simonov, and N. V. Tonkova. Characteristics of the circadian sleep rhythm in relation to environmental factors associated with the rotation of the earth and to biological macrorhythms in man. J. Interdiscip. Cycle Res. 7: 15-24, 1976.

Numerous recent studies suggest that the living circadian system is sustained both by intrinsic oscillations and by time clues from the environment, associated with the rotation of the earth (Halberg, 1960; Snyder, 1967; Gazenko and Aliakrinsky, 1970).

A wide frequency range of rhythms turns out to be closely related to the circadian rhythms, from the ultradian (period longer than 30 min and less than 20 hrs) to the circannual (period about a year) rhythms. The ultradian rhythms of metabolic processes involve, for instance, oscillations of the trophic function as reflected both by the rhythmicity of animal growth (Sipatchev, 1970) and oscillations of physical performance in sportsmen (Herring, 1971; Akrabov,1972). During the life-long interaction between the organism and environment, the "superimposition" of environmental rhythms on the set of inner rhythms occurs continuously.

The mechanisms of this interaction and the response of the organismic rhythms to changes in the environment are the subject of the present work. The sleep rhythm is regarded as a "model" circadian system and environmental time clues occurring at unusual time intervals (as during transmeridional flight) is regarded as the systems input.

1249.
Moiseyeva, N. I., M. Yu. Simonov, and N. V. Tonkova. Rol' biologicheskikh makroritmov v reguluatsii protsessasna (Role of biological macrorhythms in the regulation of sleep). Fiziol. Cheloveka 1: 482-488, 1975.

1250
Moiseyeva, N. I., M. M. Yu. Simonov, V. M. Sisuev. Znacheniye sna v resulyats; tsirkadnickh ritmov (Significance of sleep in the regulation of circadian rhythms). Fiziol. Cheloveka 4: 995-1002, 1978.

1251.
Monesi, F., and F. Ravaccia. A study of behaviour during a trial of vigilance in non-piloting personnel. In: Higher Mental Functioning in Operational Environments, edited by B. O. Hartman. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-181, 1976, pp. C3-1 - C3-6.

On the topic of planning a laboratory for the assessment of the performance of subjects in operative stress conditions, conventional psychometric as well as neurophysiological methods were employed for data collection, recording and processing.

In the present study, subjects highly experienced in air traffic assessment and decision-making tasks underwent a performance trial involving visual vigilance in a simulated operative environment. Data were collected by administering self-rating scales and recording both reaction times and brain potentials. Statistical analysis of data was performed with parametric and not parametric tests.

All types of approach proved to be of value in the assessment of performance, although the greater utility of computerized neurophysiological evaluation must be emphasized for an advance in methodology.

1252.
Monk, T. H. A likelihood ratio method for studying the re-entrainment of circadian rhythms. Chronobiologia 4: 325-332, 1977.

A simple technique is described that enables the degree of adaptation at different times of day to be studied in organisms that have been subjected to a sudden change in the Zeitgeber (as typically found in shiftwork or after tranmeridian flight). The investigation is thus able to place greater emphasis on some readings than on others and to measure the amount of disruption at a particular time of day (e.g. for an important meeting) rather than to merely rely upon an overall daily measure. The method uses the likelihood ratio statistics which also allows a powerful test to be made of the statistical significance of any apparent adaptation.

The method is illustrated on some 'jet-lag' data, where it was able to determine differential rates of adaptation according to the time of day at which the subjects were tested.

1253.
Monk, T. H., and D. E. Embrey. A field study of circadian rhythms in actual and interpolated task performance (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, Fr., 1980, p. VIII-6.

1254.
Monk, T. H., and S. Folkard, Adjusting to the changes to and from daylighht saving time. Nature 261: 688-689, 1976.

1255.
Monk, T. H., and S. Folkard. Concealed inefficiency of late-night study. Nature 273: 296-297, 1978.

1256.
Monk, T. H., P. Knauth, S. Folkard, and J. Rutenfranz. Memory based performance measures in studies of shiftwork. Ergonomics, 21: 819-826, 1978.

The phase of the circadian rhythm in performance efficiency on a given task is known to be influenced by the memory load invloved. Two experiments were performed to determine whether memory load also influences the rate at which rhythms adapt to the phase-shifts involved in (a) transmeridian flight and (b) a long period of nightwork. In the first study, high and low memory load versions of a performance test were given to a 25y old female subject experiencing a 5 h eastward change in time-zone. Differences were found both in the initial phase of the two versions of the test and in the rate at which this phase adapted to the new time. In the second study, two young male subjects, working 21 consecutive night shifts, were given high and low memory load versions of the performance test, and a calculations test, every 4th around the clock. The results were similar to those of the first study; a cosinor analysis revealed that despite periods of arrhythmicity there were large differences between the rate of adaptation of the phases of the performance rhythms of high and low memory versions of the test, and also between the rhythms of temperature and performance. It is concluded that it is wrong to speak of a single 'performance rhythm', and that performance tests in shiftwork and jet-lag studies should thus simulate some aspect of the 'real' task under consideration.

1257.
Moog, R., P. Hauke, and H. Kittler. Morning-evening types and shift-work. A questionnaire study (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen Fr., 1980, p. VIII-7.

1258.
Moore, R. Y. The anatomy of central neural mechanisms regulating endocrine rhythms. In: Endocrine Rhythms, edited by D.T. Krieger, New York: Raven Press, 1979, pp. 63-87.

1259.
Moore, R. Y., and D. C. Klein. Visual pathways and the central neural control of a circadian rhythm in pineal serotonin N-acetyltransferase activity. Brain Res. 71: 17-33, 1974.

1260.
Moore Ede, M. C. Circadian rhythms of drug effectiveness and toxicity. Clin. Pharm. and Therapeut. 14: 926-935, 1973.

1261.
Moore-Ede, M. C. Control of circadian oscillations in renal potassium excretion in the squirrel monkey (Saimiri sciureus) (abstract). Harvard University, 1974, 267 pp.

1262.
Moore-Ede, M. C. Control mechanisms of circadian rhythms in body composition: implications for manned spaceflight. Final Report. Washington, D. C.: NASA, NASA-CR-144413, 1976, 173 pp.

The mechanisms that underlie the circadian variations in electrolyte content in body fluid compartments were investigated, and the mechanisms that control the oscillations were studied in order to investigate what effects internal desynchronization in such a system would have during manned space flight. The studies were performed using volunteer human subjects and squirrel monkeys. The intercompartmental distribution of potassium was examined when dietary intake, activity, and posture are held constant throughout each 24-hour day. A net flux of potassium was observed out of the body cell mass during the day and a reverse flux form the extracellular fluid into the body cell mass during the night, conterbalanced by changes in urinary potassium excretion. Experiments with monkeys provided evidence for the synchronization of renal potassium excretion by the rhythm of cortisol secretion with the light-dark cycle. Three models of the circadian timing system were formalized.

1263.
Moore Ede, M. C. Circadian rhythms in drug effectiveness and toxicity in shiftworkers: Discussion II. In: HEW Publ.-No. 76-203. Edited by R. G. Rentos, and R. D. Shephard. Washington D.C.: U.S. Dept. of Health, Education, and Welfare, 1976, pp. 140-144.

1264.
Moore-Ede, M. C. The physiological basis of circadian timekeeping in primates. The Physiologist 20: 17-25, 1977.

1265.
Moore-Ede, M. C. Medical-Toxicological Group (Discussion Summary). Shift Work and Health, HEW - Occupational Safety and Health, pp. 254-257, 1976.

1266.
Moore-Ede, M. C., M. F. Brennan, and M. R. Ball. Circadian variation of intercompartmental potassium fluxes in man. J. Appl. Physiol. 38: 163-169, 1975.

Circadian rhythms of plasma potassium concentration and urinary potassium excretion persisted in three normal volunteers when diurnal variations in activity, posture, and dietary intake were eliminated for 3-10 days. Measurements of the arteriovenous difference in plasma potassium concentration across the resting forearm and of erythrocyte potassium concentration suggested that there is a net flux of potassium from ACF to ECF in the early morning and a reverse net flux later in the day. The total net ICF-ECF were estimated from the diurnal variations in extracellular potassium content corrected for dietary intake and urinary potassium loss. The net fluxes between ICF and ECF were found to be counterbalanced by the circadian rhythm in urinary potassium excretion. Desynchronization of these rhythms would result in marked fluctuations in extracellular potassium content.

These findings suggest that some revision is required of the concept of basal state in potassium homeostatis.

1267.
Moore-Ede, M. C., and R. B. Burr. Circadian rhythm of urinary calcium excretion during immobilization. Aerosp. Med. 44: 495-498, 1973.

Ten healthy subjects were studied during 2 days of normal activity and 2-4 days of strict bedrest. Urninary calcium excretion was raised during bedrest, but the increase was not uniformly distributed over each 24 hr. Instead the incremental calcium excretion showed a marked circadian rhythm with 61% excreted between 09.00 and 15.00 hr. A similar pattern of calcium excretion was seen in four immobilized patients with recent-onset traumatic paraplegia. However two chronic paraplegics without hypercalciuria did not have such an excretory rhythm. Circadian rhythms of bone resorption appear to account for the observed rhythm of urinary calcium excretion.

1268.
Moore-Ede, M. C., and C. A. Fuller. Evaluation of aircraft accident reports on United Airlines Douglas DC-8-54 N8047U near Kaysville, Utah, December 18, 1977. Forum -- Int. Soc. Air Safety Investigators 13: 13-15, 1980.

1269.
Moore-Ede, M. C., C. A. Fuller, and F. M. Sulzman. Transient and steady-state circadian internal desynchronization in the squirrel monkey (Abstract). Fed. Proc. 36: 1330, 1977.

1270
Moore-Ede, M. C., and J. A. Herd. Renal electrolyte circadian rhythms: independence from feeding and activity patterns. Am. J. Physiol. 232: F128-F135, 1977.

The interrelationships between urinary electrolyte circadian rhythms and rhythms of feeding, drinking and activity were studied in six conscious chair-acclimatized squirrel monkeys (Saimiri sciureus) kept in temperature-controlled isolation chambers on a light-dark (LD) 12:12 h cycle. With lights on (600 lx) from 0800 to 2000 h and off (<1 lx) from 2000 to 0800 h, renal potassium excretion in monkeys fed ad libitum fell to a daily minimum of 64 +/- 6 ueq/h at 0500 h and rose to a maximum of 274 +/- 23 ueq/h at 1700 h. Sodium excretion fell to a minumum of 13 +/- 2 meq/h at 1000 h and rose to a maximum of 43 +/- 6 ueq/h at 2100 h, while water excretion fell to a minimum of 869 +/- 63 ul/h at 0500 h and rose to a maximum of 2,307 +/- 222 ul/h at 1700 h. Feeding, drinking, and activity occurred only during the lights on period. Independence of the urinary rhythms from diurnal variations in feeding, drinking, and activity was established a) by depriving monkeys of food, b) by depriving monkeys of water, and c) by training monkeys to perform a 2-hourly schedule of feeding, drinking, and activity throughout day and night. None of these three regimens resulted in major reductions of the amplitude, or changes in the excretion. These findings indicate that the circadian rhythms of urinary potassium, sodium, and water excretion are controlled by mechanisms that are not passively dependent on the behavioral patterns of feeding, drinking and activity.

1271.
Moore-Ede, M. C., D. A. Kass, C. A. Fuller, and F. M. Sulzman. Physiological significance of ultradian components in circadian rhythms (Unpublished abstract, personal communcation with Dr. Fuller, U.C. Riverside, Riverside, CA.).

1272.
Moore-Ede, M. C., D. A. Kass, and J. A. Herd. Transient circadian internal desynchronization after light-dark phase shift in monkeys. Am. J. Physiol. 232: R31-R37, 1977

In four conscious chair-acclimatized squirrel monkeys (Saimiri sciureus) studied with light on (600 lx) from 0800 to 2000 h daily (LD 12:12), prominent 24-h rhythms in feeding, drinking, activity, body temperature, and urinary potassium, sodium, and water excretion were seen. When the monkeys were subjected to 36 h of darkness followed by 36 h of light each variable demonstrated a circadian rhythm which was not passively dependent on the light-dark cycle. After the 24-h light-dark cycle was abruptly phase-delayed by 8 h, all the rhythms resynchronized with the new light-dark cycle phase, demonstrating that light-dark cycles are an effective zeitgeber. However, the resynchronization of the rhythms of feeding, drinking, activity, and body temperature was 90% complete within aproximately 2 days while the 90% resynchronization of the urinary rhythms took approximately 5 days. These results suggest that the circadian timing system in S. sciureus may consist of several spontanieously oscillating units which can become transiently uncoupled during pertubations of environmental time cues.

1273.
Moore-Ede, W. S. Schmelzer, and J. A. Herd. Synchronization of the circadian rhythm of renal potassium excretion by circadian oscillations in adrenal steroid secretion (Unpublished abstract, personal communication with Dr. Fuller, U.C. Riverside, Riverside, CA.).

1274.
Moore-Ede, M. C., W. S. Schmelzer, D. A. Kass, and J. A. Herd. Internal organization of the circadian timing system in multicellular animals. Fed. Proc. 35: 2333-2338, 1976.

Three models of the organization of the circadian timing system in multicellular animals are presented. Each can account for the observed internal synchronization of the various circadian rhythms within the organism and each is also compatible with the known responses of circadian systems to manipulations of environmental time cues. One is a single oscillator system (Model I) while the other two are multioscillator systems arranged in a hierarchical (Model II) or nonhierarchical (Model III) manner. Experiments that test the predictions of the different models are reviewed. These indicate that the circadian timing system in mammals is organized as a multioscillator system with oscillating concentrations of chemical mediators (nervous or encocrine) internally synchronizing the various potentially-independent oscillators by an entrainment mechanism. However, as yet there is insufficient evidence to indicate whether the oscillators are arranged with a predominantly hierarchical (Model II) or nonhierarchical (Model III) organization.

1275.
Moore-Ede, M. C., W. S. Schmelzer, D. A. Kass, and J. A. Herd. Cortisol-mediated synchronization of circadian rhythm in urinary potassium excretion. Am. J. Physiol. 233: R230-R238, 1977.

Conscious chair-acclimatized squirrel monkeys (Saimiri sciureus) studied with light on (600 lx) from 0800 to 2000 h daily (LD 12:12) display a prominent circadian rhythm in renal potassium excretion. The characteristics of this rhythm were reproduced in adrenalectomized monkeys by infusing 5 mg cortisol and 0.001 mg aldosterone, or 5 mg cortisol alone, between 0800 and 0900 h daily. When the timing of cortisol administration (with or without aldosterone) was phase-delayed by 8 h, the urinary potassium rhythm resynchronized by 80% of the cortisol phase shift, but only after a transient response lasting 3-4 days. With the same daily dose of adrenal steroids given as a continuous infusion throughout each 24 h, urinary potassium excretion showed free-running oscillations no longer synchronized to the light-dark cycle. These results indicate that the circadian rhythm of plasma cortisol concentration acts as an internal mediator in the circadian timing system, synchronizing a potentially anonomous oscillation in renal potassium excretion to environmental time cues and to other circadian rhythms within the animal.

1276.
Moore-Ede, M. C., and F. M. Sulzman. The physiological basis of circadian timekeeping in primates. The Physiologist 20: 17-25, 1977.

Extensive evidence demonstrates that the circadian timing system in primates is a multiple oscillator system which on occasion can become uncoupled. THis system appears to be basically hierarchical in nature with the suprachiasmatic nucleus of the hypothalamus playing a role as a pacemaker in the system. This predominantly hierarchical organization is confirmed by studies which demonstrate that hormonal mediators appear to control only those rhythms below them in the hierarchy. However, studies of environmental zeitgebers in the squirrel monkey have demonstrated that the input of light-dark cycle phase and period information, and food timing phase and period information, and food timing phase and period information impinges on different points within the circadian timing system. Thus while the system may be predominantly hierarchical, the external inputs may enter at several levels.

1277.
Moore-Ede, M. C., F. M. Sulzman, and C. A. Fuller. Circadian organization in the squirrel monkey: the internal coupling between oscillators. In:

Biological Rhythms and their Central Mechanism (A Naito Foundation Symposium), edited by M. Suda, O. Hayaishi, and H. Nakagawa. New York: Elsevier/North-Holland, 1979, pp. 405-418.

1278.
Moore-Ede, M. C., F. M. Sulzman, and C. A. Fuller. Uncoupling of circadian oscillators at the limits of light-dark cycle entrainment in the squirrel monkey. Fed. Proc. 38: 1318, 1979.

To examine the properties of the competent oscillators in the circadian timing system, squirrel monkeys were exposed to symetrical light-dark cycles with periods ranging from 18 hrs to 30 hrs. The rhythms of feeding, colonic temperature and urinary potassium excretion were simultaneously examined in individual monkeys maintained in isolation chambers. The range of entrainment of the urinary potassium rhythm was much smaller that that of feeding and temperature rhythms supporting previous studies indicating a separate renal oscillator. At Zeitgeber periods <24 hours feeding and temperature rhythms showed similar ranges of entrainment but at periods 24 hrs there was some indication of a wider range for feeding than temperature. However, the average waveforms for each intrained rhythm of feeding or body temperature indicated passive responses to light as well as the entrainment of the circadian oscillators. High frequency LD cycles (LD 2 2) clearly showed that these passive increases in feeding and body temperature depended on circadian phase. The interpretation that there were separate temperature and feeding oscillators is therefore tentative because of the passive responses to light.

1279.
Moore-Ede, M. C., F. M. Sulzman, C. A. Fuller, and L. G. Hiles. Dissociation of squirrel monkey circadian rhythms in an environment with conflicting temporal information (abstract). Fed. Proc. 37: 832, 1978.

1280.
Moraal, J. Effects of training and sleep deprivation on visual inspection of static and dynamic patterns. Ergonomics 16: 332, 1973.

Several possibilities were investigated to improve human inspection of sheet steel surfaces passing on a moving belt. The investigation was part of an ergonomic research programme in the Dutch Steel industry, supported by a grant from the Council of European Communities. As a result of this investigation the lighting at the workplace and the lay-out of the inspector's cabin were altered in order to improve the conditions under which the inspectors have to make their 'go/no go' decisions with respect to the surface qualities of the sheets. In addition some laboratory experiments were done to study the effects of some training conditions and of sleep deprivation on inspection performance. A rather simple simulation of the abovementioned task was used. Inspection of moving or dynamic patterns (like the real task) was compared with inspection of static patterns. Results of the experiments will be presented and some conclusions with respect to the development of real work situations will be discussed.

1281.
Morgan, B. B., Jr. Effects of continuous work and sleep loss in the reduction and recovery of work efficiency. Am. Ind. Hyg. Assoc. J. 35: 13-20, 1974.

The synthetic-work technique has been employed in a series of investigations designed to determine (1) the extent to which performance efficiency is degraded during extended periods of continuous work, and (2) the amount of sleep necessary for the recovery of performance from the effects of continuous work and sleep loss. The results of these studies indicate that 36, 44, and 48 hr of continuous work and sleep loss result in decrements in over-all work efficiency of approximately 15, 20, and 35% respectively. Following 36 hr. of continuous work, it was found that 12 hr of sleep is sufficient for complete(100%) recovery of performance, but complete recovery is not provided by 2 (58% recovery), 3 (53% recovery), or 4 (73% recovery) hr of sleep. It also has been indicated that the time course of recovery is different following different durations of continuous work and subsequent sleep.

1282.
Morgan, B. B., Jr., and E. A. Alluisi. Applicability of research on sustained performance, endurance, and work-rest scheduling to the development of concepts and doctrine of continuous operations. In: Human Eng. Labs. Mil. Requirements for Res. on Continuous Operations, 1972, pp. 89-115.

The effects of work-rest schedules, circadian rhythms, continuous work, and sleep loss on work behavior or sustained performance were studied. A description of this research, including a discussion of the synthetic-work methodology and the multiple-task performance battery that is the foundation of that methodology, is presented. Some of the more important findings of this research are also presented, and the applicability of these findings to the requirements for continuous operations is discussed.

1283.
Morgan, B. B., and B. R. Brown. Effects of 48 hours of continuous work and sleep loss on sustained performance. TRC Report No. P-175482, Sept., 1970.

The synthetic-work approach was employed in an investigation of the decrements in performance produced by a 48 hour period of continuous work and sleep loss, and the recovery of performance from these decrements as a result of 24 hours of rest and recovery. Performance during the 48 hours of continuous work was greatly influenced by the circadian rhythm. The first performance decrements occurred after approximately 18 hours of work; during the early morning hours of the first night, average performance decreased to approximately 82% of baseline performance. All measures of performance indicated that the recovery of performance was complete (to baseline levels) following the 24-hour period of rest and recovery.

1284.
Morgan, B. B., Jr., B. R. Brown, and E. A. Alluisi. Effects on sustained performance of 48 hours of continuous work and sleep loss. Hum. Factors 16: 406-414, 1974.

The work efficiency of 10 subjects during a 48-hr period of continuous work and sleep loss was assessed using the synthetic-work technique. Performance during the period of stress was found to be significantly influenced by the circadian rhythm. Decrements first occurred after approximately 18 hr of continuous work, and performance decreased to an average of 82% of baseline during the early morning hours of the first night. Performance improved to about 90% of baseline during the daytime of the second day but decreased to approximately 67% during that night. All measures of performance recovered to baseline levels following a 24-hr period of rest and recovery.

1285.
Morgan, B. B., B. R. Brown, G. D. Coates, and E. A. Alluisi. Sustained performance during thirty-six hours of continuous work and sleep loss. Catalog of Selected Documents in Psychology 7: 97 pp., 1977.

1286.
Morgan, B. B. and G. D. Coates. Sustained performance and recovery during continuous operations. Government Reports Announcements (Report No. AD-4012 908 OGA), 1974, 47 pp.

The two sections of the report represent the reproduction of papers presented at the 82nd annual meeting of the American Psychological Association, New Orleans, Louisiana, 30 August-3 September 1974 and the 18th annual meeting of the Human Factors Society, Huntsville, Alabama, 15-17 October 1974. Both papers were based on studies of continuous work and recovery conducted at the Performance Research Laboratory, University of Louisville, Louisville, Kentucky. Results summarized herein suggest that performance decrements during 36 hr of continuous work and sleep loss will vary between 11 and 35% depending upon the time of day at which the continuous-work session begins. It is also suggested that appropriately scheduled military personnel will be able to maintain acceptable levels of performance during 36 hr of continuous field operations and that these personnel will require 6 to 8 hrs of sleep before they are ready to return to duty.

1287.
Morgan, B. B., G. D. Coates, and E. A. Alluisi. The Effects of Continuous Work and Sleep Loss on Sustained Performance and Recovery during Continuous Operations. Norfolk Va.: Old Dominion University Research Foundation, 1975, 20 pp.

The results of two studies - one conducted at the Performance Research Laboratory of the University of Louisville under support of U. S. Army Grant No. DAHC-73-G-0007, and the second conducted at the Performance Assessment Laboratory of Old Dominion University under support of U. S. Army Grant No. DAHC-19-74-G-0018 - are reported.

These studies were designed to extend prior findings and to provide data concerning questions left unanswered by previous sustained-performance studies conducted by the authors at the University of Louisville.

The results of the reported studies answer two specific questions; namely, they indicate (1) that man's ability to work continuously for 36 hr is determined to a large extent by the interaction of the work duration with the circadian rhythm, and (2) that the recovery of performance from decrements associated with 36 hr of continuous work and sleep loss will require 8-12 hr of rest and recovery or sleep. Data reviewed herein suggest that appropriately motivated and scheduled individuals should be able to follow a 36-hr continuous-work, 12-hr recovery schedule with minimum decrements in performance.

1288.
Morgan, B. B. , G. D. Coates, B. R. Brown, E. A. Alluisi. Effects of continuous work and sleep loss on the recovery of sustained performance. Catalog of Selected Documents in Psychology 4: 104-105, 1974.

1289.
Morgan, B. B., G. D. Coates, R. H. Kirby, and D. L. Corson. Efficacy of self-regulation in the enhancement of sustained performance. Catalog of Selected Documents in Psychology 7: 125-126, 1977.

1290.
Mori, K. Circadian rhythms of corticoid and catecholamine excretion during and after an experimental night shift. Jap. J. Industr. Hlth 16: 566-567, 1974.

1291.
Mori, K., Diurnal rhythm and reversal of the biological clock. Horumon To Rinsho 26: 423-428, 1978.

1292.
Morimoto, Y., T. Oishi, K. Arisue, and Y. Yamamura. Effect of food restriction and its withdrawal on the circadian adrenocortical rhythm in rats under constant dark or constant lighting condition. Neuroendocrinology 29: 77-83, 1979.

Effects of food restriction and its withdrawal on the circadian adrenocortical rhythm were studied in adult female rats under constant darkness (DD) and constant lighting (LL). The animals were fed restrictedly during the daytime under DD and at night under LL for 10 days, and thereafter allowed to take food ad libitum. All the studies were performed as group data. The circadian peak of mean plasma corticosterone (B) levels was demonstrated just before the beginning of feeding under either DD or LL condition. Thus, the food restriction seemed to be an apparent single entrainer of the periodicity of plasma B levels if the light-dark cycle was absent. However, the circadian variation of plasma B was rapidly shifted after the withdrawal of 10-day food restriction and turned to a similar pattern to those seen in the rat fed ad libitum throughout DD or LL for 10 days. The circadian periodicity of food intake after the withdrawal of food restriction was also shifted to the pattern shown by the rat fed ad libitum under DD. These findings suggest that the forced alteration of eating rhythm induced by the restriction of feeding may act only as a temporary entrainer of the periodicity in the pituitary-adrenal system. Thus, it is possible that an endogenous adrenocortical rhythm may exist under the free-running conditions and only be entrained by feeding scheules, and that the food restriction regimen may have no essential effect on the supposed biological clock(s) which regulates the circadian rhythm of the pituitary-adrenal system as well as that of locomotor activity or eating behavior.

1293.
Morimoto, Y., and Y. Yamamura. Factors entraining circadian rhythms in mammals: Regulation of circadian adrenocortical periodicities and of eating-fasting cycles in rats under various lighting conditions. In: Biological Rhythms and Their Central Mechanism, edited by M. Suda, O. Hayaishi, and H. Nakagawa. New York: Elsevier/North-Holland Biomedical Press, 1979, pp. 177-188.

1294.
Morin, L. P., K. M. Fitgerald, and I. Zucker. Estradiol shortens the period of hamster circadian rhythms. Science 196: 305-306, 1977.

Continuous administration of estradiol benzoate by means of subcutaneously implanted capsules shortened the free-running circadian period of locomotor activity of blind hamsters (Mesocricetus auratus) that had had their ovaries removed. Estradiol also advanced the phase of the wheel running of sighted female hamsters without ovaries that were entrained to a photoperiod with 12 hours of light and 12 of darkness. These results, and findings from hamsters undergoing natural estrous cycles, indicate that endogenous estradiol is involved in the regulation of circadian periodicity.

1295.
Morris, G. O., and M. T. Singer. Sleep deprivation: the context of consciousness. J. Nervous Mental Dis. 4: 291-304, 1966.

129[illegible].
Mor[illegible]s, T. R. The photoperiodic effect of ahemeral light-dark cycles which entrain circadian rhythms. Br. Poult. Sci. 19: 207-212, 1978.

1297.
Moses, J. M., D. J. Hord, A. Lubin, L. C. Johnson, P. Naitoh. Dynamics of nap sleep during a 40 hour period. Electorenceph. Clin. Neurophysiol. 39: 627-633, 1975.

Following one baseline night, the sleep of 8 adult males in equally spaced 1 h naps was investigated over a 40 h period. The amount of stage REM during the naps and the total sleep time were negatively related to the circadian -temperature cycle. A reciprocal positive relation was found between REM and stage 4. Stage REM often occurred with 10 min of stage 1 onset. Autocorrelation and cross-correlation analysis showed that the progression of sleep stages from hour to hour in baseline sleep was altered in sequential naps.

No significant differences were observed between baseline and recovery sleep was altered in sequential naps. A second group of men who were sleep-deprived for 40 h, with exercise periods substituted for naps, showed typical sleep-loss effects during recovery sleep. It is suggested that the timing of REM onset may be controlled by a sleep-dependent ultradian clock.

1298.
Moses, J. J., L. C. Johnson, P. Naitoh, and A. Lubin. Sleep stage deprivation and total sleep loss: effects on sleep behavior. Physiology 12: 141-146, 1975.

The combined effects of total sleep loss and the deprivation of stage 4 or stage REM were studied in two separate experiments. Two full nights of sleep loss preceded stage 4 deprivation or stage REM deprivation in Experiment 1 (N= 12); 1 full night of sleep loss followed 3 nights of stage 4 deprivation or stage REM deprivation in Experiment 2 (N=14).

Total sleep loss before sleep stage deprivation significantly increased the number of attempts to enter stage 4, but had little influence on stage REM. A significant REM rebound was found in only one of the REM-deprived groups, but there was a significant stage 4 rebound in all groups on the first full recovery night, supporting the hypothesis from other studies that stage 4 has priority over REM in terms of recovery from sleep loss. The results suggested that stages 2, 3, and 4 partially overlap in their recuperative functions.

1299.
Moses, J. M., A. Lubin, L. C. Johnson, and P. Naitoh. Rapid eye movement cycle is a sleep-dependent rhythm. Nature 265: 360-361, 1977.

1300.
Moses, J. A. Lubin, P. Naitoh, and L. C. Johnson. Exercise and sleep loss: Effects on recovery sleep. Psychophysiol. 14: 414-416, 1977.

The effects of exercise and sleep loss on recovery sleep were studied in young male naval volunteers. For 1 hr out of every 4 hrs during a 40-hr period, 20 subjects rested in bed and 10 subjects bicycled. Eleven measures of recovery night sleep were selected for comparison of the bedrest and exercise groups. Only one reached significance under the conservative Dunn-Bonferroni criterion: the exercise group had a higher percent total sleep time. The results indicate that exercise does increase the effects of sleep loss on recovery sleep, but that there is no simple, direct effect on specific sleep stages.

1301.
Moses, J., A. Lubin, P. Naitoh, and L. C. Johnson. Circadian variation in performance, subjective sleepiness, sleep, and oral temperature during an altered sleep-wake schedule. Biol. Psychol. 6: 301-318, 1978.

The effect of an altered sleep-wake schedule on the interrelation of oral temperature, performance, and sleepiness was studied in 38 male Naval volunteers who maintained a 60 min. treatment - 160 min testing schedule for 40 consecutive hrs. During the 60 min treatment portion of each epoch, 8 subjects napped, 10 subjects exercised, and 20 subjects rested in bed. Sleep measures (for the nap subjects), oral temperature, performance on several tests, and Stanford Sleepiness Scale ratings were obtained at 10 equidistant intervals throughout the 40-hr period. Within-subject correlations showed that minimum oral temperature was significantly associated with maximum nap sleep time, errors on a vigilance task, and sleepiness ratings. In the nap subjects, errors and sleepiness ratings were highest following naps with high total sleep time, suggesting that sleep was detrimental to immediately subsequent performance and alertness. The distribution and interrelation of temperature, errors, and sleepiness, however, was similar in the three groups; this indicated that the synchronous circadian variation in these measures was responsible for the apparent detrimental effect of sleep in the nap subjects. When the diurnal effect was removed by holding time of day constant, the correlations among the variables fell to near-zero, indicating no causal relationship among the variables independent of the circadian rhythm.

1302.
Moses, J. P. Naitoh, L. C. Johnson. The REM cycle in altered sleep/wake schedules. Psychophysiol. 15: 569-575, 1978.

The length and rhythmicity of the REM cycle was studied using data from three laboratories. In the three studies, 25 subjects obtained their sleep in naps under three different sleep/wake schedules: 60/160 min (N=8), 30/60 min (N=10), and 60/120 min (N=7), over a period of 40 hrs to 10 days. Previous results from these subjects (Moses, Lubin, Johnson, & Naitoh, 1977) indicated that the REM cycle is sleep-dependent, rather than an expression of an ongoing Basic Rest-Activity Cycle (BRAC). As a further test of the sleep-dependent hypothesis, autocorrelation and r^2 analysis was applied to the compressed sleep (i. e., all wake time between and within sleep periods subtracted) of the baseline, nap, and recovery conditions. Compared to baseline, there were no significant differences in nap REM cycle length in the 60/160 and 60/120 groups; the 30/60 group had significantly shorter cycles. It appeared that this REM cycle shortening was due to the significantly shorter REM episodes in this group. The nap r^2 values were significantly lower than baseline in the 30/60 and 60/120 groups, indicating increased variability in the timing of REM episodes during naps. All the nap r^2 values, however, were significantly larger than those obtained from a random distribution of sleep stages.

To further examine the effects of the degree of sleep fragmentation on REM cycle rhythmicity, two additional groups of subjects whose sleep was fragmented by either REM or SWS deprivation were compared to the nap groups. REM deprivation was the most disruptive of REM cycle rhythmicity; the r^2 values for REM deprivation were significantly less than those for napping or SWS deprivation.

These data offer further support that the REM cycle is a sleep-dependent rhythm and is not an expression of an ongoing BRAC.

1303.
Mosier, J. E. An Investigation of Biorhythmic Influence Upon Human Performance. (M. S. Thesis), Naval Postgraduate School, Monterey, Ca., 39 pp., Report No. AD/A-001 266, 1974.

Hand grip strength and a psychomotor task (pursuit rotor task) measurements were obtained from 7 male subjects for 50 days. Subjects and experimenters were unfamiliar with biorhythm theory. Analysis of the relationship between biorhythm theory and performance was made by Kolmogorov-Smirnov test for uniformity of distribution(KS), chi square contingency test (CSCT), calculation of correlation coefficients(R) and Multiple regression (MR). The KS revealed nonuniformity in hand grip scores with respect to the physical biorhythm cycle. No other relationships were significant. The CSCT revealed a significnat relationship between hand grip performance and the physical cycle. The author also claims a significant relationship for psychomotor performance and the emotional and intellectual cycles but uses P 1. e. 0.1 as the significance criterion. The values obtained for R and MR exhibited considerable variability. The author interprets this as evidence for individual variability in the biorhythmic influence on performance but one could, with equal validity, interpret this variability as a reflection of a stochastic process (i. e. random distribution of performance with respect to biorhythm cycles. The author concludes that a functional relationship between biorhythm cycles and performance may exist. However, the failure to control possible circadian influences, the use of coded (+ or -) performance data instead of the real data (perhaps normalized with linear trend removal), and the variability of the correlation and multiple regression coefficients leave this conclusion in doubt.

1304.
Mosko, S. S., and R. Y. Moore. Aging of circadian rhythms in female rats. Soc. Neurosci. Abstr. 5: 9, 1979.

During the normal course of aging in female rats, estrous cycling breaks down near the end of the first year and rats enter a constant vaginal estrous(CVE) state at 12-15 mo which is succeeded by a series of repetitive pseudopregnancies beginning at about 2 yrs. The primary deficit responsible for the breakdown in cycling is unknown. Rats with neonatal or adult lesions of the suprachiasmatic nucleus, which abolish circadian rhythmicity, exhibit a permanent CVE syndrome. The estrous cycle of rodents has a circadian organization which is timed by the light-dark cycle, and recent evidence indicates that there may exist a circadian signal for LH release which is responsible for the preovulatory LH surge. We compared circadian rhythms in 7 old constant estrous (OCE;16-18 mo) and 4 old repetitive pseudopregnant (ORPP; 24-26 mo) rats to rhythms in 6 young cycling (YC; 3-4 mo) rats to determine if aging of circadian rhythm generating mechanisms could be a factor in the breakdown of estrous cycling in aging females. In addition, since neonatal androgenization induces a permanent CVE state which has been viewed as a model of early reproductive senescence, we also examined circadian rhythmicity in young, early androgenized (YEA; 3-4 mo) rats (100ug testosterone proprionate, s. c., on the day after birth).

Circadian rhythms in locomotor activity and drinking behavior were monitored in all rats (Long Evans, hooded) in both entrained (L. D. 14-10) and free-running (constant dim illumination, 1.0 lx) conditions. The results indicate that circadian rhythmicity in both behaviors declines with increasing age. In diurnal lighting YC, OCE and ORPP rats restrict 72.7 +/- 2.4%, 67.1 +/- 1.7% and 58.9 +/- 2.2%, respectively, of their drinking behavior to the 10 hrs of darkness. This percentage decrease in aged rats is primarily the result of fewer drinking events during the dark phase. Power spectral analyses of drinking events in both entrained and free running conditions reveal a progressive flattening of the spectrum and a diminished circadian peak with advanced age. YEA rats, in contrast, exhibit normal rhythmicity in activity and drinking.

Our findings indicate that the amplitude of circadian functions declines significantly with advancing age in rats. Aging of central circadian rhythm generating mechanisms is implicated. Dampened circadian functions in old age could contribute to the normal pattern of reproductive senescence observed in female rats. The observation that YEA rats exhibit normal circadian rhythms may indicate that different mechanisms underlie the CVE states of the YEA rat and rat with suprachiasmatic nucleus ablation.

1305.
Mouret, J., J. Coindet and G. Chouvet. Circadian rhythms of sleep in the rat: Importance of the feeding schedule. Int. J. Chronobiol. 1: 345, 1973.

Twelve male Wistar rats (210-230 g in weight) were chronically implanted with cortical and muscular electrodes after at least 15 d of adaptation to the environmental conditions of the laboratory (L.D. 12:12); light on from 0700 to 1900; 25°C; food and water ad libitum. Following the surgery they were housed singly in glass jars and connected to the recording cable. After a further 15 d to adapt to this new condition, they were recorded continuously (24 h per day) for an 8-d span. The records were scored to the nearest minute for the presence of Wakefulness (W), Slow Wave Sleep (SWS) and Paradoxical Sleep (PS) and utilized as base-line data. Then food and water availability were restricted to the light part of the cycle for 8 rats, and to the dark half for 4 rats, for respectively a 26-d and 6-d span, at the end of which food and water were given ad lib. again Whereas no changes in diurnal sleep and circadian rhythms were observed after restriction of food and water to the dark hours as compared with the control span (increase in SWS and PS during the light), some impressive changes in these rhythms appeared on the other feeding schedule: 1) Progressive disappearance of the differences in SWS between the light and dark hours, without variations in SWS amounts on a 24-h base, and 2) specific increase in PS which became more prominent during the dark hours, and was increased on a 24-h base. The importance of this specific increase, as well as the respective roles of light and food in maintaining the diurnal pattern of sleep in the rat will be discussed in relation with the current theories of sleep.

1306.
Mouton, A. Aspects particuliers de l'adaptation du travail a l'homme en milieu saharien (Thesis). Lille, France 1960.

1307.
Mueller-Seitz, P. The factory doctor and shift work. Zentralbl. Arbeitsmed. Arbeitsschutz Prophylaxe 28: 187-197, 1978.

1308.
Mukku, V., S. Prahalada, and N. R. Moudgal. Effect of constant light on nychthemeral variations in serum testosterone in male Macaca radiata. Nature 260: 778-780, 1976.

In conclusion, the present study shows that the bonnet monkey exhibits a high level of serum testosterone during night hours, which is abolished on exposure to constant light, suggesting that this variation in serum testosterone is a nychthemeral rhythm.

1309.
Mullaney, D. J., L. C. Johnson, P. Naitoh, J. K. Friedmann, and G. G. Globus. Sleep during and after gradual sleep reduction. Psychophysiology 14: 237-244, 1977.

To determine: 1) the minimum amounts of sleep subjects would tolerate, 2) the changes in EEG sleep measures, and 3) whether subjects would revert to baseline sleep after study termination, 4 couples gradually reduced their sleep. Three couples reduced their TST in 30-min steps from a baseline of 8 hrs and one couple from a baseline of 6.5 hours. Subjective estimates of sleep time, sleep quality, and mood were collected daily. Home EEG sleep recordings were obtained 3 nights a week.

Two of the 8-hr sleepers reduced their sleep to 5.5 hrs, 2 to 5.0 hrs, and 2 reached 4.5 hrs. These 6 subjects continued sleeping 1 to 2.5 hrs. below baseline amounts a year after reduction terminated. The 6.5-hr baseline couple reached 5.0 hrs and returned to 6.4 hrs TST during follow-up.

Stages 1, 2, and REM decreased significantly in absolute amounts. Percentage of stages 1 and 2 also decreased significantly. REM percent remained constant. Stage 3 was constant. Stage 4 rebound on 7-hr nights was not observed during times of greatest sleep reduction. Occurrences of stage REM within 109 min. of stage 1 onset were observed in 2 subjects when their TST was below 6.5 hrs.

Our results are consistent with other studies of shortened sleep, indicating that TST is the major determinant of sleep-stage characteristics.

1310.
Muller-Seitz, P. Tagesschwankungen Menschlisher Arbeitsergiebigkeit (Daily fluctuations in worker performance. (In German) Wt-Zeitschrift fur Industrielle Fertigung 68: 23-26, 1978.

There are 24-h cyclic variations in human working capacity which are incompatible with industrial productivity requirements. These permanently conflicting factors may result in qualitative/quantitative decrease in performance and /or higher accident frequency. The author studies the mechanism of the cyclic 24-h performance rhythm and the effects of decreased performance on production, and recommends the following organizational measures: concentration of work peaks in periods where performance is above average; introduction of work breaks with physical exercise and work to music, linked to the physiological rhythm; adaptation of speed of assembly-line work to peaks and troughs of the 24-h performance cycle; informing workers and supervisors about the 24-h performance.

1311.
Murakami, H., and H. Imai. A digital auto-recorder for measuring the drinking frequency of mice. Lab. Anim. Sci. 25: 634-637, 1975.

1312.
Murakami, H. and Murakami, Y. Effect of an altered rest-activity or feeding schedule on the shift of motor activity rhythm of mice. Aviat. Space Environ. Med. 51: 371-374, 1980.

Preflight acclimatization to the rhythm of destination and postflight daytime activity are assumed to be effective countermeasures against the jet lag syndrome. Regarding this idea, resynchronization of motor activity rhythm was investigated in mice subjected to daytime exercises on a driven belt before or after the reversal of lighting regimen. In addition, the effect of prior daytime feeding was studied. No evidence was manifested that the forced exercises or feeding schedule would hasten synchronization. This result indicates that the central control system of motor activity rhythm could not be manipulated favorably by such method in mice. On the basis of the result obtained, the applicability of countermeasures to human beings was discussed.

1313.
Murphy, M. R., R. J. Randle, and B. A. Williams. Diurnal rhythms of visual accommodation and blink responses: Implications for flight-deck visual standards. Aviat. Space Environ. Med. 48: 524-526, 1977.

The major purpose of this study was to determine whether 24-h variations in accommodation responses occur and, if they do, whether they should be considered in setting visual standards for flight-deck tasks. A recently developed servo-controlled optometer and focus stimulator were used to obtain monocular accommodation response data on four college-age subjects. No 24-h rhythm in accommodation was shown. Heart rate and blink rate also were measured and periodicity analysis showed a mean 24-h rhythm for both; however, blink rate periodograms were significant ($p<0.003$) for only two of the four subjects. Thus with the qualifications that college students were tested instead of pilots and that they performed monocular laboratory tasks instead of binocular flight-deck tasks, it is concluded that

24-h rhythms in accommodation responses need not be considered in setting visual standards for flight-deck tasks.

1314.
Murrell, K. F. H. Industrial work rhythms. In: Biological Rhythms and Human Performance, edited by W. P. Colquhoun, New York: Academic Press, 1971, pp. 241-272.

1315.
Myasnikov, V. I. Characteristics of the sleep of men in simulated space flights. Aviat. Space Environ. Med. 46: 401-408, 1975.

1316.
Myers, R. D. Temperature regulation: Neurochemical systems in the hypothalamus. In: The Hypothalamus, edited by S. W. Haymaker, E. Anderson, and W. J. H. Nauta. Springfield, Ill.: C. Thomas, 1969, pp. 507-523.

1317.
Nachreiner, F. Role perceptions, job satisfaction and attitudes towards shiftwork of workers in different systems as related to situational and personal factors (abstract). Int. J. Chronobiol. 3: 4, 1975.

A survey program on the perception of the social situation, the attitudes and subjective evaluations of health state in shift workers was conducted. The sample consisted of 1005 workers in different shift systems, who completed a questionnaire with a variety of topics. Analyses showed that attitudes towards shiftwork, subjective evaluation of health state, perception of the social situation and tenure of jobs in shiftwork are influenced by the type of shift system, neuroticism and extroversion.

1318.
Nachreiner, F. Einstellung zur Schicht arbeit. Zeitschrift Arbeitswissenschaften 32: 152-159, 1977.

1319.
Nachreiner, F. Role perceptions, job satisfaction, and attitudes towards shiftwork of workers in different systems as related to situational and personal factors. In: Experimental Studies in Shiftwork, edited by W. P. Colquhoun, S. Folkard, P. Knauth, and J. Rutenfranz. Opladen: Westdeutscher Verlag, 1975, pp. 232-243.

1320.
Nachreiner, F., and J. Rutenfranz. Sozialpsychologische, arbeitspsychologische und arbeitsmedizinische Erhebungen in der Chemischen Industrie. In: Schichtarbeit bei kontinuierlicher Produktion, edited by F. Nachreiner, R. Frielingsdorf, R. Romahn, P. Knauth, W. Kuhlmann, F. Klimmer, J. Rutenfranz, and E. Werner. Dortmund: Bundesanstalt fur Arbeitsschutz und Unfallforschung, 1975, pp. 83-177.

1321.
Nagayama, H., A. Takagi, Y. Sakurai, K. Nishiwaki, and R. Takahashi. Chronopharmacological study of neuroleptics. II. Circadian susceptibility rhythm to chlorpromazine. Psychopharmacology 58: 49-53, 1978.

In order to study differences in the effect of the neuroleptics due to time of administration, rats were administered chlorpromazine (CPZ) in a variety of combinations of dose and time and the sedation period was measured. There was daily fluctuation in the sedative effect and the pattern of fluctuation differed according to dosage. A similar study under the condition of reversed light and dark gave a reversed curve of the daily fluctuation., showing that the rhythm of light and dark controls the fluctuation externally. In an attempt to elucidate the mechanism of these phenomena, CPZ was administered at two different times, between which there was a significant difference in the sedation period, and time-course changes in plasma and brain concentration of the drug and its metabolites were measured. No difference was found. These results are interpreted as indicating that the phenomena could arise at the level of amine-receptor activity in the brain. In addition, daily fluctuation due to time of administration was noted in lethality.

1322.
Naitoh, P. Sleep Loss and its Effects on Performance. Washington D. C.: Bureau of Medicine and Surgery, Dept. of the Navy, Report 68-3, 1969, 65 pp.

The effects of sleep loss on human task performance were discussed under total, partial, and selective deprivations of sleep. Some of the frequently used psychological tasks in studies of total sleep loss were described in sufficient detail so that experimenters could choose, on the basis of materials presented in this monograph, adequate tasks to fit their experimental objectives. Factors which played critical roles in determining the degree of task sensitivity to total sleep loss were listed. Effects of shortened hours of sleep on human task performance were discussed. Effects of selected sleep deprivation on performance were also briefly commented upon. The commentary of this monograph covered almost all studies conducted on sleep loss under laboratory conditions, including a series of on-going experiments on total and selective sleep deprivations at the Navy Medical Neuropsychiatric Research Unit, San Diego, California 92152. The commentary was followed by a bibliography on sleep deprivation with author and subject indices.

1323.
Naitoh, P. Sleep deprivation in human subjects: a reappraisal. Waking and Sleeping 1: 53-60, 1976.

Some recent studies on sleep loss reveal significant improvements in biochemical, physiological and psychological methods of assessment. Critical examination of these studies indicates altered research emphasis, some newly developed research concepts, and a new awareness of tne methodological complexity involved in the seemingly simple research tool, sleep deprivation. This present paper suggests that sleep deprivation research will remain important in advancing our understanding of the impact of sleep loss, and of the mechanisms for the need of sleep.

1324.
Naitoh, P., C. E. Englund, J. Spinweber, and R. Hilbert. Effects of vigil on human circadian rhythms: normative data (abstract).. Chronobiologia 6: 135, 1971.

1325.
Nakagawa, H., K. Nagai, K, Kida, and T. Nishio. Control mechanism of circadian rhythms of feeding behavior and metabolism influenced by food intake. In: Biological Rhythms and their Central Mechanism (A Naito Foundation Symposium), edited by M. Suda, O. Hayaishi, and H. Nakagawa. New York: Elsevier/North-Holland, 1979, pp. 283-294.

A biological clock of circadian feeding rhythm was shown to be present in the suprachiasmatic nuclei (SCN), through which feeding behavior was entrained to environmental lighting. The SCN was also involved, not only in memory of feeding time learned during meal feeding, but also in anticipatory reactions, such as drinking behavior, just before eating. Experiments on the effects of lesions of the brain suggested that circadian time signal for feeding behavior might be transmitted form the SCN to the CMH and LH. Food is also a Zeitgeber, since the phases of the enzyme rhythms in gluconeogenesis and urogenesis are shifted in entrainment with newly established feeding times, irrespective of the lighting conditions. It seems likely, however, that food may affect the VMH and/or LH more than the SCN, though the feeding time may be imprinted through the function of the SCN. These relationships are summarized schematically in Fig. 8. It is also suggested that Ca^{2+} channels and /or carbohydrate metabolism may be involved in generation of the time signal.

1326.
Narinskaia, A. L. Dynamics of psychic performance during continuous 72-hour wakefulness. Aktual'nyye Voprosy Kosmicheskoy Biologii i Meditsiny, Moscow, 1971, pp. 201-202. (Engl. transl. In: Current Problems in Space Biology and Medicine. Arlington, VA: Joint Publications Research Service, 1972, pp. 79-80.)

1327.
Narinskaia, A. L. Study of psychic performance during modification of the daily schedule. In: Aktualnyye Voprosy Kosmicheskoy Biologii i Meditsiny, Moscow, 1971, pp. 199-200. (Engl. transl. In: Current Problems in Space Biology and Medicine, Arlington, Va.: Joint Publications Research Service, 1972, pp. 77-78.)

The results of a study on individual characteristics of the dynamics of psychic performance during man's adaptation to an unusual work and rest schedule are presented. Two pairs of subjects were selected from two groups segregated during an experiment with 72-hour sleeplessness. Both pairs of subjects were exposed successively to two 45-day experiments in an isolation chamber. During the first stage of the 45-day experiments the dynamics of performance was studied for a normal daily regime. On the 11th day there was an inversion of the daily schedule: a shift by 12 hours. After the shift psychic performance was studied using the same psychological methods. The results of the study indicate an individual character of the process of adaptation to a new regime. The decrease in the indices of psychic performance for the more rhythmic subjects was greater than for less rhythmic subjects.

1328.
Narinskaia, A. L. Diurnal dynamics of psychic performance during 72-hour continuous wakefulness. Kosm. Biol. Med. 6(6): 64-69. 1972.

An investigation was made of psychic performance during a 72 hour period of continuous wakefulness. Experiments were made using male subjects in the age group from 25 to 36 years. Tests cover (1) reproduction of a text (cognitional voluntary memory), (2) complicated conversion of figures into letters, (3) addition of numbers with switching, (4) making corrections, and (5) number and letter combinations (capacity for working when a time deficit prevails). The collected data indicate that performance levels for all methods during the 72 hour period decreased in all subjects. Data also show a deterioration in the productivity of mental performance, concentration and stability of attention, a slowness in mental processes, and difficulties in working when there was a deficit.

1329.
Narinskaia, A. L. Dynamics of the human mental work capacity during some activity regimes. In: Optimization of the Professional Activity of a Cosmonaut. Moscow: Izdatel'stvo Nauka, ?977, pp. 109-120.

Experimental studies of the dynamics and characteristics of human mental work capacity during some activity regimes are described. The regimes were: 72 hours awake; 45 days with the daily sleep-wakefulness rhythm reversed (that is, shifted by 12 hours); 25 days with 72 hour periods of wakefulness as well as reversal of the daily sleep-wakefulness rhythm; and 16 hour diurnal periods. The possibility of restructuring the diurnal dynamics of some mental functions was demonstrated, and indices of mental work capacity were used to determine the adaptation period to new diurnal regimes.

1330.
Natalini, J. J. The human body as a biological clock. An overview of biorhythms and how they affect us. Am. J. Nurs. 77: 1130-1132, 1977.

1331.
Naunton, E. Are emotional ups and downs set at birth? Philadelphia Enquirer, June 6, 1974.

1332.
Naunton, E. Biorhythm may let you have a happy day. The Miami Herald, June 2, 1974.

1333.
Neil, D. E. Biorhythms and industrial accidents. Paper presented at the National Safety Congress, Chicago, 1974.

1334.
Neil, D. E. Reply to letter of A. Ahlgren. Aviat. Space Environ. Med. 48: 678, 1977.

A rebuttal to the letter of A. Ahlgren (Aviat. Space Environ. Med., p. 678, 1977) is presented. The author believes that "biorhythm" is a worthwile area of study due to its popular impact and that attempts to limit research in this area are as nonobjective as are the biorhythm proponents.

1335.
Neil, D. E., L. J. Giannotti, and T. A. Wyatt. Statistical Analysis of the Theory of "Biorhythms". Monterey, Ca.: Naval Postgraduate School, unpublished Report, 46 pp.

The contents of this report are essentially covered in the thesis by L. J. Giannotti (A Statistical Evaluation of the Theory of Biorhythms, M. S. thesis, Naval Postgraduate School, Monterey, Ca., Report No. N75-19090, 1974, 75 pp.)

1336.
Neil, D. E., and S. O. Parsons. Biorhythms - Possible Application to Flight Safety. Paper presented at the Int. Air Transport Assoc., Twentieth Techn. Conf., Safety in Flight Operations, Istanbul, 1975, 14 pp.

In this review article on the application of the biorhythm theory to flight safety the authors discuss results of studies performed on biorhythm and performance at the Naval Postgraduate School, Monterey, Ca. (for further information see: Cobb 1975, Mosier 1974, Gianotti 1974, Sacher 1974 and Sink 1974). Also cited is a study of 127 randomly selected industrial accidents from a major aircraft maintenance facility in which the authors claim a statistically significant relationship between accidents and the physical and emotional biorhythm cycles was observed. The occurrence of accidents on biorhythm critical days was mean ± std. deviation above expected frequencies. The authors view biorhythm theory not as a predictive factor but as one of many variables contributing to day to day variation in human functioning. Biorhythm cycles represent a predisposing factor which contributes to limitation of an individuals capacity in the same way as fatigue, motivation or circadian effects. They suggest further studies be made on the biorhythm-performance relationship including flight simulator studies using Fourier analysis for rhythm periodicities and accident studies in which near-accidents and incidents related to unsafe performance are included in the accident data base. They suggest providing pilots with biorhythm cycle printouts and including biorhythm application to accident reduction in safety meetings, as well as the use of biorhythm theory for pilot work scheduling.

1337.
Neil, D. E., and F. L. Sink. Laboratory investigation of "biorhythms". Aviat. Space Environ. Med. 47: 425-429, 1976.

Three male students were tested on an information processing task on a daily basis for a period of 70 days. Performance measurements included reaction time, movement time, and information processing rates. Data were subjected to Fast Fourier Transforms to identify periodicities in performance. Statistically significant periods were found only in subjects 2 (11 and 5 days) and subject 3 (14.8 and 35 days) for reaction time. Significant movement time periods were found in subject 1 (30 days), subject 2 (11.4) and subject 3 (11.8 and 16.25 days). Information processing rate significant periods were found in subject 1 (29 days), subject 2 (11 days) and subject 3 (11.5 and 16 days). Of the 12 significant harmonics, 9 occurred within 1 day of the postulated 23, 28, or 33 day biorhythm cycles. The probability of this occurring by chance is less than .04. The lack of exact correspondence to biorhythm periods, required by the biorhythm theory of cycle invariance is explained by the effect increased effort on the part of the subject, which "masks" the biorhythm influence. The authors conclude that the results suggest biorhythm cycle contribution to performance. However, their justification for deviation of performance periods from biorhythm cycle periods could be used to justify any deviation of biological periods from predicted biorhythm cycles, thus making impossible to test the constancy of the biorhythm cycles. This paper is one of very few to utilize time series analysis and therefore the periods obtained are independent of a biorhythm cycle assumption (assuming subjects are naive with respect to the biorhythm theory). Therefore it is not necessary to assume that the periods found represent biorhythm influences. It could be assumed that they represent true biological infradian or low-frequency oscillations, which have been found in many physiological paramenters, independent of a biorhythm cycle assumption. The significance of the identity of the performance periodicities with biorhythm cycles is limited by the use of only 3 subjects. A published critique of this paper is available (Ahlgren, A. 1974 Int. J. Chronobiol. 2: 107-109).

1338.
Nelson, E. New facts on biorhythms. Science Digest 79: 70-75, 1976.

The author provides a skeptical review of claims by biorhythm proponents that the method can be used to lower industrial accident rates. He indicates that reports of high accident rates on critical days (e. g., Sanheim reported 40% of accidents occurring on critical days) often reflect small sample size and that larger scale studies, such as the Canadian Workmans Compensation Board analysis of 13000 accidents, did not find significantly high accident incidence on critical days. He quotes a study by B. L. Newcomb a New Jersey engineer, who found only small differences in accident rates between a control group, a group of workers warned about critical days, and another group warned about critical days but given erroneous information. He also quotes a study by S. Keddie, a Stockton, CA science teacher whose students charted 150 self-caused auto accidents and found no significant correlation of accidents with biorhythm critical days. He also quotes safety professional criticizing G. Thommens methodology of only using "self-caused" accidents in biorhythm studies as possibly biasing the samples.

1339.
Nelson, W., et al. Survival of immunocytoma-bearing rats affected by meal-feeding and timing of adriamycin treatment. Chronobiologia 2 Suppl. 1: 51, 1975.

1340.
Nelson, W., and F. Halberg. Effects of a synchronizer phase-shift on circadian rhythms in response of mice to ethanol or ouabain. Space Life Sci. 4: 249-257, 1973.

The percentage of mice dying from a toxic dose of ethanol of ouabain was determined a 4-hour intervals during the first 3 days after inversion of an LD (23:12) lighting regimen. In comparison to unstated control animals at similar stages of the synchroniser schedule, spans of relative advantage alternated with spans of relative disadvantage due to a gradual phase-shift of the circadian susceptibility rhythm. Overall mortality, determined for an integral number of days, was not obviously affected by the regimen-shift.

1341.
Nelson, W., G. Nichols, F. Halberg, and G. Kottke. Interacting effects of lighting (LD 12:12) and restricted feeding (4 h/24 h) on circadian temperature rhythm of mice (abstract). Int. J. Chronobiol. 1: 347, 1973.

1342.
Nelson, W., L. Scheving, and F. Halberg. Circadian rhythms in mice fed a single daily meal at different stages of lighting regimen. J. Nutr. 105: 171-184, 1975.

Circadian rhythms in systemic and cellular variables were studied in three groups of mice on different schedules of daily food accessibility: (1) only during the first 4 hours of the 12-hour light span; (2) only during the first 4 hours of the 12-hour dark span; and (3) at all times. The amplitudes of circadian variation in rectal temperature, serum corticosterone, and liver glycogen were increased by "meal-feeding" in either early light or early darkness. The overall averages of corticosterone and glycogen were also increased by meal-feeding at either stage of the lighting regimen. The times of peak values in temperature, corticosterone, and glycogen were determined by the time of food presentation, regardless of its relation to the lighting regimen. On the other hand, the interval between food presentation and peak values in the corneal mitotic index was greater when feeding was restricted to early light. Mice fed in early light also weighed more and exhibited more irregular circadian variation in temperature, corticosterone, and mitotic index than did mice fed in early darkness. These differences among the three groups of animals resulted in different relations among variables at any given interval after feeding onset. Such effects concerning total bodily function, energy storage, hormonal regulation, and basic cellular processes indicate the pertinence of meal timing to nutritional research and practice.

1343.
Nett, D. M. A Study of the Relationship of Biorhythms to Accidents at Two AMC Installations. U. S. Army Material Command Report, USAMC-ITC-02-08-75-414, 1975, 75 pp.

This report presents a review of both biorhythm theory and biological rhythm literature. A sample of 200 accidents each from the Rock Island Arsenal (RIA) and Lone Star Army Ammunition Plant were analyzed with respect to frequency of occurrence of biorhythym cycle critical days using a binomial model. A significant level of accident occurrence for the intellectual biorhythm cycle-LSAAP data was found. There were no other statistically significant relationships demonstrated between biorhythm cycles and accidents. The author suggests that the LSAAP workers, under higher stress levels than the RIA workers, may have been more susceptible to critical days. Most critical day accidents occurred when the other 2 cycles were out of phase. No sex differences were found in critical day accident levels. A circadian, but not seasonal effect was observed in accident times of occurrence. The author concludes that the suggestion of biorhythm-accident correlation, along with the monetary loss due to accidents at these facilities, justifies further study. It should be noted that biorhythm theory predicts that correlation between accidents and critical days should be higher for the physical and emotional cycles than for the intellectual cycle.

1344.
Newcomb, B. L. Biorhythm. Paper presented at the meeting of the Greater New York Safety Convention, New York, 1970.

A study at National Lead Co. tracked the accident rates of two experimental groups which were given accurate biorhythm critical day information, and a control group which was given false, randomly-assigned critical day information. The results showed a small decrease in the accident rates for the two experimental groups. During the same period, the control group experienced an increased accident rate which paralleled a plant-wide increase in the accident rate.

1345.
Nicassio, P., and R. Bootzin. A comparison of progressive relaxation and autogenic training as treatments for insomnia. In: Biofeedback and Self-control, edited by L. V. DiCara, et al. Chicago: Aldine Publ. Co., 1974, pp. 487-493.

Two relaxation techniques, progressive relaxation and autogenic training, were evaluated as treatments for insomnia. No-treatment, a baseline control group, and a self-relaxation group designed to control for nonspecific therapeutic elements were employed. Subjects were 30 adult insomniacs who had chronic and severe difficulties in falling asleep. As indicated by global measures of improvement and by reduction in time to fall asleep, progressive relaxation and autogenic training were equally effective as treatments and superior to both control groups. At a six-month follow-up, treatment gains had been maintained in time to fall asleep but not in self-reported global improvement, while control subjects showed no spontaneous improvement on either of the measures.

1346.
Nicholson, A. N. Influence of duty hours on sleep patterns in aircrew operating in the long haul transport role. A study of single crew operations and double crew continuous flying operations. In: Rest and Activity Cycles for the Maintenance of Efficiency of Personnel Concerned with Military Flight Operations, edited by A. J. Benson. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research Development, AGARD-CP-74, 1970, pp. 7-1 - 7-9.

1347.
Nicholson, A. N. Military implications of sleep patterns in transport aircrew. Proc. Roy. Soc. Med. 63: 570-572, 1970.

1348.
Nicholson, A. N. Sleep patterns of an airline pilot operating world wide east-west routes. Aerosp. Med. 41: 626-632, 1970.

1349.
Nicholson, A. N. Duty hours and sleep patterns in transport aircrew operating long haul routes. Aerosp. Med. Assoc., Preprints, 1971, pp. 101-102.

1350.
Nicholson, A. N. Physiological considerations of disturbed sleep-wakefulness cycles in the aerospace environment. In: Man in Space, edited by O. G. Gazenko and K. H. Byurstedta. (Proc. of the 4th symp. on basic environmental problems of man in space). Moscow: Erevin, 1971, 4th ed., pp. 285-298.

Difficulties in obtaining satisfactory sleep have been encountered during man space missions and it is generally recognized that an appropriate rest and activity pattern is essential to maintain the well-being and operational effectiveness of spacecrews. During earth orbital flights and lunar explorations satisfactory sleep is more likely if the crews maintain a reasonable relation with their normal terrestrial rhythm but many missions have required unusual patterns of activity. In the future prolonged extraterrestrial flights may also demand that the sequence of work and rest be subordinated to operational requirements and under these circumstances work and rest regimes developed under earth conditions may be of little use.

Irregular duty periods superimposed upon daily cycles of varying duration are experienced by long haul transport aircrew and an analysis of these schedules has suggested that irregular patterns of rest are compatible with a satisfactory sleep pattern as long as the workload is defined. It is considered that a similar relationship could be established for prolonged spaceflights and in this context the sleep patterns of an airline pilot operating world-wide schedules have been examined and relevant recent work on modified sleep regimes discussed.

It is concluded that irregular schedules of work during space missions may be feasible but that further study is needed of the nature of sleep in a disturbed rest-activity environment. Techniques to assist man in adapting to new work schedules, such as pharmacological control of sleep and wakefulness without undesirable side effects on performance, should also be examined.

1351.
Nicholson, A. N. Duty hour and sleep patterns in aircrew operating world-wide routes. Aerosp. Med. 43: 138-141, 1972.

1352.
Nicholson, A. N. Rest and activity patterns for prolonged extraterrestrial missions. Aerosp. Med. 43: 253-257, 1972.

1353.
Nicholson, A. N. Sleep patterns in the aerospace environment. Proc. Roy. Soc. Med. 65: 192-193, 1972.

1354.
Nicholson, A. N. Physiological and pharmacological studies related to the work of airline pilots. Proc. Roy. Soc. Med. 67: 27-28, 1974.

1355.
Nicholson, A. N. Residual effects of hypnotics on human performance. Aerospace Med. Assoc., Preprints, 1975, pp. 97-98.

The use of hypnotics by persons involved in skilled activity presents several problems, and particularly in the case of aircrew, it is essential to consider the residual effects which such drugs may have on performance. The present communication is concerned with human performance after ingestion of the normal maximum therapeutic dose of several hypnotics. Though it is appreciated that laboratory tests may not reflect accurately performance on the flying task, never-the-less an experimental approach provides a means by which comparisons of drug effects can be made. In this way it may be possible to select hypnotics which are least likely to impair performance during the subsequent working day.

1356.
Nicholson, A. N. Performance and impaired performance. Brit. J. Clin. Pharmacol. 3-4: 521-522, 1976.

1357.
Nicholson, A. N. Residual effects of hypnotics. In: AGARD 4th Advanced Operational Aviation Med. Course. Farnbourough, England: Royal Air Force Inst. of Aviation Medcine, 1976, 8 pp.

The residual effects of hypnotic drugs after their therapeutic purpose is fulfilled was considered. Test subject motor skills were examined for residual effects using a method of adaptive tracking.

1358.
Nicholson, A. N. Irregular work and rest. In: Aviation Medicine, Physiology and Human Factors, edited by G. Dhenin and J. Ernsting. London: Tri-Med Books, 1978, pp. 494-503.

1359.
Nicholson, A. N. Differential effects of the 1,4- and 1,5- benzodiazepines on performance in healthy man. Br. J. Clin. Pharmacol. Suppl. 1: 83S-84S, 1979.

1360.
Nicholson, A. N. Performance studies with diazepam and its hydroxylated metabolites. Br. J. Clin. Pharmacol. 8: 39S-42S, 1979.

1361.
Nicholson, A. N., R. G. Borland, C. H. Clarke, B. M. Stone. Experimental basis for the use of hypnotics by aerospace crews. In: Recent Advances in Space Medicine, Neuilly - sur- Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD, 1977, 11 pp.

The work which was carried out at the Royal Air Force Institute of Aviation Medicine on the immediate and residual effects of hypnotics on performance, the effectiveness of hypnotics, and the problems associated with the use of hypnotics at unusual times of the day is reviewed.

1362.
Nicholson, A. N., R. G. Borland, and G. M. Stone. Hypnotics and the management of disturbed sleep. In: Sleep, Wakefulness and Circadian Rhythm. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-LS- 105, 1979, pp. A12-1 - A12-11.

1363.
Nicholson, N., P. Jackson, and G. Howes. Shiftwork and absence: an analysis of temporal trends. Occup. Psychol. 51: 127-137, 1978.

In the literature on shiftwork there are many studies describing interesting and complex temporal variations in employee absence behaviour, though none have had the opportunity to unravel the independent effects of shift-turn (mornings, afternoons, and nights) days of the week (Sunday to Saturday), and position in the shift cycle (start, middle and end cycle). The independent effects of these variables and their interactions were the focus of a study of 250 male steelworkers on the 6-on 2-off Metropolitan shift system, with certified and uncertified absence as the two dependent variables. The results were consistent with the study hypotheses, showing strong main effects for each of the three independent variables and complex interaction effects, all in relation to uncertified absence only. These findings are discussed in terms of the fresh light they shed on multiple causes of absence and the problems associated with long cycle, shift systems. They also indicate that studies of temporal variations, in the absence rates of shiftworkers should attempt to investigate further, or at least take some account of shift cycle position, a powerful but neglected influence on absence.

1364.
Nicholson, A. N., and C. M. Wright. Use of hypnotics by aircrew. 1: Operational considerations and experimental studies. In: The Use of Medication and Drugs in Flying Personnel, Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD, 1973, 5 pp.

The residual effects of hypnotic drugs for normalizing aircrew sleeping patterns on human nervous function and performance are studied. Delayed matching-to-sample tests on monkeys show that barbiturates do ot affect matching-to-stimuli time: but some benzodiazepines increase response times up to 6 hrs after administration.

1365.
Nikolic, Z. Miloski Ritmovi Coveka (Human biological rhythms). Ergonomija 6: 11-19, 1979.

Rhythmicity oscillating within a mean value is manifested in many functions of the protoplasm of every living cell. Rhythms completed in 24-hour cycles are called circadian, whereas those with periodicity shorter than 24 hours are called infradian. It is generally accepted that eucaryotic organisms possess diurnal rhythms. Man is capable of measuring time physiologically even in the absence of any external time indicators. Circadian variations have been found in the functioning of all systems of the human organism. Mild depression in respiratory functions, lower resting and working heart rate, diminished blood flow, as well as decreased physical and mental performance, exist with the majority of people during night hours. The activity of the adrenal glands is circadian with its maximum level in the late morning and afternoon hours and its minimum in the early morning hours, both during rest and physical exertion. On the other hand, the ability of blood to bind oxygen and the concentration of noradrenaline in the cerebrospinal fluid are at their minimum levels in the mornings and at the maximum in the afternoons. Body temperature behaves similarly, i. e. its maximum is in the late-evening hours and minumum in the early morning hours. In the cases of prolonged isolation in caves or specially prepared rooms, the duration of certain functions tends to either exceed or become shorter than 24 hours, and free-running rhythms are established. It has been established that the so-called "day" and "night" types of persons exist, and that the "night" types are better able to tolerate the night-sleep loss, sleep better in day-time, compensate for sleep-loss, react better to stresses involved with night-work and are less vulnerable, enabling them to give better performance and to adapt themselves to night-work. With the majority of people ("day" type) working in shifts, catecholamine concentrations are high in the day-time and low at night: body-temperature curve is flattened at night with lower amplitudes, which is reflected in the degree of reactivity of the organism. Permanent night-workers are adapted to night-work, and manifest high catecholamine and body-temperature values, as well as high degree of general body activity, at night. The circadian system activity is of an endogenic origin and almost every cell has its own biological clock. The clock is probably located in the molecular organization of every living cell, and macro-oscillators, the oscillations of which can be measured are formed through synchronization and summation of micro-oscillators.

1366.
Nillus, P. Etude de Quelques Consequences Biophysiologiques de l'Isolement Souterrain de Sept Jeunes Femmes Bien Portantes. (Ph. D. thesis). Paris, 1967.

1367.
Nilsson, C. The psychological and social consequences of the scheduling of working hours (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. VIII-8.

1368.
Niskanen, P., et al. Psychiatric symptoms in the shift work of 427 female office workers. Psychiatr. Fenn., pp. 369-376, 1974.

1369.
Nitsch, J. R. Biorhythmus and Arbeit (Biological rhythm and work). Sicherheitsingenieur 3: 252-257, 1972.

Human physiological and mental functions vary in accordance with a distinctly biphased curve which peaks out during the day and reaches its lowest point during the night. Research has shown that sleep, work, and eating do not significantly effect this circadian rhythm. The effect of periodic environmental factors and the biological nature of the ciracdian rhythm are discussed. The second part of this study ddeals with the practical significance of circadian functional variations with special reference to appetite for work and circadian output peaks. A brief reference is made to conclusions relating to personnel selection and work organization.

1370.
Norton, D. L. Spectral analysis of hamster motor activity under different lighting conditions (abstract). Fed. Proc. 33: 369, 1974.

Gross motor activity rhythms were measured with a capacitance type activity meter from hamsters housed individually, with running wheels, and under different conditions of illumination. Animals were entrained 10 days in a 12:12 photoperiod followed by 20 days of constant light (LL) and 20 days of constant dark (DD). The data

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exhibits clearer sleep-wakefulness rhythms than those of the gerbil previously reported. Spectral analyses were run on sequential 3 day data segments. Several periodic families of harmonics were revealed from the data under all 3 lighting conditions. A circadian period of 24.02 ± 0.05 hours and its harmonics dominated the spectrum of 10 entrained animals, both in amplitude and in number of times assessed. In addition, periods of approximately 25.6 and 22.5 hours were clearly demonstrable. Spectral analyses were examined for changes in the frequency spectrum of the significant periodicities. LL and DD animals showed fewer harmonics of the major circadian period. Lighting regimes did not appear to affect the period lengths of the major periodic families. However, they did affect the number of times a particular period appeared. Although no affect of lighting on frequency could be demonstrated, changes in phase angles and amplitude were clearly affected. This suggests that amplitude-phase modulation rather than frequency modulation was influenced by lighting status.

1371.

Norton, D. A. Multiple Circadian Periodicities in Hamster Motor Activity as Determined by Time Series Analysis. (Ph. D. Thesis). Michigan State University, 1975, 175 pp.

1372.

Nunez, A. A. Neural Control of Circadian Rhythms and Their Entrainment to the Light-dark Cycle. (Ph. D. thesis). Florida State University, 1977, 99 pp. Diss. Abstr. 38: 4511-B, 1978.

1373.

Nurminen, M., J. Ilmarinen, R. Ilmarinen, and O. Korhonen. Application of periodic regression analysis to a study of physiologic functions related to physical working capacity (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. I-5.

1374.
Oatley, K. Circadian rhythms and representations of the environment in motivational systems. In: Motivational Control Systems Analysis, edited by D. J. McFarland. New York: Academic Press, 1974, pp. 427-459.

1375.
O'Connor, P. J.. AVMED policy on sleep in aircrew. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-108, 1973, 2 pp.

The role of the aviation medical practitioner in relation to aircrew sleep is to instruct the crews in how to anticipate sleep requirements and the best physiological ways of encouraging adequate sleep. Hypnotics should not be used by crews to get sleep as they cause decrement in performance during the subsequent day.

1376.
O'Dell, L. Waking hours circadian rhythmicity of physiological and mental performance measurements of morning and evening-alert nursing students. Diss. Abstr. 38: 6625B, 1978.

The purpose of this study was to evaluate the waking hours circadian rhythmicity of temperature, pulse, verbal reasoning, and perceptual speed self-measurements taken in the natural environments of female nursing students classified as possessing morning or evening-alertness.

1377.
O'Donnell, R. D. Secondary task assessment of cognitive workload in alternative cockpit configurations. In: Higher Mental Functioning in Operational Environments, edited by B. O. Hartman. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-181, pp. C10-1 - C10-5.

New developments in cockpit design may introduce significantly greater cognitive demand on the crew member. Yet few measurement techniques exist which are able to provide an objective, reliable estimate of the workload introduced by these new systems. New approaches are therefore required. In a series of pilot studies, traditional secondary-task reserve capacity concepts were modified to be used at sub-maximal levels of workload. A primary flight simulation was performed simultaneously with the item recognition task proposed by Sternberg. This task was chosen because the intercept and slope functions of the memory-load/reaction time function appear to independently assess cognitive and sensory-motor workload. Results indicate the secondary task shows reliable and consistent changes with variations in workload, and appears promising as an objective measure of higher mental functions. Auditory and visual versions have been constructed, and further validation studies are being carried out.

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1378.
O'Donnell, R. D., R. Bollinger and B. O. Hartman. The Effects of Extended Missions on the Performance of Airborne Command and Control Teams: A Field Study. Wright-Patterson AFB Ohio: Aerospace Medical Research Lab. AMRL-TR-74-20, 1974, 33 pp.

The report covers the effects of extended mission lengths on the performance of airborne command and control teams, wherein complex cognitive components consisting primarily of information collection, interpretation, and communication constitute the bulk of the workload. The survey centers on investigating general categories of performance-related factors, such as overall fatigue, rather than specific task performances such as long-term memory, sensory motor reaction, time of information processing.

1379.
Oequist, O. Mapping of individual circadian rhythm (thesis). Univ. of Goeteborg, 1970, 128 pp.

Former models about the formation of the 24 hour rhythm in man, animals and plants are reviewed, according to which it is acquired, established and maintained by exogenic periodicities. The present investigation maps individual daily rhythms on the basis of experience, overt behavior and performance at various times of day. A group of 85 individuals were tested by means of questionnaires, and several control groups were included. The persons were divided into two extreme groups - the morning group and the evening group which were monitored for a month (diary). From each group, five individuals were subjected to performance measurements at two time during the day. It is concluded that individual daily rhythms are a fundamental characteristic which are affected only slightly by external life routine, are associated with schizothymia cyclothymia, are coupled with age and affect performance at different times of the day.

1380.
Oginski A., L. Kozlakowska-Swigon, and J. Pokorski. Diurnal and seasonal variations in industrial fatigue of shift workers. Proc. Congr. Int. Ergonomics Assoc., 6th, The Human Factors Society, Santa Monica, CA, 1976, pp. 515-518.

The interview was carried out with 1664 steelworkers in the aim of obtaining their opinion on subjective fatigue accompanying the work on morning, afternoon and night shifts. Warm and cold seasons of the year were treated separately. Continuous work observations and telemetric heart rate registration were conducted at some workplaces. Analysis of results exhibited a great differentiation of fatigue estimation on particular shifts. Infuence of the seasonal factor was found to be very important both in the reported feeling of fatigue as in changes of the pulse rate. Conclusions concern the ergonomic approach to fatigue problems in shift work.

1381.
Oginski, A., L. Swigon, and J. Pokorski. Diurnal and seasonal variations in industrial fatigue of shift workers. Ergonomics 19: 391, 1976.

1382.
Ogle, J. Facts on sleep. Vogue 169: 548-553, 1979.

1383.
Oglivie, R., and S. Segalowitz. The effect of 20% sleep reduction upon mood, learning and performance measures. Sleep Res. 4: 242, 1975.

1384.
O'Hanlon, J. F. Some observations from a literature review to anticipate biological problems that might arise in sustained and continuous operation. Conf. on Military Requirements for Research on Continuous Operations (Human Engineering Labs.), Lubbock, TX., 1971, pp. 116-132.

1385.
Ojanlatva, A. T. T. The Relationship Between Record Setting Athletic Performance and Biorhythms (Ph. D. thesis). Southern Illinois University Carbondale, 1978.

To test the hypothesis that setting of university records in objectively measureable performances in track and swimming exceeds normal probability during positive biorhythm phases, the author studied rocord performances by 127 track and field athletes and 82 swimmers. Chi square analysis revealed no relationship between biorhythm positive phases and record performances. The author concludes that biorhythms should not be used as performance predictors until further evidence of their influences is obtained and recommends further study. Multiple regression analysis and further analysis of biorhythm performance relationships with respect to biorhythm cycle low phases and critical days should have been performed. Gittelson (Biorhythm Sports Forecasting, Arco, New York, 1977) claims that outstanding sports performance may be significantly high on biorhythm critical days.

1386.
Okimura, Y. and K. Tatai. Biorhythm for Mother and Child. Sankoshobo, Osaka, 1974. (Cited in : Tatai 1977 Biorhythm For Health Design, Japan Pub., pp. 1118-123).

The author recommends educational and safety programs for children, based upon the physical and emotional biorhythm cycles, but not the intellectual cycle, which is not manifested in children. Parents should use biorhythm theory to direct the activities of their children.

1387.
Oleron, G., P. Fraisse, N. Zuili, and M. Siffre. The effects of variations in the sleep-wakefulness cycle during a 'time - isolation' experiment on reaction time and spontaneous tempo. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep (Proc. of a Symp., Strasbourg, FR., 970), edited by W. P. Colquhoun. London: English Universities Press, 1972, pp. 171-176.

Variations in the sleep-wakefulness cycle were studied in an experiment with a subject (aged 24) who lived 174 days in a cave at a depth of 70 m. without any time reference, and was free to arrange his own sequence of work, rest, food intake, and leisure. The effects of these variations on reaction time and spontaneous tempo show that the rhythm toward which an individual tends during a prolonged 'time isolation' experiment is a circadian one.

1388.
O'Neil, B., and R. Philips. Biorhythms: How to Live with your Life Cycles. Pasadena: Ward Ritchie Press, 1975, 120 pp.

This book presents an introduction to biorhythms and how they affect personal physical and emotional characteristics. Sample biorhythm charts are presented, along with charting instructions and suggestions for coping with daily problems using biorhythmic information. They claim that in 1973 the United Airlines office of industrial engineering initiated a program to explore the application of biorhythm. A reduction in injuries following initiation of a safety program was claimed but the results were not published. The authors claim that the Fliess biorhythm method will have future application in marriage counseling, surgery planning, psychological and physical therapy, industrial safety and athletic performance.

1389.
Oppenheim, M. Why some people can't sleep. Woman's Day, 10 June 1980, pp. 44, 46, 114, 116.

1390.
Opstad, P. K., R. Ekanger, N. Nummestad, and N. Raabe. Performance, mood, and clinical symptoms in men exposed to prolonged, severe physical work and sleep deprivation. Aviat. Space Environ. Med. 49: 1065-1073, 1978.

There were 44 young men who participated in strenuous combat courses of 4 d (course I) or 5 d (course II), almost without sleep. They were tested and examined clinically each morning. Groups 1 and 2 had no organized sleep, whereas groups 3 and 4 got 3 and 6 h., respectively, in the middle of each course. Substantial impairment was observed in all test, as well as clinical symptoms toward the end of the courses for groups 1 and 2. In the vigilance test, the reaction time task, the code test, and the profile of mood-state, significant impairment was observed even after 24 h. Complaints of symptoms came first. Disturbance of senses and behaviour appeared later. Group 4 had significantly better results than groups 1 and 2 in clinical symptoms and all tests, except the positive score in mood-state. Group 3 occupied an intermediate position. Corresponding results were obtained in the two separate courses. In the morning following the course, recovery after 4 h of sleep was less extensive for course II than course I participants.

1391.
Orford, R. R., and E. T. Carter. Survival as an airline pilot. Aerospace Med. Assoc., Preprints, 1975, pp. 226-227.

1392.
Orr, W. C., H. J. Hoffman, and F. W. Hegge. Ultradian rhythms in extended performance. Aerospace Med. 45: 995-1000, 1974.

Eleven healthy, young, male volunteers participated in an experiment which involved continuous monitoring of heart rate and performance on a complex vigilance task. Ss were instructed to continue in the experiment for 48 h or until they felt they could go no longer. All Ss completed at least 21 h and two went for 44 h. Heart rate and behavioral measures were subjected to complex demodulation analysis to determine the phase and amplitude characteristics of cyclic activity with a period in the range of 90 min +/- min. The primary findings were a rather marked increase in the amplitude of the 90-min rhythm, in both heart rate and performance measures, as the time on task increased, reaching their highest level near the end of the run. This response pattern was found in over three-fourths of the analyses done, and was independent of the total duration of the experiment. It is felt that this marked amplitude rise is indicative of a cummulative stress response. In most subjects, the heart rate response did appear to show some similarity of patterning with at least one of the behavioral measures. Only three Ss showed an obvious dissociation between heart rate and the behavioral responses. There was, however, greater concordance of response patterning among the behavioral measures.

1393.
Orr, W. C., H. J. Hoffman, and F. W. Hegge. The assessment of time-dependent changes in human performance. Chronobiologia 3: 293-305, 1976.

This paper describes a series of experiments to illustrate the use of various methods of time series analysis in the delineation of the effects of circadian and ultradian cycles on human performance. These experiments are concerned with measures of both human performance and physiology. They illustrate how the parameters of these time series analytic techniques can be used to postulate physiological mechanisms where time-dependent changes have been shown to be significant. The use of analytic techniques in both the time and frequency domain is illustrated.

1394.
Orser, M., R. Brightfield, and G. Brightfield. Astrorhythms. New York: Harper Colophon Books, 1980, 128 pp.

This book attempts to integrate astrological concepts with those of Fliess biorhythm method (i.e., to combine the Fliess idea of monthly physical and emotional cycles with cycles induced by motion of the planets). The authors develop a concept of "energy" rhythms, unsupported by any references or studies, manifested by four phases: inward energy turned, balance point, outward energy turned, balance point.

1395.
Osada, H., E. Sakaguchi, H. Maru, and R. Yurugi. Effects of cold exposure on circadian rhythm of body temperature in rats and rabbits. Japan Air Self Defense Force, Aeromedical Laboratory, Reports 20: 49-59, 1979.

A study of the effects of cold exposure on the circadian rhythm of the body temperature in rats and rabbits is presented. 5 rabbits were exposed outdoors during winter for 48 hr. and 5 rats were placed in a cold room (5 plus or minus 1 C) for 2 months. Body temperatures of the animals were measured every one or two hours, and the circadian rhythm of the body temperature was analyzed by the cosinor method in which the mean value, amplitude, and the phase shift of the body temperature alteration during 24 hr were mathematically expressed. Both the cold and warm acclimatized rats showed approximately the same pattern in the circadian diagram, acutely cold exposed rabbits exhibited reduced amplitude in cosinor diagram in rectal, subcutaneous and skin temperature as compared with the warm acclimatized rabbits and a reversed phase with the environmental air temperature and human circadian pattern.

1396.
Ostberg, O. Circadian rhythms of food intake and oral temperature in "morning" and "evening" groups of individuals. Ergonomics 16: 203-209, 1973.

The most marked 'morning' and 'evening' types in a psychology class were identified by means of a questionnaire, and asked to record their oral temperatures and food intakes throughout the day during a 4-week and a 4-day period respectively. The morning group had its mean circadian temperature maximum 5 h earlier than the evening group, and had its cumulative food intake distribution curve 1 3/4 h ahead of the evening group. After adjusting the food distributions by 1 3/4 h in the time base to get a least-square fit, significant differences between the distributions remained. It is suggested that morning types have a more autonomous 24-hour periodicity than evening types. It is concluded that the questionnaires have the power to discriminate extreme morning and evening types of individuals in terms of oral temperature and food intake. Food intake seems to be a sensitive enough measure to be included in studies of inter-individual differences of circadian rhythms.

1397.
Ostberg, O. Interindividual differences in circadian fatigue patterns of shiftworkers. Br. J. Ind. Med. 30: 341-351, 1973.

Data from 37 computer operators and output-handlers, working on discontinuous 8-16-24 alternating shifts, were collected in the morning, evening, and night shifts during a one-year period. The study was directed to the interindividual differences in the workers' circadian patterns of activity, sleep, oral temperature, time estimation, physical fitness, and food intake. By means of a questionnaire on preferences and habits of activity and time of day, three subgroups of five subjects each were selected - 'morning', 'middle', and 'evening' groups. Significant differences were found between the groups and between the shifts. Most interesting was the significant interaction of group x shift, on the basis of which it could be concluded that the 'morning' type of subjects had the most pronounced difficulty in adapting to the shift system practiced. It is thought that a refinement of the questionnaire used should eventually result in a tool for assessing a person's circadian type and the interaction of type x shift.

1398.
Ostberg, O. Zur Typologie der circadianen Phasenlage. Ansatze zu einer praktisschen Chronohygiene (On the typology of the circadian phase position. Formulation for a practical chronohygiene). In: Biologische Rhythmen und Arbeit, edited by G. Hildebrandt. Vienna: Springer-Verlag, 1976, pp. 117-137.

1399.
Ostberg, O., and G. Svenson. "Functional age" and physical work capacity during day and night. In: Experimental Studies of Shiftwork, edited by P. Colquhoun, S. Folkard, P. Knauth, and J. Rutenfranz, Opladen: Westdeutscher Verlag, 1975, pp. 254-264.

The effects of circadian rhythms in man have hitherto not been included in the calculation of physical work capacity from submaximum tests. This has had the effect that in most earlier investigations the ergometer tests paradoxically seemed to indicate an increased work capacity after a long day of work. By means of studying the change in heart rate and rated perceived exertion, it is shown that individuals can be looked upon as growing older during the night, and that nomograms for calculation of work capacity should be corrected for functional age rather than chronological age. It is also shown that interindividual differences in circadian phase ('morning' and 'evening' types of individuals) must be taken into consideration in evaluating work capacity and functional age.

1400.
Panferova, N. Y. Sostoyaniye termoregulyatsii pri dlitel'nom prebyvanii v usloviyakh ogranicheniyem myshechnoy deyatel'nosti (Heat regulation under prolonged limitation of muscular activity). Fiziol. Chel. 4: 835-839, 1978.

Under conditions of limitation on muscular activity, heat regulation changes. The skin temperature topography is redistributed, in the direction of decrease in skin temperature of the lower half of the body and the weighted mean temperature. Coordination of the heat production and heat transfer processes is disrupted, a consequence of which is a periodic increase of body temperature above 37°. Discrimination of temperature stimuli is hampered, cold ones to a greater extent.

1401.
Panov, A. G., and N. I. Komandenko. Neurological fatigue-indices of flight crews of long-range and military transport aviation. Voenno-Med. Zh.(1): 76-78, 1973.

1402.
Papaloizos, A. and J. Cariact. Les biorhythmes. Une theorie sans fondements (Biorhythms. A theory without foundation). Z. Praventivmed. 5: 64-70, 1960.

The biorhythm theory was tested on 500 drivers who caused an accident; the occurrence of an accident could not be predicted by the theory any better than chance.

1403.
Papin, J. P. Problems in maintaining the alertness of air force personnel - the organization of work schedules during long-distance flights. (AGARD, Meeting, Scuola Militare di Sanita Aeronautica, Rome), Riv. Med. Aeronaut. Spaz. 40: 153-164, 1976.

1404.
Papousek, M., H. P. Frank, and H. Stohr. Sleep deprivation therapy in endogenous depression. Effects on circadian rhythms. Sleep: Europ. Congr. Sleep Res., 2nd, Rome, 1974, edited by P. Levin and W. P. Koella. Basel: Karger, 1975, pp. 474-477.

1405.
Parker, D. C., E. Pekary, and J. M. Hershman. Effect of normal and reversed sleep-wake cycles upon nyctohemeral rhythmicity of plasma thyrotropin: evidence suggestive of an inhibitory influence in sleep. J. Clin. Endocrinol. Metab. 43: 318-328, 1976.

1406.
Parker, D. C., L. Rossman, D. Kripke, W. Gibson, and K. Wilson. Imposed 30 hr sleep-wake cycle elicits a 30 hr periodicity and its harmonics in growth hormone (hGH) rhythmicity (abstract). Sleep Res. 7: 124, 1978.

1407.
Parlee, M. B. The rhythms in mens lives. Psychology Today 11: 82-91, 1978.

Mood evaluation was performed daily at the same time for 90 days in 15 men, using the Thayer Activation-Deactivation Checklist, Profile of Mood States and the Weissman-Ricks Personal Feelings Scale. Time series analysis revealed cycles from 6-90 days with clusters at 7, 23, 30 and 45 days.

1408.
Parlee, M. B. Night people and body rhythms. Psychology Today : 45, 1979.

1409.
Parrot, J., and J. C. Petiot. Less than 24 hour pseudo-periodicity in work schedules of train drivers in relation to their sleep. Int. Arch. Occup. Environ. Health 41: 181-188, 1978.

Work schedules from a random sample of 180 successive on and off duty days of 4 train drivers were analyzed. Work blocks cover 4 to 8 consecutive days, with off duty times spent at home or away from home. Within these work blocks it appears that in 84% of the cases, individual starting and finishing times of service fall earlier from one service to the following. On the whole they tend to sweep continuously the nycthemere counterclockwise, which results into less than 24 hr blocks, estimated periods are less than 24 hr ranging in these cases from 19 hr to 24.60 hr (sample mean: 20.68 hr). Mean service duration observed in the sample as 7 hr. Mean effective driving task corresponds to 60% of that time. The general hypothesis is made that such an artificial application of a work rest cycle which is less than 24 hr provides the least propitious conditions for development of so called adaptive responses, at least as far as duration of sleep and intrasleep patterns are concerned, if subjects are at the same time submitted to circadian influences of environmental and social Zeitgeber.

1410.
Parrot, J., J. C. Petiot, M. Baudot, and J. M. Goutorbe. Remarks on some work schedules of train drivers, in relation to their sleep. Chronobiologia 4: 137, 1977.

In a previous research, Foret and Lantin (1972) presented evidence for major disturbances in sleep duration and EEG patterns of French train drivers. Because of that research we paid attention to train driver work schedules. Train driver work schedules are very often organized in advance into work-day blocks separated by rest-day blocks which have no automatic coincidence with the conventional week-end. Our analysis involved a random sample of 24 such work-blocks and corresponding rest-blocks cover 4 to 8 consecutive days, with off-duty times spent at home or far from home. Within these work-blocks it appears that time sharing results into pseudoperiodicity in successive starting times or finishing times of service. In 23 cases out of 24, the estimated period is less than 24 H, ranging from 1900 to 0000 (sample mean: 2108, SD 1.34h). In 84% of the cases individual starting and finishing times fall earlier from one service to the following, and corresponding work schedules sweep the nyctohemeral counter-clockwise. Mean service duration observed in the sample is 7 h (SD1.25 h). Mean effective driving task corresponds to 60% of that time. Implications of such work schedules for health and performance of train drivers are discussed in relation to observations by Foret and Lantin and to other relevant findings by Lewis and Lobban (1957).

1411.
Patkai, P. Diurnal differences between habitual morning workers and evening workers in some psychological and physiological functions. The Psychological Laboratories of the University of Stockholm, Report No. 311., 1970.

1412.
Patkai, P. Satisfaction with different types of rapidly rotating shift systems (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen FR., 1980, p. IV-6.

1413.
Patkai, P., T. Akerstedt, and K. Pettersson. Field studies of shiftwork: I. Temporal patterns in psychophysiological activation in permanent night workers. Ergonomics 20: 611-619, 1977.

The diurnal variation in body temperature, catecholamine excretion performance, and subjective alertness was studied among 24 permanent night workers suring the 1st, 3rd, and 5th day of their work 'week' of six nights. Most of the variables showed a significant diurnal pattern with high values during work. Furthermore, the patterns of variation were similar during the three nights of measurement without any observable adjustment over the week. It was therefore suggested that permanent night work might facilitate a more rapid switch over to night work after free days.

1414.
Patkai, P., and Dahlgren. Adjustment of diurnal rhythms to unusual working hours as related to measures of subjective adaptation. Ergonomics 21: 869, 1978.

1415.
Patkai, P., G. Johannson, and B. Post. Mood, alertness and sympathetic-adrenal medullary activity during the menstrual cycle. Psychosom. Med. 36: 503-512, 1974.

Six healthy women were studied during a daily work routine for a period covering two menstrual cycles. Urninary catecholamines and body temperature were measured each morning of ordinary weekdays. On each occasion estimates of subjective mood and alertness were obtained. Four periods of the menstrual cycle, premenses, postmenses, ovulation and postovulation, were compared in respect to physiological and subjective variables. No significant differences in adrenaline and noradrenaline excretion between periods were found. Estimates of subjective states did not generally differ between periods except for feelings of restlessness. Night sleep was most disturbed during premenses, coinciding with the longest sleep duration. All physiological variables exhibited a high degree of intraindividual constancy during the cycle.

1416.
Patkai, P., K. Pettersson, and T. Akerstedt. Flexible working hours and individual diurnal rhythms. Reports from the Psychological Laboratories, U. Stockholm, No. 406, 1973, 12 pp.

The relevance of individual diurnal rhythms was studied among workers with flexible working hours. Workers classified as habitual morning vs evening workers, on the basis of their answers to a questionnaire, were compared with regard to body temperature, catecholamine excretion, performance efficiency and subjective alertness during a morning, mid-day and afternoon session. The time patterns for variations in body temperature, performance efficiency and subjectively estimated alertness during the day differed significantly between the two groups. Morning types showed a diurnal rhythm where the peak levels of these variables were reached during the morning hours, decreasing towards the afternoon, while the opposite trend was characteristic of the evening types.

1417.
Patkai, P., K. Petersson, and T. Akerstedt. The diurnal pattern of some physiological and psychological functions in permanent night workers and in men working in two-shift (day and night). Int. Symp. on Night- and Shiftwork: Experimental Studies of Shiftwork, 3rd., Dortmund, W. Ger., 1974, pp. 1-9.

The gains of permanent or longer periods of night work is discussed in terms of "short-term" and "long-term" adaptation, where the latter refers to a decrease in the time recessive periods of night work. Results are presented from two studies involving 24 printers with permanent night work and 13 type-setters working in two-shift with alternate days and nights. Data on catecholamine excretion, body temperature, performance and subjective state were collected in the beginning, in the middle and at the end of the night shift period for both groups. The signs of better long-term adaptation in the sense that their night curves did not improve during the night period as much as those of shift workers. It appears that permanent working hours may be a requirement for the development of long-term adaptation to night work.

1418.
Patkai, P., K. Pettersson, and T. Akerstedt. The diurnal pattern of some physiological and psychological functions in permanent night workers and in men working on a two-shift (day and night) system (abstract). Int. J. Chronobiol. 3: 5, 1975.

1419.
Patkai, P., K. Petterson, and T. Akerstedt. The diurnal pattern of some physiological and psychological functions in permanent night workers and in men working on a two-shift (day and night) sytem. In: Experimental Studies in Shiftwork, edited by W. P. Colquhoun, S. Folkard, P. Knauth, and J. Rutenfranz. Opladen: Westdeutscher Verlag, 1975, pp. 131-141.

1420.
Paunovic-Pfaf, J. and D. Georguevicïolin. Stav Radnika Prema Nocnom Radu (Attitude of workers to night-work). Ergonomija 5: 41-44, 1978.

Night work, which involves a series of changes - from habits of the organism to social contacts - is in most cases experienced as an unpleasantness which can lead to reactions of frustration especially with the younger and unadapted workers. The authors have investigated 150 workers who work in three shifts. The methods used were those of interview and questionnaires containing a choice of answers. The aim of the investigation was to establish the attitude of workers to night work, sources of interference with social habits and disturbance of sleep after night work. Negative attitude was evident with 77% of workers, positive with 11%, and only 12% of the workers considered it as an inevitability involved with the post. The authors recommend that a selection is made among the candidates for night work, that changes in shifts are organised, more suitable diets during night work and organised recreation. Particular emphasis is placed on the necessity of improving the standard of living and on ensuring adequate rest after night shift.

1421.
Peck, A. W., R. Adams, C. Bye, and R. T. Wilkinson. Residual effects of hypnotic drugs: evidence for individual differences on vigilance. Psychopharmacology 47: 213-216, 1976.

1422.
Pegram, G. V., R. J. Bradley, and J. M. Rhodes. Alteration of sleep and circadian rhythms by the use of drugs. In: Medical Primatology, 1970. (Proc. of the Second Conf. on Exper. Med. and Surgery in Primates, New York, N.Y., 1969), pp. 455-461.

Study of the interaction between the two independent desynchronizers of normal endogenous rhythms in monkeys rperesented by time zone shift and p-chlorophenylalanine(PCPA). The primary objective of the study was to determine if 5-HT depletion (PCPA administration) could enhance physiological and behavioral adjustment to a 6-hr phase shift. The results presented are of a preliminary nature and form part of a larger study investigating the interaction of environmental parameters, work/rest cycles and sleep patterns.

1423.
Pengelley, E. T. (ed). Circannual Clocks. (140th AAAS meeting San Francisco, 1974) New York: Academic Press, 1974, 523 pp.

1424.
Pequignot, G., J. Claudian, and F. Vinit. Journee countinue et alimentation. In: Alimentation et travail, edited by G. Debry and R. Bleyer. Paris: Masson, 1972, pp. 179-199.

1425.
Perelli, L. P. Physiologic aspects of workload/fatigue/stress. In: Survey of Methods to Assess Workload, edited by B. O. Hartman and R. E. McKenzie. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-AG-246, 1979, pp. 13-16.

1426.
Peret, J., M. Chanez, and G. Pascal. Schedule of protein ingestion and circadian rhythm of certain hepatic enzyme. Nutr. Metabol. 20: 143-157, 1976.

1427.
Perlow, M. J., M. H. Ebert, E. K. Gordon, M. G. Ziegler, C. R. Lake, and T. M. Chase. The circadian variation of catecholamine metabolism in the subhuman primate. Brain Res. 139: 101-113, 1978.

1428.
Perry, I. C. Helicopter aircrew fatigue. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-AR-69, 1974, 25 pp.

A study was conducted to provide: (1) a definition of aviator fatigue, (2) a list of the effects of fatigue on operational effectiveness, (4) a statement of causal factors and diagnostic criteria, (4) a statement of preventive measures, and (5) a statement of methods of treatment of aviator fatigue. These specific aims were accomplished and are presented. In addition, the results are given o an aircrew opinion questionnaire and a review of 120 helicopter accidents.

1429.
Persinger, M. A., W. J. Cooke and J. T. Janes. No evidence for relationship between biorhythms and industrial accidents. Percept. Mot. Skills 46: 423-426, 1978.

The frequencies of 400 mining accidents from two mining industries were compared to expected frequencies on biorhythm cycle high and low phases and critical days, using chi square analysis. The critical day definition included adjacent days. The number of accidents occurring on critical days or high or low biorhythm phases did not differ from chance for any of the cycles. The authors conclude that their analyses demonstrate no support for the several predictions generated from the biorhythm model.

1430.
Pettersson-Dahlgren, K. Biologische Tagesrhythmen bei unterschiedlicher Anordnung der Arbeitzeit (Biological daily rhythms in different work time arrangements) In: Biologische Rhythmen und Arbeit, edited by G. Hildebrandt. Vienna, New York: Springer-Verlag, 1976, pp. 97-108.

1431.
Pflug, B., and R. Tolle. Disturbance of the 24-hour rhythm, endogenous depression and the treatment of endogenous depression by sleep deprivation. Int. Pharmacopsychiat. 6: 187-196, 1971.

1432
Philbert, M. Le Travail Poste (Shift Work). In: Annee du Medecin. Paris, France: Editions Flammarion Medecine-Sciences, 1977, pp. 286-292.

Present knowledge on shift work in all its forms, and its effects on the individual (sleep disturbances, autonomic and gastrointestinal disorders) and the family and social spheres are reviewed. Remedies consist in the design of shift work (limitation or suppression of alternating shifts, adaptation of rotation periods, etc), design of the workplace and neighbouring environment (rest rooms, home close to the undertaking, arrangement of the home, balanced diet), strict medical surveillance, reduction of retiring age, and above all technical measures reducing the need for shift work.

1433.
Philippens, K. M., The manipulation of circadian rhythms. Arch. Toxicol. (Berl.) 36: 277-303, 1976.

1434.
Philippens, K. M. H., H. von Mayersbach, S. Cardoso, L. E. Scheving, and W. Poesche. Biological and seasonal influences on the response of the Wistar rat circadian system to phase-shifted LD 12:12 cycles. Chronobiologia 4: 139, 1977.

1435.
Philippens K. M., H. von Mayersbach, and E. Scheving. Effects of the scheduling of meal-feeding at different phases of the circadian system in rats. J. Nutr. 107: 176-193, 1977.

This study was designed to determine whether or not a number of diverse rhythmic variables in the rat could be synchronized to meal timing. This was tested by restricting the availability of food; once during each 24-hour period an unrestricted quantity of food was made available for a 4-hour period to four different groups at different phases of the light-dark cycle, and the rhythms of the variables studied in the different groups were compared. Liver glycogen and serum glucose did synchronize to or were strongly influenced by feeding schedules; corticosterone and the several enzymes measured seemed to reflect an interaction of both the restricted feeding schedule and the light-dark cycle. The mitotic index in the corneal epithelium in all groups remained remarkably synchronized to the light-dark cycle and was altered only minimally by restricted meal timing. All groups on restricted feeding schedules gained less weight than the group fed ad libitum and maintained on a light-dark cycle. These studies caution against assuming that all body functions react in the same manner to different synchronizers; and they emphasize that one must not generalize about the synchronizing effect of meal-timing or even the light-dark cycle.

1436.
Pickersgill, J. A., R. B. Stone, and R. L. Masters. Interim report on fatigue. Air Line Pilots Assoc. In: Executive Board Meet., 28th, Denver, Item 4, p. 248-251, 1977.

1437.
Pickett, G. F., and A. F. Morris. Effects of acute sleep and food deprivation on total body response time and cardiovascular performance. J. Sport Med. 15: 49-56, 1975.

1438.
Pierson, W. R. Intellectual performance during prolonged exposure to noise and mild hypoxia. Aerosp. Med. 44: 723-724, 1973.

The purpose of this study was to investigate the effects of 6.5 hr exposure to 85 dB(A) turboprop aircraft noise and an 8,000-ft simulated altitude on intellectual judgments common to aircrew tasks. No significant effects were noted in the ability to recall analogous situations and solutions, the ability to decode series of symbols into meaningful groups, or the ability to perform appropriate sequential psychomotor tasks. There was no apparent synergistic effect on these same variables.

1439.
Pigors, P., and F. Pigors. Human aspects of multiple shift operations (series, 2, no. 13). Cambridge, Mass.: Department of Economics and Social Science, Massachusetts Institute of Technology, 1944.

1440.
Pittendrigh, C. S. Circadian rhythms and the circadian organization of living systems. Cold Spring Harbor Symp. Quant. Biol. 25: 159-184, 1960.

1441
Pittendrigh, C. S. Principle of circadian organization: some functional aspects of circadian pacemakers. In: Biological Rhythms and Their Central Mechanism, edited by M. Suda, O. Hayaishi, and H. Nakagawa. New York: Elsevier/North-Holland Biomedical Press, 1979, pp. 3-16.

1442.
Pittendrigh, C. S., V. G. Bruce, and P. Kaus. On the significance of transients in daily rhythms. Proc. Natl Acad. Sci. 44: 965-973, 1958.

1443.
Pittendrigh, C. S., and P. C. Caldarola. General homeostasis of the frequency of circadian oscillations. Proc. Natl. Acad. Sci.(USA)70: 2697-2701, 1973.

Some well-defined statistical regularities characterize the change in period (tau) of cockroach circadian oscillations subjected to a large temperature step. These are explainable in terms of the well-known temperature-compensation (homeostasis) of (tau) of circadian oscillations. The same regularities are detectable in published data on the effect of several other variables affecting several other circadian oscillations. The proposition is then developed that the temperature-compensation of (tau) is only a special case of a general homeostatic conservation of the frequency of circadian oscillations in the face of all changes they are likely to encounter in the cell. Such a general homeostasis of (tau) is a functional prerequisite for an oscillator to function as a useful "clock."

1444.
Pittendrigh, C. S., and S Daan. Circadian oscillations in rodents; a systematic increase of their frequency with age. Science 186: 548-550, 1974.

The circadian activity rhythms of golden hamsters and two species of deermouse, when released from a light-dark cycle of 12 hours light and 12 hours of darkness into constant darkness, had progressively shorter periods as the animals became older. A possible bearing of this fact on the aging process is briefly outlined.

1445.
Pittendrigh, C. S., and S. Daan. A functional analysis of circadian pacemakers in nocturnal rodents. I. The stability and lability of spontaneous frequency. J. Comp. Physiol. 106: 223-252, 1976.

1446.
Pittendrigh, C. S., and S. Daan. A functional analysis of circadian pacemakers in nocturnal rodents. IV. Entrainment: Pacemaker as clock. J. Comp. Physiol. 106: 291-331, 1976.

1447.
Pittendrigh, C. S., and D. H. Minis. Circadian systems: longevity as a function of circadian resonance in Drosophila melanogaster. Proc. Nat. Acad. Sci. 69: 1537-1539, 1972.

Drosophila melanogaster, which had been reared under standard conditions (24° and a 24-hr light/dark cycle involving 12 hr of light) were exposed, on the first day of adult life, to four environments (all at 25°) as follows: (1) a 24-hr day consisting of 12 hr light and 12 hr dark; (2) a 21-hr day (10.5 hr dark); (3) a 27-hr day (13.5 hr dark); and (4) constant light. The experiment was repeated four times. In all four experiments the flies on a 24-hr day lived significantly longer than the flies in the other environments. This result, comparable to other observations on plants, indicates that eukaryotic systems as oscillators perform most effectively when they are driven close to their natural "circadian" frequency.

1448.
Pittner, E. D., and P. Owens. Chance or destiny? A review and test of the biorhythm theory. Professional Safety 21: 34-39, 1975.

1449.
Plonait, H., U. Nuschen, D. Buttner, and H. Stiller. Circadian and ultradian rhythmicity of motor activity, heart rate and body temperature in the unrestrained rat and the modification of motor activity by artificial light-dark cycles. Chronobiologia 6: 143, 1979.

The purpose of this study was to prove the existence of periodicities shorter than 20 h in motor activity, heart rate and internal body temperature of the rat. Furthermore, we examined the alterations in the behavior of motor activity under the influence of continuous light, continuous darkness and 8:8, 2.3:2.3 and 1:1 LD cycles. In our experimental design we used rats of the Sprague-Dawley and Lewis/Zum strains which were housed singly and fed ad libitum. Movement of the animals was detected by a capacitance sensor placed under the standard Makrolon cage; telemetry transmitters were used to measure heart rate and body temperature. Periodicity analysis was done by computing autocovariance and by computation of a variance spectrum.

It was shown that under the usual 12:12 LD cycle the well known diurnal rhythm of motor activity, heart rate, and body temperature is superimposed by an ultradian cyclicity of 4 to 5 h during night hours. It was possible to amplify the ultradian rhythmicity of motor activity through a corresponding lighting regimen of 2.3:2.3. Under these conditions of illumination the circadian rhythm was weak or not detectable. Even a LD cycle shortened to 1:1 caused the rats to either cease or to enhance their activity but there was a tendency to omit single phases. Examination of the influence of continuous darkness and a 8:8 LD cycle is presently in progress and should be completed at the time of presentation.

1450.
Pochobradsky, J. Periodogram analysis of menstrual cycles. J. Interdiscipl. Cycle Res. 1: 303-315, 1970.

Periodogram analysis of long-term menstrual calendars of women shows that there is an individual dominant frequency. Analysis of ten menstrual calendars revealed dominant periods ranging from 24.2-30.2 days.

1451.
Pocock, S. J., R. Sergean, and P. J. Taylor. Absence of continuous three-shift workers: a comparison of traditional and rapidly rotating systems. Occup. Psychol. 46: 7-13, 1972.

Complete absence records of 782 shift workers in one factory have been studied before and after a change from a continuous seven day 'traditional' rota to a rapidly rotating 'continental' rota. A comparison between a twelve month period before the change and a similar period afterwards showed a rise in certified sickness absence of 36 per cent, in uncertified sickness absence of 29 per cent and a fall in absence for reasons other than sickness of 2 per cent. Certified sickness of the insured population in that part of England rose by only 8 per cent. Sickness absence commenced most frequently on the night shift under both systems but this became even more marked for uncertified sickness after the change. These results suggest that social acceptability should not be the only factor considered when a change of system is contemplated.

1452.
Pohl, H. Die Aktivitatsperiodik von zwei tagaktiven Nagern, Funambulus palmarum und Eutamias sibiricus, unter Dauerlichtbedingungen (The activity rhythm of the two day-active rodents, Funambulus palarum and Eutamias sibiricus, in continuous illumination. Author's transl.) J. Comp. Physiol. 78: 60-74, 1972.

1453.
Pohl, H. Comparative aspects of circadian rhythms in homeotherms, re-entrainment after phase shifts of the zeitgeber. Int. J. Chronobiol. 5: 493-517, 1978.

1454.
Pokorny, M. L. I., D. H. J. Blom, and P. van Leeuwen. Analysis of traffic accident data (from busdrivers) - an alternative approach (1). Leiden, the Netherlands: Netherlands Institute for Preventive Health Care/TNO, 1979, pp. 1-8.

The analysis of traffic accident data of busdrivers presented in these two papers, forms an integral part of a major project, focussing on the effect of the busdriver's task on the performer. The accidents were thought to be a possible indicator for this effect. Data were obtained from the accident-archives of a bus company, together with additional information about the work organization, circumstances at the time of the accident, etc. A total of 944 documented accidents of 197 busdrivers in a 5-year period were available. The analysis starts by presenting the accident frequencies found at the hours of the day that buses are in operation (from 5.00 to 1.00 hr.)

A measure of exposure is then introduced, being the total number of kilometers driven during each 30-minute period of the day, and accident ratios are constructed for the same 30-minute period (number of accidents per 100,000 km). It is shown that part of the variability between the accident frequencies at various hours of the day can be explained by the different exposure. In the next part of the analysis the data are divided into different organizational groups, according to the type of shift (early - late - "broken" shifts). It is shown that the three shifts differ significantly with regard to their mean overall accident ratios: Early: 3.39 acc/100.000 km; Late: 2.47; Broken: 3.08; $x^2 = 16.03$ ($p<0.001$). This result is quite interesting, because it can be regarded as an effect of the shift itself: These shifts were performed by all busdrivers on all buslines in rotating schedules, therefore each driver had the same conditions regarding shifts, buslines, kilometers driven, and the like.

The main difference between these shifts (apart from certain aspects of the broken shift) can be seen as their occurrence at a different stage of the day. It is shown that also within the three shifts a significant difference exists in the overall accident ratios between groups, selected with regard to their starting hour: within the early shift, five groups could be selected (starting 5.00 hrs to 9.00 hrs respectively) with different overall accident ratios ($x^2_{(4)} = 284.5$; $p < 0.001$), within the late shift, four groups (starting 13.00 hrs to 16.00 hrs) ratios differing with $x^2_{(3)} = 35.41$ ($p < 0.001$) and within the "broken" shift, two groups (starting 6.00 hrs to 7.00 hrs) ratios differing with $x^2_{(1)} = 32.8$ ($p < 0.001$).

Within all three shifts the following conclusion can be drawn: the earlier a driver started working the higher the overall accident ratio.

1455.
Pokorny, M. L. I., D. H.J. Blom, and P. van Leeuwen. Analysis of traffic accident data (from busdrivers) - an alternative approach (II). Leiden, the Netherlands: Netherland Institute for Preventive Health Care/TNO, 1979, pp. 9-16.

In the previous paper the different overall accident ratios were discussed between various shiftgroups with different starting hours. This paper is focussed on differences within these groups. Of course the same type of construction of traffic accident ratios is used as in the first paper (number of accidents / 100.000 km), but now the pattern of these ratios during the different hours of the day and the different hours of service is analysed. It will be recalled that the various hours of the day had different accident ratios. Analysis of the data from above mentioned groups (with different starting hours) now shows that every group had at the same hour of the day a very different accident ratio.

Therefore, it can be concluded that the hour of the day itself (and related external factors like traffic density, etc., and internal factor such as circadian rhythm effects, etc.) seem not to have a substantial influence on the accident risk, according to our data.

On the other hand it is shown that characteristic patterns in accident ratios exist in the starting hour groups (subgroups of the shifts). These patterns are related, again, to the starting hour of the shift (pattern-level) and to the type and duration of the shift itself (pattern-form).

Summarizing the conclusions it can be said that, in our material, the major part of the variability between bus accident risks during the day can be explained by: 1. Differences in exposure (number of kilometers); 2. Starting hour of the shift; 3. Type of shift and duration of service.

1456.
Poland, R. E., R. T. Rubin, B. R. Clark, and P. R. Gouin. Circadian patterns of urine 17-OHCS and VMA excretion during sleep deprivation. Diseases of the Nervous System 33: 456-458, 1972.

1457.
Poley, G. E., C. A. Shively, and E. S. Vesell. Diurnal rhythms of aminopyrine metabolism: failure of sleep deprivation to affect them. Clin. Pharmacol. Ther. 24: 726-732, 1978.

After a single oral dose of aminopyrine (9mg/kg), mean salivary aminopyrine half-lives (t1/2s) and metabolic clearance rates in 12 normal male volunteers exhibited diurnal variations. Salivary aminopyrine t1/2s were approximately 50% longer at 8 P. M. (2.1 +/- 0.7 hr) than at 8 A. M. (1.4 +/- 0.3 hr). Mean aminopyrine metabolic clearance rates decreased 20% from 8 A. M. (418.2 +/- 152.0 ml/min) to 8 P. M. (335.3 + 107.6 ml/min).

1458.
Pollack, H. The rhythmic cycles in man. Federation of American Societies for Experimental Biology, Bethesda, Md. CSS: Life Sciences Research Office.

There is ample evidence to accept the concept of multiplicity of cyclic and rhythmic functions in plants, animals and man. These vary from the ultradian and circadian to seasonal and annual cycles. There are numerous factors involved in these cyclic phenomena, from photostimulation (day-night cycle) to exhaustion-replenishment feedback mechanisms. Man's ability to override the rhythms is an important factor which allows him to undertake many activities and not be limited by the rhythmic nature of these underlying mechanism. The override capability enables him to maintain his work performance efficiently providing he is motivated and interested. Thus motivation may be more important than the circadian rhythm which can be disrupted but restored easily with the proper stimulation. The report reviews research in this field and notes areas for future research and names key investigators.

1459.
Pollak, C. P., P. McGregon, E. D. Weitzman. The effects of flurazepam on daytime sleep after acute sleep-wake cycle reversal (abstract). Sleep Res. 4: 112, 1975.

1460.
Pollmann, L. Continuous measurements of heart and respiratory rate during a long-term experiment with an inverted activity cycle (abstract). Int. J. Chronobiol. 3: 9, 1975.

1461.
Polzella, D. J. Effects of sleep deprivation on short term recognition memory. J. Exp. Psychol. 104: 194-200, 1975.

A probe recognition short term memory paradigm was used to inquire into the precise effects of sleep deprivation on human memory. It was found that recognition performance, as measured by d', was generally impaired for each subject after 24 hr of sleep deprivation. While d' was shown to decrease exponentially as the number of items intervening between the target and the probe increased, this decay rate was not affected by sleep loss. In addition there was confirmation of a previously observed increase in the positive skewness of reaction times after wakefulness. The data were consistent with the hypothesis that sleep deprivation increases the the occurrence of lapses, periods of lowered reactive capacity, which prevent the encoding of items in short term memory.

1462.
Ponomarenko, I. I.,and V. I. Belyavskaya. Comparative characterization of physiological shifts during studies in students of technical and biological departments. Gig. Trud. Prof. Zabol. 15: 33-36, 1971.

Some bodily functions of students at institutions of higher learning engaged in relatively different types of mental work were studied under natural conditions. Psychological tests of "addition of digitals with switch-over", chronoreflexometry, Martinet-Kushelevsky functional test were used for the purpose. The final materials bear witness to the expediency of a differentiated approach to the organization of the teaching process at diverse departments. The use of psychological tests demonstrated their high sensitivity and the possibility of employing them both in studying the general mental performance capacity and in establishing the extent of functional changes, depending upon different types of mental activity.

1463. *
Popescue-Neveanu, F., M. Mameli, and P. Ene. Aspects of operators fatigue determined by night work and shift work. Rev. Psychol. 12: 345-366, 1966.

1464.
Poppel, E. Jet travel - body and soul. New Sci. : 232-235, 1972.

The physiological upsets caused by "jet lag" - the result of flying through several time zones - are now well known. But the general desynchronisation of internal bodily rhythms caused by jet lag also results in a phase shift between physiological and psychological functions. Neurotics seem particularly susceptible to this temporary dislocation of body and mind.

1465.
Post, R. M., J. Kotin, and F. K. Goodwin. Effects of sleep deprivation on mood and central amine metabolism in depressed patients. Arch. Gen. Psychiatr. 33: 627-632, 1976.

1466.
Potvin, A. R., J. G. Salamy, and W. G. Crosier. Effects of secobarbital on performance upon arousal from stage 4 sleep. Appl. Neurophysiol. 38: 240-250, 1975.

Secobarbital or placebo was administered to six subjects in a random double-blind crossover design. The subjects were interrupted from stage 4 sleep and required to perform a battery of tests. Compared to control scores the results indicate that secobarbital had a negligible effect (less than 5%) on hand tapping coordination and dynamic steadiness; a slight (5 - 10%) performance decrement on hand tapping speed, critical tracking ability, step reaction time, step movement time, and mental arithmetic; a moderate decrement (20 - 40 %) on visual plus auditory tracking ability, and auditory tracking ability, and 12% improvement on static steadiness. Few changes were statistically significant. Performance was near normal upon morning awakening. Secobarbital appeared to adversely affect performance primarily on those tasks requiring fast reactions and skilled hand-eye coordination ability in response to unpredictable events.

1467.
Poulton, E. C., G. M. Hunt, A. Carpenter, and R. S. Edwards. The performance of junior hospital doctors following reduced sleep and long hours of work. Ergonomics 21: 279-295, 1978.

1468.
Powell, P. I., M. Hale, J. Martin, and M. Simon. 2000 Accidents: A shop-floor study. London: National Institute of Industrial Psychology, 1971.

1469.
Powell, E. W., J. N. Pasley, L. E. Scheving. Effects of suprachiasmatic nucleus (SCN) on the circadian rhythm of mitotic activity in the corneal epithelium of the mouse. Chronobiologia 6: 145, 1979.

Recently great deal of interest has centered around the suprachiasmatic nucleus (SCN) of the hypothalamus as a generator of rhythms. Some investigators have reported the abolishing of the rhythm in core temperature, serum corticosterone, locomotor activity and feeding and drinking. On the other hand others have reported that the rectal temperature and core temperature rhythms persist, although modified, subsequent to SCN ablation.

We have studied the effect of SCN ablation on the mitotic index rhythm of the mouse corneal epithelium and found that this rhythm was dramatically reduced in amplitude and phase advanced by 4 h. The data show that caution should be exercised when generalizing about the effects of ablation of the SCN, and they certainly challenge the statement frequently made that ablation of the SCN abolishes circadian rhythms.

1470.
Presser, H. B. Temporal data relating to the human menstrual cycle. In: Biorhythms and Human Reproduction, edited by M. Ferin, F. Halberg, R. M. Richert, and R. L. Vandewiele. New York: John Wiley, 1974, pp. 145-160.

In this review of menstrual length and variability the author reports studies in which mean cycle length varies from 27.3 to 33.9 days. In longitudinal studies of individual women, menstrual cycle standard deviations were found ranging from 2.1 - 4.3. The length of the menstrual cycle per woman declines with age.

1471.
Preston, F. S. Further sleep problems in airline pilots on world-wide schedules. Int. Cong. Aviat. Space Med. 20th, Nice, 1972, preprints, p. 36.

This study follows previous work carried out on airline pilots operating long-haul trans-meridian routes with particular respect to the sleep patterns obtained at slip stations en route.

The author accompanied a B. 707 crew on a long trans-meridian tour when all members kept careful sleep logs for a period of one month and the data obtained shows clear evidence of sleep deficit occurring in tours of this nature with some evidence of age variation in individuals. The practical problems in scheduling crews in such operations are discussed in some detail in relation to performance, the use of hypnotics, and difficulties surrounding pilots in bidding for successive tours which may result in sleep deprivation.

1472.
Preston, F. S. Aspects of sleep regulation in airline pilots. In: Use of Medication and Drugs in Flying Personnel, edited by H. S. Fuchs. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-108, 1973, pp. A41-A47.

Probably the greatest problem facing long haul civil airlines is the need to ensure that pilots are given adequate time while on a tour of duty to ensure sufficient sleep and so enable them to cope successfully with the ensuing period of work. The problem on long haul routes is greatly compounded by the effect of time zone changes, night flights and changes of a climatic nature which all affect the individual's ability to achieve sleep on arrival. There is definite evidence of cumulative sleep loss on longer trans-meridian routes. As a result, the individual pilot may be tempted to use hypnotics which he can purchase freely over the counter in some parts of the world without medical supervision. In addition, he may use alcohol for its hypnotic action or combine with other hypnotics which may affect not only his fitness to fly on the next day, but have addictive and cumulative effects. The problems are discussed for a long haul airline and some suggestions are made for controlling the situation from both the medical and executive standpoints.

1473.
Preston, F. S. Further sleep problems in airline pilots on world-wide schedules. Aerosp. Med. 44: 775-782, 1973.

1474
Preston, F. S. Physiological problems in air cabin crew. Proc. Roy. Soc. Med. 67: 825-829, 1974.

1475
Preston, F. S. Work in the aviation environment: physiological problems in aircabin crew. Proc. Roy. Soc. Med. 67: 23-27, 1974.

1476
Preston, F. S. Transport flying and circadian rhythms. IATA Conference 20/WP 60, 1975

1477
Preston, F. S. The health of female air cabin crews. Occup. Med. 20: 597-600, 1978.

1478
Preston, F. S. Temporal discord. J. Psychosom. Res. 22: 377-383, 1978.

Airline crews are subject to the effects of sudden and often drastic changes in their circadian cycles in trans-meridian flight quite apart form obvious changes in climate. These changes result inevitably in sleep deprivation and impaired mental performance in skilled tasks.

In an attempt to measure these mental performance changes a series of experiments was carried out in the University of Manchester's Isolation Unit at Risley using groups of airline stewardesses as test subjects. Simulated changes of time were made representing easterly and westerly flights of long duration and the subjects were asked to complete a battery of workload tasks including addition, reaction time, short-term memory, vigilance and visual search. The results of these experiments are discussed and their possible application to airline scheduling and passenger travel.

1479.
Preston, F. S., S. C. Bateman, F. W. Meichen, R. Wilkinson, and R. Short. Effects of time zone changes on performance and physiology of airline personnel. Aviat. Space Environ. Med. 47: 763-769, 1976.

1480.
Preston, F. S., S. C. Bateman, R. V. Short, and R. T. Wilkinson. Effects of flying and of time changes on menstrual cycle length and on performance in airline stewardesses. Aerosp. Med. 44: 438-443, 1973.

The paper describes a study on the effects of transmeridian flights on the menstrual cycle length of 29 airline stewardesses. From this group, eight stewardesses were selected for further study in an isolation unit at the a University of Manchester. Four subjects spent four days as a control group and were not subjected to time-zone changes, of eight hours, each representing long easterly flights. Both groups were required to complete a similar battery of workload tasks during isolation. These tests included Addition, Reaction Time, Short-term Memory, Vigilance and Visual Search. Only one subject of the time-zoned group showed any change in menstrual cycle length, but there was a significant impairment in efficiency of this group both over the performance tasks as a whole and in particular in the ability to react quickly, memorize and search.

1481.
Preston, F. S., S. C. Bateman, R. V. Short, and R. T. Wilkinson. The effects of flying and of time changes on menstrual cycle length and on performance in airline stewardesses. In: Biorhythms and Human Reproduction, edited by M. Ferin, F. Halberg, F. M. Richart, and R. L. Vande Wiele. New York: Wiley, 1974, pp. 501-112.

1482
Preston, F. S., and D. J. Cussen. Sleep patterns in a lone global pilot. Aerosp. Med., 44: 669-674, 1973.

1483.
Preston, F. S., H. P. Ruffell Smith, and V. M. Sutton-Mattocks. Sleep loss in air cabin crew. Aerosp. Med. 44: 931-935, 1973.

In recent years there have been a number of studies of the changes in circadian rhythms and their effect on the sleep of pilots. Little definitive work has been carried out on this aspect as it affects air cabin crews. As part of a cabin crew workload study in BOAC the sleep patterns of 12 stewards and 12 stewardesses were studied for periods of about 14 weeks. Attempts were made to correlate sleep loss with variables such as time zone change, days away on tour and rest days during any given integration. In this particular group, sleep loss seemed to be related to the number of night flights, at local time, per tour and not to time zone changes.

1484.
Pribil, M. Poruchy Biologickeho Rytmu pri Presunu Sportovcu Podel Poledniku (Disturbances of biological rhythm during shifts of stays along the Meridians). Teorie a Praxe Telesne Vychovy 24: 615-618, 1976.

1485.
Price, W. J. The apparent ignoring of pilot fatigue by the NTSB in airline crashes. Proc. SAFE Assoc., 7th, Las Vegas, 1979, pp. 234-246.

1486.
Price, W. Task force on pilot fatigue. pp. 16-17.

1487.
Price, W. J. Sleep loss and the pilot. Arlington: Pilots Safety Exchange Bulletin, Flight Safety Foundation, Inc., May/June, 1979, pp. 1-4.

1488.
Price, W. Model of probable fatigue factors involved in United Airlines Flight #2860 accident. Forum - The International Society of Air Safety Investigators 13: 11-12, 1980.

The model described herein does not presume to explain the crash of United Airlines Flight 2860. It is designed as an explorative projection in order to search areas of inquiry concerning pilot fatigue which play an important and very subtle role in debilitating human performance. Heretofore the role of human fatigue has all but been ignored in aviation accident investigation. It is hoped that this model will initiate sufficient curiosity so that inquiry will be conducted into this area of human factors. This model does not represent the opinion of the United Airlines/Air Line Pilots Association Task Force on Pilot Fatigue.

1489
Price, W. J., and D. C. Holley. The last minutes of flight 2860: and analysis of crew shift-work scheduling. In: Advances In Studies on Night- and Shift-work, (Proc. of the Vth International Symposium on Night- and Shift-work), edited by A. Reinberg. Oxford: Pergamon Press, 1980, In press.

The debilitating effect of circadian desynchronosis on flight crews is generally accepted world-wide. It appears, however, that in the United States the organization responsible for air carrier accident investigation (the National Transportation Safety Board, NTSB), does not recognize that these debilitations can contribute to air carrier accidents. The authors have analyzed a fatal air carrier crash, United Airlines Freighter near Salt Lake City, Utah, December 18, 1977, and have hypothesized a probable sequence of events leading to the tragedy. The NTSB determined the crash to be caused by imprecise communication procedures by the pilots and controller, and imprecise adherence to flight procedures. The authors propose that this impreciseness may have resulted from fatigue caused by frequently changing shift-work schedules and that this fatigue fostered a series of errors that compounded into the fatal crash.

1490.
Pternitis, C. Shift-work(3x8): Workload, fatigue and alertness (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. III-7.

1491.
Quaas, M. Probleme der Adaptation, Leistungsfahigkeit und Organisation der Schichtarbeit in der DDR. In: On Night And Shift Work. (Proceedings of an International Symposium on Night and Shift Work, Oslo, 1969), edited by A. Swensson. (Studia Laboris et Salutis, no. 4). Institute of Occupational Health, Stockholm 1969, pp. 112-123.

1492.
Quay, W. B. Regional and circadian differences in cerebral cortical serotonin concentrations. Life Sci. 4: 379-384, 1965.

1493.
Quay, W. B. Effect of pinealectomy on circadian phase shifting following changes in photoperiod. Fed. Proc. 29: 325, 1970.

Running activity of individual adult female rats was recorded continuously under controlled conditions for about 1 year. Characteristics of this activity were compared in matched pinealectomized (P), sham-operated(S) and unoperated (U) siblings before and following 4 separate 12-hour shifts in photoperiod (AØ-12) with standard conditions - LD 12:12 (110-470 white light: 5-20 red light). Entrainment time for all groups was about 8 days, but during the transient cycles following the shifts in photoperiod, the P animals differed in having: (1) more rapid initial shifts in starting time and activity midpoint, (2) less post-phase shift increase in amount of activity phase (A), and (4) a different and more skewed distribution of activity per transient cycle. These and other responses of the pinealectomized rat suggest that pineal activity may be more closely related to, and important for, rhythmic central homeostatic mechanisms than to direct mediation of photoperiod information to peripheral responses. Present results suggest that the pineal may have as an adaptive value, the dampening of energy -consuming circadian activity oscillations following short-term fluctuations in environmental illumination, such as those produced by variable daily meteorological conditions. (Supported in part by USPHS, NIH Grant NB-06296.)

1494.
Quay, W. B., Physiological significance of the pineal during adaptation to shifts in photoperiod. Physiology and Behavior 5: 353-360, 1970.

Running activity was continuously recorded for about one year from individual adult female S1 rats under controlled conditions. Characteristics of this activity were compared in matched pinealectomized, sham-operated, and unoperated siblings during and following 4 separate 12-hr shifts in photoperiod ($\Delta \emptyset = 12$) with standard conditions = LD 12:12 (110-470:5-20). Time for entrainment was about 8 days in all groups but during the phase shifting of the animals' circadian running activity, that of the pinealectomized animals differed in shifting initially more quickly in starting time and activity midpoint, in having less increase post $\Delta \emptyset$ in activity phase length (α) and amount of activity (A), and in having a different distribution of activity per transient cycle. These results suggest that the mammalian pineal may be more closely related to general central homeostatic mechanisms than to specific service in transducing photoperiod information to peripheral response systems. However, the probable relevance of these results to the interpretation of variable and photodependent or environmentally dependent physiologic effects of pinealectomy is pointed out.

1495
Quay, W. B. Phase-shifts of circadian rhythms: Definitive representation and quantitative analysis from computer application of the beta-distribution as a model. In: Chronobiology, edited by Scheving, L. E., F. Halberg, and J. E. Pauly. Tokyo: Igaku Shoin, 1974, pp. 586-589.

A method is described for fitting circadian rhythm phase shifted data using a beta-distribution function by means of non-linear least squares. The method is applied to data from control and pinealectomized rats which were phase shifted to quantitatively determine rephasal duration.

1496.
Rader, J., and J. White. Circadian rhythms - how the patient's biological timetable affects your care. RN 41: 100-110, 1978.

1497.
Raki'c, L. J., and N. Kovacevi'c. Circadian oscillator desynchronization and conditioned behavior. Glas Srp. Akad. Nauka. (Med.)303: 39-50, 1977.

1498.
Ramsey, J. D., C. G. Halcomb, and A. K. Mortagy. Self determined work/rest cycles in the heat. Conf. on Military Requirements for Research on Continuous Operations (Human Engineering Labs.), Lubbock, TX., 1971, pp. 70-88.

1499.
Rapoport, R. Time zones: no defense for some. The American Way 5: 29-32, 1972.

1500.
Rasch, P. J. Biorhythms - claims and evaluations. Am. Correct Ther. J. 34: 15-18, 1980.

1501.
Ravaccia, F., G. Ruggieri, and S. Torrisi. Piloti di elicottero e fatica da volo. Riv. Med. Aeron. Sp. 40: 278-295, 1977.

1502.
Reader, D. C. Some problems of high speed travel. Postgrad. Med. J. 51: 848-850, 1975.

Some aspects of high speed flight are examined to investigate whether increase in speed implies any lowering of safety standards. The problem of circadian dysrhythmia is discussed and methods of attenuating its effects are explained and some new hypnotic drugs are mentioned. The risk of decompression has been quantified and predictions have been made for risks in commercial service. Cosmic radiation in supersonic aircraft is unlikely to limit commercial operation or significantly increase risks to passengers and crew. The supersonic boom is likely to limit the terrain over which supersonic aircraft can operate and regulations covering engine noise on the ground could restrict some flights.

1503.
Reams, C. L. The Effects of the 23-Day and 28-Day Biorhythm Cycles on Human Performance. (Ph.D. Thesis). Oklahoma State University, 1979.

Hand grip steadiness, manipulative dexterity, reaction time, grip strength, standing long jump, muscular endurance and maximal oxygen consumption performance were compared to biorhythm cycle 23 and 28 day high and low phases, using a t-test analysis. No significant differences were found between performance and high and low phases of the 23 and 28 day biorhythm cycles. The use of t-test analysis here instead of chi square may have been inappropriate since t-test assumes equal variances. The use of biorhythm cycle phases where both 23 and 28 day cycles were both high or low creates a biased sample. The number of samples collected/subject is not specified in the abstract nor is it indicated whether performance times were controlled for circadian effects.

1504.
Rebsch, D. Biorhythm and You: the Facts. Rockville, Md.: Universal Biorhythm Co., 1977, 149 pp.

1505.
Rehhahn, H. Probleme der Schichtarbeit aus der Sicht der Betrieblichen Praxis (Shift-work problems in industry). Sicherheitsingenieur 3: 449-454, 1972.

The author lists and analyses the technical, administrative and economic reasons for shift work, and studies the optimal arrangement of this type of work. Items of particular importance are shift-change times and shift duration. Increased fatigue due to shift work, especially during the afternoon and the night shift, can be compensated by reduced output requirement and financial compensation. The recommendations made include: avoid shifts longer than 8 h; shift changes to be made 1 h later than the traditional times.

1506.
Rehme, H. Die Veranderung tageszeitlicher Schwankungen simulierter fliegerischer Tatigkeit unter dem Einfluss der Zeitverschiebung nach Flugreisen uber mehrere Zeitzonen (Changes in the diurnal variations of simulated pilot activity after time shift due to air travel through several time zones). Bonn-Bad Godesberg: Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt. Institut fur Flugmedizin, DLR-FB 73-25, (transl. in Engl. by European Space Research Organisation, ESRO TT-49, 1974.), 81 pp.

The 24-hour performance variation of 12 pilots measured in a flight simulator was compared with the performance variation on day 1, 3, 5 and 8 after air travel through 8 time zones from East to West (Germany - U. S. A.) and vice versa (return flight after a sojourn of 16 days in the U. S. A.). Conformity of the diurnal performance variation with the preflight values was found on day 3 and 5 after the Westward flight and day 5 after the Eastward flight. A daily phase shift of 1 to 2 hours was observed. The 240 hour performance average showed a significant decrement (of 8.5%) only on the first day after the Eastward flight, but not, in contrast, after the Westward flight.

1507.
Reid, D. D. Fluctuations in navigator performance during operational sorties. In: Aircrew Stress in Wartime Operations, edited by E. J. Dearnaley and P. B. Warr. London: Academic Press, 1979, chapt. 4, pp. 63-73.

1508.
Reid, L. M. Effects of moderate sleep loss upon peripheral visual response time and selected physiological measures. Aerospace Med. Assoc., Preprints, 1975, pp. 35-36.

1509.
Reimann, H. A. Clinical importance of biorhythms longer than the circadian. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J. E. Pauly, Tokyo: Igaku Shoin, Ltd., 1974, pp. 394-305.

The author claims to have collected 2000 examples of infradian rhythms in chronopathology with periods of weekly, fortnightly, monthly or regular intervals. He cites studies by A. Morley who found 14-23 day oscillations in numbers of neutrophils and 21-35 day cycles of platelets in normal persons.

1510.
Reimann, H. A. Rhythms and periodicity in health and disease. Ann. Clin. Lab. Sci. 5: 417-420, 1975.

Biorhythms longer than the circadian that influence reactions of people and characterize some diseases have not received much medical attention. The lay press describes cycles of 23, 28, and 33 days said to regulate moods, intellectual ability and efficiency, respectively. Whether or not three overlapping cycles actually regulate three different vague reactions may be questioned. Of interest, however are rhythms of similar tempo which control mensis, cyclic changes in male hormones and a number of periodic diseases.

1511.
Reimann, H. A., and R. V. McCloskey. Periodic fever. J. Amer. Med. Assoc. 228: 1662-1664, 1974.

A periodically recurring fever was found in one man who displayed cycles of 20-23 days, 20 days and 23 days average length. The man was later diagnosed as having Hodgkins disease. Note: This paper has been cited (Gittelson, B. Biorhythm. A Personal Science, ARCO, New York, 1977) as evidence for the 23 day biorhythm cycle. However, a rhythm occurring in a pathological state in a single individual is hardly substantial evidence to extrapolate to the entire population of healthy individuals. Also the period was not exactly 23 days, as demanded by biorhythm theory, but varied between 20 and 23 days.

1512.
Riemersma, J. B., A. F. Sanders, C. Wildervanck, and A. W. Gaillard. Performance decrement during prolonged night driving. In: Vigilance: Theory, Operational Performance and Physiological Correlates, edited by R. R. Mackie. New York: Plenum Press, 1977, pp. 41-58.

1513.
Reinberg, A. Evaluation of circadian dyschronism during transmeridian flights. In: Life Sciences and Space Research VIII. Amsterdam: North-Holland Publ. Co., 1970, pp. 172-174.

1514.
Reinberg, A. Fatigue, Sommeil et Rythmes Circadiens (Fatigue, rest and circadian rhythms). Gazette Medicale de France 80: 4475-4490, 1973.

1515.
Reinberg, A. Aspects of circannual rhythms in man. In: Circannual Clocks, edited by E. T. Pengelley. London: Academic Press, 1974, pp. 423-505.

1515a.
Reinberg, A. Chronopharmacology in man. Chronobiologia (Suppl.) 1: 157, 1974.

1516.
Reinberg, A. Chronosusceptibility, chronopharmacology (with special reference to corticosteroids) and allergic diseases. Folia Allergol. Immunol. Clin. 22: 559-569, 1975.

1517.
Reinberg, A. Effets des changements d'horaire de travail. Resultats d'une autometrie chronobiologique (Effects of changes in work timetable. Results of a chronobiologic autometry). Arch. Med. Normandie 6: 353-366, 1975.

Changes in parameters characterizing circadian rhythms of human biological and physiological functions can be detected objectively after what we use to call an intercontinental flight. Under these conditions the organism can be submitted to the influence of a shift in environmental factors after crossing several time zones. The expression transmeridian flight is more specific than intercontinental or long distance flight if this type of shift is being considered.

Biorhythms are concerned with these problems, thus it seems pertinent to keep in mind a chronobiologic background from a theoretical as well as practical point ofd view.

1518.
Reinberg, A. Rythmes circadiens endocriniens dans ces circonstances ou des milieu inhabituels. In: Problemes Actuels D'endocrinologie et de Nutrition. Expansion Scientifique Francaise, vol. 19., 1975, pp. 209-221.

1519.
Reinberg, A. Appreciation of the effects of changes in work rest schedules upon various circadian rhythms by auto estimation techniques (fatigue, etc) and auto measurement. Arch. Mal. Prof. Med. 38: 145-146, 1977.

1520.
Reinberg, A. Aspects chronobiologiques de la prevention de la fatigue (Chronobiological aspects of the prevention of fatigue). Psychol. Med. 10: 2117-2120, 1978.

Chronobiological studies reveal not only circadian rhythms but also circannual variations in the author's main functions, in particular hormonal secretions and their effect upon principal activities, and inversely upon periods of deficiency and illness. The present distribution of maximum work during the spring and winter and summer holidays is against endogenous rhythms. Rethinking is required of work timetables both for adults and children, in order to rationally envisage winter holidays, contrasting with a period of agricultural work of fresh air activities during the summer.

1521.
Reinberg, A. Clinical chronopharmacology, an experimental basis for chronotherapy. Arzneim. -Forsch. 28: 1861-1867, 1978.

1522.
Reinberg, A. Fatigue et travail poste (Fatigue and shift work). Psychol. Med. 10: 1925-1928, 1978.

1523.
Reinberg, A. Circadian and circannual rhythms in healthy adults. In: Sleep, Wakefulness and Circadian Rhythm. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-LS-105, 1979, pp. 1-15 - 1-27.

1524.
Reinberg, A. Tolerance to shift work: a chronobiologic approach. In: Sleep, Wakefulness and Circadian Rhythm. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development. AGARD-LS-105, 1979, pp. 9-1 - 9-12.

1525.
Reinberg, A., P. Andlauer, P. Guillet, and A. Nicolai. Oral temperature, circadian rhythm amplitude, aging and tolerance to shift-work. Ergonomics 23: 44-64, 1980.

1526.
Reinberg, A., A. Chaumont, and A. Laporte. Ajustement rapide des rhythmes circadiens de metaboites hormonaux aux changements d'horaire de travail (Fast adjustment of circadian rhythms (hormonal metabolites) in 20 shift-workers of an oil refinery (8-hour shift; weekly rotation)). Ann. Endocrinol. 35: 309-308, 1974.

The timing of the peak value (circadian acrophase phi) in the 24 h changes of 17 physiologic variables (urinary 17-OHCS, 17-KS, 5-HIAA, K+ and Na+ among others) was studied in 20 shift-workers: the larger dyschronism, by comparison to phi's of "normal day" (work from 17:45 to 16:30) corresponds to "night-shift" (work from 21:00 to 05:00); Phi's adjustment to a shift may vary from variable to variable in any one subject, and from subject to subject for a given variable; However, in the present study, fast adjustment occurs in each and all experienced shift workers. This latter finding on obviously selected subjects (they were shift-working for 6 years, as a mean) raises the question of an inherited ability to a fast adjustment (demonstrated by Yunis et al. in mice). A biological index to detect this ability in certain men (if any) is needed.

1527.
Reinberg, A., A. J. Chaumont, and A. Laporte. Circadian temporal structure of 20 shift-workers (8-hour shift weekly rotation). An autometric field study. Int. J. Chronobiol. 3: 16-17, 1975.

1528.
Reinberg, A., A. J. Chaumont, A. LaPorte, P. Chambon, G. Vincendon, G. Skoulios, M. Bauchart, A. Nicolai, C. Abulker, and J. Dupont. Etude chronobiologique des effets des changements d'horaires de travail. Arch. Mal. Prof. Med. 35: 373-394, 1973.

1529.
Reinberg, A., A. Chaumont, A. LaPorte, P. Chambon, G. Vincendon, G. Skoulios, M. Bochart, A. Nicolai, C. Abulker, and J. DuPont. Changes in circadian temporal structure (including sleep) of 20 shift-workers (8-hr shift-weekly rotation). A field study with autorhythmometry (abstract). Int. J. Chronobiol. 1: 352-353, 1973.

1530.
Reinberg, A., and M. Lagoguey. Annual endocrine rhythms in healthy young adult men; their implication in human biology and medicine. In: Environmental Endocrinology, edited by I. Assenmacher and D. S. Farner. Berlin, Heidelberg, New York: Springer-Verlag, 1978, pp. 113-121.

1531.
Reinberg, A., C. Migraine, M. Apfelbaum, L. Brigan, J. Ghata,N. Vieux, and A. Laporte. Circadian and ultradian rhythms in the feeding behaviour and nutrient intake of oil refinery operators on a rapidly rotating shift system. Ergonomics 21: 862, 1978.

Five healthy young shift-workers volunteered to record what and when they ate both at work and at home, every day, for eight consecutive weeks. The results showed (1) that the timing of the two main meals (lunch and supper) was maintained during all shifts, in order that the ususal routine of social and family life should not be disturbed; (2) that the major intake of protein and lipids occurred in these two main meals for all shifts; (3) that the pattern of carbohydrate intake was modified by the particular shift being worked, the night-shift especially being associated with the taking of frequent snacks; (4) that despite the latter, there was no change either in the mean 24h caloric intake, or in the percentage of protein in this intake in the different shifts; (5) that there was a rapid phase adjustment of physiological circadian rhythms in each of the five shiftworkers to changes in work hours. The contrast between the constancy of the timing of major meals, and the shift of the timing of the circadian rhythm acrophases, indicates that meal timing has little if any, synchronising effect on rhythms in shiftworkers. It would appear that a precise mechanism for controlling food intake exists, since the pattern of such intake persists when environmental conditions are altered.

1532.
Reinberg, A., C. Migraine, M. Apfelbaum, L. Grigant, J. Ghata, N. Vieux, A. Laporte, and A. Nicolai. Circadian and ultradian rhythms in the feeding behavior and nutrient intakes of oil refinery operators with shift-work every 3-4 days. Diabete and Metabolisme 5: 33-41, 1979.

Seven healthy adult men, five shift-workers and two non-shift-workers (from 21 to 36 years: mean = 26.4) volunteered to record what and when they ate, both at work and at home, every day, during eight consecutive weeks (Oct. - Dec. 1974). 1) All the subjects maintained the timing of main-meal (lunch and supper) during all shifts. 2) The major intake of protein and lipid was concentrated on the two main meals during all shifts. 3) only the pattern of carbohydrate intake was modified by the shift-work: e. g. night-shift is associated with nibbling behavior; 4) However, shift-work and in particular the occurrence of nibbling behaviour did not result in change either in the mean 24 h caloric intake, or in the percentage of protein calories. 5) The comparison between the constancy of the timing of major meals and shift of the timing of circadian rhythm acrophases of the 5 shift-workers leads to conclude that meal timing had a poor synchronizing effect, if any.

1533.
Reinberg, A., M. H. Smolensky, J. Ghata, and P. Gervais. A chronobiological approach to the normal menstrual cycle. Int. J. Chronobiol. 1: 354-355, 1973.

A series of studies demonstrated menstrual rhythms for 6 CNS end points, 22 systemic variables and 21 cervical and endometrial variables. In additon they found menstrual modulation of circadian rhythm mean, amplitude and phase.

1534.
Reinberg, A., N. Vieux, P. Andlauer, P. Guillet, A. Laporte, and A. Nicolai. Oral temperature, circadian rhythm amplitude and tolerance to shift-work. In: Chronobiological field studies of oil refinery shift-workers. Chronobiologia (suppl. 1) 6: 1-119, 1979.

1535.
Reinberg, A., N. Vieux, P. Andlauer, P. Guillet, and A. Nicolai. Tolerance of shift-work, amplitude of circadian rhythms and aging (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. VI-6.

1536.
Reinberg, A., N. Vieux, J. Ghata, A. J. Chaumont, and A. Laporte. Circadian rhythm amplitude and individual ability to adjust to shift work. Ergonomics 21: 763-766, 1978.

1537.
Reinberg, A., N. Vieux, J. Ghata, A. Chaumont, and A. Laporte. Is the rhythm amplitude related to the ability to phase-shift circadian rhythms of shift-workers? J. Physiol. (Paris) 74: 405-409, 1978.

1538.
Reinberg, A., N. Vieux, A. Laporte, J. Ghata, and C. Migraine. Rapid adjustment of circadian rhythms in shift worker of an oil refinery. Proc. Congr. Int. Ergonomics Assoc., 6th, Santa Monica, Ca.: Human Factors Soc., 1976, pp. 507-509.

Some subjects (selected shift-workers) are able to rapidly adjust (within 1 or 2 days) the timing of their physiological circadian rhythms to changes of work-rest schedule in the 24 h scale. In shift workers, able to adjust quickly, the rapid rotation of shifts (304 days) seems to be well tolerated from a chronophysiological point of view. This fact has to be kept in mind since socially as well as psychologically the rapid rotation is preferred to the conventional weekly shift.

1539.
Reinberg, A., N. Vieux, A. LaPorte, C. Migraine, J. Ghata, C. Abulker, J. Dupont, and A. Nicolai. Ajustement de rhythmes circadiens physioloqiques d'operateurs d'une raffinerie, lors de changements d'horaires travail-repos tous les 3 - 4 jours (Adjustment of physiological circadian rhythms to shifts in the work-rest schedule every 3 - 4 days in oil refinery operators). Arch. Mal. Prof. Med. 37: 479-494, 1976.

1540.
Reiter, R. Umwelteinfluesse auf die Reactionszeit des gesunden Menschen. Muench. Med. Wschr. 96: 526, 1954.

The period of cyclical variability of reaction time is found to be age dependent.

1541.
Renemann, H. H., K. Wink, and H. Reindell. Fitness for air travel - the medical point of view. Med. Klin. 69: 1311-1316, 1974.

The stresses of air travel on medical patients are described as well as the airlines' obligation with respect to transporting patients. A number of heart, circulation system and other diseases are evaluated with respect to air travel safety.

1542.
Renios, P. G., and R. D. Shepard, editors. Shift Work and Health. Washington, D. C.: U. S. Dept. H.E.W, Publication No. (NIOSH) 76-203, 1976, 283 pp.

1543.
Reshetyuk, A. L., L. G. Vanin, V. N. Vasilkov, et al. Effectiveness of physiologically rational intershift work schedules of development and breakage face stopers in coal mines of the Donetsk basin. Gig. Trud. Prof. Zabol. 20: 6-9, 1976.

1544.

Rey, G., H. Riedwyl, and A. Widmer. Zur "Lehre von den Biorhythmen" nach Fliess (On "Theory of biorhythms" according to Fliess). Sozial- und Praventivmed. 21: 43-46, 1976.

More than 1000 cases of suicide in Switzerland from 1961 to 1970 were used to test the hypothesis that biorhythm cycles result in differences in the frequencies of suicides at different days of the cycles, in particular, at critical days. The results did not support the hypothesis; there was no indication of a verification of the biorhythm theory.

1545.

Richardson, J. E. CFIT: A human factors problem. Aerospace Safety, February, 1978. pp. 2-5.

1546.

Richter, C. P. "Dark-active" rat transformed into "light-active" rat by destruction of 24-hour clock: function of 24-hr clock and synchronizers. Proc. Natl. Acad. Sci. (USA) 75: 6276-6280, 1978.

1547.

Rietveld, W. J., F. Ten Hoor, M. Kooij, and W. Flory. Changes in 24-hour fluctuations of feeding behavior during hypothalamic hyperphagia in rats. Physiol. Behav. 21: 615-622, 1978.

1548.

Robson, B. M., et al. Some Effects of Disturbed Sleep on a Simulated Flying Task. RAE Farnborough Tech. Report 74057, 1974.

1549.

Rockwell, D. A. The jet lag syndrome. West. J. Med. 122: 419, 1975.

1550.

Rockwell, D. A., M. G. Hodgson, J. R. Beljan, and C. M. Winget. Psychologic and psychophysiologic responses to 105 days of social isolation. Aviat. Space Environ. Med. 47: 1087-1093, 1976.

The responses of nine subjects to 105 d of social isolation are reported. The study reveals that crew selection plus ongoing support by psychiatric staff permits continued function in an exotic milieu. Prediction of psychophysiologic symptoms was possible using paper and pencil tests. Trait anxiety was altered by the isolation in a psychologically healthy direction. Sudden time shifts of 8 h led to an immediate significant increase in depression, aggression, and hostility, and are accompanied by marked increases in physical symptoms. During the first free-running phase of the experiment, significant shifts were found on four psychological measures. The shifts indicate that subjects became less trusting, more orderly, more routinized, less energetic, and more depressed. A reducer-augmenter scale predicted the number of psychophysiologic complaints reported by individual subjects while isolated. A group interaction effect on circadian rhythms was isolated but needs further examination.

1551.
Rockwell, D. A., C. M. Winget, L. S. Rosenblatt, E. A. Higgins, and N.W. Hetherington. Biological aspects of suicide. J. Nerv. Ment. Dis. 166: 851-858, 1978.

Disturbances in the circadian rhythmicity of biological functions have been reported in various mental disorders. Four lines of research - hormonal, electroencephalographic, cerebral spinal fluid, and circadian rhythmicity - suggest possible changes in suicidal individuals. During a study investigating the effect of a photoperiod shift on circadian rhythms, 15 male, healthy, normal subjects were used. Following a 5-day baseline period a 12-hour photoperiod shift took place and was followed by 10 days of recovery period. Multiple parameters were monitored. Two weeks following completion of the study one subject suicided. The data were examined to determine whether the suicided subject differed, rhythmically, from other subjects. Summation dials describing phase changes and vector difference dials describing dynamic phase relationships of rhythm pairs showed that the rhythms of this subject were poorly synchronized internally during baseline. Total urinary output of all parameters was lower than all other subjects during baseline and more of his urinary parameters rephased incompletely during recovery. The results suggest that circadian asynchrony and an inability to respond effectively to a phase shift may characterize a presuicidal state. These results are discussed in terms of the four lines of research involving biological aspects of suicide and suggest some intriguing interactions.

1552.
Rodahl, A., M. O'Brian, and R. G. R. Firth. Diurnal variation in performance of competitive swimmers. J. Sport Med. 16: 72-76, 1976.

1553.
Rodgers, C. W., R. L. Sprinkle, and F. H. Lindberg. Biorhythms: Three tests of the predictive validity of the 'critical days' hypothesis. Int. J. Chronobiol. 2: 247-252, 1974.

Self-ratings (37 days from 20 subjects), work ratings (an average of 17 days from 9 subjects) and sleep-ratings (an average of 53 nights from 10 subjects) were obtained from psychotic mental patients and chi square analysis was performed on rating scores with respect to biorhythm cycle critical or non-critical days. No significant differences were found between rating scales on non critical days and single or double critical days. The authors speculate that these psychotic subjects are not normal in the sense that their biorhythms do not conform to biorhythm theory. In this connection it would have been more interesting if they had performed multiple regression or time series analysis on the rating scores to see if unusual infradian periodicities were present in the rating scores.

1554.
Roessler, R. Physiological correlates of optimal performance. Washington, D. C.: NASA Office of Grants and Research Contracts, N71-35236, 1971, 50 pp.

1555.
Rohles, F. H., Jr. Drive and performance modification following multiple (dark-dark) shifts in the photoperiod. Aerosp. Med. 42: 1167-1172, 1971.

1556.
Rohles, F. H., Jr., and G. Osbaldiston. Social entrainment of biorhythms in Rhesus monkey. In: Circadian Rhythms in Non-human Primates, edited by F. H. Rohles. Bibl. Primatol. 9: 39-51. Basel-New York: S. Karger, 1969.

1557.
Rohles, F. H., and C. H. Ptacek. Drive and performance modification following multiple (light-light) shifts in the photoperiod. Aerosp. Med. 44: 135-139, 1973.

The effects of 12-hour phase shifts in the light-dark cycle on feeding behavior and performance were studied by requiring monkeys to perform an 18-component serial task for all of their food ad lib. The photoperiod of 12 hours light/12 hour dark was advanced by 12 hours (light-light shift) and was advanced again when the slower of the two subjects received none of its food on two consecutive dark periods. Ten shifts were made and the results showed that between 7 and 11 days were required to reach criterion of "no dark-phase eating." When compared with an earlier study involving multiple dark-dark shifts, performance was impaired less following the light-light shift; however, resynchronization of the feeding behavior was longer following the light-light shifts than after the dark-dark shifts.

1558.
Rohmert, W., G. Hildebrandt, and J. Rutenfranz. Nacht- und Schichtarbeit von Triebfahrzeugfuhrern. 2. Mitteilung. Untersuchungen uber die Dienstplangestaltung (Night and shift work of locomotive engineers. 2nd Report. Investigations on the organization of daily service schedules). Int. Arch. Arbeitsmed. 33: 99-114, 1974. (transl. in Engl. by NASA, NASA TT F-16, 229.)

Analyzing the present regulation of work for engine drivers of the German-railroad demonstrates that discontinuity is the outstanding characteristic of their work schedule. All shifts are changed daily so that the driver is subject to an alteration in route, starting time, working time, and in the particular engine driven. For discussion of negative physiological and social effects of today's shift work we analyzed the structure of the shift. Specific time-tables of engine drivers in two German stations are discussed.

Practical suggestions are given, aimed at avoiding negative effects of work schedules that put intolerable strain on engine drivers.

1559.
Rohmert, W., and H. Luczak. Studies on part time shift work and rest periods in repetitive mental work. Int. Arch. Arbeitsmed. 31: 171-191, 1973.

1560.
Romano, S., L. Biricchi, P. T. Scarpelli, and A. Contigiasni. Spectrometry of some vital signs sampled by autorhythmometry. Influence of rest-activity shifting (abstract). Chronobiologia 4: 144-145, 1977.

1561.
Ronchi, L. Intra-day variations in visual reponsiveness. Space Life Sci. 4: 231-239, 1973.

1562.
Ronchi, L. Human biological and performance rhythms, in the frame of illuminating engineering. Atti.Fond. G. Ronchi 31: 405-408, 1976.

The report is a brief review of the literature concerning the possible influence of lighting on 'rhythms' in human beings. There is a paramount of literature on the so called 'biological rhythms', which concern some basic functions of the body. Another chapter of research deals with the rhythms of both performance and responsiveness. The link between these 2 fields is given by the cyclical variation of body temperature, which has been found to be related to both biological rhythms and performance rhythms. For animals, the light dark cycle represents a strong Zeitbeber, for the entrainment of several functions. For man, the light dark cycle seems to be a weak Zeitgeber, compared to social cues, waking sleep cycle, knowledge of time, etc. However there seems to be a link between performance rhythms on one side and both quality and quantity of light, on the other side, through fatigue, which depends on the time of the day. The relationship with fatigue is not simple, because of the interaction between the 2 parameters, intensity and spectral composition. The term 'action spectrum' should be used, therefore, in its broadest and more complex sense.

1563.
Ronchi, L., and L. Barca. Biological rhythms and rhythms of performance, an annotated bibliography. I. On the link between biological rhythms and performance rhythms. Atti. Fond. G. Ronchi 31: 781-830, 1976.

1564.
Ronchi, L., and L. Barca. Biological rhythms and rhythms of performance. An annotated bibliography. III. Research on animals. Atti. Fond. G. Ronchi 31: 987-1007, 1976.

1565.
Ronot, P. Suggestions pour des horaires de nuit. (Suggestions for night schedules). Arch. Mal. Prof. Med. 39: 535-536, 1978.

1566.
Roscoe, A. H. Stress and workload in pilots. Aviat. Space Environ. Med. 49: 630-636, 1978.

Several studies have highlighted the increase in physiological activity which occurs in pilots during flight and especially during takeoffs and landings. For example, it has been clearly demonstrated that pilots' heart rates increase during the landing approach to reach a peak at or just before touchdown. These changes have been attributed to workload and to psychological or emotional stress. This paper examines a number of test pilots' heart rate responses recorded during various flight trials involving different types of aircraft. Examples include ramp take-offs in a VTOL fighter, automatic landings in fog, supersonic flight through monsoon rain, and a sortie in which the pilot developed acute appendicitis. It is concluded that heart rate responses in experienced pilots are influenced almost entirely by workload-related factors and not by emotional stressors, such as risk and anxiety. Because of the emotional overtones of the word "stress," it is suggested that the term workload should be used when referring to the reason for increased cardiovascular activity in pilots.

1567.
Rose K. D., C. Grant, L. Dick, S.I. Fuenning, and P. Horsbrugh. Physiological evidence for variations in intellectual circadian periodicity. J. Am. Coll. Health Assoc. 20: 135-140, 1971.

1568.
Rosenblatt, L. S., K. E. Klein, C. M. Winget, N. W. Hetherington, and J. R. Beljan. Resynchronization rates of a psychomotor test rhythm in man following translongitudinal flights. Aerosp. Med. Assoc., Preprints, pp. 225-226, 1973.

1569.
Rossi, S., and E. Rossi. Body time and social time: Mood patterns by menstrual cycle phase and day of the week. Soc. Sci. Res. 6: 273-308, 1977.

1570.
Rotenberg, V. S., V. M. Shakhnarovich, I. S. Kandror, S. R. Roitenburd, A. M. Goncharenko, N. I. Kosilina, M. S. Tyurin, and R. Arencibis -Garcia. Struktura nochnovo i dnevnovo sna pri smennoi rabote v cvyazi s problemoi adaptatsii k nochnomu trudu (Structure of nocturnal and diurnal sleep during shift work in connection with the problem of adaptation to night work). Fiziol. Chel. 1: 756-762, 1975. (Eng. transl. in Human Physiology 1: 674-678, 1975.)

1571.
Roth, T. M. Kramer, W. Lefton, and T. Lutz. The effects of sleep deprivation on mood (abstract). Sleep Res. 3: 154, 1974.

1572.
Rotondo, G. Workload and operational fatigue in helicopter pilots. Aviat. Space Environ. Med. 49: 430-436, 1978.

The possible causes of the operational fatigue to which flight crews are subject during the performance of their duties are reviewed. The influence of the physical, psychic, and emotive components of the stress factor associated with the professional activities of helicopter pilots are analyzed and their effects in the genesis of fatigue is assessed. On the basis of this analytical survey, it is possible to conclude that the piloting of helicopters involves a psycho-physical workload that is not inferior to the one experienced by the pilots of faster and more powerful aircraft.

1573.
Rowan, R. Jet lag isn't just a state of mind. Fortune 97: 140-145, 197, 198, 200, 202. Aug. 1976.

1574.
Rubin, R. T., and R. E. Poland. Synchronies between sleep and endocrine rhythms in man and their statistical evaluation. Psychoneuroendocrinol. 1: 281-290, 1976.

The transitions between wakefulness and sleep are periodic and quantifiable, and because they represent major changes in the functional activity of the CNS., they have been used as paradigms for the study of CNS influences on endocrine functioning. Sleep-endocrine studies have shown that hormones are secreted in a pulsatile, episodic fashion, and many have prominent circadian and ultradian rhythms (e. g. adrenocorticotropic hormone (ACTH), growth hormone (GH), prolactin (PRL), testosterone). (3) Some of these hormone rhythms closely linked to the sleep-wake cycle (e.g. PRL) or to the specific stages of sleep (e.g. GH).

1575.
Rudnii, N. M. Effect of certain flight factors on crew efficiency. Voenno-Med. Zh. (6): 51-55, 1973.

Consideration of the effect of hypoxia, decompression, acceleration, noise, and vibration on the efficiency of spacecraft crew members. Particular attention is paid to the often subtle effects of hypoxic hypoxia on crew efficiency and to certain factors and conditions which can exacerbate these effects. In particular, the relation between the effects of hypoxia and the pronounced cyclic character of human efficiency is considered, noting the importance of knowledge of diurnal periodic patterns in estimating the effect of even small degrees of hypoxia on crew efficiency. A study is then made of two commonly occurring decompression disorders - high-altitude muscle-joint ailments and high-altitude meteorism, and the effect of repeated flights involving accelerations on pilot efficiency is considered. A few brief comments are made on the effects of noise and vibration under space flight conditions.

1576.
Rudnii, N., and V. Bodrov. Allowing for psychophysiological indicators of the quality of pilot performance. Aviatsiya i Kosmonautika 6: 14-15, 1977.

1577.
Rudolf, G. A., et al. Circadian rhythm of circulatory functions in depressives and on sleep deprivation. Int. Pharmacopsychiatry 12: 174-183, 1977.

1578.
Rummel, J. A. Rhythmic variation in heart rate and respiration rate during space flight - Apollo 15. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J. E. Pauly. Tokyo: Igaku Shoin, Ltd.,1974, pp. 435-440.

1579.
Rusak, B., and I. Zucker. Biological rhythms and animal behavior. Ann. Rev. Psychol. 26: 137-171, 1975.

1580.
Rutenfranz, J. Arbeitsphysiologische Aspekte der Nacht- und Schichtarbeit, Arbeitsmed. Sozialmed. Arbeitshygiene, 2: 17, 1967.

> During the course of his life, every day, the human organism is controlled by several Zeitgebers, both natural and artificial. When passing from night- to day-work, in general, only a part of those factors which are responsible for the phase of the circadian system, undergoes some changes. The relevant Zeitgebers persist in their natural phase relation. Therefore, a conflicting situation takes place, which exerts contradictory effects on the circadian system.

1581.
Rutenfranz, J. Arbeitsmedizinische Gesichtspunkte zum Problem der Schichtwechselperiodik. In: Actuelle Probleme der Arbeitsumwelt, Vol. 38, edited by J. Rutenfranz and R. Singer. Stuttgart: A. W. Gente Verlag, 1971, pp. 61-68.

1582.
Rutenfranz, J. Probleme der Schichtarbeit. Werksarztliches 2: 1-27, 1971.

1583.
Rutenfranz, J. Risikofactor Nacht- und Schichtarbeit (Risk factor of night and shiftwork). Med. Klin. 69: 12-16, 1971.

1584.
Rutenfranz, J. Pathogene Auswirkungen von exogenen Rhythmusstorungen (Pathogenic effects of exogenous rhythm disturbances). Verhdl. Dtsch. Ges. Inn. Med. 79: 31-37, 1973.

1585.
Rutenfranz, J. Physiologische Grundlagen der Industriearbeit (The physiological basis for industrial work). Zentralbl. Bakteriol. Parasitenkd. Infectionskr. Abteilungl. 158: 219-238, 1973. (Translated into Engl. by NASA, NASA TT F-16, 808, 1975.).

1586.
Rutenfranz, J. Schichtarbeit und biologische Rhythmik. Arzneim. -Forsch. 28: 1867-1872, 1978.

1587.
Rutenfranz, J., P. Knauth, G. Hildebrandt, and W. Rohmert. Nacht- und Schichtarbeit von Triebfahrzeugfuhrern. 1. Mitteilung. Untersuchungen uber die tagliche Arbeitszeit und die ubrige Tagesaufteilung (Night and shiftwork of railway engineers. 1. Investigations of the daily working hours and the distribution of leisure time and sleep). Int. Arch. Arbeitsmed. 32: 243-259, 1974.

1588.
Rutenfranz, J., J. Aschoff, and H. Mann. Wakefulness period duration and body temperature effects on reaction time in multiple choice visual task. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep. (Proc. of a Symp., Strasbourg, Fr., 1970). London: English Universities Press, Ltd., 1972, pp.297-228.

Description of an experiment carried out during a three-month sea voyage to investigate the influence both of a cumulative sleep deficit and of the duration of the immediately preceding period of sleep or wakefulness on performance at different times of night. In addition, the simultaneous measurement of reaction time and body temperature carried out in this study provided information about the dependency of reaction time on body temperature. Body temperature, reaction time, potassium excretion, and pulse rate showed clear 24-hr rhythms. Restriction of sleep to about 5 hr/day had no significant effect either on the periodicity or on the daily mean level of reaction time Reaction time at night is affected by the duration of the preceding period of sleep or wakefulness. Both body temperature and reaction time exhibit circadian rhythms.

1589.
Rutenfranz, J., and W. P. Colquhoun. Circadian rhythms in human performance. Scand. J. Work Environ. Health 5: 167-177, 1979.

Circadian rhythms in performance exist for a wide range of tasks studied under laboratory conditions; they also occur in measures of efficiency obtained in real-life situations. The rhythms appear to be related to the daily cycle of sleep "need," and the largest negative variations in performance are normally observed when this need is greatest. The detailed forms of the circadian functions are influenced to some extent by individual differences in age and personality. However, task factors are of equal, if not greater, importance in determining the nature of a performance rhythm, since its basic phase is markedly different in cases involving memory. This latter finding raises the practical problem of job design in relation to time of day, and a taxonomic approach is suggested as the most fruitful way of arriving at the optimal solution for particular work situations requiring different abilities.

1590.
Rutenfranz, J., W. P. Colquhoun, and P. Knauth. Hours of work and shiftwork. Proc. Congr. Int. Ergonomics Assoc., 6th, Santa Monica, Ca.: Human Factors Soc., 1976, XLV-LII.

First, the time elements of a working day, the duration of working time and the time positioning of working time are treated under ergonomical aspects. Second the reasons for shiftwork, different types of shift work as well as effects on health and on family ansd social life are discussed. Finally, the following physiological criteria for optimal shift-schedules are presented: (1) Single night shifts are better than consecutive night shifts. (2) At least 24 hours free time should be allowed after each night shift. (3) The cycle of a shift system should not be too long. (5) The length of the shift should be related to the type of work. (5) In connection with continuous shift work as many free weekends as possible should be arranged.

1591.
Rutenfranz, J., W. P. Colquhoun, P. Knauth, and J. N. Ghata. Biomedical and psychosocial aspects of shift work. A review. Scand. J. Work Environ. Health 3: 165-182, 1977.

A survey of the different types of shift-work systems in use, and the incidence of shift work in different industries and countries, is followed by a discussion of (a) the effects of shift work on health and (b) the physiological problems raised by the phase-shifting of the circadian cycle in night workers. Summaries of the existing knowledge of the effects of shift work on performance efficiency, accidents, and family and social life are then given, and a set of criteria for designing optimal shift systems is proposed. Next, the questions of selection for shift work and the provision of health services for shiftworkers are discussed. Finally, the need for further research on the problems of shift work is explained, and suggestions are offered on the lines such research should follow.

1592.
Rutenfranz, J., and T. H. Hettinger. Ueber Tagesschwankungen der Rechnenge-schwindigkeit bei elf-jaebrigen Kinder. Z. Kinderheilk. 79: 65-81, 1957.

The speed with which calculations are performed varies periodically with time. The frequency of this oscillation is found to be age-dependent.

1593.
Rutenfranz, J., F. Klimmer, and P. Knauth. Desynchronization of different physiological functions during three weeks of experimental nightshift with limited and unlimited sleep (abstract). Int. J. Chronobiol. 3: 2, 1975.

1594
Rutenfranz, J., P. Knauth, and W. P. Colquhoun. Hours of work and shiftwork. Ergonomics 19: 331-340, 1976.

First the time elements of a working day, the duration of working time and the time positioning of working time are treated under ergonomics aspects. Second the reasons for shiftwork, different types of shiftwork as well as effects on health and on family and social life are discussed. Finally the following physiological criteria for optimal shift-schedules are presented: (1) Single night shifts are better than consecutive night shifts. (2) At least 24 hours free time should be allowed after each night shift. (3) The cycle of a shift system should not be too long. (4) The length of the shift should be related to the type of work. (5) In connection with continuous shiftwork as many free weekends as possible should be arranged.

1595.
Rutenfranz, J., H. Mann, and J. Aschoff. Circadianrhythmic physischer und psychischer Funktionen bei 4-stundigen Wachwechsel auf einer Schiff. In: Night and Shift Work, edited by A. Swensson. Stockholm: Inst. Occup. Health, 1969, pp. 31-41.

1596.
Rutenfranz, J., and R. Singer. Aktuelle Probleme der Arbeitsumwelt - Probleme der Nacht - und Schichtarbeit (Present-day problems of the work environment - problems of night and shift work). Arbeitsmedizin Sozialmedizin Arbeitshygiene 38: 21-112, 1971.

In the first part of the proceedings, various authors deal with the following problems of night and shift work; human circadian rhythm; health hazards and their prevention; problems of industrial medicine and their evaluation on the works level; subjective stress and its evaluation; special problems with female employees; effect of interrupted sleep and night work on heart rhythm and respiration.

1597.
Rutenfranz, J., and E. Werner, (editors). Schichtarbeit bei Kontinuierlicher Produktion (Shift work in continuous production processes). Dortmund-Maren, Germany: Forschungsbericht, No. 141, 1975, Bundesanstalt fur Arbeitsschutz und Unfallforschung. 431 pp.

Analysis of surveys in some 2,000 workers in the chemical and iron and steel industries with various forms of shiftwork; time-budget studies in relation to continuous work methods; sociopsychological, occupational psychological and occupational medical factors in the chemical industry; personal and social data and occupational and operational data in the iron and steel industry. Inquiries among executive staff and councils of workers' delegates on problems related to continuous shift work specific to their branch are assessed, and the extent of recourse to continuous working methods in European countries compared. Finally, problems involved in introducing the 40-h week in plants with continuous production are assessed and solutions proposed.

1598.
Ruzicka, W. Biorhythmus und Unfalle (Biorhythm and accidents). Beihefte zur Monatsschrift fur Unfallheilkunde 130: 296-300, 1978.

A study was made of 85953 Austrian work accidents with respect to the 3 biorhythm theory cycles. The number of accidents occurring on each day of the biorhythm cycles was computed from birthdays. Variation in accident frequencies do not correspond to biorhythm theory. However, a high accident incidence was evident on day 20 of the 23 and 28 day but not 33 day cycles, from graphical and chi square analysis. This suggests the presence of a rhythmicity and a modified biorhythmic theory should be developed which takes into account sex, age and occupational factors and which eliminates the birth dependent hypothesis.

1599.
Sacher, D. The Influence of Biorhythmic Criticality on Aircraft Mishaps. (M. S. Thesis). Naval Postgraduate School, Monterey, CA. Report No AD-783 817/OGA, 1974, 68 pp.

The author investigated the probability of biorhythmic criticality and its influence on human error and accidents based on data from 4346 naval aircraft mishaps. By straightforward application of critical days or critical periods there was no significant influence from biorhythms; however, a significantly lower number of accidents than expected in pilots younger than 30 years were found when a critical physical day was accompanied by a positive state of the emotional cycle (which contradicts biorhythm theory), and in pilots older than 30 when physical critical days coincide with the negative state of the emotional cycle. The findings of the study support the relativity-idea in the theory of biorhythms: critical days of the three biorhythmic cycles have different effects on groups of people with different characteristics, according to the author. Klein and Wegmann state that with these results, in conflict with biorhythm theory, it is not easily comprehended that the author recommends biorhythmic criticality to be incorporated into a Sortie System Safety Evaluation.

1600.
Sackett, L. L., M. Haus, W. K. Babb, E. K. Bixby, and E. Haus. Cardiovascular and temperature adaptation to phase shift by intercontinental flight. Proc. Minn. Acad. Sci., 1978, p. 18.

A total of 35 intercontinental flights between Minnesota, U. S. A. and Central or Western Europe (time difference 6-7 hours) were studied 2 male and 3 female subjects. Of these, 10 west-east and 10 east-west flights over a 14-year span were investigated in one of the male subjects (age 37-51): 5 east-west flights and 4 west-east flights over a 5-year span were studied in one of the subjects (age 27, 30 and 30), a single flight pair was investigated. In each subject, systolic and diastolic blood pressure, heart rate and/or body temperature were followed by autorhythmometry with 4 to 6 measurements per 24-hour span during at least 1 month before each intercontinental flight, and between 10 days and 2 months thereafter. The circadian rhythms and their phase shifts were quantitated by least squares fits of cosine functions applied, among others, in the form of chronobiologic serial sections and by group cosinor analysis over consecutive nonoverlapping time spans. Phase adaptation occurred slowly over several transient cycles with differences in the adjustment rates between the variables studied. Differences in speed of phase adaptation between west-to-east and east-to-west flights were observed in some subjects but were not consistent in the group.

1601.
Saiki, H., and M. Nakaya. Dynamics of sleep patterns during prolonged simulated weightlessness. In: Life Sciences and Space Research, edited by R. Holmquist. New York: Pergamon Press, vol. 15, 1977, pp. 225-231.

Subjects immersed for 6 days in water, simulating weightlessness, exhibited marked changes in the total time spent in sleep and in the percentage of that time spent in each sleep stage. The length of time spent in Stage 4 deep sleep and in REM sleep decreased in the first half of the 6-day immersion period. During the latter half of the immersion period, a clear adaptive response was observed in the sleep patterns: The sequential appearance of the different stages of sleep and the percentage of time spent in the six stages of sleep showed a clear approach to the pre-immersion data. During the 3-day post-immersion period, the patterns approached the normal pre- immersion levels, although there was some overshoot or a negative phase period characterizing this approach. By the sixth day of immersion the percentage of time spent in each stage of sleep had returned to near normal pre-immersion values, but the total time spent in sleep was still somewhat less than normal. This fact suggests that, once adapted to a condition of weightlessness, the sleep requirement may be less than during normal ambulatory life. During the post-immersion period, the pattern of Stage 4 sleep at early evening, midnight and dawn showed no special reactive characteristics, but rather a clear recovery towards the original pattern. On the other hand, at the duration of REM sleep, it overshot the pre- immersion values at the beginning of the post-immersion period, and then returned to the original pattern.

These experiments suggest that some of the changes in sleep patterns which are observed under conditions simulating weightlessness may be adaptive.

1602.
Saiki, H., M. Nakaya, and C. Sekiguchi. Characteristics of sleep under simulated weightlessness. Aerosp. Med. Assoc. Preprints, 1971, pp. 62-63.

1603.
Saito, Y. Specification of variation patterns of physiological and performance measurements in sleep loss. J. Hum. Ergol. 1: 207-216, 1972.

Factor analysis was performed for sixteen physiological and performance measurements in order to find some common distinct features of the variation patterns during a 48 hr period of sleep loss. The measurements were repeated through the 5-day experimental session, which included a training day or a recovery day. The results were averaged for three male adult subjects and standardized for each measure, coefficients of correlation being calculated between each pair of the measurements. Principal component analysis was performed specifying three factors for rotation by the varimax method. The variation patterns could be classified into three common specific patterns. The first pattern, exhibited by heart rate, systolic blood pressure, critical fusion frequency of flicker, and subjective ratings of fatigue, was characterized by gradual decrement with modification of diurnal variability. The second pattern, which was followed by simple reaction time and body temperature, showed a distinctive sharp decrement in the early morning hours. The third pattern, regarded as combining the characteristics of the first two patterns, was exhibited by such complex performances as choice reaction time or tracking error. Exhausting processes caused by 48 hr of wakefulness were discussed on the basis of these three patterns.

1604.
Saito, Y., and K. Kogi. Psychological conditions of working night and subsequent day shifts with short sleep hours between them. Ergonomics 21: 871, 1978.

1605.
Sakai, K., and Y. Takahashi. Driving and subsidiary behavior of taxi drivers working alternate-day shifts. J. Hum. Ergol. 4: 115-127, 1975.

1606.
Sakata, T., M. Fukushima, J. Kodama, and H. Fuchimoto. Light-dark patterns in running-wheel activity in rats during chronic administration of theophylline. Physiol. Behav. 19: 397-400, 1977.

Running-wheel activity for 24 hr. and activity patterns were studied during chronic theophylline administration. Theophylline altered the normal relations between activity level and illumination. Dark-time activity was decreased to approximately 50% and 24 hr activity was unaffected. These observations were consistent with previous results showing that theophylline suppressed dark-time feeding but had no effect on 24 hr food intake. A possible mechanism to account for these results may be dependent on levels and turnover of brain norepinephrine.

1607.
Sakellaris, P. C., A. Peterson, A. Goodwin, C. M. Winget, and J. Vernikos-Danellis. Response of mice to repeated photoperiod shifts: Susceptibility to stress and barbituates. Proc. Soc. Exp. Biol. Med. 149: 677-680, 1975.

1608.
Salamy, J. Effects of REM deprivation and awakening on instrumental performance during Stage 2 and REM sleep. Biological Psychiatry 3: 321-330. 1971.

This study tested the hypothesis that the need for REM sleep was analogous to other physiological motives (e. g., hunger, thirst, etc.). Therefore, subjects (Ss) should perform a response to avoid being awakened from REM sleep, and REM deprivation should facilitate this performance. Ss were required to close a switch three times when tones were presented during the last 2.5 hr of sleep Ss were randomly divided such that: tones were either presented in stage 2 or in REM sleep; Ss were either awakened or not awakened for failing to respond to the tone; and they were either deprived of REM sleep up to the last 2.5 hr, or they were not REM-deprived at all. In general, main effects were not significant, but several significant interactions were obtained. It was found that awakening for response-failure improved performance in REM sleep, but not in stage 2. Awakening for response-failure in combination with REM deprivation produced 85% successful performance when tones were presented in REM sleep. Under the same conditions, except that Ss were not aroused for response failure, only 1% success was achieved. It concluded that the need-for-REM sleep appears to possess motivational properties that are analogous to othe physiological motives.

1609.
Saldivar, J. T., and S. M. Hoffman. Sleep in air traffic controllers. Washington, D. C.: Federal Aviation Agency, FAA-AM-77-5, 1977, 15 pp.

Data obtained from sleep logs maintained for a period of 5 weeks by 185 air traffic controllers indicate that on a weekly basis there is no significant difference in the amount of sleep obtained by controllers working the 2-2-1 rotation pattern and that obtained by those on the 5-day rotation pattern. Approximately half the controllers indicated satisfaction with their present shift rotations; however, preferences indicate that they would prefer to work a shift rotation that excluded the midshift. Age and experinece do not appear to be related to pattern of sleep or amount of sleep obtained. 'Fatigue', 'weakness', and 'somnolence' were complaints most often expressed on the midshift on both rotation patterns. Reasons most often given for not sleeping were 'work related' and illness by controllers on the 2-2-1 rotation pattern and 'work related' and 'nonspecific' by those on the 5-day rotation pattern.

1610
Saleh, M. A., P. J. Haro, and C. M. Winget. Loss of circadian rhythmicity in body temperature and locomotor activity following suprachiasmatic lesion in the rat. J. Interdiscipl. Cycle Res. 8: 341-346, 1977.

1611
Saleh, M. A., and C. M. Winget. Effect of suprachiasmatic lesions on diurnal heart rate rhythm in the rat. Physiol. Behav. 19: 561-564, 1977.

Heart rate and locomotor activity of rats kept under 12L/12D illumination regimen was recorded every six minutes for ten days using implantable radio transmitters. Some of the rats then received bilateral radio frequency lesions into the suprachiasmiatic nucleus(SCN). Control sham operations were peformed on the rest of the animals. After recovery from surgery, recording of heart rate and locomotor activity was continued for ten days. SCN lesioned rats showed no significant diurnal fluctuation in heart rate, while normal and sham operated rats showed the normal diurnal rhythm in that function. The arrhythmic diurnal heart rate pattern of SCN rats appeared to be correlated to their sporadic activity pattern. The integrity of the suprachiasmatic nucleus therefore is necessary for the generation and/or the expression of diurnal rhythmicity in heart rate in the rat.

1612.
Saline, C. Don't make a move -until you check our chart. Today/The Philadelphia Enquirer, Nov. 4, 1973.

1613.
Saline, C. Blame it on your biorhythms. Boston Magazine, pp. 7-14, June, 1974.

1614.
Saltarini, H. Bioritmo (Biorhythms). Milan: Siad. 1976, 194 pp.

1615.
Sanders, A. F., and A. A. Bunt. Some remarks on the effects of drugs, lack of sleep and loud noise on human performance. Ned. Tijdschr. Psychol. Grensgeb. 26: 670-684, 1971.

1616.
Sandler, H., and D. L. Winter. Physiological Responses of Women to Simulated Weightlessness. Washington, D. C.: NASA, NASA-SP-430, 1978, 87 pp.

A survey is presented of the findings of the first bed-rest study using all female subjects. The 12 volunteer subjects (active Air Force nurses or reserves) were exposed to centrifugation, to lower body negative pressure (LBNP), and to exercise stress both before and after bed rest. Areas studied were centrifugation tolerance, fluid electrolyte changes and hematology, tolerance to LBNP, physical working capacity, biochemistries, blood fibrinolytic activity, female metabolic and hormonal responses, circadian alterations, and gynecology. The subjects were first tested to establish baseline values during a 14-day control period; on the basis of their baseline values, the 8 subjects most capable of tolerating acceleration and LBN) were selected for the bed-rest test. The bed-rest period lasted 17 days, after which the subjects underwent a 5-day recovery period. The 4 ambulatory controls underwent all requirements of the study except bed rest. Results were compared with the responses observed in similarly bed-rested male subjects. The bed-rested females showed deconditioning responses similar to those of the males, although with some differences. The surprising finding of the study was that the ambulatory control subject also exhibited a degree of deconditioning, which was thought to result from the stress of confinement. The results of the study indicate that women are capable of coping with exposure to weightlessness and, moreover, that they may be more sensitive subjects for evaluating countermeasures to weightlessness and developing criteria for assessing applicants for Shuttle voyages.

1617.
Sanford, A. J. A periodic basis for perception and action. In: Biological Rhythms and Human Performance, edited by W. P. Colquhoun. New York: Academic Press, 1971, 283 pp.

1618.
Sanheim, J. Biorhythm analysis as applicable to safety. Paper presented at the National Safety Congess and Exposition, Sept. 30, 1975.

He studied 1308 accidents at the Naval Weapons Support Center and claims that 41.75% of these accidents occurred on biorhythmic critical days.

1619.
Santandreu, H. A. Casualties due to sickness and incapacitation in aviation. Iberia Lineas Areas De Espana: 7-89, 1977 or 1978.

1620.
Sasaki, T. Circadian rhythm in body temperature. In: Advances in Climatic Physiology, edited by S. Itoh, K. Ogata, and H. Yoshimura. Tokyo: Igaku Shoin, Ltd., 1972, pp. 319-333.

1621.
Sasaki, T. Infradian rhythm with linear trend following phase shift (abstract). Int. J. Biometeorol. 22: 335, 1978.

1622.
Sassin, J. F., D. C. Parker, L. C. Johnson, L. G. Rossman, J. W. Mace, and R. W. Gotlin. Effects of slow wave sleep deprivation on human growth hormone release in sleep: preliminary study. Life Sci. 8: 1299-1307, 1969.

1623.
Savic, N. Turnusni rad--specifikum zeleznicko-saobracajne tehnologije (Working in shift--in the railroad industry). Narodno Adravlje 27: 248-253, 1971.

1624.
Scafarczyk, A., and J. Nouguiek-Soule. I. Assenmancher: Diurnal locomotor and plasma corticosterone rhythms in rats living on periodically lengthened "day". Int. J. Chronobiol. 2: 373-382, 1974.

1625.
Scapagnini, U., G. P. Moberg, G. R. van Loon, J. de Groot, and W. F. Ganong. Relation of brain 5-hydroxytryptamine content to the diurnal variation in plasma corticosterone in the rat. Neuroendocrinology 7: 90-96, 1971.

1626.
Scapagnini, U., and P. Preziosi. Role of brain norepinephrine and serotonin in the tonic and phasic regulation of hypothalamic hypophyseal adrenal axis. Arch. Int. Pharmacodyn. Suppl. 196: 205-220, 1972.

1627.
Schadewald, R. Biorhythms: A critical look at critical days. Fate 32: 75-80, 1979.

In this critical review of the biorhythm theory, the author quotes reputable scientists who consider biorhythm theory to be a

pseudoscientific fad. Documentation of Swoboda and Teltscher supporting the theory has apparently disappeared. Recalculation of biorhythm charts for anecdotal examples in Thommen's (Is This Your Day, Crown, New York, 1973) revealed mistakes and misstatements. The author illustrated the power of suggestion in biorhythm theory by quoting a demonstration by a magician (The Amazing Randi) who provided a woman with a biorhythm chart, deliberately using the wrong birthday. Nevertheless, the woman felt the chart was quite accurate. Randi then admitted his error and sent the woman a second "corrected" chart, but based on a wrong birthday. The woman claimed the second chart was even better than the first. The author criticizes a German study (see Bochow 1954/55) which claimed a remarkably high coincidence of accidents on biorhythmic critical days as being so inconsistent with other studies involving accidents that it is either a fabrication or the most astounding statistical anomaly on record.

1628.
Schaefer, K. E. New London, Conn: Naval Medical Research Lab, NASA-CR-156-536, 1964, 20 pp.

Research on the diurnal periodicity of physiological functions and of performance level: including studies of the effects of removing, or of changing the perior or the phase of, environmental time indicators.

1629.
Schaefer, K. E., C. M. Kerr, D. Buss, and E. Haus. Effect of 18-h watch schedules on circadian cycles of physiological functions during submarine patrols. Undersea Biomedical Research, Submarine Supplement 16: 581-590, 1979.

Circadian rhythms of body temperatures, pulse rate, and respiration rate were measured in 11 subjects every 4 h during certain periods on two submarine patrols. Data on systolic and diastolic blood pressure were also obtained on five crew members during the first period. All the subjects of the first patrol were on an 18-h watch schedule (6 h on, 12 h off). During the second patrol, three subjects were on an 18-h watch schedule and three were on a 24-h watch schedule. Cosinor analysis for positive ($P < 0.05$) detection of rhythm demonstrated that all subjects on the 180h watch schedule developed 18-h cycles of body temperature, pulse rate, respiration rate, and systolic and diastolic blood pressure, which were then superimposed on the persisting 24-h cycles of the same function. The three subjects on a 24-h watch schedule did not show the 18-h cycles. Moreover, additional 12-, 36-, and 48-h cycles (harmonics and subharmonics of 24-h cycles) were found in all subjects on both patrols, attesting to the disintegration of circadian cycles under these conditions. Average sleep time tended to decrease toward the end of the patrol.

1630.
Schaffler, K., and H. H. Renemann. Sleep disturbances of cockpit personnel after transmeridian long distance flights. Med. Klin. 71: 1985-1995, 1976.

1631.
Schara, A. W. All the Presidents Plus: An Insight Into Moments of History Through Biorhythms. Hicksville, New York: Exposition Press, 1978.

1632.
Schavone, R. M. The Effects of Monthly Biorhythms on Selected Motor Performance. (Ph. D. Thesis). Stanford University

Reaction time, balance (stabilometer), hand grip and endurance (bicycle ergometer) performance were obtained twice at biorhythm cycle positive phase, negative phase, and critical days from 30 female students. T-tests for correlated groups were performed between the three treatment levels. The results failed to support the relationship between biorhythms and physical performance. The use of biorhythm cycle high and low phases tends to bias the smaple population. A more meaningful experimental design would have involved a double blind sampling of performance on various days, with chi square analysis of the biorhythm phase-performance relationship. However, the authors' use of a biased sample tends to add more weight to his conclusions.

1633.

1634.
Scherrer, M. J., and P. Andlauer. Table ronde sur la vigilance (Round-table discussion on vigilance). Arch. Mal. Prof. Med. 38: 133-157, 1977.

1635.
Scheving, L. E., et al. (no title) Postepy Higieny: Medycyny Doswiadczalnaj 33: 249-262, 1979.

1636
Scheving, L. E., E. R. Burns, J. E. Pauly, T. H. Tsai, H. O. Betterton, and F. Halberg. Meal scheduling, cellular rhythms and the chronotherapy of cancer (abstract). In: International Congress of Nutrition, 10th, Kyoto, Japan, 1975, pp. 141-142.

1637.
Scheving, L. E., and J. E. Pauly. Einfluss der Circadianrhythmik auf Tierexperiments (Influence of circadian rhythm on animal experiments). Nova Acta Leopoldina 46: 237-258, 1977.

1638.
Schlieper, H. Der Rhythmus des Lebendigen (The rhythm of vitality). Jena: Eugen Diederichs, 1909.

A review of the discovery of regulated rhythms by Wilhelm Fliess.

1639.
Schlosberg, A., and M. Benjamin. Sleep patterns in three acute combat fatigue cases. J. Clin. Psychiatry 39: 546-549, 1978.

A preliminary report is presented on the sleep patterns of three combat fatigued patients with recurrent nightmares, insomnia, low frustration thresholds and impotence. All the patients had undergone acute partial sleep deprivation prior to their breakdown. The results show severe deficiency in REM sleep and absence of stage 4 sleep. EMG was usually high with numerous body movements and bursts of tachycardia throughout the night. Nightmares occurred in stage 2. Total effective sleep time was between 129' and 250'. Most of the sleep was in stage 2, and patients woke up with the feeling that "they had not slept at all." It is hypothesized that acute partial sleep deprivation prior to breakdown was an important predisposing factor, and that chronic partial sleep deprivation was a constant aggravating factor of combat fatigue. Replacement therapy for the specific deficient sleep states is proposed.

1640.
Schmid, B. Zur Psycho-Vegetativen Belastung Durch Schichtarbeit und Akkordarbeit (Psychovegetative stress associated with shift work and piece work). Arbeitsmedizin-Sozialmedizin-Arbeitshygine 6: 263-265, 1971.

Following introductory remarks on methods used for measuring psychovegetative stress at work-places, the author examines the effect of shift work, night work and piece work. Sustained effort during night shifts results in insomnia, anorexia and digestive disorders. Piece work was found to be harmful only if performed at an excessive rate, in which case the effort involved caused emotional stress accompanied by sympathicotonia.

1641.
Schmidt-Amelung, J. Auswirkungen von zwei Transatlantikflugen in rascher Folge auf die Tagesrhythmik in der Ausscheidung von 17-Hydrocorticosteroiden und catecholaminen (Effects of two transatlantic flights in rapid sequence upon the 24-hour rhythm in the urinary excretion of 17 hydroxycorticosteroids and catecholamines). Bad Godesberg, West Germany: Deutsche Forschungs - und Versuchsansfalt fuer Luft- und Raumfahrt. Inst. fuer Flugmedizin, 1974, 70 pp.

The effects were studied in eight male subjects. Flights were performed as outgoing and return flight between Frankfurt and Chicago with a time shift of 6 hrs and a stopover time of 26 hrs. The results showed distinct excretion patterns in all studied functions on day 1 and 2. The diurnal rhythm of the 17-hydroxycorticosteroids showed marked time shift effects on day 1 after return. These changes and their operational significance for the flying personnel are discussed.

1642.
Schmidtke, H. Psychophysiological influences and their consideration in measurements in man-machine systems. In: WGLR Proc. of the 5th WGLR Meeting on Human Factors, Eng., 1968, pp. 37-45.

1643.
Schneider, D. Stress and sleep. Schweiz Arch. Neurol. Neurochir. Psychiatr. 121: 47-54.

For this paper, psychophysiological relationships between stress and sleep are considered with reference to clinical psychiatric problems. Answers to the first question- how does sleep affect the tolerance of stress in the waking state? - are provided by sleep deprivation experiments. The latter show that total sleep deprivation has a great influence on stress. However gradual partial sleep deprivation to a sleep time of 5 hours seems well tolerated by most individuals. In some special cases we found subjects well adapted to the workaday world who could live with briefer sleeping periods. Because of experimental problems, the second question how does stress affect sleep? - is more difficult to answer. Anxiety is one of the most important factors deteriorating sleep under conditions of stress. This reduced sleep is in turn stressful for waking behavior. Thus, the relationship between stress and sleep, two factors separated for scientific investigation, is essential and especially important in the problem of insomnia.

1644.
Schonholzer, G., G. Schilling, and H. Muller. Biorhythmik (Biorhythmic). Schweiz. Z. Sportmed. 1: 7-27, 1972.

The biorhythmic characteristics of more than 1000 athletic records were calculated by the Biorhythmic Research Center, Switzerland. The authors then computed the level of significance for differences between the actual events and their theoretical probability with special attention to critical periods. The results demonstrated that biorhythms have no influence on the frequency of such events. They concluded that the idea of biorhythm is a theory without biological and mathematical foundation.

1645.
Schubert, F. C. Personality traits and polygraphic sleep parameters: correlation between personality factors and polygraphically recorded sleep in healthy subjects (abstract). Waking and Sleeping 1: 165-170, 1977.

1646.
Schulz, H. Sleep and wake-cycle as circadian rhythm. Wien Klin Wochenschr. 91: 3-5, 1979.

1647.
Schulz, H., G. Dirlich, and J. Zulley. Phase shift in the REM sleep rhythm. Pflugers Arch. 358: 203-212, 1975.

The periodic alternation between REM and NREM sleep was analyzed. Usually, sleep records of consecutive nights of a subject are regarded to be independent events. However, it may be that consecutive nights are realizations of a continuously ongoing rhythm. This was tested in the present study. The temporal patterns of REM and NREM sleep in sequences of about 30 consecutive nights for 3 subjects were analyzed. The results show that only the onset of the first REM sleep phase during any one night may be predicted from the sleep onset time, whereas a systematic phase shift between consecutive nights was observed in the later REM sleep phases. Thus, the onset of later REM sleep phases is better predicted by assuming a rhythm with stable period length which controls the appearance of REM sleep phases in successive nights. Under the experimental conditions the phase shift was between 5 and 10 min. per 24 hrs for the 3 subjects. The result is accordance with Kleitman's basic rest activity cycle (BRAC) hypothesis.

1648.
Schulze, H. H. The detectability of local and global displacements in regular rhythmic patterns. Psychol. Res. 40: 173-181, 1978.

1649.
Schunck, K. H. Ein neues Schichtsystem in seiner Auswirkung auf den Krankenstand, das Unfallageschehen und die Freizeitgestaltung. Dtsch. Gesundheitswes. 13: 1092-1095, 1958.

1650.
Schwarz, G. R. A look at the matter of susceptibilityy to work errors as related to biorhythm. Professional Safety 21: 34-39, 1976.

1651.
Schwing, H. Uber Biorhythmen und deren technische Anwendung (On biorhythms and their technical application). (Ph. D. Thesis) Swiss Federal Institute of Technology, A. G. Gebr. Leemann and Co., 1939.

In an analysis of 700 accident cases from Swiss insurance companies and the Workmans Compensation Board, he found 322 accidents occuring on biorhythm critical days, 74 on double critical days and 5 on triple critical days, all incidences will above expected levels. He also found that 197/ 300 deaths from the civil records of Zurich occurred on biorhythm critical days.

1652.
Scott, E. What to believe about biorhythms. Seventeen 37: 90, May, 1978.

This popular article on "biorhythm" and biological rhythms quotes A. Ahlgren, a biorhythm detractor but confuses biorhythm accident prevention with biological rhythm research.

1653.
Scott, V. R., and G. J. Kidera. Anemia and airline flight duties. Aerospace Med. Assoc., preprints, 1975, pp. 191-192.

1654.
Sekiguchi, C., O. Yamaguchi, T. Kitajima, and Y. Ueda. Effects of rapid round trips against time displacement on adrenal cortical-medullary circadian rhythms. Aviat. Space Environ. Med. 47: 1101-1106, 1976.

The effects of rapid round trips against time displacement on circadian rhythms was investigated. The study was carried out on three occasions using one volunteer healthy physician on east-west trips (Tokyo-San Francisco-Tokyo) of short and prolonged stays. The control study was performed on a north-south trip (Tokyo-Sydney-Tokyo) which had practically no time displacement. The circadian rhythms of urinary 17-OHCS, 17-KS, and noradrenaline excretions and plasma cortisol in short-stay trips were disrupted and not synchronized; however, the recovery was rapid with the circadian rhythms returning to normal within 1 to 2 d. On the other hand, the circadian rhythms of these variables in the control study were not disrupted. These results suggest that 2 short, overnight stay during the trip minimizes the ill effects due to time displacement.

1655.
Sekyrova, M. Frauenschichtarbeit und deren Einfluss auf die Fluktuation und Erkrankungen. 15th Internationaler Kongress fur Arbeitsmedizin 4: 91-93, 1966.

1656.
Seminara, J. L., and R. J. Shavelson. Effectiveness of space crew performance subsequent to sudden sleep arousal. Aerosp. Med. 40: 723-723, 1969.

The effectiveness of crew performance upon sudden awakening is a question that relates to the advisability of simultaneous vs. staggered sleep schedules for space crews. Four test subjects, participating in a five-day lunar mission simulation study, performed space-typical emergency responses to an audible alarm which sounded during sleep and during normal-awake periods. It was found that time to perform a task upon sudden sleep arousal was inversely related to the length of time required to preform a task. It was also found that while the largest decrement in performance time occurs within the first three minutes subsequent to awakening, the effects of sleep drowsiness persisted up to at least 9 to 12 minute post-alarm period studied. The simultaneous vs. staggered sleep schedules and between automated system responses vs. crew responses to emergency/hazard situations that might arise in space systems.

1657.
Sen, R. N., and M. R. Kar. Circadian rhythms in some groups of Indians working in shifts. J. Hum. Ergol 7: 65-79, 1978.

The present study was undertaken in order to find out the effect of changes in shifts on different physiological responses in Indian industrial workers. Two groups, one of eight workers from industires and another of six sedentary subjects used as control, acted as volunteers in this study. The first group worked in three different shift rotations: morning, afternoon and night. The second group worked in two shifts; day and night only. Different physiological responses, specially the pulse rate and oral temperature were recorded hourly. The other physiological responses, such as frequency of micturition, gastro-intestinal disturbances, hours of sleep were also noted. Several days of consecutive work and recreational activities were considered in each subject. In the control group, the oral temperature rhythm did not change significantly with the change of shifts; so did the pulse rate rhythm. But this group had less sleep and higher frequency of micturition in the night shift routine than those during day shift. The typical industrial workers' oral temperature rhythm, also did not change significantly with the shift changes, but their pulse rate rhythm changed slightly with shift change, possibly in an attempt to adapt. They generally slept well in all three shifts and had micturition equally frequent. However, there were individual variations with some peculiarities in both the groups.

1658.
Sergean, R. A note on current trends in the arrangement of working hours in the U. K. In: Aspects of Human Efficinecy: Diurnal Rhythm and Loss of Sleep, edited by W. P. Colquhoun. Proc. Symp., Strasbourg, FR., 1970. London: English Univ. Ltd., 1972, pp. 283-288.

1659.
Sergean, R. Managing Shiftwork. London: Gower Press, 1971.

1660.
Sergean, R., and J. Bierley. Absence and attendance under non-continuous three-shift systems of work. Nature 219: 536, 1968.

1661.
Shaffer, J. W., C. W. Schmidt, H. I. Zlotowitz, and R. S. Fisher. Biorhythms and highway crashes. Arch. Gen. Psychiatry 35: 41-46, 1978.

Although many scientists consider biorhythm theory unworthy of investigation, the authors believe it is important to study since if it has merit, it could have important practical implications from the standpoint of health and safety, large numbers of people worldwide schedule their activities in accordance with biorhythm theory, and deductions from the theory are simply stated and easily tested. The relationship between expected and observed frequencies of 135 fatal and 70 non-fatal driver at fault accidents at different biorhythm phases was tested by binomial distribution and chi square goodness of

fit. There was no significant deviation of accident frequencies on critical days, low biorhythm cycle phases, combinations of critical days, and combinations of high and low cycle phases from expected frequencies in fatal or non-fatal accidents. The authors believe the misled popularity of biorhythm theory stems from its role as self-fulfilling prophecy: anticipation of a particular day may sensitize the individual to its positive or negative effects. The occurrence of an untoward event by chance on a critical day may constitute compelling evidence to suggestible people.

1662.
Shah, D. K. Biorhythms blues. National Observer, p. 1, Dec. 7, 1974.

1663.
Shannon, R. H., and J. C. Ferguson. Problems of fatigue in patrol aircrewmen during extended flight operations. Aerosp. Med. Assoc. Preprints, 1979, pp. 105-106.

1664.
Shashkov, V. S., and N. V. Gordeycheva. Performance, methods of evaluating it, and drug stimulation. Kosm. Biol. Med. 6(2): 3-13, 1972.

1665.
Shealy, C. N., and A. S. Freese. Occult Medicine Can Save Your Life. New York: Dial Press, 1975.

The author believes that physicians should be aware of their own critical days and should then avoid serious decisions or actions. Surgeons should not operate on critical days. Patients should be protected by not having any surgery performed on their critical days.

1666.
Shepherd, R. D., and J. Walker. Three-shift working and the distribution of absence. Occupat. Psychol. 30: 105-111, 1956.

1667.
Shiotsuka, R., J. Jovonovich, and J. A. Jovonovich. In vitro data on drug sensitivity: circadian and ultradian corticosterone rhythms in adrenal organ cultures. In: Chronobiological Aspects of Endocrinology, edited by J. Ashoff, F. Ceresa, and F. Halberg. Stuttgart: Schattauer, 1974, pp. 255-267.

1668.
Shkol'nikov, B. I., et. al. Effect of shift work with an irregular work and rest schedule on some objective sleep parameters. Library of Congress Science and Technology Alert (S & T) Alert, Item No. 4634, 2 April 1978.

Irregular work/rest schedule were studied in 2000 railroad mail workers. Workers had difficulty falling asleep and awakening, had superficial, restless and intermittent sleep and express dissatisfaction with sleep quality. Sleep during travel was low quality and did not restore work capacity. Most workers with irregular sleep patterns adjusted poorly to the working regimen.

1669.
Shurley, J. T., C. M. Pierce, L. Natani, and R. E. Brooks. Sleep and activity patterns at South Pole Stations. Arch. Gen. Psychiatry 22: 385-389, 1970.

1670.
Sieber, W. Synchronisierte und autonome circadiane Periodik Physiologisher Funktionen bei Blinden unter besonderer Beruksichtigung des freien Urin-Cortisols. Ph.D. Dissertation, Munich, 1976.

1671.
Siegel, P. V., S. J. Gerathewhol, and S. R. Mohler. Time Zone Effects. Science 164: 1249-1255, 1969.

1672.
Siffre, M. Convention de Recherche de la Deleagation Generale a la Recherche Scientifique et Technique. Washington NASA Transl. into English, 1970, pp. 1-346.

Two simultaneous experiments are described that give confirmation of the fact that human beings will spontaneously adopt a 48-hour sleep-wakefulness rhythm when placed under beyond-time conditions in a subterranean environment such as a cave. The time required for the onset of this rhythm varies with the individual, however; one subject achieved it in 15 days, while another did so only after three months. It was found that sleep requirements do not increase in proportion to the period of the cycle: on an average of 1/3 more sleep, it was possible to achieve more than twice the activity duration. Alertness was measured through various tests, including reaction time, grip strength, and dexterity, and these findings were correlated with various physiologic parameters - most importantly, polygraphic recordings of sleep. Results indicate that there is no decrease in alertness on a 48-hour rhythm.

1673.
Silverstone, T. Appetite and food intake. Life Sciences Research, Report #2. Abakon Verlagsgesellschaft, Berlin: Dahlem Konferenzen, 1976, p. 498.

1674.
Simenhoff, M. L. Influence of photic input on circadian rhythms in man. J. Appl. Physiol. 37: 374-377, 1974.

1675.
Simon, J. Biorhythms: pseudoscience or scientific frontier? New Orleans 12: 12, Aug., 1978.

1676.
Simon, P. A bioritmus hatasanak kiserieti vizgalata a teljesitmenyre es a balesefek alakulasara (An experimental analysis of the effect of biorhythm on performance and accidents). Ergonomia 11: 133-139,1978.

Based on two recently published studies, the author outlines the results of scientific investigations of biorhythm. These results do not support non-professional opinions on biorhythm effect, however further research work is needed to analyze the effect-mechanism of the theory and practice of biorhythm.

1677.
Simpson, H. W. Modifications of living schedules and circadian rhythms with special reference to performance. Gegenbaurs Morph. Jahrb. 117: 303-311, 1972.

1678
Simpson, H. W. The human circadian system and aerospace travel. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J. E. Pauly. Tokyo: Igaku Shoin, 1974, pp. 448-450.

1679.
Simpson, H. W. Human 21-h day studies in the high arctic, a review of analyses carried out on the 1960 Spitzbergen and 1969 Devon Island studies. Nova Acta Leopold. 46: 407-429, 1977.

1680.
Simpson, H. W., N. Bellamy, and F. Halberg. Double blind trial of a possible chronobiotic (quiadon); field studies in N. W. Greenland. Int. J. Chronobiol. 1: 287-311, 1973.

1681.
Simpson H., J. Bohlen. Latitude and the human circadian systerm. In: Biological Aspects of Circadian Rhythms, edited by J. N. Mills. London: Plenum Press, 1973, pp. 85-120.

1682.
Simpson, H. W., and F. Halberg. Phase modulation of desynchronized human circadian adrenocortical cycle on 21-hr day simulating circumglobal travel (45°longitude/day). In: Endocrinology, Proccedings of the Fourth Int'l. Congress of Endocrinolgy, edited by R. O. Scow. Amsterdam: Excerpta Medica, 1973, pp. 229-232.

1683.
Simpson, S., and Galbraith, J. J. Observations on the normal temperature of the monkey and its diurnal variation, and on the effect of changes in the daily routine on this variation. Trans. Soc. Edinb. 45: 65-104, 1905-06

1684.
Simpson, H. W., M. C. Lobban and F. Halberg. Arctic chronobiology. Urinary near-24-hour rhythms in subjects living on a 21-h routine in the Artic. Arct. Anthropol. 7: 144-164, 1970.

1685.
Sink, F. L. Periodic Variations in Human Performance. (M. S. Thesis) Naval Postgraduate School, Monterey, CA, 1974, 30 pp.

1686.
Sisk, C. L., and F. Stephan. Effects of limbic lesions on circadian drinking rhythms in the rat. Soc. Neurosci. Abstr. 5: 224, 1979.

1687.
Skol'nikov, B. I., V. M. Shakhnarovich, A. M. Goncharenko, and V. S. Rotenberg. Vlijanie Smennoj Rabotys Neuporjadocennym Rezimon Truda i Otdyvha na Nekotorye Objektivnye Pokazateli Sna. (Influence of shift work with irregular work-rest schedule on objective indices of sleep). Gig. Trud. Prof. Zabol. 7: 18-21, 1977.

Results of a questionnaire study in 2,000 postal workers on long-distance trains (journeys of several days), and EEG examinations in 15 of them. Ninety-eight per cent suffered from various sleep disturbances. In the course of several journeys, these workers no longer recovered their full working capacity after sleep from the third day on. Comparison of sleep indices in these workers during the night after a rest period, and controls, indicated poor adaptation to this type of shift work.

1688.
Slonim, A. D. Circadian rhythms in man in the U.S.S.R. and their peculiarities under conditions of industrial work. J. Interdiscipl. Cycle Res. 4: 83-88, 1973.

1689.
Smart, R. G. Drinking problems among employed, unemployed and shift workers. J. Occup. Med. 21: 731-736, 1979.

1690.
Smirnov, K. M. Metodiceskie Rekomendacii po Ucetu Bioritmov Celoveka v Organizacii i Ohrane Truda (Recommendations Concerning the Recording of Workers' Biological Rhythms for the purpose of work organization and occupational safety). Leningrad, USSR: Vsesojuznj Naucno-Issledovatel'skij Institut Ohrany Truda VCSPS, 1976, 32 pp.

1691.
Smith, H. F. Prediction and observation of sleep-waking cycles (Master's thesis). Knoxville: University of Tennessee, 1976, 44 pp.

1692.
Smith, H. F. Prediction and observation of sleep-wakeful-ness cycles and the morningness-eveningness phenomenon. (Ph. D. thesis). Knoxville: University of Tennessee, 1978, 98 pp.

1693.
Smith, P. A. Oral temperature rhythms in two groups of industrial shift workers. Studia Laboris et Salutis 11: 66-78, 1972.

1694.
Smith, P. A Study of the Circadian Rhythms of body Temperature, Alertness, Activity, and Sleep in Different Groups of Industrial Shift Workers. Unpubl. (Ph. D. Thesis). Heriot-Watt University, Edinburgh, 1977.

1695.
Smith, P. A study of weekly and rapidly rotating shift workers. Ergonomics 21: 847, 1978.

Daily sleep and oral body temperature data are presented for two groups of experienced rotating shift workers(two or three, and five successive night shifts. The data analysis shows for both rotas, a flattened temperature curve on night shift; 'sleep loss" on both morning and night shift; few breaks in sleep for either day or night sleeps, with no significant increase for day sleeps, a marked tendency for no day sleep to be taken prior to the first night shift, and shorter latency to sleep onset for day sleep. The night shift body temperature curves and diary sleep data are related to earlier studies. They are interpreted as reflecting partial - not chronic - sleep loss, and an ongoing normal circadian rhythmicity. No particular number of consecutive night shifts is recommended. Rather it is suggested that shift rota selection should be based on an assessment of how the rota will facilitate an acceptable balance between useful free time and sleep duration for individual work groups.

1696.
Smith, P. A study of weekly and rapidly rotating shiftworkers. Int. Arch. Occup. Environ. Health 43: 211-220, 1979.

1697.
Smith, P. Twenty-four-hour changes in psychological alertness in 3 shift workers (abstract). Chronobiologia 6: 158, 1979.

1698.
Smith, R. D., D. K. Tessman, B. J. Olszewski, and H. R. Kaplan. Circadian periodicity of heart rate rate in conscious rats: a background against which to evaluate drugs. Fed. Proc. 39: 977, 1980.

The direct continuous monitoring of pulsatic aortic blood pressure (AS)) and heart rate (HR) was carried out in conscious (chronically cannulated) normotensive and spontaneously hypertensive rats 24 hours a day for periods up to 28 days. On a 12 hour light/12 hour dark routine all groups of rats displayed distinctive periodic variations of HR with an amplitude which commonly exceeded 75 bpm. The highest values fo HR occurred during the dark period. ABP appeared to be higher during the dark period, however, it was not possible to characterize it periodicity without complex time series analysis. Subjecting rats to either 24 hr. dark or 24 hr. light significantly altered the normal pattern of HR variation. Following surgery and anesthesia (Tilazol, 20-40 mg/kg I. M.) the periodicity of HR was depressed for greater than 24 hrs. in both normotensive and hypertensive rats. Vasodilators, e. g. minoxidil and hydralizine administered to SHR produced marked acute increase in HR but did not change the cyclic nature of the variation. The present data suggest: (HR) of the rat displays a circadian periodicity, (2) this periodicity can be altered by change in the light/dark routine, (3) recovery from surgery-anesthesia was heralded by the return of the HR rhythms and, (4 the interpretation of vasodilator induced changes in HR in the conscious rat should be made against a background of normal circadian variation.

1699.
Smith, R. E. The Complete Book of Biorhythm Cycles. New York: Aardvark Publishing, 1976, 195 pp.

1700
Smolensky, M. H. Human biological rhythms and their pertinence to shift-work and occupational health (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen FR., 1980, p. I-6.

1701.
Smolensky, M. H., and A. Reinberg. Circatrigintan secondary rhythms related to hormonal changes in the menstrual cycle. In: Biorhythms and Human Reproduction, edited by M. Ferin, F. Halberg, R. M. Richart, and R. L. Vande Wiele. New York, London: John Wiley & Sons, 1974, pp. 241-258.

1702.
Snoyer, J., L. Cobb., and D. Hayes. Interactional aspects of the sleep-wake cycle of human couples in a time-free environment (abstract). Sleep Res. 6: 114, 1977.

1703.
Snyder, F., and J. Scott. The psychophysiology of sleep. In: Handbook of Psychophysiology, edited by N. S. Greenfield and R. A. Sternbach. New York: Holt, Rinehart & Winston, 1972, pp. 645-708.

1704.
Solakova, S. Trudove-Higienni Aspekti no Biologicnite Ritmi (Occupational health aspects of biological rhythms). Letopisi na Higienno-Epidemiologicnata Sluzba 10: 49-54, 1978.

The literature concerning the repercussions of biological rhythms on work capacity and resistance to harmful factors at the workplace, expecially shift work and night work, is reviewed. The physiological functions of the body are clearly subject to rhythmic changes. Further research into biological rhythms should improve prediction of occupational hazards.

1705.
Soliman, K. F., and C. A. Walker. Diurnal rhythm of ethanol metabolism in the rat. Experientia 35: 808-809, 1979.

1706.
Solov'yeva, V. P. and G. M. Gambashidze. Physiological peculiarities of the work of workers on nighttime shifts. In: Isslevodaniya po fiziologii trudovykh protsessov (Investigations of the Physiology of Work Processes). Moscow: Medgiz, 1962, pp. 147-155.

1707.
Sommer, B. The effect of menstruation on cognitive and perceptual motor behavior: a review. Psychosom. Med. 35: 515-534, 1973.

The increasing demand of women for a greater role in decision-making capacities and in professional areas raises persistent questions about the effect of menstrual cycle fluctuation on performance. A critical review of research on nonaffective correlates of the reproductive cycle is provided. The methodological problems inherent in such research, such research, such as phase definition, determination of hormonal state, response bias, and generality of results are discussed. Studies using response measures based on self report and social behaviors indicate a behavioral decrement associated with the premenstrual and menstrual phase. Studies utilizing objective performance measures generally fail to demonstrate menstrual cycle related changes. Socially-mediated expectations are suggested as a possible basis for these contradictory findings.

1708.
Sommer, H. C., and C. S. Harris. Combined effects of noise and vibration on mental performance as a function of time of day. Aerosp. Med. 43: 479-482, 1972.

1709.
Sonderfeld, A. T. Der Einfluss der Tageszeit der Reise auf die De- u. Resynchronization der Tagesrhythmik der Koerpertemp. nach Transatlantikfluegen (Influence of the journey's time of day on the de- and resynchronization of the 24-hours rhythm of body temperature after transatlantic flights). Bonn-Bad Godesberg: Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt. Institute fur Flugmedizin, DLR-FB-77-10, 1977, 47 pp. (transl. in Engl. by European Space Agency, ESA TT-420, 1978, 56 pp.)

The influence of a time-shift of six hours on the 24-hour rhythm of body temperature was investigated in a group of 8 students in Germany and the U. S. A. by measuring their rectal temperatures after transatlantic flights. The temperatures were taken continuously over the first 6 days and on days 8 and 13 after an East-West flight and after a West-East flight. In contrast to previous studies in which the West flight was day-flight, the East flight a night-flight, both flights in this case were day-flights. The time of resynchronization after the East-West flight ran up to seven days, the time after a flight in the opposite direction up to ten days. This result squares with the results gained from previous experiments on day and night flights insofar as an influence of the hour of the day, at which the flight is carried out, is not supposed.

1710.
Sothern, R. B. Low-frequency rhythms in the beard growth of a man. In: Chronobiology, edited by L. E. Scheving, F. Halberg and J. E. Pauly. Tokyo: Igaku Shoin, 1974, pp. 241-244.

Beard growth was measured in one man for 7 months along with oral temperature, pulse, respiration, grip strength, time estimation, blood pressure, eye-hand coordination, peak expiratory flow, mood and vigor ratings. Least squares periodicity analysis revealed a best fit at 16.5 days and secondary peaks at 18.0 and 24.5 days in all variables except temperature. A probable connection between beard growth and the 17-21 day male hormone cycle is suggested.

1711.,
Sothern, R. B., and F. Halberg. Timing of circadian core temperature rhythm in rats on 5 lighting schedules with different photofractions. Chronobiologia 6: 158-159, 1979.

1712.
Speck, L. B. Trends in current research. Conf. Military Requirements for Research on Continuous Operations (Human Engineering Labs.), Lubbock, TX., 1979, pp. 8-19.

1713.
Spencer, C. Employee attitudes to shift work. Pers. Pract. Bull. 26: 25-33, 1970.

1714.
Spencer, C. M. The Complete Biocycle Kit. PSI Rhythms, 1974.

1715.
Srinivasan, R., and V. Gopal. Modulation of the circadian variation of cloacal temperature rhythm in the fowl by altering the meal timing (abstract). Indian J. Physiol. Pharmacol. 22: 224, 1978.

1716.
Stary, D., Ispitivanje Povezanosti Radnih Smjena i Nezgoda pri Radu u Nekim Jugoslavenskim Poduzecima (Investigation into the relationship between work shifts and occcupational accidents in a number of Yugoslav undertakings). Sigurnost 15: 70-79, 1973.

A literature review on the relationship between work shifts (especially the night shift) and accidents is followed by the description of a survey carried out in ten Yugoslav undertakings. Accident frequency and severity indexes are tabulated and broken down according to the three shifts; they are also broken down into four two-hour shift periods for a factory and a coal mine. After analysing the data collected, the author concludes that the differences in accident frequency during various shifts may be due to differences in intensity of work, fatigue and disrupted circadian rhythm.

1717.
Steer, R. A. Moods and biorhythms of heroin addicts. Psychol. Rep. 43: 829-830, 1978.

1718.
Steinhoff, W. D. Tagesrhythmische Schwankungen von Kreislauf, Atmung und Gasstoffwechsel unter fliegerischer Belastung (Circadian rhythms of bold circulation, respiration and catabolism under stress in a flight simulator). Bonn-Bad Godesberg: Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt. Institut fur Flugmedizin, DLR-FB 72-49, 1972, 57 pp.

In order to determine the circadian rhythms of physiological standards under the stress of flying, the pulse rate, frequency of respiration, O_2 -inspiration and CO_2 -exspiration have been investigated in a flight simulator with 17 pilots of the GAF. The results showed an exact circadian rhythm with gradual ascent of the physiological activity during the morning hours until a maximum during the early morning. The nightly trough in performance, which another time is proven by our results, should be considered seriously in flight schedules of military and civilian aviation.

1719.
Steinmetz, K. H. Die Biorhythmen und ihr Einfluss auf die sportliche Leistung. (Biorhythms and their influence on sport performance). Leistungssport 3: 217-224, 1972.

1720.
Stepanova, S. I. Human adaptation to some types of day-nite cycle in space. Int. Cong. Aviat. Space Med., 21st, Munich, 1973, preprints p. 80.

1721.
Stepanova, S. I. Role of social synchronizers in adaptation to unusual daily schedules. Kosm. Biol. Med. 7(1): 65-72, 1973.

The use on space missions of work and rest schedules with significant time shifts which are close to inverted makes it necessary to study the possibility of inverting the diurnal cycles of physiological functions of man exposed to social and physical isolation. There is reason to believe that the absence of traditional synchronizers as such cannot be an obstacle to inversion of diurnal cycles which can be attained using existing social factors and primarily with strict adherence to a predetermined work and rest cycle. During space flight restructuring of diurnal cycles is difficult due to a number of factors. Inversion of the in-flight work and rest cycle is undoubtedly a negative phenomenon. It should be avoided, and if necessary, the diurnal cycles of cosmonauts should be restructed prior to flight in accordance with the expected "spaceday."

1722.
Stepanova, S. I. Study of the possibility of human adaptation to a 16-hour day. Kosm. Biol. Med. 7(3): 68-75, 1973.

The possibility of adapting to a 16-hour work-sleep cycle (11 hours of wakefulness and five hours of sleep) was investigated in seven test subjects (two males and five females). The experiment lasted 16 astronomical days. The result gave evidence that the body temperature did not change under the influence of a new daily schedule and remained related to the real time of day. The experimental findings also indicated that if the test subjects went to sleep after the normal time their sleep was longer and quieter, the body temperature being altered. These facts are discussed from the point of view of the difficulties involved in adaptation to the time shifts accompanying west-to-east and east-to-west flights.

1723.
Stepanova, S. I. Effect of transmeridional flights on the human body. Kosm. Biol. Aviakosm. Med. 8(1): 3-12, 1974.

The pertinent literature is reviewed. The functions which have exhibited desynchronosis after transmeridional flights are described. The relationship between the time of synchronization of circadian rhythms in the body and local time and the level of the time change, individual factors, geeographical direction of the flight (to the west or east) and the "outgoing" and "return" flight is discussed. Recommendations on how to reduce the negative effect of transmeridional flights on flight personnel, athletes and businessmen are presented.

1724.
Stepanova, S. I. Biorhythmic selection of cosmonauts. Kosm. Biol. Aviakosm. Med. 9(11): 40-46, 1975.

1725.
Stepanova, S. I. Dynamics of some temperature rhythm phases during its inversion. Kosm. Biol. Aviakosm. Med. 9(1): 70-79, 1975.

The process of inversion of the diurnal rhythm of body temperature was studied in two test subjects during an alternating work-rest regime. The temperature changes during individual phases were investigated. With respect to certain phases it is concluded that that the rate of restructuring was dependent on the relationship between these phases and the level of the physical and mental activity of the body. Inversion of the temperature rhythm induced changes in those phases of the temperature curve in which the temperature should not have changed due to an altered work-rest cycle. In evaluating the completeness of the restructuring of the diurnal rhythm of body temperature brought about by an altered work-rest regime, it is important to pay particular attention to body temperature in the minimum phase and in the adjacent phases because in these phases the rate of restructuring of the temperature rhythm can be the lowest.

1726.
Stepanova, S. I. Use of elongated and shortened days in space flights. Kosm. Biol. Aviakosm. Med. 9(3): 37-48, 1975.

1727.
Stepanova, S. I. An attempt to "imbalance" diurnal periodices of potassium excretion with urine. Kosm. Biol. Aviakosm. Med. 10(1): 76-86, 1976.

1728.
Stepanova, S. I. Problemy Kosmicheskoi Biologii: Actual'nye Problemy Kosmicheskoi Bioritmologii (Problems of Space Biology: Current Problems in Space Biorhythmology). Moscow: Izdatel'stvo Nauka, 1977, 311 pp.

This book covers current topics in space biological rhythms with regard to the prevention of desynchronization in space crew. A comparison is drawn between desynchronosis in shift workers and circadian changes in transmeridional flights. As a result of desynchronosis, various diseases (gastric and neurological) appear. Desynchronosis is one of the early signs of disease and, having appeared as a result of disruption of the customary schedule of the day, it could itself become the cause of different diseases. The author develops the concept of information-energy cost of the daily cycle, which refers to the fact that the amount of information received by man and energy expended is a constant. With increase in duration of the daily cycle, the information-energy cost per hour should decrease. Also developed is the concept of rhythmic stereotype which defines the rhythmic stability, with deviations of 1-2 hours. The author demonstrates that a wisely planned work and rest schedule is the principal means of preventing desynchroncsis. She defines three rhythmic types: labile, inert and intermediate as a basis for biorhythmological screening of cosmonauts. Data are reviewed concerning human adaptability to phase shifts in sleep-wake cycle and to days of extended length.

1729.
Stepanova, S. I. Stability of circadian system of the body. Kosm. Biol. Aviakosm. Med. 12(6): 28-34, 1978.

1730.
Stepanova, S. I., and S.P. Kukishev. Reorganization of human temperature periodicity following life rhythm inversion in isolation. Kosm. Biol. Aviakosm. Med. 9(5): 35-44, 1975.

The diurnal dynamics of body temperature of four male test subjects was studied before and after inversion of their sleep-wakefulness cycle in the anechoic chamber. One test subject showed rearrangement of the temperature rhythm in accordance with the new cycle which was completed by the 11th day of confined life. The other test subjects displayed only a partial adaptation of body temperature to the new sleep-wakefulness cycle during the experiment.

1731.
Stephan, F. K., and N. S. Kovacevic. Multiple retention deficit in passive avoidance in rats is eliminated by suprachiasmatic lesions. Behav. Biol. 22: 456-462, 1978.

1732.
Stephan, F. K., and A. A. Nunez. Developmental plasticity in retinohypothalamic connections and the entrainment of circadian rhythm. Behav. Biol. 22: 77-84, 1978.

1733.
Stephan, F. K., Swann, J. M., and Sisk, C. L. Anticipation of 24-hr feeding schedules in rats with lesions of the suprachiasmatic nucleus. Behav. Neural. Biol. 25: 545-554, 1979.

1734
Stephan, F. K., Swann, J. M., and C. L. Sisk. Entrainment of circadian rhythms by feeding schedules in rats with suprachiasmatic lesions. Behav. Neural. Biol. 25: 545-554, 1979.

Rats with lesions of the suprachiasmatic nucleus (SCN) and controls were maintained in constant light and exposed to a restricted feeding schedule at 23 and 24-hr intervals, as well as to a 12 hr phase shift in the feeding schedule. Despite the absence of circadian preiodicity in activity or drinking in ad lib. conditions, rats with SCN lesions showed anticipatory wheel running to both feeding schedules, comparable to sham-operated rats. Following the 12 hr phase shift, transients qualitatively similar to those seen following phase shifts in the light-dark cycle were observed. During a 3-day period of total food deprivation following prolonged entrainment to a 24-hr feeding schedule, wheel running persisted with a near 24-hr periodicity while return to ad lib. conditions resulted in a rapid desynchronization of activity. These results indicate that anticipatory wheel running in rats with SCN lesions is based on endogenous circadian oscillators which are entrainable by feeding schedules in the circadian range. Apparently, such oscillators free run under certain conditions (food deprivation) but become rapidly desynchronized in others (ad lib. feeding). The evidence strongly supports a multioscillator model of the circadian system in mammals.

1735.
Stephens, G. J. Periodicity in mood, affect, and instinctual behavior. The Nursing Clinics of North America 11: 595-607, 1976.

1736.
Stetson, M. H., and M. Watson-Whitmyer. Nucleus suprachiasmaticus: the biological clock of the hamster? Science 191: 197-199, 1976.

1737.
Stevenson, N. R., F. Ferrigni, K. Parnicky, S. Day, and J. S. Fierstein. Effect of changes in feeding schedule on the diurnal rhythms and daily levels of intestinal brush border enzymes and transport systems. Biochim. Biophys. Acta 406:131-145, 1975.

1738.
Steves, M. Biorhythmische Verkehrunfallverhutung (Biorhythmic traffic accident prevention). Deutsche Polizei 4: 116, 1965.

1739.
Stolze, H. J. Die tageszeitabhangigen Schwankungen fliegerischer Leistungskriterien im Flugsimulator (The daily time dependence of oscillations of pilots' performance criteria in a flight simulator). Detsche Forschungs und Versuchsanstalt fur Luft und Raumfahrt Report No. DLR FB 71-14, 65 pp., 1971.

In order to investigate variations in pilots performance, possibly existing in dependency on time of day, 18 pilots had to perform a standardized instrument flight in a simulator. Their deviations from the preset flight task were measured and their responses to flight incidents were evaluated. The results showed an almost constantly high performance plateau during the late afternoon and a trough during the night hours between 3 and 6 a. m. The range of oscillation in performance parameters amounting to 28.1% of the 24 hour mean, was considerably larger than that of reaction time with 8.1%, which was measured at the same time for reasons of comparison. From the results it can be concluded that, considering the nightly trough in performance, pilots on night flight duty may be subjected to a substantial stress. It is suggested that a possible safety risk can be reduced by a sufficiently long rest period prior to the night flight duty and by limiting the duration of the night work shift.

1740.
Stone, B. M., and A. N. Nicholson. Studies on the use of hypnotics for day-time and night-time sleep. Aerospace Med. Assoc., Preprints, 1976, pp. 147-148.

Previous studies (Nicholson & Stone, 1976) showed that temazepam was an effective drug for night-time sleep, but the present studies have shown that the effectiveness of temazepam is much less than that of diazepam for day-time sleep. Diazepam has limited effects as an hypnotic at night, but it is much more effective for sleep during the day. It shortens sleep onset latency, and maintains sleep during the latter half of a 6 h day-time rest period. This is seen with 10 & 15 mg doses. Unfortunately the 15 mg dose of diazepam leads to impaired performance for at least 14 h after ingestion (Borland, Nicholson & Wright, 1976) and so it would appear that 10 mg diazepam may prove to be the useful dose for sleep during the day. It is evident that studies on the effect of hypnotics on night-time sleep do not indicate their usefulness for sleep during the day. This is particularly important for aircrew because of their unusual sleep patterns, and the need in long haul operations to sleep at times of the day when the circadian rhythm of sleepiness does not coincide with the time available for rest. Currently used hypnotics may not be appropriate for sleep at unusual times, and the relative effects of hypnotics may vary according to the circadian rhythm of the subject.

1741.
Stones, M. J. Memory performance after arousal from different sleep stages. Br. J. Psychol. 68: 177-181, 1977.

Learning material was presented to independent groups of subjects either after arousal from non-Rapid Eye Movement (non-REM) sleep, after arousal from REM sleep, or under conditions of no prior sleep. Measures of immediate and subsequent free recall were taken.

Memory performance was found to be impaired where learning took place after non-REM arousal. This was manifest in the number of categories recalled, over both immediate and subsequent recall, and in the number of items recalled per category over subsequent recall. It was suggested that the memory performance decrement after non-REM arousal may be understood in terms of a retrieval deficit as well as a coding deficit. It is possible that the former is consquent upon a lower general level of arousal, whereas the latter is specific to memory.

1742.
Storm, W. F. Interaction of biorhythms with Air Force operational requirements. USAF School of Aerospace Medicine, March, 1971.

1743.
Storm, W. F., et al. Aircrew fatigue in nonstop, transoceanic tactical deployments. In: Studies on Pilot Workload, Neuilly-sur-Seine: Nato, Advisory Group for Aerospace Research and Development, AGARD-CP-217, 1977, 7 pp.

The central issue addressed by this study was operational effectiveness following long-range deployment. Stress and fatigue were evaluated in F-4D crews before and after flying nonstop, transoceanic deployments from New Mexico to Germany and return. The measurement battery consisted of subjective fatigue ratings, self ratings of fitness to fly, sleep logs, and biochemical analyses of urine samples for norepinephrine, epinephrine, 17-hydroxycorticosteroids, urea, sodium, and potassium. The magnitude and the consistency of behavioral and physiological changes indicated the occurrence of mild fatigue immediately after both flights. The fatigue was acute and was ameliorated by one uninterrupted sleep period.

1744.
Storm, W. F., and C. L. Giannetta. Effects of hypercapnia and bedrest on psychomotor performance. Aerosp. Med. 45: 431-433, 1974.

Two weeks of continuous exposure to simulated weightlessness (bedrest) and/or an elevated (30 torr) CO_2 environment had no detrimental effect on complex tracking performance, eye-hand coordination, or problem-solving ability. These results were consistent with previously reported behavioral findings which investigated these two factors only as independent stressors.

1745.
Storm, W. F., and S. F. Gray. Minuteman missile crew fatigue and 24-hour alerts. TLSP: Final Report, May 1977 - Feb. 1978. Brooks AFB, Tex.: School of Aerospace Medicine, Rpt. # SAM-TR-78-19, 1978, 15 pp.

A battery of psychobiological measures was used to evaluate the degree of fatigue experienced by missile crews performing 24-hour continuous duty alert tours at Minuteman launch control centers. Operationally significant findings relative to the duty schedule occurred for subjective fatigue scores, hours slept per day, and urinary outputs of 17-OHCS, sodium, and potassium. The moderate postalert fatigue and physiologic cost present at the end of the 24-hour alerts were ameliorated by one night of undisturbed sleep. Values indicative of severe crew fatigue or stress were never attained for any of the measures. A buildup of cumulative fatigue over several alerts could be avoided by scheduling a minimum of two consecutive nights sleep at home between alerts. The impact of the duty schedule on contingency and emergency situations was also considered.

1746.
Storm, W. F., Storm, W. F., B. O. Hartman, G. P. Intano, and G. L. Peters. Encocrine-metabolic effects in short-duration, high-workload missions: feasibility study. Brooks Air Force Base, Tex.: USAF School of Aerospace Medicine, 1976, Report SAM-TR-76-30, 9 pp.

A study was conducted at the USAF Instrument Flight Center to test an augment assembly of measures for assessing the relative merits of various flight instrumentation systems. The USAF School of Aerospace Medicine (SAM) stress battery was included. Although the study was not designed so as to permit an optimized evaluation of the SAM stress battery, the following results were noted: anticipatory stress, mild flight stress, and no habituation across missions. The SAM battery appears to be a useful addition to the flight instrumentation research program.

1747.
Storm, W. F., B. O. Hartman, and D. L. Makalous. Aircrew fatigue in nonstop, transoceanic tactical deployments. In: AGARD Studies on Pilot Workload, Brooks AFB, TX: School of Aerospace Medicine, 1977, 7 pp.

Stress and fatigue were evaluated in F-4D crews before and after flying nonstop, transoceanic deployments from New Mexico to Germany and return. The measurement battery consisted of subjective fatigue ratings, selfratings of fitness to fly, sleep logs, and biochemical analyses of urine samples for norepinephrine, epinephrine, 17-hydroxy corticosteroids, urea, sodium, and potassium. The magnitude and the consistency of behavioral and physiological changes indicated the occurrence of mild fatigue immediately after both flights. The fatigue was acute and was ameliorated by an uninterrupted sleep period.

1748.
Storm, W. F., P. H. Henry, J. F. Sanford, and J. C. Noah. Effects of low humidity on human performance. Brooks AFB, Tex.: School of Aerospace Medicine, RP # SAM-TR-73-3, 1973, 18 pp.

Human volunteers were trained to high levels of proficiency on three tasks involving various degrees of psychomotor and cognitive skills. Environments of 0.4-mm. water vapor pressure and/or simulated 8.000-ft barometric pressure had no adverse effects on performance during four 36-hour chamber exposures. Systematic day-night variations were found for Multidimensional Pursuit tracking skill and self-ratings of subjective fatigue.

1749.
Storm, W. F., R. C. McNee, R. A. Albanese, and B. O. Hartman. The effects of two stressors on traditional and engineering analogues of cognitive functioning. In: Higher Mental Functioning in Operational Environments, edited by B. O. Hartman. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-181, 1976, pp. C11-1 - C11-12.

The sensitivities to stress of traditional psychometric measures and human operator technology HOT) engineering parameters were compared in two experiments. In the first study, the effects of mild (8,000 ft) and moderate (15,000 ft) hypoxia were assessed. In the second study, standby "alert" duty was simulated. Systematic comparison was made between performance following sudden awakening and performance follwing enforced wakefulness. A battery of tasks emphasizing cognitive processes generated traditional performance measures. Psychomotor functions involving vigilance, problem solving, short-term memory, and compensatory tracking were exercised. In addition, a two-dimensional tracking (NOT) task were systematically varied and models developed for each condition. Both the traditional task measures and the NOT model parameters were analysed for changes suggestive of alterations in cognitive functioning. The data suggest significent influences of both stressors on cognitive functioning. Conventional performance measures from the NOT task were more sensitive to the stress affects than the traditional task battery. Preliminary parameter values from human operator modeling did not reflect stress effects.

1750.
Stroh, C. M. The influence of personality and age on the relationship between vigilance performance and arousal level. In: Vigilance: Theory, Operational Performance, and Physiological Correlates, edited by R. R. Mackie. New York: Plenum Press, 1977, pp. 617-622.

Twenty-four male volunteer subjects took part in a 1-hour visual vigilance task in which they were required to detect flashes of unusual intensity in a regular series of flashes. EEG alpha

incidence, log skin conductance, and pulse rate, recorded in the 10-second period prior to each of the 18 signal presentations, did not distinguish between signals missed and signals detected. Analysis of individual differences in EEG change revealed significant differences due to neuroticism and age. Older, less neurotic subjects improve their performance when their arousal level is raised; younger, more neurotic individuals evidence a performance decrement when arousal level is increased. Our hypothesis concerning the effects of neuroticism and/or extraversion on the vigilance-arousal relationship was supported.

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Strughold, H. The physiological clock in aeronautics and astronautics. Ann. N. Y. Acad. Sci. 134: 413-422, 1963.

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Strughold, H. Rhythmostasis - a fundamental life characteristic aerospace medical aspect. Riv. Med. Aeronaut Spaz. 34: 168-175, 1971.

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Strughold, H. Cycloecology in space on the moon and beyond. In: Chronobiology, edited BY L. E. Scheving, F. Halberg, and J. E. Pauly. Tokyo: Igaku Shoin, 1974, pp. 417-423.

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Strughold H., and H. B. Hale. Biological and physiological rhythms. In: Foundations of Space Biology and Medicine, edited by M. Calvin and O. G. Gazenko. Washington, D. C.: NASA, 1975, Vol. II, Book 2, Chapt. 13, pp. 535-548.

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Strumpf, I. J., M. S. Simmons, J. W. Sayre, and D. P. Tashkin. Biorhythm theory and asthma. Ann. Allergy 41: 330-332, 1978.

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Stupfel, M. Computer-prepared displays of feeding-time and lighting effects upon circadian rhythms in CO_2 emission by rats. Int. J. Chronobiol. 1: 203-221, 1973.

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Stupfel, M. Biorhythms in toxicology and pharmacology. I. Generalities, ultradian and circadian biorhythms. Biomedicine 22: 18-24, 1975.

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Stupfel, M. M., E. Halberg, and F. Halberg. L'acces alimentaire periodique des rats groupes surmonte l'alternance lumiere-obscurite comme synchroniseur du rythme circadien d'emission de gaz carbonique. C. R. Acad. Sci. Paris 277: 873-875, 1973.

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Stupfel, M., J. P. Montet, F. Romary, and M. Magnier. Circadian and infradian variations of mortality of mice exposed to hypoxia. XI Internat. Conf. of the Internat. Soc. of Chronobiol., Hannover, 26-29 July, 1973.

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Stupfel, M., A. J. Valleron, M. Demeestere, and H. Masse. Hypoxia survival variations in male and female mice as functions of chronological and environmental factors. Aviat. Space Environ. Med. 49: 1086-1092, 1978.

1761.
Stupnitskii, B. P., V. V. Pozdniakov, V. N. Trofimov, R. B. Bogdeshevskii, and O. N. Kuznetsov. Operatorskaia deiakl'nost' v usloviiakh nepreryvnogo bodrstvovaniia (Operator activity in a state of continuous wakefulness). In: Characteristics of Cosmonaut Activities During Flight. Moscow: Izdatel'stvo Mashinostroenie, 1976, pp. 121-127.

Astronauts in space flight may encounter situations where they would be forced to perform control and monitoring operations for prolonged periods of wakefulness. The paper describes an experiment performed in an isolation chamber to evaluate the effects of prolonged wakefulness - up to 74 hours - on the performance of operators in reading and processing information from various sensors. A block diagram of a setup for monitoring the sensorimotor functions of operators during prolonged wakefulness is presented and curves indicating operator performance with progressing wakefulness are given.

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Sturtevant, R. P. Timing of a single daily meal, but not of ethanol, may phase-shift body temperature rhythm of rats. Anat. Rec. 193: 697, 1979.

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Suggs, T. Behind the Scenes. Biorhythm. York, Pa: Strength and Health Publishing Co., 1967.

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Sukharebskiy, L. Biorhythms and mental ability to concentrate and organize. Library of Congress Science and Technology (S & T) Alert, Item No. 4490, 13 March 1978.

The author emphasized the importance of organizing personal work/rest patterns in order to avoid mental fatigue and increase concentration. He recommended performing most demanding work in the morning, with interruptions every 40-45 minutes for brief physical exercise and 10-15 minute relaxation every 2 hours.

1765.
Sulzman, F. M., C. A. Fuller, L. G. Hiles, and M. C. Moore Ede. Circadian rhythm dissociation in an environment with conflicting temporal information. Am. J. Physiol. 235: R175-R180, 1978.

The relative contributions of light-dark(LD) cycles and feeding (EF) cycles in providing temporal information to the circadian time-keeping system were examined in chair-acclimatized squirrel monkeys (Saimiri sciureus). The circadian rhythms of drinking, colonic temperature, urine volume, and urinary potassium excretion were measured with the LD and EF cycles providing either conflicting phases or periods. In conflicting phase experiments, animals were exposed to 24-h LD cycles providing either conflicting phases or periods. In conflicting phase experiments, animals were exposed to 24-h LD cycles consisting of 12 h of 600 lx followed by 12 h of < 1 lx and concurrent 24-h EF cycles in which the animals ate for 3 h and then fasted for 21 h. One group had food available at the beginning and a second group at the end of the light period. In conflicting period experiments, monkeys were exposed to 23-h LD cycles (LD 11.5:11.5) and 24-h EF cycles (EF 3:21). Analysis of the rhythms showed that both phase and period information were conveyed to the drinking and urinary rhythms by the EF cycle, and to the temperature rhythm by the LD cycle.

1766.
Sulzman, F. M., C. A. Fuller, M. McLaughlin, and M.C. Moore-Ede. Synchronization of primate circadian rhythms by food timing (abstract). Fed. Proc. 36: 423, 1977.

1767.
Sulzman, F. M., C. A. Fuller, and M.C. Moore-Ede. Influence of light intensity on squirrel monkey circadian rhythms (abstract). Fed. Proc. 38: 832, 1978.

1768.
Sulzman, F. M., C. A. Fuller, and M. C. Moore-Ede. Environmental synchronizers of squirrel monkey circadian rhythms. J. Appl. Physiol.: Respirat. Environ. Exercise Physiol. 43: 795-800, 1977.

Various temporal signals in the environment were tested to determine if they could synchronize the circadian timing system of the squirrel monkey (Saimiri sciureus). The influence of cycles of light and dark, eating and fasting, water availability and deprivation, warm and cool temperature, sound and quiet, and social interaction and isolation was examined on the drinking and activity rhythms of unrestrained monkeys. In the absence of other time cues, 24-h cycles of each of these potential synchronizers were applied for up to 3 wk, and the periods of the monkey's circadian rhythms were examined. Only light-dark cycles and cycles of food availability were shown to be entraining agents, since they were effective in determining the period and phase of the rhythmic variables. In the presence of each of the other environmental cycles, the monkey's circadian rhythms exhibited free-running periods which were significantly different from 24 h with all possible phase relationships between the rhythms and the environmental cycles being examined.

1769.
Sulzman, F. M., C. A. Fuller, and M. C. Moore Ede. Feeding time synchronizes primate circadian rhythms. Physiol. Behav. 18: 775-779, 1977.

Circadian rhythms of squirrel monkeys maintained in constant light and temperature can be entrained by 24 hr cycles of food availability with eating for 3 hr. and fasting for 21 hr (EF 3:21). Rhythms of drinking, body temperature and urinary potassium and water excretion exhibited periods which matched the 24 hr period of the EF 3:21 cycle. These results suggest that temporal patterns of food intake are capable of synchronizing the circadian tiemkeeping system which underlies the observed rhythms.

1770.
Sulzman, F. M., C. A. Fuller, and M. C. Moore Ede. Spontaneous internal desynchronization of circadian rhythms in the squirrel monkey. Comp. Biochem. Physiol. 58A: 63-67, 1977.

The circadian rhythms of feeding, colonic temperature, and urinary potassium and water excretion persisted with free-running periods in chair-acclimatized squirrel monkeys (Saimiri sciureus) maintained in isolation in constant bright light. Spontaneous internal desynchronization, i.e. separate rhythmic variables oscillating with different periods, was shown to occur between the rhythms of feeding and colonic temperature (25 hr) and the urinary rhythms (21 hr). This evidence indicates that the circadian timing system in squirrel monkeys is composed of multiple potentially-independent oscillators.

1771.
Sulzman, G. M., C. A. Fuller, and M. C. Moore-Ede. Comparison of synchronization of primate circadian rhythms by light and food. Am. J. Physiol. 234: R130-R135, 1978.

Several circadian rhythms in squirrel monkeys (Saimiri sciureus) entrained by two different agents were studied to compare their mode of coupling with the environmental Zeitgebers. Synchronization was accomplished either by light-dark cycles consisting of 12 h of 600 lx followed by 12 h of <1 lx (LD 12:12), or by eat-fast cycles in which the animals could eat for 3 h and then had to fast for the remaining 21 h each day (EF 3:21). The rhythms of drinking, colonic temperature, and urinary potassium and water excreetion were measured in chair-acclimatized monkeys. The drinking and urinary rhythms were more reproducible (smaller mean variance) and more stable (smaller standard deviation of the timing of a phase reference point) in EF than in LD cycles, whereas the temperature rhythm was more tightly controlled by LD cycles than by EF cycles within one day, while the temperature rhythm required about 6 days to resynchronize. In contrast, previously published data for a similar phase delay in the LD cycle with food available ad libitum show that the drinking and temperature rhythms resynchronized more rapidly than the urinary rhythms. These results indicate that separate mechanisms are involved in transducing temporal cues from LD and EF cycles in the circadian timekeeping system of these nonhuman primates.

1772.
Sulzman, F. M., C. A. Fuller, and M. C. Moore Ede. Extent of circadian synchronization by cortisol in the squirrel monkey. Comp. Biochem. Physiol. 59A: 279-283, 1978.

1. The circadian timing system in primates consists of an organization of multiple oscillators in various tissues internally synchronized through hormonal and neural coupling. To test the scope of the circadian rhythm of plasma cortisol concentration as a synchronizing mediator, adrenalectomized, chair-acclimatized squirrel monkeys (Saimiri Sciureus) were studied.

2. With each monkey isolated in constant light (600 lx), a pulse of 10 mg cortisol was administered via a chronically implanted venous catheter at 08:00 hr daily.

3. The circadian rhythm of renal potassium excretion was entrained to a 24 hr period by the cortisol rhythm, but the circadian rhythms in feeding and body temperature were not synchronized by cortisol.

4. These findings confirm that the plasma cortisol rhythm acts as an internal synchronizer of renal potassium excretion, but demonstrate that it plays no role as a general hormonal coupler of circadian oscillators.

5. The oscillators which compose the circadian timing system would appear to be arranged in a hierarchical organization so that the feedback action of cortisol on the pituitary-adrenal axis does not synchronize the entire circadian system.

1773.
Sulzman, F. M., C. A. Fuller, and M. C. Moore-Ede. One second light pulses entrain circadian rhythms in a diurnal primate. Fed. Proc. 33: 1318, 1979.

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Sulzman, F. M., C. A. Fuller, and M. C. Moore-Ede. Phasic effects of light on a diurnal primate (abstract). Chronobiologia 6: 161, 1979.

1775.
Sulzman, F. M., C. A. Fuller, and Moore-Ede, M. C. Tonic effects of light on the circadian system of the squirrel monkey. J. Comp. Physiol. 129: 43-50, 1979.

1776.
Sulzman, F. M., W. Schmelzer, C. A. Fuller, J. C. Zimmerman, and M. C. Moore-Ede. Specificity of cortisol as an internal synchronizer of circadian rhythms in the squirrel monkey (abstract). Fed. Proc. 35: 694, 1976.

The tonic effects of constant light were examined on the organization of the circadian time-keeping system of squirrel monkeys. The rhythms of feeding, colonic temperature and urinary potassium excretion were measured in chair-restrained animals maintained in 1 lux, 60 lux or 600 lux in isolation chambers at constant temperature with food available ad lib. When compared to previous results from monkeys synchronized by light-dark cycles, there was a reduction in the ranges (R) of all 3 rhythms in constant light. As the intensity of light increased, the computed ratio increased for the feeding and temperature rhythms but not for the renal potassium rhythm. The average free-running period (t) for all three rhythms was approximately 25 h, and long term experiments with unrestrained monkeys showed a small lengthening of t with brighter light. There was a much broader distribution of t for the urinary potassium rhythm than for the feeding and temperature rhythms. Spontaneous internal desynchronization between the potassium rhythm and the feeding and temperature rhythms occurred in approximately one-quarter of the experiments, with the light intensity having no influence on the incidence of desynchronization.

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Swade, R. H., and C. S. Pittendrigh. Circadian locomotor rhythms of rodents in the Arctic. Am. Nat. 101: 431-463, 1967.

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Swann, J. M., and F. K. Stephan. Anticipation of 24 hour feeding schedules in rats with lesions of the suprachiasmatic nuclei and hypophysectomy. Soc. Neurosci. Abstr. 5: 225, 1979.

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Swensson, A. Spezielle gesundheitliche Gefahrdung von Nacht- und Schichtarbeit, einschliesslich deren Vorbeugung. In: Aktuelle Probleme der Arbeitsumwelt, edited by J. Rutenfranz and R. Singer, Vol. 38. Stuttgart: A. W. Gente Verlag, 1971, pp. 45-60.

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Swensson, A., editor. Proceedings of the second international symposium on night and shift work, Slanchev Bryag, 1971 (Studia laboris et salutis no. 11). Stockholm: National Institute of Occupational Health, 1972.

1781.
Swoboda, H. Die Perioden des menschlichen Lebens in ihrer psychologischen und biologischen Bedeutung (The periodicity of human life in its psychological and biological meaning). Leipzig: Franz Deuticke, 1904.

1782.
Swoboda, H. Studien zur Grundlegung der Psychologie (Studies on the fundamentals of psychology). Leipzig: Franz Deuticke, 1905.

1783.
Swoboda, H. Die kritische Tage des Menschen und ihrer Berechnung mit dem Periodenschieber) The critical days of humans and their calculation with the period slide rule). Leipzeig: Franz Deuticke, 1909.

The author describes the design of a slide rule to make it simple to find biorhythm cycle critical days.

1784.
Swoboda, H. Das Siebenjahr (The year of seven). Vienna: Orion-Verlag, 1917, 579 pp.

With documentation covering hundreds of family trees, he endeavored to prove that most major events in life fall on biorhythmic periodic days and involve family relationships.

1785.
Swoboda, H. Die Bedeutung des Siebenjahr Rhythmus fur die menschliche Vererbung (The significance of the seven year rhythm for human heredity). Florence: Industria Tipografica Fiorentina, 1954.

1786.
Symonds, C. P., and D. J. Williams. Clinical and statistical study of neurosis precipitated by flying duties. In: Aircrew Stress in Wartime Operations, edited by E. J. Dearnaley and P. B. Warr. London: Academic Press, 1979, chapt. 2, pp. 9-41.

1787.
Szafarczyk, A., J. Nouguier-Soule, I. Assenmacher. Diurnal locomotor and plasma corticosterone rhythms in rats living on photoperiodically lengthened "days". Int. J. Chronobiol. 2: 373-382, 1974.

1788.
Szafarczyk, A., J. Nouguier-Soule, and I. Assenmacher. Responses of the diurnal locomotor and adrenocortical rhythms in rats exposed to a weekly 8-h phase shift of the Zeitgeber. In: Environmental Endocrinology, edited by J. Assenmacher and D. S. Farner. New York: Springer-Verlag, 1978, pp. 200-201.

1789.
Szafarczyk, A., J. Nouguier-Soule, and I. Assenmacher. Effects of repetitive weekly shifts of the photoperiodic 'Zeitgeber' on the diurnal rhythms of locomotor activity and of plasma corticosterone in the rat. Ergonomics 21: 867, 1979.

Female rats which had been adapted in bunkers to a lighting regimen of 8L-16D (L:0800 - 1600h.50 lux), were then expoosed for 9 weeks, every seventh day, to a single phase-shift of 8 h (-120°) of the Zeitgeber. Locomotor activity was recorded continuously from actographic cages. The estimation of the day-to day shift of the acrophase by Halberg's Noise/Signal method showed that 4 to 7 days

were typically required for a resynchronisation of the locomotor rhythm to the zeitgeber. However, a joint matrix analysis (Statis method) revealed that resynchronisation occurred significantly earlier every third week, i. e. when the phase of the synchroniser returned to its original timing (L:0800-1600h). From measurements of plasma corticosterone taken between days 2 and 4 of the fifth week of the experiment, it would appear that the pattern of resynchronisation of the rhythm in this variable was similar to that of the locomotor rhythm.

1790.
Takagi, K. Influence of shift work on time and frequency of meal taking. J. Hum. Ergol. 1: 195-205, 1972.

Effect of shift work on time and frequency of meals of workers at an iron works, a chemical factory, and five textile factories were investigated, and the results were compared with two-meal habits in former times. A meal was defined as an occasion when two or more kinds of food were taken. Meal time proved to be affected by an evening or night shift, resulting in a decrease of meal frequency among up to nearly half the workers. Many tended to omit either breakfast or a midday meal, but to take the evening meal at regular hours. Few shift workers increased meal frequency. Female double-day shifters generally had three meals a day, though the midday meal had to be delayed by the morning shift. Bibliographical studies on meal habits in the early modern period in Japan demonstrate that a change from two to three meals a day was accomplished in the 18th century by adding a third meal following the late afternoon meal, the latter then becoming the chief meal at midday. Modern industrial work has helped establish the three-meal habit in accordance with the lengthening of activity time toward the night hours, the chief meal being taken in the evening. It remains doubtful, therefore, whether the two meals of modern shift workers supply enough nutrients.

1791.
Takahashi, K., K. Hanada, and Y. Takahashi. Factors entraining circadian rhythms in mammals: factors setting the phase of the circadian adrenocortical rhythm in rats. In: Biological Rhythms and Their Central Mechanism, edited by M. Suda, O. Hayaishi, and H. Nakagawa. New York: Elsevier/North-Holland Biomedical Press, 1979, pp. 189-198.

1792.
Takahashi, K., K. Inoue, K. Kobayashi, C. Hayafuji, Y. Nakamura, and Y. Takahashi. Effects of food restriction on circadian adrenocortical rhythm in rats under constant lighting conditions. Neuroendocrinol. 23: 193-199, 1977.

Influences of food restriction on the circadian adrenocortical rhythm were studied in blinded and unblinded rats under constant light (LL). Blinded rats, which were allowed access to food ad libitum, manifested a phase shift of the circadian adrenocortical rhythm. However, restricted feeding between 19.00 and 21.00 h for 2 weeks prevented the phase shift and the peak levels of plasma corticosterone (B) still appeared at 19.00. On the other hand, unblinded rats, allowed to feed ad libitum, showed an abolition of the circadian periodicity of adrenocortical activity 5 weeks after exposing the rats to LL. However, the rhythm, synchronizing with the feeding periods was promptly recovered under food restriction. These results suggest a synchronizing and generating action of feeding for the circadian adrenocortical rhythm.

1793.
Takahashi, K., K. Inoue, and Y. Takahashi. No effect of pinealectomy on the parallel shift in circadian rhythms of adrenocortical activity and food intake in blinded rats. Endocrinol. (Jpn) 23: 417-421, 1976.

Twentyfour-hr patterns of plasma corticosterone levels were determined at 4-hr intervals every 3-4 weeks in sighted and blinded pinealectomized rats of adult age. Through the whole period of the experiment, 24-hr patterns of food intake were also measured weekly. These results indicate that the pineal gland does not play any ...rtant role either in the maintenance of normal circadian periodicities of adrenocortical activity and food intake or in the shift in circadian rhythms of the two activities in the blind rats.

1794.
Takahashi, K., K. Inoue, and Y. Takahashi. Parallel shift in circadian rhythms of adrenocortical activity and food intake in blinded and intact rats exposed to continuous illumination. Endocrinol. 100: 1097-1107, 1977.

1795.
Tapp, W. N. Disrupting Circadian Organization Produces Retrograd Amnesia (Ph. D. thesis). University of Oklahoma, 1979, 63 pp.

1796.
Tapp, W. N., and F. A. Holloway. Phaseshift induced amnesia: effects of shock intensity and ACTH 4-10. Soc. Neurosci. Abstr. 5: 324, 1979.

1797.
Tasker, D. I., S. G. Kinel, and T. J. Tredici. The effect of sleep deprivation on visual function in U. S. Air Force flying personnel. Aerospace Med. Assoc., Preprints, 1974, pp. 41-42.

This was a pilot study on the possible retinal pathophysiological effects induced by prolonged sleep deprivation. The unexpected large variance in the EOG of the sleep-deprived group compared to that of the control nonsleep-deprived group needs further study. It is not considered significant that the sleep-deprived group was drawn from patients who were scheduled for a sleep-deprived electroencephalogram.

In this experiment, the significant finding is that some sleep-deprived subjects exhibited a statistically significant variance in their ratios on the EOG as compared to a control group. No significant changes on the ERG were detected. There was no detectable abnormality in the ERG or EOG induced by sleep deprivation of over 24 hours.

1798.
Tasto, D. T., and M. J. Colligan. Shift work practices in the United States. U. S. Department of Health, Education, and Welfare, Publication No. 77-148, 1977, 52 pp.

1799.
Tasto, D. L., M. J. Colligan, E. W. Skjei, and S. J. Polly. Health consequences of shift work. Menlo Park, CA.: SRI International, URU-4426, 1978, 137 pp.

This 30-month study, conducted by SRI International and sponsored by the National Institute for Occupational Safety and Health, investigated the effect of working unconventional hours, i. e. afternoon, night, and rotating shifts, on the psychological and physiological well-being of workers. Data for a sample of about 1200 nurses and a similar number of food processors were collected by review of health and accident files and from the administration of a lengthy questionnaire. Areas of inquiry included: basic subject demography (e. g. age, sex, race, marital status, and length of employment), incidence and prevalence of physical complaints and illness histories; eating patterns; sleep patterns; medication usage; life style and domestic patterns; and psychological profiles. The results of extensive computer analyses of the health and accident records and the questionnaire data are reported in separate sections of this report. Findings confirm studies of European shift workers that demonstrate a significantly greater difficulty in adapting to work schedules experienced by all other categories of shift worker than by day shift workers. Rotating shift workers, who not only work at unconventional hours but who move from shift to shift, clearly encounter the most difficulty in adjusting their psycho-biological rhythms and patterns to their work schedules. Shift work may well pose a distinct health hazard for cerain rotating shift workers. An adaptation index, developed in conjunction with the analyses of questionnaire results, indicates, among other things, that shift workers adapt best if (1) they are not too neurotic, (2) they are satisfied with their shift schedules, and (3) they are satisfied with the type of work they are doing.

1800.
Tatai, K. Biorhythm Information. Japan Biorhythm Laboratory, 1968-1973.

1801.
Tatai, K. Baiorizumu to wa nani ka (What is biorhythm). Tokyo: Bru Bakkusu, 1973.

1802.
Tatai, K. Studies on the reduction of automobile accidents in applying the theory of biorhythmics by Fliess. Paper presented at the International Interdisciplinary Cycle Research Symposium, 7th, Germany, June 27 - July 3, 1976.

1803.
Tatai, K. Biorhythm for Health Design. Tokyo: Japan Publications, Inc., 1977, 159 pp.

1804.
Taub, J. M. Psychobehavioral Effects of Sleep Pattern Variation (Ph.D. Thesis). University of California, Santa Cruz, 1973.

1805.
Taub, J. M. Effects of daytime napping on performance and mood in a college student population. J. Abnorm. Psychol. 85: 210-217, 1976.

The effects of daytime naps on performance and mood were studied. The subjects were eighteen helathy male university students who habitually slept 1/2 hr.-2 hr. in the afternoon. Measurements were obtained from an auditory reaction time task and a mood adjective checklist 20 min. before and after a control condition and two electroencephalographically recorded afternoons of sleep. The experimental conditions comprised a 2-hr. period of wakefulness, a 1/2 hr. nap from 4:35 5:05 p.m. and a 2-hr. nap from 3:05-5:05 p.m. Following each sleep treatment there where statistically significant shifts of improved reaction time performance and elevated subjected arousal as assessed by the mood scales, when compared with the control condition. The effect of increased efficiency following sleep was approximately equivalent in extent between 2-hr. and 1/2-hr. naps. These findings indicate that behavioral and psychological functions are facilitated by short periods of habitual sleep in the afternoon.

1806.
Taub, J. M. Individual differences in the effects of altered sleep duration and sleep period time displacements. Europ. Congr. Sleep Res., 3rd, Montpellier, 1976, pp. 406-408.

The purpose of this study was to compare the magnitude of differences produced by effects of shifting sleep time and altering sleep duration between long sleepers and regular 7- to 8-hour sleeper studied under identical experimental designs. Results showed that a 3-hour advance or delay and a 3-hour extension or reduction of established 7- to 8-hour and 9.5- to 10.5-hour sleep periods of resulted in generally equivalent degrees of impaired performance. The findings further indicate that 7- to 8- hours sleepers were more imparied by acute alterations in the length and timing of sleep than habitual long sleepers.

1807.
Taub, J. M. Behavioral and psychophysiological correlates of irregularity in chronic sleep routines. Biol. Psychol. 7: 37-53, 1978.

1808.
Taub, J. M. Effects of habitual variations in napping on psychomotor performance, memory and subjective states. Int. J. Neurosci. 9: 97-112, 1979.

Effects of habitual variations in napping on psychomotor performance, short-term memory and subjective states were investigated. The subjects were 32 healthy male university students who napped twice or more weekly in the morning and at night. Sixteen were randomly assigned to a control group and 16 to a nap (treatment) group. The experiment comprised two conditions of electrographically (EGG) recorded sleep for the nap group and two EEG monitored conditions of wakefulness for the controls. THese conditions were scheduled from 9:35 to 11:35 a. m. and 12 hr. later between 9:35 p.m. and 11:35 p. m. Measurements were obtained from:(a) a continuous 10-min auditory reaction time task, (b) a free recall task of short-term memory, (c) and activation-mood adjective check list, and (d) the Stanford Sleepiness scale. Except for memory the dependent variables of waking function were assessed 20 min before and 20 min after all conditions. Following each sleep condition the nap groups opposed to the controls showed a statistically significant improvement in reaction time performance, higher short-term retention, less reported sleepiness and elevated subjective states reflected by five factors on the adjective mood-activation check list. Among the correlations computed the largest significant coefficients were of stage 4 and REM with post-treatment Stanford Sleepiness ratings. After naps, increased postdormital sleepiness was correlated with stage 4 and decreased sleepiness with REM sleep. Although few strikingly divergent functional effects were associated with morning and nocturnal naps, these did covary with sleep psychophysiology. It is postulated that the phase, the EEG-sleep stages and possibly the duration of accustomed naps are less salient factors influencing performance when the time since awakening until behavioral assessment can be kept constant.

1809.
Taub, J. M., and R. J. Berger. Extended sleep and performance: the Rip Van Winkle effect. Psychon. Sci. 16: 204-205, 1969.

An investigation was undertaken of the possible effects upon performance of sleep in excess of that habitually taken. Twelve Ss worked on 15-min vigilance and calculation tasks on 2 successive days 30 min after either 8 or 11 h of nocturnal sleep. The order of sleep length and task presentation was counterbalanced among Ss. Performance on the vigilance task was significantly poorer after 11 h of sleep than after 8 h of sleep ($p = .05$). Performance on the calculation task was unaffected by the sleep condition. The results indicate that extended sleep can produce decrements in performance similar to those which occur with sleep deprivation.

1810.
Taub, J. M., and R. J. Berger. Effects of acute shifts in the sleep-wakefulness cycle on performance and mood. Psychophysiol. 9: 132, 1972.

1811.
Taub, J. M., and R. J. Berger. Performance and mood following variations in the length and timing of sleep. Psychophysiology 10: 559-570, 1973.

The relative effects of extended sleep, sleep deprivation, and shifts of accustomed sleep time on subsequent performance and mood were studied. Ten regular 2400-0800 sleepers worked on E-paced addition and vigilance tasks, and completed an adjective check list to rate their mood following 2100-0800 extended, 2100-0500 advanced-shift, 2400-0800 habitual, 0300-0800 deprivation, and 0300-1100 delayed-shift conditions of sleep. Accuracy and speed of response on the vigilance task were significantly poorer, and negative affect was signigicantly greater after the conditions of shifted sleep and altered sleep duration than after the habitual sleep condition. Changes in the mood and performance measures were unrelated to prior sleep length or any specific alterations in the electrophysiological patterns of sleep.

1812.
Taub, J. M., and R. J. Berger. Sleep stage patterns associated with acute shifts in the sleep-wakefulness cycle. Electroenceph. Clin. Neurophysiol. 35: 613-619, 1973.

1813.
Taub, J. M., and R. J. Berger. Acute shifts in sleep-wakefulness cycle: effects on performance and mood. Psychosom. Med. 36: 164-173, 1974.

Ten regular 12-8 a. m. 8-hour sleepers performed a 5-min experimenter-paced calculation task, a 30-min vigilance task and completed an adjective check list to rate their mood following a 12-8 a. m. habitual sleep condition and 8 p. m. -4 a. m. , 10 p. m.-6a. m. 2-10 a. m., and 4 a. m.- 12 p. m. conditions of shifted sleep. After the shifted sleep conditions compared to the 12-8 a. m. condition performance on the vigilance and calculation tasks was significantly impaired, and negative effect was significantly greater as measured by three scales of the adjective check list. Sleep length did not differ between the various conditions and the decrements in performance and mood were unrelated to any specific changes in the electrophysiological patterns of sleep.

1814.
Taub, J. M., and R. J. Berger. Effects of acute shifts in circadian rhythms of sleep and wakefulness on performance and mood. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J. E. Pauly. Tokyo: Igaku Shoin, 1974, pp. 571-575.

1815.
Taub, J. M., and R. J. Berger. Altered sleep duration and sleep period time displacements: effects on performance in habitual long sleepers. Physiol. Behav. 16:177-184, 1976.

1816.
Taub, J. M., and R. J. Berger. Altered sleep duration, sleep period time displacements, performance, sleep stages and individual differences (abstract). Sleep Res. 5: 218, 1976.

1817.
Taub, J. M., and R. J. Berger. Effects of acute sleep pattern alteration depend upon sleep duration. Physiol. Psychol. 4: 412-420, 1976.

The magnitude of the differences in performance, body temperature, and sleep stages following reduced, habitual, extended, and shifted sleep was compared in two groups of 10 healthy male university students who regularly slept nocturnally for 7-8 or for 9-5-10.5 h. Measurements were obtained of sublingual temperature and from a 45-min Wilkinson audityory vigilance task 30 min after awakening in the morning, at midday, and in the evening following five electro-encephalographically recorded nights of sleep. The experimental treatments comprised a habitual sleep condition and four conditions in which the regular sleep period was lengthened, reduced, delayed, and advanced by 3 h. After all sleep conditions, the long sleepers compared with the control (7-8 h) group had a higher daily level of body temperature, less misses on the vigilance task, and shorter reaction times. As a result of the mean difference in total sleep time existing between groups, under all conditions the control subjects averaged less stage 2 and stage REM sleep, but more of established 7-8 h and 9.5-10.5 h sleep periods all result in generally equivalent degrees of impaired performance. The present findings indicate that 7-8 sleepers were more impaired by acute alterations in the length and timing of sleep than habitual long sleepers.

1818.
Taub, J. M., and R. J. Berger. The effects of changing the phase and duration of sleep. J. Exp. Psychol. Hum. Percept. Perform.2: 30-41, 1976.

The relative effects of extended sleep, reduced sleep, and shifts of habitual sleep time on subsequent performance and mood were studied. Ten healthy male university students who regularly slept 9.5-10.5 hr were the subjects. Measurements were obtained from a 45-min auditory vigilance task, a 5-min experimenter-paced addition task, and a mood adjective check list 30 min after awakening, at midday, and in the evening following five electroencephalographically recorded nights of sleep. The experimental treatments comprised a 9.4-10.5 hr habitual sleep condition and four conditions in which the regular sleep period was lengthened, reduced, delayed, and advanced by 3 hr. Following each 3-hr altered condition of sleep there was an equivalent decline in vigilance performance and in subjective arousal as measured by the mood scales. Together with other recent evidence, the present results support the hypothesis that acute disruption of the 24-hr sleep-wakefulness cycle produces degradations in human performance largely independent of total sleep time.

1819.
Taub, J. M., and D. R. Hawkins. Nocturnal sleep schedules, performance, mood and diurnal rhythms. Sleep Res. 6: 115, 1977.

1820.
Taub, J. M., and D. R. Hawkins. Aspects of personality associated with irregular sleep habits in young adults. J. Clin. Psychol. 35: 296-304, 1979.

Studied psychological correlates of irregularity in chronic sleep routines. The California Psychological Inventory (CPI) and Cornell Medical Index (CMI) were administered to two groups of 18 male university students who were categorized as either irregular sleepers or control Ss. The control group was composed of persons who habitually slept from 12-8:00 A.M. Irregular sleepers were defined as those whose retiring and awakening times continuously varied by about 2 to 4 hours. Control Ss scored significantly higher than the irregular group on the CPI scales of Do (dominance), Syu (sociability), Sa (self-acceptance), Sc (self control), Ac (achievement via conformance), and Je (intellectual efficiency), but lower on the Fx (flexibility) scale. There were no significant differences between the groups in scores on the CMI or average sleep length recorded over 2 weeks. The present findings indicate that in young adults, personality functioning is related more closely to the regularity of nocturnal sleep routines than to differences in chronic sleep duration. It is postulated that stable or irregular sleeping patterns are largely dependent factors not only of the psychological characteristics that distinguished the groups, but as yet unspecified constitutional and sociocultural antecedents of the human sleep response.

1821.
Taub, J. M., D. R. Hawkins, and R. L. Van de Castle. Personality characteristics associated with sustained variations in the adult human sleep/wakefulness rhythm. Waking and Sleeping 2: 7-15, 1978.

1822.
Taub, J. M., D. R. Hawkins, and R. L. Van de Castle. Temporal relationships of napping behavior to performance, mood states and sleep physiology (abstract). Sleep Res. 7: 164, 1978.

1823.
Taub, J. M., and P. E. Tanguay. Effects of naps on physiological variables, performance and self reported activation. Sleep Res. 6: 117, 1977. (abstr.)

1824.
Taub, J. M., P. E. Tanguay, and D. Clarkson. Behavioral and psychological effects of afternoon naps. Sleep Res. 4: 272, 1975.

1825.
Taub, J. M., P. E. Tanguay, and R. R. Rosa. Effects of afternoon naps on physiological variables: performance and self-reported activation. Biol. Psychol. 5: 191-210, 1977.

Fluctuations in physiological variables resulting from naps and the relationship of these to previously studied changes in performance and subjective activation associated with napping were examined. The subjects were eighteen healthy male university students who habitually slept 1/2-2 hr in the afternoon. Measurements were obtained of four physiological variables, from a continuous 10-min auditory reaction time task and two factors of an Activation Deactivation Adjective Checklist 20 min before and after a control condition and two electroencephalographically recorded afternoons of sleep. The experimental conditions comprised a 2-hr period of wakefulness, a 1/2 hr nap from 4.35-5.05 p. m., and 1 2-hr nap from 3.05-5.05 p. m. Following each sleep treatment, when compared with the control condition, there were statistically significant shifts of improved reaction time performance, and elevated activation as reflected by the two self-report scales, increased EEG frequency, heart rate, and electrodermal responses. The shifts of increased behavioral efficiency, subjective and physiological activation were approximately equivalent in extent between 2-hr and 1/2- hr naps. These findings indicate that besides the previously reported facilitation by naps of performance and mood, physiological activation is increased following accustomed episodes of afternoon sleep.

1826.
Taylor, M. F. Biorhythm - 7 Cycles. San Francisco, Ca.: Macrovision, 1976.

1827.
Taylor, M. F. The Biorhythm 4-Cycle Bioscope and Biorhythm Meditation. San Francisco, CA.: Macrovision, 1977.

1828.
Taylor, P. J. The problems of shiftwork. J. Roy. Coll. Physicians Lond. 3: 370-384, 1969.

1829.
Taylor, P. J. Shift work - some medical and social factors. Trans. Soc. Occup. Med. 20: 127-132, 1970.

This paper reviews the present state of knowledge of the physiological and social effects of shift work, and attempts to assess the often contradictory opinions of various authors. After indicating the different patterns of shift work which are possible, some of them irregular and largely unpredictable (as in the case of seamen and hospital doctors, for example), and presenting statistics showing the distribution of shift workers in Britain by type of shift and sector of industry, the author considers medical aspects (difficulties in sleeping, digestive complaints, etc.) and presents some conclusions concerning the effect of shift work on health. He then discusses the social difficulties encountered by many shift workers and, in view of the overlapping of medical and social problems, suggests that a joint study of the question might be undertaken by a social scientist, a physiologist and a physician.

1830.
Taylor, P. J. The effects of shift work on worker health. J. Med. Surg. 42: 13-19, 1973.

1831.
Taylor, P. J., and S. J. Pocock. Mortality of shift and day workers, 1956-68. Brit. J. Industr. Med. 29: 201-207, 1972.

Little research has been reported about the long-term effects of shift work. An investigation is described on 8,603 male manual workers from 10 organizations in England and Wales designed to assess the mortality experience of day, shift, and ex-shift workers. Three major types of shift system were involved. All had been employed by the same organization for not less than 10 years and the follow-up period was between 1956 and 1968. Only 22 men could not be completely traced and the cause of death was obtained for all but eight of the 1578 deaths. Man-years at risk for each group were calculated in order to compare observed deaths with those expected from national mortality rates. The overall number of deaths was very close to that expected and no significant excess mortality was found in either the shift or ex-shift groups. Shift workers in some age groups had higher mortality than expected but this was not consistent between either organizations or types of shift work. A study of 14 main causes of death revealed some differences from national experience in both day and shift workers but these can be attributed to regional and occupational differences. To eliminate any occupational factor the mortality of skilled craftmen and their mates was compared for day and shift work with no evidence of any shift work effect. The results lead to the conclusion that shift work would appear to have no adverse effect upon mortality.

1832.
Taylor, P. J., S. J. Pocock, and R. Sergean. Absenteeism of shift and day workers. A study of six types of shift system in 29 organizations. Br. J. Ind. Med. 29: 208-213, 1972.

Previous evidence on the effect of shift work upon absence behaviour is conflicting, this being due in part to the variety of in shift systems in use. A study is described in which absence records over two years were obtained for nine hundred and sixty-five matched pairs of shift and day workers from twenty-nine organizations. Six types of shift system were involved, providing comprehensive coverage of shift work in the United Kingdom. Matching was achieved for sex, age, workplace, and occupation. Absence records included certified sickness, short sickness, and non-medical absence. The overall results showed that shift workers had less absence of all three types than their colleagues on day work, this difference being most marked in the numbers of men having several episodes. No significant differences were found in the diagnostic pattern of certified absence. Comparisons between day work and each of the six types of shift work did not provide any definite conclusions as to their relative merits as far as absence is concerned. The results from the different organizations were not wholly consistent, but a substantial majority followed the general trend.

1833.
Taylor, T. C. A Study of the Relationship of the Intelligence Bio-Rhythm and High School Students' Mental Ability Test Scores (Ph.D. Thesis). University of Kentucky, 1978.

1834.
Tebbs, R. B. Post-awakening visualization performance as a function of anxiety level, REM or REM sleep, and time of night. Colorado Springs, Colo.: U. S. Air Force Academy, SRL-TR-72-005, 1972, 76 pp.

The determinants of post-arousal performance (PAP) decrement are not well established. Prior research has suggested that PAP should be better on cognitive tasks after REM than after NREM sleep. Level of anxiety and time-of-night (TON) also have been implicated as being imnportant in PAP. On the basis of their Q4 scores (calm-tense) on the 16 PF, 16 "calm" and 16 moderately "tense" young adult male Ss were aroused twice each night on two non-consecutive nights in the labotatory and tested with two visualization tests in a 3 to 15 min. period after arousal REM and NREM awakenings were counterbalanced for early (about 1:00 A. M.) and late (about 3:00 A. M.) positions across nights and subjects. No REM-NREM effects were found on PAP. This was interpreted to mean that PAP deficits for the post-awakening period tested are due to the tonic effects of sleep *per se* and not to sleep stage. TON effects were not interpreted, since awakenings could not be positioned according to the pre-experimental plan. No significant PAP differences were found between calm and tense Ss. One significant difference was found between the PAP of night Ss and the performance of comparable day Ss. Specifically, a comparison of the day Ss' second trial and the night Ss' fourth trial showed that tense Ss' performance was inferior at night to that in the day. No such difference was found between day- and night-calm Ss. These results strongly suggest that the most important determinant of PAP is the anxiety level of the Ss.

1835.
Tejmar, J. Shift work round the clock in supervision and control. Appl. Ergonom. 7: 66-74, 1976.

1836.
Telegdy, G., I. Vermes, and K. Lissak. Correlation between the diurnal rhythm of brain serotonin and plasma corticosterone in rats. In: Cellular and Molecular Bases of Neuroendocrine Processes, edited by E. Endroczi. Budapest: Akademiai Kiado, 1976, pp. 451-459.

1837.
Templeton, J. Biorhythm: If your're exasperated it must be Wednesday. Sales and Marketing Management 121: 58-59, 1978.

1838.
Tepas, D. I., C. G. Stock, J. W. Maltese, and J. K. Walsh. Reported sleep of shift workers: a preliminary report (abstract). Sleep Res. 7: 313, 1978.

1839.
Tepas, D. I., J. K. Walsh, P. D. Moss, and D. Armstrong. Polysomnographic correlates of shift worker performance in the laboratory (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. III-8.

1840.
Thackray, R. I., R. M. Touchstone, and J. P. Bailey. A comparison of the vigilance performance of men and women using a simulated radar task. Oklahoma City, OKL. : Civil Aeromedical Inst., FAA-AM-78-11, 1978, 11 pp.

Possible sex differences are considered in the ability to sustain attention to a complex monitoring task requiring only a detection response to critical stimulus changes. The visual display was designed to approximate a futuristic, highly automated air traffic control radar display containing computer-generated alphanumeric symbols. Twenty-six men and an equal number of women were each tested over a 2 hour session. Sixteen targets appeared on the screen at all times, with 10 signals (a designated change in the alphanumerics) randomly presented during each half hour of the test session. Detection latency to the signals increased significantly during the session, but there was no evidence of any significant difference between the sexes in the magnitude or pattern of this increase. The results are discussed in terms of a general decline in alertness that was apparently equal for both sexes.

1841.
Tharp, V. K. Sleep loss and stages of information processing. Waking and Sleeping 2: 29-33, 1978.

The reaction time (RT) performance of seventeen male subjects (Ss) was tested during four consecutive sessions: Baseline 1, Baseline 2, Sleep Deprivation (one night) and Recovery. The difficulty of the task was varied by manipulating two levels of stimulus discriminability, two levels of stimulus-response compatibility, and two levels of stimulus-response uncertainty in a balanced design. For each possible condition, the means of the 25% fastest and the 25% slowest RTs were calculated. These data were then analyzed and interpreted within the framework of an information processing model by means of the Sternberg (1969) additive factor method. The results indicate that sleep loss has two primary effects on choice RT. First, it produces lapses in performance which are not readily interpretable within the framework of the proposed information processing model. Second, it produces a highly significant performance deficit in the fastest RTs which appears to be a slowing of the response selection process.

C-6

1842.
Theorell, T., and T. Akerstedt. Day and night work: changes in cholesterol, uric acid, glucose and potassium in serum and in circadian patterns of urinary catecholamine excretion. Acta Med. Scand. 200: 47-53, 1976.

Two groups of railway workers (n=16 and n=17) have been followed on their place of work during a period of shifts between day and night work. Catecholamine excretion in the urine and blood levels of lipids, glucose, uric acid, potassium and calcium were followed during the different phases of shift work. Dramatic fluctuations were noted in the diurnal pattern of catecholamine excretion during and after night work. Significant elevations in the serum levels of cholesterol, glucose, uric acid and potassium were observed during the first week after a night shift, and these changes could not be explained on the basis of shifts in the diurnal pattern or changes in dietary or other habits.

1843.
Thierry, H. Potential interventions for compensating shift work inconveniences (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, Fr., 1980, p. IV-7.

1844.
Thierry, H., G. Hoolwerf, and P. J. D. Drenth. Attitudes of permanent day and shift workers towards shiftwork - a field study (abstract). Int. J. Chronobiol. 3: 10-11, 1975.

1845.
Thiis-Evensen, E. Shift work and health. In: On Night and Shift Work, edited by A. Swensson. Proceedings of an international symposium, Oslo, 1969. (Studia Laboris et Salutis, no. 4). Stockholm: National Institute of Occupational Health, 1969, pp. 81-83.

1846.
Thommen, G. Biorhythm Cyclgraf. New York: Biorhythm Computers, 1961.

1847.
Thommen, G. S. Is This Your Day? How Biorhythm Helps You Determine Your Life Cycles. New York: Crown Publishing Co., 1973, rev. ed., 160 pp.

This book, originally published in 1964, stimulated the recent surge of popular interest in "biorhythm". The biorhythm method was developed by Wilhelm Fliess and Herman Swoboda and postulates the existence of three cycles: a 23 day (physical) cycle influences physical strength, endurance, energy, and physical confidence; a 28 day (emotional) cycle influences feeling, love, cooperation and irritability; and a 33 day cycle (intellectual) corresponds to learning, memory and creative thinking. The theory holds that these cycles are generated (synchronized) from the moment of birth and cycle with constant period length throughout the lifetime of any indiviudual. "Critical" days are defined as days which occur on boundary points between low and high phases of each cycle in which individual performance is deteriorated and individuals are more accident prone than on other days during a given cycle. This deterioration is enhanced during simultaneous occurrence of critical

days between the three cycles (double cricitcal or triple critical). The book presents a detailed account of the historical development of biorhythm. Swoboda discovered periodicities in fevers which led to studies of rhythms in dreams, asthma attacks and anxiety in mothers of new-born babies in which he claimed the existence of 23 and 28 day cycles with "critical days" in the phases of these rhythms. An associate of Freud, Fliess also studied rhythms in disease states and tied the 23 day (male) and 28 day (female) cycles into a general theory of human bisexuality. Alfred Teltscher later found 33 day cycles in student intellectual performance (apparently never published). Rexford Hershey reported 33-36 day cycles in the mood of industrial workers. Methods of calculating and charting biorhythms were later developed by Alfred Judt and Hans Frueh. Hans Schwing first studied the relationship between accident statistics and phases of the biorhythm cycles which led to the formulation of the "critical" day concept. The author quotes a number of other investigators claiming to have demonstrated significantly higher accident rates on critical days. The author then relates anecdotal information on the connection between aviation and space flight accidents and performance lapses and critical days. He quotes R.M. Woodham of the Guggenheim Aviation Safety Center at Cornell University, who claims that 80% of private pilot accidents occur on critical days (which statistically constitute 20% of the total number of days). He mentions the use of biorhythm safety programming by a number of business companies in Japan. A number of examples of athletic performance in relation to biorhythm phases are presented. Although it is admitted that rhythms may be present prior to birth, the author maintains that the trauma and excessive environmental stimulation of birth synchronizes all three cycles at the moment of birth. He justifies the invariant precision of biorhythm periods by analogy to the precision of circadian rhythms. It is further suggested that biorhythm can be used to predict the sex of a child based on the claim that when the mother's physical cycle is high the egg is predisposed to accepting Y chromosome cells (no supportive evidence is presented). Finally, he claims that couples whose biorhythmic cycles are closely in phase will be more compatible than those couples in which the cycles are out of phase (biorhythm compatibility). This claim seems to be intuitive rather than based on experimental evidence.

C-6

1848.
Thomson, H. M. Biorhythm for Life: A Life Time Universal Biorhythm Chart. North Andover, Md.: Evergreen Publishing, 1976, 84 pp.

1849.
Thumann, A. Biorhythms and Industrial Safety. Atlanta: Fairmont Press, 1977, 166 pp.

1850.
Ticca, M. Effects of reversing the feeding cycle and the light period on the spontaneous activity of the rat. S. & TA. NU. 6: 153-160, 1976.

1851.
Tilley, A. J., R. T. Wilkinson, and M. Drud. Night and day shifts compared in terms of the quality of sleep recorded in the home and performance efficiency measured at work (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, Fr., 1980, p. III-9.

1852.
Tobler, I., et al. Short light-dark cycles and paradoxical sleep in the rat: effect of strain difference and hypophysectomy. Behav. Biol. 23: 395-398, 1978.

1853.
Tokarz, T. P., An analysis of sleep deprivation factors and consequences of staying awake in the stimulus control treatment of sleep disturbances. U. North Carolina, Greensboro, 1977, 162 pp.

1854.
Tolaas, J. REM sleep and the concept of vigilance. Biol. Psychiatry 13: 135-148, 1978.

1855.
Tom, C. K. Nursing assessment of biological rhythms. Nurs. Clin. North Am. 11: 621-30, 1976.

1856.
Tomarchenko, I. S. Evaluation of the functional state of the human body under protracted flight conditions. Biol. Nauki 17: 39-42, 1974.

1857.
Tooraen, L. A. Physiological effects of shift rotation on ICU nurses (abstract). HRP-0011547/7GA, 1972, 8 pp.

The physiological effects on intensive care unit nurses of rotating from night to day schedules are examined. Nine nurses employed in four intensive care units in two hospitals participated in the study in which physiological effects of shift rotation were measured through examination of urinary excretion of potassium and

sodium, a method chosen in light of underlying biological or circadian rhythms of excretion of these electrolytes. The basic assumption of the study was that stressors, regardless of their nature, cause homeostatic upsets. Results revealed that the shift rotation followed by the nurses did not produce a significant physiological adaptaion to reversing their activity-sleep or stress patterns. Nurses continued to follow the same physiological activity patterns regardless of whether they slept during daylight or night hours. Supporting data and a review of literature on 'chronobiology' are included.

1858.
Tope, O. Biorhythmische Einflusse und ihre Auswirking in Fuhrparkbetrieben (Biorhythmical influences and their effect on the operation of trucking fleets). Hannover: Stadtehygiene, 1956.

The author claims to have found that 83% of accidents occurring to street cleaners and shopworkers take place on biorhythmic critical days.

1859.
Torsvall, L., and T. Akerstedt. Shift work and diurnal type: a questionnaire study (abstract). Chronobiologia 6: 163, 1979.

1860.
Townsend, R. E., L. C. Johnson, and A. Muzet. Effects of long term exposure to tone pulse noise on human sleep. Psychophysiol. 10: 369-376, 1973.

1861.
Treherne, J. E., W. A. Foster, P. D. Evans, and C. N. Ruscoe. Free-running activity rhythm in the natural environment. Nature 269: 796-797, 1977.

1862.
Tribukait, B. Die Aktivitatsperiodik der weissen Maus im Kunsttag von 16-29 Stunden Lange. Z. Vergl. Physiol. 38: 479-490, 1956.

1863.
Tsai, T. H., and T. Sasaki. Phase-shifting of circadian activity rhythm in hamsters following alterations in lighting schedules (abstract). Chronobiologia 6: 165, 1979.

1864.
Tsaneva, N., and M. Daleva. Field study of the diurnal changes of the adrenal system (abstract). Int. J. Chronobiol. 3: 7, 1975.

The changes in the 17-ketosteroids and the catecholamines were determined in aquanauts, supermarket cashiers and miners, in relation to shift work and the circadian rhythm.

Our investigations showed that studying the changes in the circadian rhythm by following the changes in the catecholamines and the 17-ketosteroids it was possible to obtain satisfactory results.

We were able to draw the following conclusion: when investigating the circadian rhythm under field conditions there exist many additional factors which could influence the excretion of the 17-ketosteroids and the catecholamines, and thus could mask or disturb the circadian rhythm. Among the factors which may have this effect are the emotional stress, the degree of adaptational effect, fatigue which precedes the work and the character of the task which is performed.

1865.
Tsaneva, N., E. Dincheva, S. Douney, I. Hadjiolova and H. Daleva. Physiological and biochemical changes during morning and afternoon shifts. Ergonomics 21: 873, 1978.

Working heart rate and the urinary excretion of catecholamines, 17- oxycorticosteroids and 17- ketosteroids were studied in airline booking display operators working on morning shift (0700 h to 1500 h) and on afternoon shift (1100 h to 1900 h) with daily alternation. Whereas at 11:00 h no difference in heart rate was observed between the shifts, at 1300 h and 1500 h it was significantly higher when the subjects were on morning shift than when they were on afternoon shift. Similar results were obtained for the biochemical measures. Thus changes in heart rate and in catecholamine and steroid excretion due to fatiue and strain, can be distinguished from those caused by circadian variation.

1866.
Turton, M. B., and T. Deegan. Circadian variations of plasma catecholamine, cortisol, and immunoreactive insulin concentrations in supine subjects. Clin. Chim. Acta. 55: 389-397, 1974.

1867.
Tyurin, V. Biorhythms in space flight. Nauka i Zhizn 11: 43-47, 1976.

This laboratory is working on a method of biorhythmological selection of astronauts. A complex of criteria and a test program have been developed.

1868.
Ulbrecht, G., E. Meier, R. Rothenfuber, and K. V. Werder. Time dependence of the flight induced increase of free urinary cortisol secretion in jet pilots. In: Simulation and Study of High Workload Operations, edited by A. N. Nicholson. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-CP-146, 1974, pp. A11-1 - A11-6.

A modified competitive protein binding assay of free urinary cortisol using a single solvent extraction and a cortisol binding globulin from a dexamethasone suppressed male subject was developed. The separation of bound and free cortisol was performed by absorption of the free cortisol to dextran coated charcoal. The sensitivtity of the method allows to measure as low as 0.2 ng per tube. The coefficient of variation within one assay is only 4.8%, which makes this method suitable to measure minute changes of free urinary cortisol excretion during the day in a fractionated 24 hr-urine collection. The mean free cortisol excretion in 35 normal men was 63 +/- 3 ug/24 hrs showing the expected circadian rhythm of adrenal cortical activity. In seven F-104 pilots flying two missions a day the 24 hr. free urinary cortisol secretion was significantly higher (89 $\pm$ 12 ug/24 hrs - SE) compared to 12 pilots on day of rest (43 +/- 7 ug/24 hrs). When 26 F-104 pilots, 12 RF 4E pilots and 14 weapon system operators(WSP) were evaluated by measuring free urinary cortisol excretion in short intervals it could be demonstrated, that only the pilots flying early in the morning showed an enhancement of adrenocortical activity compared to normal controls, suggesting a change of excitability of the hypothalamo-pituitary-adrenal system during the day. This might have to be taken into account if investigations about stress of flying and adrenocortical activity are carried out.

1869.
Ulich, E. Zur Frage des arbeitenden Menschen durch Nacht-und Schicht arbeit. Psychologische Rundschau 8: 42-61, 1957.

1870.
Ulich, E. Schicht- und Nachtarbeit im Betrieb. Koln-Opladen: Westdeutscher Verlag, 1964.

1871.
Ullner, R., J. Kugler, F. Torres and F. Halberg. Nachtschlafzyklen nach Interkontinentalflugen (Cycles in night sleep after intercontinental flights). In: Biologische Rhythmen und Arbeit, edited by G. Hildebrandt. New York: Springer-Verlag, 1976, pp. 81-89.

Polygraphic analysis was performed in a healthy subject during nights 1-7, 12, 13, 19 and 10 after a 6 time zone flight from Munich to Minneapolis. Sodium, potassium, chloride and calcium excretion were measured 3 weeks before and after the return flight. During nights 1-7, sleep stages A and B were more frequent than normal. Following adaptation, the frequencies of stages D and E increased. REM sleep proportion increased from 1.7% to 26.7% from nights 1 to 7. REM cycle length normalized from 114 to 101 min. The first stage of electrolyte rhythm adaptation took 3-5 days but was not completed until after 6 days. Differences in sleep stages between eastward and westward flights were observed.

1872.
Umanskiy, S. S. H., Y. Y. Krist'yukhan, and I. Y. Saydasheva. Pattern of urokinase excretion by workers on different shifts. Gig. Sanit. 38: 96-97, 1973.

1873.
Underwood, H. Circadian organization in lizards: the role of the pineal organ. Science 195: 587-589, 1977.

1874.
Vallet, M., V. Blanchet, J. C. Bruyere, and J. C. Thalabard. La perturbation du sommeil par le bruit de circulation routiere. Etude in situ. Institute de Recherche des Transports. Bron (France): Centre d'Evaluation et de Recherche des Nuisance, 1975.

1875.
Valsik, J. A., R. Stukovsky, D. Marcinkova, and M. Slovakova. Altered performance during phases of the menstrual cycle. J. Interdiscip. Cycle Res. 8: 281-285, 1977.

1876.
Vasil'ev, V. N., A. I. Kikolov, T. V. Brodskaya, and E. A. Matlina. Ekskrecija katcholaminov v dnevnoe i nocnoe vremja pri dispetcerskoj rabote (Catecholamine excretion during day and night shifts in chief railway switchmen). Gig. Trud. Prof. Zabol. 2: 6-11, 1974.

The urine of chief railway switchmen aged 45 to 55 years working in 12-h shifts was monitored. Noradrenaline excretion on their rest day was lower than that recorded in other occupations where shifts are not worked (physicians, engineers, laboratory staff). During day shifts, the switchmen's neuropsychic stress was evidenced by an increase in noradrenaline excretion, followed by an increase in adrenalin excretion. This increase was even more pronounced during the night shift. Adrenal-sympathetic system activity did not return to normal until the second day after the last night shift.

1877.
Vasilevskii, N. N. Adaptive self-regulation of functions and its relationship to dynamic control by endogenous biorhythms. Zh. Evol. Biokhim. Fiziol. 9: 374-382, 1973.

1878
Vaughan, G. M., R. W. Pelham, S. F. Pang, L. L. Loughlin, K. M. Wilson, L. L. Sandock, M. K. Vaughan, S. H. Koslow, and R. J. Reiter. Nocturnal elevation of plasma melatonin and urinary 5-hydroxyindoleacetic acid in young men: attempts at modification by brief changes in environmental lighting and sleep and by autonomic drugs. J. Clin. Endocrinol. Metab. 37: 752-764, 1976.

In order to determine whether the human pattern of circulating melatonin resembles that previously described in lower animals, men 19-32 years old were exposed to a light-dark cycle with 14 hours of light per day (LD 14:10). In whites and blacks, nocturnal (dark phase, sleeping) melatonin levels were almost always elevated to 0.05-0.1 ng/ml plasma compared with lower or undetectable levels during the day, measured by the tadpole bioassay. Thin-layer migration of bioactive material was identical to that for melatonin standard. A rhythm with nocturnal elevation of urinary 5-hydroxyindoleacetic acid (5-HIAA) was observed. Nocturnal (sleep phase) rise in blood melatonin (but not urinary 5-HIAA) continued during 2 1/2 day-night cycle lengths after the onset of constant light. Though the dark phase plasma melatonin rise was less marked after reversal of the sleep-wake cycle (no change in the light cycle), dark phase rise in urinary 5-HIAA continued. Though marked cardio-vascular and other effects were produced by intravenous isoproterenol or scopolamine, no definite effect on melatonin levels was observed after either drug during the light phase in waking subjects.

1879
Vaysfel'd, I. L., and R. F. Il'icheva. Diurnal rhythm of the content of biogenous amines (histamine, serotonin) in human blood under normal conditions and during altered work-sleep cycles. Kosm. Biol. Med. 6(5): 56-62, 1972.

It has been established that variations in the diurnal cycle of the histamine-diaminoxidase system in the blood of healthy subjects involve diaminoxidase activity alone. Its considerable decline in the evening and far greater decrease (to zero) at night indicates an enhanced influence of histamine at night. The blood serotonin content tends to decrease at night. Changes in work-sleep cycles give rise to noticeable qualitative and quantitative changes in the mentioned parameters. The disturbances become more distinct under hypokinetic conditions. Variations in the diurnal cycle of histamine-diaminoxidase and histamine-serotonin ratios are related not only to the stressor applied, but also to the initial state of the organism. The results of this study show the importance of taking the internal state of the organism into account when formulating work-sleep cycles.

1880.
Vernikos-Danellis, J., M. F. Dallman, P. Forsham, A. L. Goodwin, and C. S. Leach. Hormonal indices of tolerance to $+G_z$ acceleration in female subjects. Aviat. Space Environ. Med. 49: 886-889, 1978.

The secretions of the pituitary-adrenal system and of the adrenal medulla have been generally considered as the most reliable indices of the presence of a stress. The relationship of the function of these systems to $+3\ G_z$ acceleration was studied in female subjects in order to assess their possible predictive value for screening Shuttle passengers. The 12 female subjects used were divided into two groups on the basis of their $3G_z$ tolerance; eight subjects with the highest tolerance formed the bedrested group while the remaining four served as ambulatory controls. Blood samples were collected for cortisol determinations by repeated venous puncture at 4-h intervals for 24-h periods before, during, and after bedrest. Epinephrine and norepinephrine excretions were determined in 24-h urine pools. In addition, blood samples for ACTH and cortisol determinations were collected before, immediately after, and 10 min. after the completion of each $+3G_Z$ run. During the prebedrest period, there was a marked increase in both plasma ACTH and cortisol in all subjects following centrifugation. Although no difference existed in the plasma cortisol response to centrifugation between those subjects with a high or low tolerance, plasma ACTH increases were significantly greater in the high tolerance group. In addition, there was good correlation between the diurnal amplitude in plasma cortisol and $+G_Z$ tolerance, but the correlation between 24-h urinary epinephrine; norepinephrine was weak. The relationship between the plasma ACTH response to centrifugation and the $+G_Z$ tolerance no longer held after bedrest when, in fact, ACTH secretion was greater as the tolerance decreased. In contrast to the ACTH response, the correlation between $+G_Z$ tolerance and the plasma cortisol amplitude persisted after bedrest.

1881.
Vernikos-Danellis, J., W. L. Goldenrath, and C. B. Dolkas. The physiological cost of flight stress and flight fatigue. U. S. Navy Medicine 66: 12-16, 1975.

1882.
Vernikos-Danellis, J., C. S. Leach, C. M. Winget, A. L. Goodwin, and P. C. Rambaut. Changes in glucose, insulin, and growth hormone levels associated with bedrest. Aviat. Space Environ. Med. 47: 583-587, 1976.

Changes in plasma glucose insulin, and growth hormone (HGH) resulting from exposure to 56 d of bedrest were determined in five healthy young male subjects. Blood samples were collected by repeated venous puncture at 4-h intervals for 48-h periods before bedrest, at 10,20, 30, 42 and 54 d after confinement to bed and at 10 and 20 d after bedrest. Changes in the daily levels of these factors for each subject were expressed as the mean of the six samples per 24-h period. The level of HGH dropped after 10 d of bedrest, then showed a 1.5-fold increase at 20 d ($p<0.05$) and subsequently decreased gradually reaching levels of 2.5 mg/ml/24 h, well below pre-bedrest controls of 4.2 mg/ml/24 h, by the 54th d. In spite of a marked increase in the daily plasma insulin levels during the first 30 d of bedrest, glucose levels remained unchanged. Beyond 30 d of bedrest, insulin began decreasing toward pre-bedrest levels and glucose followed with a similar reduction to below the control levels of 75 mg/100 ml/24 h on day 54. The daily mean changed reflect a change in the amplitude of the diurnal variation. The daily peak in plasma insulin shifted progressively to the late evening during the bed-rest period.

1883.
Vernikos-Danellis, J., C. S. Leach, C. M. Winget, P. C. Rambaut, and P. R. Mack. Thyroid and adrenal cortical rhythmicity during bed rest. J. Appl. Physiol. 33: 644-648, 1972.

The effects of prolonged bed rest on adrenocortical and thyroid function were assessed in eight healthy males, aged 20-40 years, who were submitted to bed rest for 56 days on a 14L:10D regimen (lights-on, 9:00 a. m.). Four of these subjects exercised with an Exergenie three times daily throughout the experiment. Circulating cortisol, triiodothyronine (T_3), and thyroxine (T_4) concentrations were determined in blood samples drawn at four hourly intervals for 48-hr periods before, 10, 20, 30, 42, and 54 days during, and 10 days post-bed rest. Significant fluctuations in the circulating levels of all three hormones occurred with peaks at 7:30 a. m. Bed rest reduced the amplitude of the cortisol rhythm but the rhythm persisted. In contrast, thyroid hormone rhythms were considerably less stable during bed rest, showing marked rephasing with progressive bed rest and returning to original rhythmicity at the 10-day post-bed-rest sampling period. The main daily concentration of T_3 increased promptly during bed rest and remained elevated. Neither exercise nor the 10-day-post-bed-rest ambulatory period prevented or corrected these effect. The suggestion is advanced that thyroid rhythms may be posture dependent.

1884.
Vernikos-Danellis, J., and C. M. Winget. The importance of light, postural and social cues in the regulation of the plasma cortisol rhythm in man. In: Advances in the Biosciences, Vol. 19: Chronopharmacology, edited by A. Reinberg and F. Halberg. New York: Pergamon Press, 1979, pp. 101-106.

The relative importance of various environmental synchronizers regulating the diurnal rhythm of plasma cortisol in humans was studied in a series of experiments using young healthy adult males, aged 20-25. They were housed in a facility in which the environment, including the photoperiod, could be regulated. Blood samples were collected in heparinized containers by repeated venous puncture at 4-hr intervals for 24 or 48-hr periods at various time points during the studies. These were used to determine plasma cortisol concentrations by the competitive binding radioassay. Removal of postural cues by exposure to bed rest for 54 days in 16L:8D did not alter the time at which peak cortisol levels occurred. Exposure of the subjects in groups of three to constant light (24L:0D) and *ad libitum* feeding in a soundproofed environment devoid of time cues shifted the time of the occurrence of the peak plasma cortisol level. The rate of desynchronization of this rhythm was very different for the two test groups (0.370 and 0.691 hr/day) but very similar within each group. After recovery in 16L: 8D, a second exposure of the same subjects to constant light resulted in a considerably slower rate of desynchronization (0.159 and 0.539 hr/day, respectively). Furthermore, the rate of desynchronization in constant light of a subject from the slower shifting group was greatly accelerated by transferring him into the room of subjects whose peak plasma cortisol level was shifting at the faster rate. These findings suggest that the plasma cortisol rhythm is not affected appreciably by the absence of postural change, whereas light and social interaction affect this rhythm profoundly.

1885.
Vernikos-Danellis, J., C. M. Winget, A. E. Goodwin, and T. Reilly. Comparison of hormone and electrolyte circadian rhythms in male and female humans. Waking and Sleeping 1: 365-368, 1977.

Circadian rhythm characteristics in healthy male and female humans were studied at 4-hour intervals for urine volume, cortisol, 5-hydroxyindoleacetic acid (5-HIAA), Na, K, Na/K ratios in the urine, as well as plasma cortisol. While plasma and urinary cortisol rhythms were very similar in both sexes, the described rhythms in urine volume, electolyte, and 5-HIAA excretion differ for the two sexes. The results suggest that sex differences exist in the circadian patterns of important hormone and metabolic functions and that the internal synchrony of circadian rhythms differs for the two sexes. The results seem to indicate that the rhythmical secretion of cortisol does not account for the pattern of Na and K excretion.

1886.
Vernikos-Danellis, J., C. M. Winget, C. S. Leach, and P. C. Rambaut. Dissociation of effects of prolonged confinement and bed rest in normal human subjects: cortisol, insulin, thyroxine, and triiodothyronine. In: Proc. of the 1971 Manned Spacecraft Center Endocrine Program Conf., Houston, Tex.: Lyndon B. Johnson Space Center, National Aeronautics and Space Administration. 1972, 8 pp.

Endocrine and metabolic information on the the relative effect of confinement and prolonged bed rest in man was obtained by assaying blood samples for changes in cortisol, insulin, thyroxine, and triiodothyronine levels. Diurnal rhythms existed in all four hormone levels during prebed rest control period. Thyroid rhythms were most affected by bed rest and decreased markedly or showed considerable phase shifts: whereas the hydrocortisone rhythm was little affected. A marked decrease in the amplitude of the steroid rhythm developed by the end of the study.

1887.
Vernikos-Danellis, J., C. M. Winget, C. S. Leach, and P. C. Rambaut. Circadian, endocrine, and metabolic effects of prolonged bedrest: two 56-day bedrest studies. Washington, D. C.: NASA, NASA TM X-3051, 1974, 42 pp.

1888.
Vernikos-Danellis, J., C. M. Winget, C. S. Leach, L. S. Rosenblatt, J. Lyman, and J. R. Beljan. Space motion sickness medications: interference with biomedical parameters. XXVII Congress International Astronautical Federation Preprint, Oct., 1976, 5 pp.

The possibility that drugs administered to Skylab 3 (SL-3) and 4 (SL-4) crewmen for space motion sickness may have interfered with their biomedical evaluation in space was investigated. Healthy volunteers received combinations of Scopolamine/Dexedrine for four days in regimens similar to those used in these missions. Urine samples, heart rate, body temperature, mood and performance were analyzed for drug-related changes. Twenty-four hour urine samples were analyzed by the same procedures as those used to analyze the flight samples. Hormone concentrations determined included cortisol, epinephrine, norepinephrine, aldosterone and antidiuretic hormone(ADH). In addition, volume, specific gravity, osmolarity, sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), chloride(Co), inorganic phosphate, uric acid and creatinine were measured. Performance was not affected by the Scopolamine/Dexedrine. The drug combination increased daily mean heart rate (HR) significantly in all the subjects and daily mean rectal temperature (RT) in some of the subjects. A 2-4 hr phase shift in the HR circadian rhythm was also observed which indicates that internal circadian synchrony was disturbed by the drugs.

Psychological and subjective evaluation indicated that the subjects could usually identify which days they were given the drugs by an increase in tension and anxiety, decreased patients, restlessness, decreased appetite, difficulty in sleeping and feelings of increased heart rate and body temperature. Urinary electrolytes were not changed significantly by the drug, but marked and significant changes occurred in urine volume and hormone excretion patterns. Scopolamine/Dexedrine caused consistent elevations in urinary cortisol and epinephrine and a transient elevation in ADH. Norepinephrine excretion was decreased, but there was no significant change in aldosterone excretion or in 24 hr. urine volume. A comparison of these findings with the first four days of inflight data from the SL-3 and SL-4 missions leads to the conclusion that the dramatic increases in aldosterone excretion during the first three days of spaceflight probably can be directly attributed to weightlessness, whereas the antimotion sickness medication could have substantially contributed to the early increased excretion of epinephrine and cortisol during these missions.

1889.
Veylon, R. Biological rhythms: use of time by the human organism. Nouv. Presse. Med 7: 1655-7, 1978.

1890.
Vinogradova, O. V., G. A. Sorokin, and N. N. Havkina. Fiziologo-gigieniceskoj harakteristike nocnogo truda pri progruzocno razgruzocnyh rabotah (Physiological and health characteristics of night work of longshoremen). Gig. Trud. Prof. Zabol. 2: 5-8, 1975.

This study covered 600 longshoremen working 8 h shifts on the Leningrad docks. Physiological data (heart rate, blood pressure, muscle tone, etc.) obtained during the night shift were compared to those in the same people under identical conditions during the day shift. All the physiological parameters were at their lowest levels during the last hours of night. The consequences were that productivity decreased 17-18% and that morbidity and accident frequency increased.

1891.
Vogt, E. D., P. Engel, and H. Klein. Ueber den Tagesgang der koerperlichen Leistungsfaehgigkeit. Int. Z. Angew. Physiol. 25: 1, 1968.

The period of some biological and performance rhythms is found to be age-dependent.

1892.
Vokac, Z., and K. Rodahl. Field study of rotating and continuous night shifts in a steel mill (abstract). Int. J. Chronobiol. 3: 4-5, 1975.

A comparison is presented between longitudinal observations during continuous night work (21 x 2200 - 0600 h) and during a cycles of rotating shifts (4 x 2200 - 0600h, 6 x 0600 - 1400 h, 3 x 2200- 0600 h, 7 x 1400 - 2200 h). Continuous monitoring of the heart rate by portable tape recorders showed that the individual circulatory strain as well as the estimated energy output were comparable from day to da throughout the observation periods. At the beginning of the continuous night shifts the rectal temperature (4 subjects) followed the usual circadian rhythm, decreasing during the night in spite of physical activity, and rising again during the sleep in the morning.

1893
Vollman, R. F. Some conceptual and methodological problems in longitudinal studies on human reproduction. In: Biorhythms and Human Reproduction, edited by M. Ferin, F. Halberg, R. M. Richert, and R. L. Vandewiele. New York: John Wiley, 1974, pp. 161-170.

In a study of 691 women with 31,676 recorded menstrual cycles it was found that in the first years after menarch the length of the menstrual cycle may oscillate irregularly between 10 and more than 60 days. Approximately 40-50 cycles prior to menopause, the length of the cycle increases abruptly, as does the degree of variability. Therefore the length of the menstrual cycle is a function of the personal characteristics of the individual woman and her age.

1894.
Wagman, A. M., et al. Effects of alcohol consumption upon parameters of ultradian sleep rhythms in alcoholics. Adv. Exp. Med. Biol. 85A: 601-616, 1977.

1895.
Wagner, D. R., and E. D. Weitzman. Neuroendocrine secretion and biological rhythms in man (submitted for publication).

We have attempted to outline the normal relationships of the hypothalamic-pituitary axis to time and sleep, and the effect of both experimental and disease-state alterations on these relationships. The further study of these complex, dynamic interactions will provide key information to our ultimate understanding of both normal human biology and the mechanisms by which organic and mental diseases alter it.

1896.
Wahlberg, I., and I. Astrand. Physical work capacity during the day and at night. Work-Environm.-Health 10: 65-68, 1973.

1897.
Walker, J. The Human Aspects of Shift Work. London: Institute of Personnel Management, 1978, 214 pp.

Contents of this pocket-size manual, issued in the IPM 'Management Paperback' series: nature and extent of shift work (types of shift work; comparison between the United Kingdom and other countries, etc.); reasons for introducing shift work; biological effects and performance (circadian rhythms and performance; frequency of shift changes; output on the night shift; individual differences; accidents); shift work and health (absenteeism; longitudinal study; gastro-intestinal conditions; sleep disturbance; subjective feelings of malaise; preventive action); effects on social and family life; arranging the shift system (doubleday shift for alternating day/night; fixed or rotating shifts; shifts of long duration; continuous 3-shift rotas; frequency of shift changes on continuous work; frequency of shift changes on the 2-shift system; starting and stopping times: recent trends etc.); introduction and administration of shift work; welfare and legal aspects, etc. An alphabetical index is appended.

1898.
Walker, J. Pressures leading to changes in the arrangement of shift systems (abstract). Ergonomics 21: 870, 1978.

1899.
Walker, J. and G. de la Mare. Absence from work in relation to length and distribution of shift hours. Br. J. Ind. Med. 28: 36-44, 1971.

1900
Wallerstein, M. R., and N. L. Roberts. All together on the bio-curve. Hum. Behav. 2: 8-15, 1973.

In this review article on biorhythm theory and biological rhythms, the authors cite anecdotal incidents supporting the theory. They cite a report of 24-26 day body temperature cycles in a patient and female menstrual cycles as support for the theory even though these cycles deviate from the exact 23 and 28 day cycles required by the theory. They also cite the studies of Hersey as evidence for the 33 day biorhythm cycle (for critique of this claim, see Hersey, R. 1931 J. Mental Sci. 77: 151-159 in bibl.) They have designed a system for calculating biorhythm profiles of the members of athletic teams using weighting factors and claim that performance is best when individual biorhythm curves are low on the average, although this is difficult to reconcile with the theory. Anecdotal examples are given of the presumed successful application of this method to team performance prediction. They fail to distinguish between scientifically studied biological rhythms and biorhythms, although the period lengths and variability of rhythms found by biological rhythm investigators conflict with biorhythm theory. A. Ahlgren had published a critique of this article (Int. J. Chronobiol. 2: 107-1909, 1974).

1901.
Walsh, J. K., C. G. Stock, and D. I. Tepas. The EEG sleep of workers frequently changing shifts (abstract). Sleep Res. 7: 314, 1978.

1902.
Warfield, R. How will you behave tomorrow? Vogue, Jan. 1, 1962.

1903.
Wax, T. M. Effects of age, strain, and illumination intensity on activity and self-selection of light-dark schedules in mice. J. Comp. Physiol. Psychol. 91: 51-62, 1977.

Young and senescent albino A/J mice, pigmented C57BL/6J pure inbred mice, and thir hybrid F_{1s} were tested under low or high illumination intensities to observe differences in self-selected wheel running, bar pressing, and durations of light and dark over time. The animals (N = 120) were always allowed ad lib. access to food, water, running wheel, and bar-press levers. During the pre- and postexperimental phases, the mice were kept under a standard 12:12 hr light/dark cycle; during the experimental phase, however, they were allowed to select their own light and dark schedules by pressing on either of two accessible bars, one light contingent and the other dark contingent. Measures of general running and bar-pressing activities, motivational aspects of illumination change and intensity preferences, time-series analyses of periodicities, power ratios, and significant other multiples were obtained from the subjects during a total of three experimental phases. Age differences were found for most of the measures studied and in general showed declines in activity levels, increases in motivation to change illumination conditions, lengthening of activity cycles (slower periods), and decreases in the strengths of the oscillations underlying these behaviors as well as an increase in the number of other periodic components in old mice relative to young. Genetic group and illumination-intensity differences were also found, and the results are discussed in light of theories concerning illumination preference and stimulus change, earlier work involving voluntary light selection behavior, and aging studies.

1904.
Weaver, C. A. The question of ups and downs. U. S. Army Aviation Digest 20(1): 13-17, 1974.

He found that 49% of Army Aviation Accidents occurred on biorhythm critical days, 64% of these accidents occurring on doubly critical days. Note: Wolcott, J. et al. (Biorhythms - Are they a waste of time? TAC Attack 15(11): 4-9, 1975) criticizes Weavers' method of selecting critical days and also found, using the same accident statistics as Weaver in a large sample of aviation accidents that no significant relationship between accident frequency and critical days was found.

1905.
Webb, W. B. Patterns of sleep behaviour. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep. (Proceedings of the Symp., Strasbourg, France, 1970), edited by W. P. Colquhoun. London: English Universities Press, Ltd., 1972, pp. 31-46.

Discussion of the electroencephalogram as the critical measurement procedure for sleep research, and survey of major findings that have emerged in the last decade on the presence of sleep within the twenty-four-hour cycle. Specifically, intrasleep processes, frequency of stage changes, sequency of stage events, sleep stage amounts, temporal patterns of sleep, and stability of intrasleep pattern in both man and lower animals are reviewed, along with some circadian aspects of sleep, temporal factors, and number of sleep episodes. It is felt that it is particularly critical to take the presence of sleep into account whenever performance is considered. When it is recognized that responsive performance is extremely limited during sleep, it is easy to visualize the extent to which performance is controlled by sleep itslef.

1905a.
Webb, W. B. Sleep behavior as biorhythm. In: Biological Rhythms and Human Performance, edited by W. P. Colquhoun, New York: Academic Press, 1971, 283 pp.

1906.
Webb, W. B. The rhythms of sleep and waking. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J. E. Pauly. Tokyo: Igaku Shoin, Ltd., 1974, pp. 482-486.

1907.
Webb, W. B. Schedules of work and sleep. In: Memory, Environment, Epilepsy, Sleep Staging, edited by W. P. Koella and P. Leum. New York: Karger Press, 1977, pp. 86-91.

1908.
Webb, W. B. The forty-eight hour day. Sleep 1: 191-197, 1978.

Four normal young adult male subjects were evaluated in a systematically imposed regime of 32 hr. of wakefulness and 16 hr of sleep time in an environment free from time cues. Electroencephalographic and electrooculographic recordings were made continuously during the experiment, which lasted for 10 complete cycles. Sleep efficiency was assessed by determining the percentage of sleep time during the assigned sleep period. The average sleep efficiency for the experimental period was 77%. Results, in general, conformed to earlier findings of non-24 hr schedules of sleep and waking: the overall sleep system remains relatively stable across a variety of scheduled variations: however, utilization of the sleep period becomes less efficient as the schedule increasingly deviates from the normal approximately 16 hr wakefulness 8 hr sleep schedule.

1909.
Webb, W. B. Sleep, Biological Rhythms and Aging. In: Aging and Biological Rhythms, edited by H. V. Samis and S. Capobianco. New York: Plenum Press, 1978, pp. 309-323.

1910.
Webb, W. B. A shifted work shift schedule with older subjects (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, FR., 1980, p. III-10.

1911.
Webb, W. B., and H. W. Agnew. Stage 4 sleep: influence of time course variables. Science 174: 1354-1356, 1971.

Age, length of prior wakefulness, length of time asleep, and a circadian influence all affect stage 4 sleep. The amount of stage 4 sleep decreases as subject's age increases and as time asleep increases. Longer periods of wakefulness before sleep result in greater amounts of stage 4 sleep in the first 3 hours of sleep. Sleep periods that begin at times other than the regular onset time tend to produce less stage 4 sleep; this decrease suggests a circadian effect.

1912.
Webb, W. B., and H. W. Agnew, Jr. Variables associated with split-period sleep regimes. Aerosp. Med. 42: 847-850, 1971.

Eight young adult males had their daily sleep period split into two periods of 4 hours in length. Different lengths of intervening wakefulness were introduced between the two periods: 1 hour, 4 hours, and 12 hours. One of the two sleep periods began at 2300 each day.

It was found that the total amount of tne various sleep stages in the two periods did not differ from baseline sleep in the 1 hour and 4 hour split conditions; there was an increase in waking and light sleep and a decrease in REM sleep in the 12 hour condition. An internal examination of the sleep within the two periods for the three conditions indicates that the particular outcome of split periods of sleep will be dependent upon three factors: the time interval between periods, the length of the periods, and the sidereal time of onset.

1913.
Webb, W. B., and H. W. Agnew, Jr. Sleep and waking in an environment free of cues to time (abstract). Psychophysiology 9: 133, 1972.

1914.
Webb, W. B., H. W. Agnew, Jr. Effects on performance of high and low energy expenditure during sleep deprivation. Percept. Mot. Skills 37: 511-512, 1973.

Fifteen male subjects (Ss) were studied once each week while on a sleep regime of 5 1/2 hrs of sleep a night for 60 days. The electroencephalogram and electro-oculogram were recorded in the laboratory once each week. Performance was measured each week using the Wilkinson Vigilance Task, the Wilkinson Addition Test, and a word memory test, and grip strength was measured using a hand dynomometer. The Zung Depression Scale and the Gough Adjective Check List were used to measure mood. The Ss completed a sleep log on a daily basis. The effect on sleep of the restricted regime was to initially increase the absolute amount of stage 4 sleep. But by the 5th week of the study the stage 4 amount decreased to near baseline levels. The initial effect on REM sleep was to sharply reduce this type of sleep when compared with baseline values. During the course of the experiment there was a REM deprivation of some 25% of baseline values and 30 min. in absolute amount. During the course of the experiment the latency to the onset of the first stage 4 and the latency to the first REM period were reduced. Only the Wilkinson Vigilance Task showed a decline in performance associated with continued restricted sleep. The sleep logs revealed that initially the Ss experienced difficulty in arousing from sleep in the morning and felt drowsy during the day, but these effects did not continue throughout the experiment. The mood scales showed no changes associated with continuing to sleep 5 1/2 hrs a night. These findings suggest that a chronic loss of sleep as much as 2 1/2 hours a night is not likely to result in major behavioral consequences.

1915.
Webb, W. B., and H. W. Agnew, Jr. The effects of a chronic limitation of sleep length. Psychophysiology 2: 265-274, 1974.

1916.
Webb, W. B., and H. W. Agnew, Jr. Regularity in the control of the free-running sleep-wakefulness rhythm. Aerosp. Med. 45: 701-704, 1974.

The natural tendency of humans to lengthen their sleepwakefulness cycle in environments which minimize natural cues to time of day poses problems for designing efficient work schedules. In the present experiment, rigid control over the sleep and wake-up times was employed in an attempt to contain the natural rhythm to a 24-h cycle. Eight subjects were isolated from all time and social cues for 10 d. They were placed on a rigid schedule of sleep between 11 p. m. and 7 a.m. The results indicate that, for practical purposes, the free-running sleep-wakefulness rhythm can be contained to a 24-h cycle by rigid control of the sleep portion of the cycle. When part of the control was released by allowing the subjects to sleep beyond 7 a.m., they slept an average of 67 min longer and showed sleep latencies which averaged 73 min. From these data it is concluded that control of the sleep portion of the sleep-wakefulness cycle, particularly control of the wake-up time, is sufficient to contain the free-running sleep-wakefulness rhythm to a 24-h cycle.

1917.
Webb, W. B., and H. W. Agnew, Jr. Sleep and waking in a time-free environment. Aerosp. Med. 45: 617-622, 1974.

The sleep and waking of 14 subjects in time-free environments for 14 d were studied. Half of the subjects had a heavy exercise regime. All subjects exhibited a longer-than-24 h rhythm but the groups did not differ from each other in this extension of the rhythm. There were large individual differences between subjects and large variations from the projected sleep and waking times. The overall amount of sleep increased in the environment, and there were marked increases in both shorter and longer sleep and waking period lengths. Exercise did not increase the overall amount of sleep but did increase the variability in the distribution of sleep. The overall distribution of sleep stages during sleep did not differ from baseline measures or between groups.

1918.
Webb, W. B., and H. W. Agnew, Jr. The effects on subsequent sleep of an acute restriction of sleep length. Psychophysiology 12: 367-370, 1975.

This experiment was designed to test the effects on subsequent sleep of a restriction in sleep length on the previous night. Eight male subjects were studied. After baseline recordings were made, sleep was restricted to either a period between 4-8 am or to a period between 6-8am. On the night following the restriction of sleep the subjects retired at 11 pm and they weere permitted to sleep ad lib. in the morning. The restricted sleep periods resulted in differential sleep deprivation. Stages REM and 2 were markedly reduced whereas stages 3 and 4 showed little or no reduction in amount. There were significant reductions in sleep latencies and in the amount of time spent in stages 0 and 1. The first 8 hrs of ad lib. sleep following the 2 restricted sleep periods did not differ in any significant way from the 8 hrs of baseline sleep. When sleep was permitted to continue until the subjects awakened spontaneously, the sleep after the restriction of sleep to 2 hrs was significantly longer and displayed significantly more of stages REM and 2 when compared with the baseline ad lib. sleep condition. The ad lib. sleep period following the 4 hr condition showed similar changes although the differences were not statistically significant. The significant reductions in stages REM and 2 during the restricted sleep periods were attributed to the effects of reduced sleep length *per se*. The increases in sleep length and specifically the increases in stages REM and 2 during the ad lib. sleep periods were attributed to a differential sleep "debt" accruing from restricted sleep length.

1919.
Webb, W. B., and H. W. Agnew, Jr. Sleep efficiency for sleep-wake cycles of varied length. Psychophysiology 12: 637-641, 1975.

This study was designed to test sleep efficiency while subjects were maintained on non-24-hr regimens of sleep and wakefulness. The regimens studied were 9, 12, 18, 30, and 36-hr sleep-wake cycles. In each regiment the ratio of sleep to wakefulness was held constant in a 1:2 ratio, i. e. there were 2 hrs of wakefulness for each hour of scheduled sleep. The amounts of sleep obtained under each experimental regimen were less than those obtained under the basseline days of 24 hrs. The sleep losses resulted both from an increase in the latency of sleep onset and increased wakefulness after sleep onset. The primary variables which resulted in less efficient sleep were scheduled differences in prior wakefulness, circadian effects on the displacement of sleep onset times, a sleep termination effect, and the frequency of occurrence of the allotted sleep periods. In the short regimens the awake time after sleep onset was strongly associated with the degree to which prior wakefulness was reduced. In the longer regimens the principal sources of awake time were extended sleep length and a sleep termination effect.

1920.
Webb, W. B., and H. W. Agnew, Jr. Analysis of the sleep stages in sleep-wakefulness regimens of varied length. Psychophysiology 14: 445-50, 1977.

Two to 4 different young adult males were studied while on five different regimens of sleep-wakefulness. The regimens studied were: 3 hrs sleep, 6 hrs wakefulness; 4 hrs sleep, 8 hrs wakefulness; 6 hrs sleep, 12 hrs wakefulness; 10 hrs sleep, 20 hrs wakefulness; and, 12 hrs sleep, 24 hrs wakefulness. The EEG-EOG was recorded during the sleep period. The largest change in sleep pattern occurred in the short regimens. In these regimens Stage 2 was reduced and Stages 3/4 increased. The amount of REM sleep was stable across all regimens. The temporal distribution of Stages REM and 4 was maintained within the modified regimens. Increases in amount of prior wakefulness acted predictably to increase the amount of Stage 4. REM sleep was responsive to sleep onset time.

1921.
Webb, W. B., and Agnew, H. W., Jr. Effects of rapidly rotating shifts on sleep patterns and sleep structure. Aviat. Space Environ. Med. 49: 384-389, 1978.

Six young adult males were assigned to a rapidly rotating shift work schedule (2 d 6 am-4 pm, 2 d 4 pm-10 pm, and 2 d 10pm-6 am). They lived in the laboratory and completed two rotations. Their nonshift activities were ad libitum including sleep times. The patterns and structure of sleep were analyzed. Shift times systematically affected sleep patterns. Within shifts, Ss slept as late as possible prior to the morning shift, went to bed shortly after the night shift, and slept approximately midway between shifts on the afternoon shift. In transitioning to a new shift, the new shift time tended to determine sleep time. Sleep was significantly longer in transitions between shifts. Sleep structure was not markedly changed.

1922.
Webb, W. B., H. W. Agnew, and R. L. Williams. Effect on sleep of a sleep period time displacement. Aerosp. Med. 42: 152-155, 1971.

Five young adult males slept from 1800 to 1600 and did performance tasks from 1100 to 0700 for four days. Electroencephalograph records for the displaced sleep periods were scored for sleep stages and compared with baseline sleep (1100-0700). The time awake after sleep onset was slightly increased. The effect on the total relative amounts of sleep stages was minimal. The temporal distribution of the amounts of state 4 and REM sleep obtained per hour was clearly affected but the cyclical character of REM in terms of the time between periods was maintained. We infer from our data that observed decrements in performance due to time displacements are not likely to be due to disturbed sleep per se..

1923.
Webb, W. B., and M. Bonnet. Two measures of circadian and sleep loss effects on performance (abstract). Sleep. Res. 5: 107, 1976.

1924.
Webb, W. B., and M. H. Bonnet. The sleep of "morning" and "evening" types. Biol. Pyschol. 7: 29-35, 1978.

A questionnaire developed by Ostberg to differentiate 'morning' types from 'evening' types was administered to 100 college students. The actual sleep behavior of the 11 extreme 'morning' types (larks) and the 'evening' types (owls) was monitored for two weeks with a sleep log and the Post-sleep Inventory. Data was collected from the owls for a further two-week period in which the owls had been instructed to attempt to arise at the lark arousal time. In addition to going to bed earlier and getting up earlier than the owls, the larks had a less variable sleep length and awakening time and took shorter naps than the owls. Larks further reported fewer physical problems and less mental activity across the night as well as more adequate sleep than owls, who differed little from the normal college population even after having their awakening time shifted.

1925.
Webb, W. B., and M. H. Chase. Reviews - sleep cycle. *Sleep Res.* 7: 423-425, 1978.

Reviews of seven papers published from 1973 to 1976 by J. M. Taub and R. J. Berger.

1926.
Webb, W. B., and J. Friedman. Attempts to modify the sleep patterns of the rat. *Physiol. Behav.* 6: 459-460, 1971.

Attempts were made to modify the sleep patterns of rats by three extensive behavior control procedures: restriction of activity from weaning for three months; prevention of sleep during a set six hr period per day by water wheel enforced movement for 30 days; shock contingently associated with the onset of sleep during a set and well cued six hr period per day for ten days. Little or no modification of any enduring character was found when compared with control conditions. The data suggest a strong inherent control of the sleep response in the rat.

1927.
Wedderburn, A. A. I. Social factors in satisfaction with swiftly rotating shifts. *Occup. Psychol.* 41: 85-107, 1967.

1928.
Wedderburn, A. Man the scientific shift worker: an evaluation of the methodology of self recording of body temperature by industrial shift workers. In: *Proceedings of the Second International Symposium on Night and Shiftwork.* Slanchev Bryag, *Studia Laboris et Salutis* II: 96-100, 1972.

1929.
Wedderburn, A. A. I. EEG and self-recorded sleep of two shiftworkers over four weeks of real and synthetic work (abstract). *Int. J. Chronobiol.* 3: 7, 1975.

1930.
Wedderburn, A. A. I. *Studies of Shiftwork in the Steel Industry.* Edinburgh: Heriot-Watt University, 1975.

1931.
Wedderburn, A. A. I. Some suggestions for increasing the usefulness of psychological and sociological studies of shiftwork. *Ergonomics* 21: 827-833, 1978.

Instead of attempting to teach one correct conclusion on the attitudes of shift workers to shift work, social psychologists should work towards amplification of the meaning of 'adjustment to ' and 'satisfaction with' shift work. Single global questions, which are open to criticism on several grounds, may be combined with Job Descriptive Index (J. D. I.)-type scales. These are easy to complete show good agreement with global questions, and may be used to point our problems in a shift work situation. These problems tend to be multiple for most shift workers: physical, social and personal, but further work is needed to map out their interrelationships in different shift work systems and situations. Sociologists could usefully explore the characteristic features of social settings where shift work is more or less acceptable.

1932.
Wedderburn, A. A. I. Is there a pattern in the value of time off work (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen Fr., 1980, p. VIII-9.

1933.
Weddige, D. Untersuchungen zum Tag-Nacht-Unterschied der korperlichen Leistungsfahigkeit (Investigations on the day-night-differences of physical peformance capacity). Bonn-Bad Godesberg: Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt. Institut for Flugmedizin, 1974, DLR-FB 74-29, 70 pp.

To investigate day-night-differences of physical performance capacity, we measured the maximal oxygen uptake in 16 male subjects during the day and the night. Maximal oxygen uptake was slightly but statistically significant higher during the night. In view of the fact, that at the same time maximal working time and performance were significantly lower, we must assume a poorer effectiveness during the night.

1934.
Wegmann, H. M., and R. Herrman, and C. M. Winget. Bioinstrumentation for evaluation of workload in payload specialists: results of assess II. In: Proc. of XXX Congress of International Astronautical Federation, Munich, 1979. New York: Pergamon Press, 1979, pp. 1-11.

1935.
Wegmann, H. N., R. Herrmann, and C. M. Winget. Effects of irregular work schedules in a space mission simulation (ASSESS II) (abstract). In: Int. Symp. on Night- and Shift-work, 5th, Rouen, Fr., 1980, p. II-3.

1936.
Wegmann, H. M., R. Herrmann, C. M. Winget, M. deMuizon, D. Rounan, P. Lena, J. Wijnbergen, H. Olthof, K. W. Michel, C. Werner, F. Melchiorri, B. Melthiorri, V. Natale, R. Falciani, L. R. Smaldone, E. Bussoletti, J. Crawford, R. Rothwell, M. Taylor, J. E. Beckman, D. Dale, J. Schmitt, and J. de Waard.

Assess II: a simulated mission of Spacelab (review article). Nature 275: 15-19, 1978.

1937.
Wegmann, H. M., and K. E. Klein. Auswirkungen transmeridianer Fluge mit raschem Ortzeitwechsel auf die Leistungsfahigkeit des Menschen (The effects of transmeridian flight with rapid time displacement on the performance capability of humans). Internal Report of the Deutsche Forshungs und Versuchsanhalt fur Luft und Raumfahrt, No. 004-71/3, 1971, 19 pp.

1938.
Wegmann, H. M., and K. E. Klein. Internal dissociation after transmeridian flights. In: Int. Congr. Aviat. Space Med., 21th Munchen, 1973, Preprints. 1973, pp. 334-337.

1939.
Wegmann, H. M., K. E. Klein, and P. Kuklinski. Storungen der Tagesrhythmik nach zwei Transatlantik flugen in rascher Folge (Changes in the 24-hour rhythm after two transatlantic flights in rapid succession). Bonn-Bad Godesberg: Deutsche Forshungs- und Versuchsanstalt fur Luft- und Raumfahrt. Institute fur Flugmedizin, DFVLR Forschungsbericht 73-15: 221-236, 1973. (trans. in Engl. by European Space Research Organisation, ESRO-TT-35, 1973.)

The effects of two transatlantic flights in rapid sequence upon the 24-hour rhythm of body functions and performance were studied in 8 male subjects. Flights were performed as outgoing and return flight between Frankfurt and Chicago with a time shift of 6 hours and a stopover time of 26 hours. The results and their operational significance for the flying personnel are discussed.

1940.
Wehr, R. A., and F. K. Goodwin. Biological rhythms and affective illness. Weekly Psychiatry Update Series 8: 2-8, 1978.

1941.
Wehr, T. A., A. Wirz-Justice, and F. K. Goodwin. Tricyclic antideptessant drugs shorten the period of hamster circadian rhythms. Chronobiologia 6: 169, 1979.

1942.
Wehr, T. A., A. Wirz-Justice, F. K. Goodwin, W. Duncan, and J. C. Gillin. Phase advance of the circadian sleep-wake cycle as an antidepressant. Science 206: 710-713, 1979.

Sleep in depressed patients resembles sleep in normal subjects whose circadian rhythms of temperature and rapid-eye-movement sleep are phase-advanced (shifted earlier) relative to their sleep schedules. If this analogy is relevant to the pathophysiology of depressive illness, advancing the time of sleep and awakening should temporarily

compensate for the abnormal timing of depressed patients' circadian rhythms. Four of seven manic-depressive patients studied longitudinally spontaneously advanced their times of awakening (activity onset) as they emerged from the depressive phase of their illness. In a phase-shift experiment, a depressed manic-depressive woman was twice brought out of depression for 2 weeks by advancing her sleep period so that she went to sleep and arose 6 hours earlier than usual. The antidepressant effect of the procedure was temporary and similar in duration to circadian desynchronization induced by jet lag in healthy subjects. This result supports the hypothesis that abnormalities of sleep patterns in some types of depression are due to abnormal internal phase relationships of circadian rhythms.

1943.
Weitzman, E. D. Effect of sleep-wake cycle shifts on sleep and neuroendocrine function. In: Behavior and Brain Electrical Activation, edited by N. Burch and H. I. Altshuler. New York: Plenum Press, 1973, pp. 93-111.

1944.
Weitzman, E. D., Neuroendocrinologic aspects of the sleep-waking cycle. Presentation to the Association for the Psychophysiological Study of Sleep, annual meeting. Los Angeles: U.C.L.A. Brain Information Service Bri Publications BIS Conf. Rpt. #32.

1945.
Weitzman, E. D. Temporal organization of neuroendocrine function in relation to the sleep-waking cycle in man. In: Recent Studies of Hypothalamic Function, edited by K. Lederis and K. E. Cooper. Proc. of the Int. Symp. Calgary, Alberta, Canada 1973. Basel: S. Karger A.G., 1974, pp. 26-38.

1946.
Weitzman, E. D. Temporal patterns of neuro-endocrine secretion in man: relationship to the 24-hour sleep waking cycle. In: Chronobiological Aspects of Endocrinology, edited by J. Aschoff, et al. Stuttgart: Schattauer, 1974, pp. 169-84.

1947.
Weitzman, E. Neuro-endocrine pattern of secretion during the sleep-wake cycle of man. Prog. Brain Res. 42: 93-102, 1975.

1948.
Weitzman, E. D. Circadian rhythms. In: Shiftwork and Health: A Symposium, edited by P. G. Rentos and R. D. Shepard. DHEW Publication No. (NIOSH) 76-203. Washington, D. C.: U. S. Government Printing Office, 1976.

1949.
Weitzman, E. D. Sleep stage organization: neuro endocrine relations. In: Sleep, Wakefulness and Circadian Rhythm. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, AGARD-LS-105, 1979, pp. 3-1 - 3-9.

1950.
Weitzman, E. D., R. M. Boyar, S. Kapen, L. Hellman. The relationship of sleep and sleep stages to neuroendocrine secretion and biological rhythms in man. Recent Prog. Horm. Res. 31: 399-446, 1975.

1951.
Weitzman, E. D., C. Czeisler, R. Coleman, W. Dement, G. Richardson, and C. Pollak. Delayed sleep phase syndrome: a biological rhythm sleep disorder. Sleep Res. 8: 221, 1979.

1952.
Weitzman, W. D., C. A. Czeisler, R. Fusco, and M. C. Moore-Ede. Relationship of cortisol, growth hormone, body temperature, and sleep in man living in an environment free of time cues (abstract). Sleep. Res. 5: 219, 1976.

1953.
Weitzman, E. D., C. A. Czeisler, and M. C. Moore-Ede. Biological rhythms of man living in isolation from time cues. In: Sleep Wakefulness and Circadian Rhythm. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development. AGARD-LS-105, 1979, pp. 7-1 - 7-9.

1954.
Weitzman, E. D., C. A. Czeisler and M. C. Moore-Ede. Sleep-wake, neuroendocrine and body temperature circadian rhythms under entrained and non-entrained (free-running) conditions in man. In: Biological Rhythms and Their Central Mechanism (A Naito Foundation Symposium), edited by M. Suda, O. Hayaishi, and H. Nakagawa. New York: Elsevier/North-Holland, 1979, pp. 199-227.

1955.
Weitzman, E. D., C. A. Czeisler, A. J. Spielman, H. Fiss, and J. C. Zimmerman. Chronotherapy treatment of a patient with a combined chronic short sleep period and delayed sleep phase syndrome (Unpublished abstract, personal communication with Dr. Weitzman, Montefiore Hospital, Bronx, N. Y.).

1956.
Weitzman, E. D., C. A. Czeisler, and J. C. Zimmerman. Sleep-wake organization during "free-running" in older men (Unpublished abstract, personal communication with Dr. Weitzman, Montefiore Hospital, Bronx, N.Y.).

1957.
Weitzman, E. D., C. A. Czeisler, J. C. Zimmerman, and M. C. Moore-Ede. Biological rhythms in man: relationship of sleep-wake, cortisol, growth hormone and temperature during temporal isolation (Unpublished), 1980, 19 pp.

1958.
Weitzman, E. D., C. A. Czeisler, J. C. Zimmerman, and J. Ronda. The timing of REM sleep and its relation to spontaneous awakening during temporal isolation in man (Unpublished abstract, personal communication with Dr. Weitzman, Montefiore Hospital, Bronx, N.Y.).

1959.
Weitzman, E. D., C. A. Czeisler, J. C. Zimmerman, and J. M. Ronda. The timing of REM and Stages 3 and 4 sleep during temporal isolation in man (submitted for publication), 1980, 27 pp.

1960.
Weitzman, E. D., D. Fukushima, C. Nogeire, L. Hellman, J. Sassin, M. Perlow, and T. F. Gallagher. Studies on ultradian rhythmicity in human sleep and associated neuro-endocrine rhythms. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J. E. Pauly. Tokyo: Igaku Shoin, 1974, pp. 503-505.

1961.
Weitzman, E. D., and L. Hellman. Temporal organization of the 24-hour pattern of the hypothalamic-pituitary axis. In: Biorhythms and Human Reproduction, edited by M. Ferin, F. Halberg, R. M. Richart, and R. L. Van de Weile, New York: John Wiley and Sons, 1974, pp. 371-395.

1962.
Weitzman, E. D., C. Kokkoris, C. P. Pollak, A. Spielman, C. A. Czeisler, H. Bradlow, J. Axel, W. Gruen, and A. Katoroff. Development of a long term solid state portable core body temperature recorder (solicorder): application to a patient with a circadian rhythm sleep-wake disturbance (abstract). Sleep Res. 6: 221, 1977.

1963.
Weitzman, E. D., D. F. Kripke, D. Goldmacher, P. McGregor, and C. Nogeire. Acute reversal of the sleep-waking cycle in man. Arch. Neurol. 22: 483-489, 1970.

Five healthy young men were subjected to an acute sleep-wake cycle reversal (a phase shift of 180°) in a laboratory. A significant increase in waking and a decrease in REM sleep time occurred during the inverted sleep period. No change in the amount of time spent instages 2, 3, and 4 was noted. After reversal there was a shift of REM and stage 2 sleep toward the early part of the sleep period, and waking shifted toward the latter part. In addition, the duration of episodes of all stage stages of sleep decreased, and the number of changes of sleep stage increased after reversal. Despite these changes in duration, amount, stability, and timing of sleep stages, the basic 90 to 200 minute cycling was preserved following acute inversion to day sleep.

1964.
Weitzman, E. D., M. C. Moore-Ede, R. E. Kronauer, J. C. Zimmerman and C. Campbell. Human sleep: its duration and structure depend on the interaction of two separate circadian oscillators (unpublished abstract , personal communication with Dr. Weitzman, Montefiore Hospital, Bronx, N.Y.).

1965.
Weitzman, E. D., C. Nogeire, M. Perlow, D. Fukushima, J. Sassin, P. McGregor, T. F. Gallagher, and L. Hellman. Effects of a prolonged 3-hour sleep-wake cycle on sleep stages, plasma cortisol, growth hormone and body temperature in man. J. Clin. Endocrinol Metab. 38: 1018-1030, 1974.

1966.
Weitzman, E. D., and C. P. Pollak. Disorders of the circadian sleep-wake cycle. Medical Times 107: 83-94, 1979.

Man's temporal relationship to his planet is clearly defined in this paper, which reveals how his circadian sleep-wake cycles are linked to the 24-hour period of the solar day. We all have a "biological clock" that can operate without time cues, such as light and dark. But if we keep shifting our light/dark cycles, sleep-wake problems may ensue. Luckily, however, our clocks can be reset so tha our cycles will conform to the solar and social day.

1967.
Welford, A. T. Stress and performance. Ergonomics 16: 567-580, 1973.

The effects on performance are discussed of various types of stress deriving from imbalance between capacity on the one hand and, on the other, the demands of tasks, environmental conditions and social situations which either overload or underload the individual. Common cybernetic principles seem to apply over an area which includes not only stress, but also motivation and arousal. A model is proposed which ties together three previously existing models current in this field: the Inverted-U Hypothesis, Signal Detection Theory and the Yerkes-Dodson Law. The model is examined further in relation to individual differences of personality and to problems of conserving talent among students and those carrying heavy executive responsibility.

1968.
Wendt, H. W., Circadian activity inventories in light of three research issues (abstract). Chronobiologia 4: 162, 1977.

1969.
Wenos, J., and K. Wenos. We all got rhythms. Track and Field News, pp. 24-25, April, 1974.

The authors claim that through the science of biorhythm, tendencies for off days or super performances by track and field athletes can be pinpointed with remarkable accuracy and cite numerous anecdotal examples of track performances related to biorhythm phases. They speculate that athletes may use biorhythm charts to program their competitive schedules to correspond with favorable biorhythmic patterns.

1970.
Wernli, H. J. Biorhythm: A Scientific Exploration into the life Cycles of the Individual. New York: Crown, 1960.

This book provides a general discussion of biorhythm theory in conversational style with primary emphasis on its application to work scheduling in various occupations. The author claims that certain airlines have the copilot take over takeoffs and landings when the pilots biothythm position is poor but no documentation is presented for this claim. He cites as a cosmic correspondence for biorhythm cycles a 23 year sunspot cycle and 28 day moon cycle. He cites the work of Hersey as evidence for the 33 day biorhythm (for critique of this claim see Hersey 1931 J. Mental Sci. 77: 151 in bibl.) along with the fact that cerebral cortex pyramidal cells undergo exactly 33 cell divisions. A series of anecdotal accounts of the relationship between events in the lives of celebrities and biorhythm phases is presented. A foreword by F. Wehrli, M. D. cites the use of biorhythm in his clinic, especially before surgery or blood transfusions, to determine the most advantageous period for surgery or treatments and claims that in over 10,000 cases in which patients biorhythms were considered, no accidents worth mentioning were observed. Note: the citing of 23 year sunspot cycles and 33 cell divisions has nothing to do with a reputed 23 day biological rhythm. It is pure numerology.

1971.
Wernli, H. Biorhythm. Cornerstone Press, 1976, 128 pp.

1972.
Wesseldijk, A. T. G. The influence of shift work on health. Ergonomics 4: 281-282, 1961.

1973.
West, J. N. Investigating the Effect of Prior Sleep on Subsequent Waking Memory, University of Colorado, 1974.

1974.
West, V., and J. P. Parker. A Review of Recent Literature: Measurement and Prediction of Operational Fatigue. Arlington, VA.: Office of Naval Research AD-A008 405, 1975, 80 pp.

1975.
Weston, L. Body Rhythm - The Circadian Rhythms Within You. New York: Harcourt Brace Jovanovich, Inc., 1979, 170 pp.

This is a popular book describing the nature of circadian rhythms. The first chapter describes the history of circadian research. The second chapter describes various circadian rhythms found in the animal kingdom. In the third chapter the author describes various human circadian rhythms. Then in chapter four through ten, he discusses circadian rhythms in relation to work, recreation, sickness, health, stress, and jet lag. The book provides a simple understanding of circadian rhythms.

1976.
Weston, L. Our rhythms and your safety. Proc. Ann. Symp. SAFE Assoc., 7th, Las Vegas, 1979, pp. 248-251.

1977.
Wever, R. Uber die Beeinflussung der Circadianen Periodik des Menschen durch Schwache elektromagnetischer Felder. (The influence of weak electromagnetic fields on the circadian rhythm in man). Z. Vergl. Physiol. 56: 111-128, 1967.

1978.
Wever, R. Gesetzmassigkeiten der circadianen Periodik des Menschen, gepruft an der Wirkung eines schwachen elektricshen Wechselfeldes. Pfluger's Arch. 302: 97-122, 1968.

1979
Wever, R. Zur zeitgeber-starke eines Licht-Dunkel-Wechsels fur die circadiane Periodik des Menschen (Strength of a light-dark cycle as a Zeitgeber for circadian rhythms in man). Pfluger's Arch. 321: 133-142, 1970.

1980.
Wever, R. Circadian rhythms in human performance. In: Proc. NATO-Symp. on Drugs, Sleep, and Performance, 1972, pp. 11/1-11/12.

1981.
Wever, R. Virtual synchronization towards the limits of the range of entrainment. J. Theor. Biol. 36: 119-132, 1972.

1982.
Wever, R. Mutual relations between different pnysiological functions in circadian rhythms in man. J. Interdisip. Cycle Res. 3: 253-265, 1972.

1983.
Wever, R. Der Einfluss des Lichtes auf die circadiane Periodik des Menschen. I. Einfluss auf die autonome Periodik. Z. Physik. Med. 3: 121-124, 1973.

1984.
Wever, R. Human circadian rhythms under the influence of weak electric fields and the different aspects of these studies. Int. J. Biometeor. 17: 227-232, 1973.

1985.
Wever, R. Internal phase-angle differences in human circadian rhythms: causes for changes and problems of determinations. Int. J. Chronobiol. 1: 371-390, 1973.

1986.
Wever, R. Der Einfluss des Lichtes auf die circadiane Periodik des Menschen II. Zeitgebereinfluss (The influence of light on the circadian rhythms of man II. The influence of Zeitgebers). Z. Physik. Med. 3: 137-150, 1974.

1987.
Wever, R. ELF - effects on human circadian rhythms. In: ELF and VLF Electromagnetic Field Effects, edited by M. A. Persinger. New York: Plenum Press, 1974, pp. 101-143.

1988.
Wever, R. The influence of self-controlled changes in ambient temperature on autonomous circadian rhythms in man. Pfluger's Arch. 352: 257-266, 1974.

1989.
Wever, R. Bedeutung der circadianen Periodik fur das Alter. Naturw. Rdsch. 27: 475-478, 1974.

1990.
Wever, R. Autonomous circadian rhythms in man, singly versus collectively isolated subjects. Naturwissenshaften 62: 43-44, 1975.

1991.
Wever, R. The circadian multi-oscillator system of man. Int. J. Chronobiol. 3: 19-55, 1975.

1992.
Wever, R. Use direction asymmetry in the duration of resynchronization of human circadian rhythms after phase shifts of the Zeitgeber (abstract). Pfluger's Arch. 359 (suppl.): R143, 1975.

1993.
Wever, R. Quantitative studies of the interaction between different circadian oscillators within the human multi-oscillator system. Chronobiologia 2, Suppl. 1: 77, 1975.

1994.
Wever, R. Probleme der zircadianen Periodik und ihrer Storungen (Problems of circadian periodicity and its disorders). Arzneim. Forsch. 26: 1050-1054, 1976.

The human circadian system controlling the variety of overt 24-h rhythms consists of some different oscillators which are separately self-sustained. Normally, all oscillators run synchronously to each other; under certain external and internal conditions (e. g. increasing score of neuroticism, or old age), however, they run in the steady state with different periods. The necessary synchronization of the endogenously driven oscillatores to the environment is effected, in man, essentially by social timing mechanisms; their efficiency presupposes the possibility as well as the ability to establish social contacts. A timing mechanism may synchronize the circadian system only partially; as a result, only several oscillators are synchronized whereas others persist to run autonomously. The different rhythm disorders, internal or external desynchronizations, when effective for a long time, may be sources of ill health.

1995.
Wever, R. Effects of weak 10 Hz fields on separated vegetative rhythms involved in the human circadian multi-oscillator system. Arch. Met. Geoph. Biokl., Ser. B, 24: 123-124, 1976.

1996.
Wever, R. Effects of low-level, low-frequency fields on human circadian rhythms. Neurosci. Res. Program Bull. 15: 39-45, 1977.

1997.
Wever, R. Quantitative studies of the interaction between different circadian oscillators within the human multi-oscillator system. Proc. International Conference of International Society of Chronobiology. 12th, Milan: Il Ponte, 1977, pp. 525-535.

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Wever, R.A. Phase shifts of human circadian rhythms due to shifts of artificial Zeitgebers. Chronobiologia 7: 303-327, 1980.

1999.
Wever, R. The Circadian System of Man, Results of Experiments Under Temporal Isolation. New York: Springer-Verlag, 1979, 276 pp.

2000.
Wever, R. A. Influence of physical workload on freerunning circadian rhythms of man. Pfluegers Arch. 381: 119-126, 1979.

2001. Wever, R., and R. Lund. Free and forced internal desynchronization of circadian rhythms. Int. Cong. Aviat. Space Med., 21st, Munich, 1973, preprint pp. 246-259.

2002.
Weybrew, B. B. Submarine crew effectiveness during submerged missions of sixty or more days duration. Groton, Conn.: Naval Submarine Medical Center, NSMRL - 686, 1971, 29 pp.

2003
Whitton, J. L. An empirical study of biorhythm in humans. New Horizons 2: 32-35.

2004.
Whitton, J. L. Periodicities in self-reports of health, sleep and mood variables. J. Psychosomatic Res. 22: 111-115, 1971.

Self-reports of health, hours sleep, mood and cognition were performed at the same time of day in 18 subjects for 320 days or more. Power spectral analysis revealed significant cycles in 54.6% of the time series. Of the periods found, 56.1% were 21-57 days long. Cycles of about 28 days were found in both sexes.

2005.
Wilkinson, C. W., J. Shinsako, and M. F. Dallman. Daily rhythms in adrenal responsiveness to adrenocorticotropin are determined primarily by the time of feeding in the rat. Endocrinology 104: 350-359, 1979.

2006.
Wilkinson, R. T. Methods for research on sleep deprivation and sleep function. In: Sleep and Dreaming, edited by E. Hartmann. Boston: Little, Brown, 1970, pp. 369-381.

2007.
Wilkinson, R. T. Sleep deprivation - eight questions. In: Aspects of Human Efficiency: Diurnal Rhythm and Loss of Sleep, (Proceedings of the Symposium. Strasbourg, France, 1970). edited by W. P. Colquhoun, London: English Universities Press, Ltd., 1972, pp. 25-30.

In the light of published findings, variations in the effects of sleep deprivation are reviewed as functions of work duration, time of day or night, memory function, information demands of tasks, environmental factors, use of drugs, and age. The effects of partial, or chronic sleep deprivation are also considered.

2008.
Wilkinson, R. T., and M. Stretton. Performance after awakening at different times of night. Psychon. Sci., 23: 283-285, 1971.

Naval ratings were roused during the night and presented themselves, dressed, for testing in a nearby room within 4 min. During the next 11 min, they were given tests of reaction time, calculation, and muscular coordination and steadiness. In all three tests, performance was well below the normal level achieved during the day. On different occasions, the men were roused at different times of night, and this factor influenced which task was affected most. Reaction time, with its intermittent call for rapid response, was impaired most in the early part of the night; the adding and coordination tasks, which demanded more continuous performance, were more affected later in the night. It is suggested that the early effects may be due to the depth of the preceding sleep, while the later ones may be influenced more by the trough in the circadian cycle of physiological activity.

2009.
Williams, H. L., and C. L. Williams. Nocturnal EEG profiles and performance. Psychophysiology 3: 164-175, 1966.

2010.
Williamson, T. B. Cancel today, and save tomorrow. Air Scoop 15: 18-20, 1975.

In an analysis of 59 USAF aviation accidents, he found that 44% occurred on biorhythm cycle critical days. However, Wolcott, et al, have criticized this study, claiming that Williamson used a 72-hour critical period and attempted to compare his results with those expected for a 24 hour period.

2011.
Willis, H. R. Biorhythm and its relationship to human error. Proceedings of the Annual Meeting of the Human Factors Society, 16th, Los Angeles, Cal, 1972, pp. 274-282.

The author cites accident statistics from the Ohmi Railway Co. of Japan in which 31% of 212 driver accidents occurred on days adjacent to the critical days. Institution of a biorhythm safety plan resulted in 2 million accident free kilometers. Kurucz and Khalil criticize the implication that a significantly high frequency of accidents in this study occurred on biorhythm critical days by pointing out that the expected accident frequency depends upon the definition of critical day. If the definition (unspecified) in this study included noon crossing days and days before and after midnight crossing then the percentage of accidents specified on critical and adjacent days would not significantly exceed chance expectation. The author refers to additional biorhythm studies being performed with respect to auto accidents, hospital records and performance of football teams.

2012.
Willis, H. R. Biorhythm and Its Relationship to Human Error. Missouri Southern State College, Joplin, Mo., 1973.

Of 200 hospital deaths in the Joplin, Mo., area, 112 (56%) died on critical days. In another sample of 120 hospital deaths, 62 (52%) occurred on critical days. Of 78 heart attack deaths, 63% occurred on critical days. In an analysis of 100 fatal auto accidents involving a single driver, 46% died on a critical day and 57% died on the critical and adjacent days. Note: depending upon the definition of critical day, these results may not be statistically significant. See Kurucz and Khalil J. Safety Res. 9: 150-158, 1977.

2013.
Willis, H. R. The effect of biorhythm cycles - implications for industry. Paper presented at the American Industrial Hygiene Conference, Miami Beach, Fla., 1974.

2015.
Wilson, M. M., R. W. Rice, and V. Critchlow. Evidence for a free-running circadian rhythm in pituitary-adrenal function in blinded adult female rats. Neuroendocrinology 20: 289-295, 1976.

2016
Winget, C. M. Circadian rhythms in human subjects. Chronobiologia 2, Suppl. 1: 78, 1975.

2017
Winget, C. M. Circadian rhythms of the Rhesus monkey. In: The Rhesus Monkey, edited by G. H. Bourne. New York: Academic Press, Vol. 2, 1975, pp. 277-302.

2018
Winget, C. M. Significance of biorhythms in space flight. In: Proc. of the 1973 JSC Endocrine Program Conf., 1975, 11 pp. Moffett Field, Calif.: National Aeronautics and Space Administration, Ames Research Center.

Evidence is presented that the most important factor in the maintenance of optimal health and performance is the stability of the relationship of one body rhythm to another. The effect of social interaction on performance, well-being, and physiological rhythm synchrony was investigated. Three groups of healthy males, ages 21 to 25, were confined in rooms (3.4 by 5.2 meters (11 by 17 feet) for a total period of 105 days. Two of the groups were in rooms in which the environment could be regulated. The third group served as the control group and was exposed to ambient experimental conditions. The confined subjects were exposed for periods to several days either to 16 hours of light and 8 hours of dark, or to continuous light at a light intensity of 161 lm/sq m (15 foot-candles). The confined subjects were deprived of all time cues, and meals were ad libitum. The subjects were observed throughout the study by a video camera and were scored for activity. Communications were limited to meal and sample-collection information, and meals and samples were passed through a two-way hatch. Rectal temperature and heart rate (HR) were sampled every 30 minutes by telemetry throughout the study. Results are presented.

2019
Winget, C. M. Biorhythms and space experiments with nonhuman primates. In: The Use of Nonhuman Primates in Space, edited by R.C. Simmonds and G.H. Bourne, Springfield, VA: National Technical Information Service, NASA Conference Publ. 005, 1977, pp. 165-177.

Man's response to exposure to spaceflight and weightlessness is expressed in physiological adjustments which involve his health and ability to function. The amplitude and periodicity of fluctuations in biological processes affect various functions and responses to provocative stimuli. Primates and other species are subjected to tests to determine the consequences of an altered biorhythm on work and performance, emotional stability, biomedical evaluation in space, the ability to cope with the unexpected, and susceptibility to

infection, toxicity, radiation, drugs, and stress. Factors in the environment or operational setup which can change the physiological baseline must be determined and controlled.

2020.
Winget, C. Telling your body where you are - post-flight adjusting. The British American, May, 1978, p. 25.

2021.
Winget, C. M. Desynchronosis on the human body - a pictorial presentation. Proc. Ann. Symp. SAFE Assoc., 7th, Las Vegas, 1979, pp. 252-256.

2022.
Winget, C. M. Telling time by the body clock. Runner's World 14: 63-65, 1979.

2023.
Winget, C. M. and J. R. Beljan. Circadian systems in medicine. PART I. Nebraska Med. J. 65(11): 303-306, 1980.

2024.
Winget, C. M. and J. R. Beljan. Circadian systems in medicine. PART II. Nebraska Med. J. 65(12): 326-329, 1980.

2025.
Winget, C. M., G. H. Bond, L. S. Rosenblatt, N. W. Hetherington, E. A. Higgins, and C. DeRoshia. Quantitation of desynchronosis. Chronobiologia 2: 197-204, 1975.

In order to find ways of preventing or correcting the effects of desynchronosis, it is necessary to know the physiological mechanisms that are affected and to quantitatively determine their rate of recovery following a time-zone change. To best accomplish this, it is necessary not only to establish the rates of change brought about in performance and physiological systems during actual flight experiments, but to complement these observations with ground-based simulation experiments. A mathematical model was developed to quantitatively describe desynchronosis and was applied to data obtained from ground-based photoperiod shift studies using monkeys. An initial steady state, V_c, and a final steady state, V_s, are postulated. The measured data vector, V_t, initially equals V_c, and finally equals V_s. The difference vector, V_{ts} with components $A(t)$ and $B(t)$, defined as the dot product and cross product of vectors V_t and V_s, is termed the desynchronosis vector. The trajectory of $A(t)$ with time is given by: $A(t) = A - e^{(a+Bt)}$, where A is the asymptote denoting complete resynchronization, a is proportional to the total desynchronosis on day 0, and B is the rate of resynchronization. The number of cycles required to achieve a 95% recovery, t_{95}, is computed. This model has been applied to body temperature (BT) data from a monkey subjected to a 180° phase-shift by alternating the photoperiod. The BT rhythm was initially stable and a 180° reversal of phase with the new environment was eventually achieved. Estimated rephasal times were: 37% in 2.6 days; 50% in 5.6 days, and 95% in 8.4 days. Similar rates of internal and external resynchronization have been obtained from human photoperiod shift, ground-based experiments. Estimated rephasal time for BT rhythms with HR rhythms to the new photoperiod (t_{95}) is 4.9 days.

2026.
Winget, C. M., L. F. Chapman, D. A. Rockwell, J. Vernikos-Danellis, and J. R. Beljan. Human circadian rhythms: psychological, performance and physiological deconditioning in the aeronautics and astronautics environment. Chronobiologia 6: 173-174, 1979.

2027.
Winget, C. M., C. W. DeRoshia, and J. R. Beljan. Influence of 105 days of social deprivation on physiological rhythmicity. Aerosp. Med. Assoc., Preprints, 1974, pp. 87-88.

2028. Winget, C. M., C. W. DeRoshia, and H. Sandler. Influences of horizontal hypokinesia on performance and circadian physiological rhythms in female humans. The Physiologist 22 (Suppl): S79-S80. 1979.

2029.
Winget, C. M., C. W. DeRoshia, and H. Sandler. The effect of bedrest and confinement on circadian rhythm synchrony of female subjects. Aerosp. Med. Assoc., Preprints, 1976, pp. 254-255.

We have in recent years reported that hypokinesis induced by bedrest in humans results in circadian rhythmic desynchronization despite the presence of a well defined light-dark cycle. This appeared to be caused by the phase shifting of different physiological parameters. The onset and rate at which this phase shifting occurred depends on the duration of bedrest and on the particular paramenter measured. For instance, although the body temperature, glucose and insulin rhythms became unstable very early during bedrest, heart rate did not phase-shift until after the twenty-second day. Since previous bedrest studies have been limited to young male subjects, the present study was designed to determine if female human subjects exhibit comparable changes in rhythmic stability in response to bed rest.

2030.
Winget, C. M., C. W. DeRoshia, J. Vernikos-Danellis, L. S. Rosneblatt, and N. W. Hetherington. Comparison of circadian rhythms in male and female humans. Waking and Sleeping 1: 359-363, 1977.

The heart rate (HR) and rectal temperature (RT) data reported here were obtained form 12 female and 27 male subjects. The subjects were housed in a facility where the environment was controlled. Human male and female RT and HR exhibit a circadian rhythm with an excursion of about 1.2°C and 30 beats/min, respectively. The acrophases, amplitudes, and level crossings are only slightly different between the sexes. The male HR and RT circadian wave forms are more stable than those of the females. However, the actual RT and HR of males were always lower than that of females at all time points around the clock. The HR during sleep in females is 15% below the daily mean heart rate and in males, 22%.

2031.
Winget, C. M., N. W. Hetherington, L. S. Rosenblatt, and P. C. Rambaut. Method for analyses of cyclic physiological data that are nonstationary in time. J. Appl. Physiol. 33: 635-639, 1972.

The application of the summation dial, a method for the analyses of cyclic physiologic data that are nonstationary in time, is presented. Previous biorhythm methods of analyses (harmonic analyses) have assumed the data to be stationary in time, i. e.,over successive cycles the period, amplitude, and phase vary only because of random error. In the study of cyclic biologic phenomena (e. g., applied rhythmometry, human asynchrony experiments) where the experiment is designed to produce changes in amplitude or phase the data are not stationary in time. Therefore, a new application of an existing analytical method (2), the summation dial, is presented. The sole assumption was that the period (tau = 24 hr) was constant. The data consisted of six points per day (on heart rate, body temperature, and other parameters) and were fit to the equation: $Y = m + a \cos wt + b \sin wt$, to produce the estimates a and b, where the amplitude, $R = (a^2 = b^2)^{1/2}$ and $\emptyset = \tan^{-1}(b/a)$. The point (a, b) represents, then the end of a vector with magnitude R and direction Ø. The summation of these vectors, or train of vectors, produces the summation dial. The direction of the vector train is the hour of the day at which estimated peak activity occurred. Analyses of data by this method indicate that the summation dial is able to detect dynamic changes in time of peak as well as "random walks" (arrhythmia); if constancy of period is assumed, a linear change of phase is also detectable. Correlations over time between physiologic parameters may be studied by use of the vector-difference dial that quantifies the angle between the summation dials of the two parameters.

2032.
Winget, C. M., L. Hughes, and J. LaDou. Physiological effects of rotational work shifting: a review. J. Occup. Med. 20: 204-210, 1978.

The high cost of capital equipment, demands of the world markets, and continuity requirements of many technological processes have forced industry to operate three-shift, 24-hour days. Workers on fixed schedules experience no particular problems from shift work,but those who are shifted periodically can undergo physiological and emotional disturbance. These disturbances occur because most human systems function according to circadian rhythms that can be easily disoriented. The primary cause is the periodic shifting of the light-dark, wake-sleep cycles. Extensive literature exists on the cause and symptoms of disturbances in the human physiological rhythms. The information contained in this literature can be applied to protecting the health and well-being of the worker.

2033.

Winget, C. M., and J. LaDou. Viking 75 - a venture into altered time (pamphlet). Moffett Field Ca.: NASA, Ames Research Center, 12 pp.

2034.

Winget, C. M., and C. S. Leach. Circadian rhythms in human subjects. Proc. Int. Conf. Int. Soc. Chronobiol., 12th., Milan: Il Ponte, 1977, pp. 537-547.

2035.

Winget, C. M., J. Lyman, and J. R. Beljan. The effect of low light intensity on the maintenance of circadian synchrony in human subjects. Dayton, Ohio: Wright State Univ. Research Inst. Plenary Meeting, 19th, Philadelphia, Pa., June 3-19, 1976, Paper, 12pp.

Experiments were conducted on six healthy male subjects aged 20-23 yr and exposed for 21 days in a confined regulated environment to 16L:8D light:dark cycle with a view toward determining whether the light environment of 16L:8D at the relatively low light intensity of 15 ft.c. is adequate for the maintenance of circadian synchrony in man. The light intensity was 100 ft. c. during the first seven days, reduced to 15 ft. c. during the next seven days, and increased again to 100 ft. c. during the last seven days. Rectal temperature (RT) and heart rate(HR) were recorded throughout the three phases. In the 100 ft. c. regime, the RT and HR rhythms remained stable and circadian throughout. It is shown that 15 ft. c. light intensity is at or below threshold for maintaing circadian synchrony of human physiologic rhythms marked by instability and internal desynchronization with degradation of performance and well-being.

2036.

Winget, C. M. L. Lyman, and J. R. Beljan. The effect of low light intensity on the maintenance of circadian synchrony in human subjects. In: Life Sciences and Space Research, Vol. IV, edited by R. Holmquist, and A. C. Stickland. New York: Pregammon Press, 1977, pp. 233-237.

The light-intensity threshold for humans is not known. In past space flights owing to power restrictions, light intensities have been minimal and reported to be as low as 14 ft.c. This study was conducted to determine whether the light(L) dark (D) environment of 16L:8D at the relatively low light intensity of 15 ft. c. was adequate for the maintenance of circadian synchrony in human subjects. Six healthy male subjects aged 20-23 years were exposed for 21 days to a 16L:8D photoperiod. During the first 7 days the light intensity was 100 ft c.: it was reduced to 14 ft. c. during the next 7 days and increased again to 100 ft. c. during the last 7 days of the study. Rectal temperature (RT) and heart rate (HR) were recorded continuously throughout the 21 days of the study. In the 100 ft. c. 16L:8D the RT and HR rhythms remained stable and circadian throughout. When the light intensity was decreased to 14 ft. c. the periodicity of the HR rhythm was significantly decreased and this rhythm showed marked instability. In contrast the period of the RT rhythm did not change but a consistent phase delay occurred due to a delay in the lights-on associated rise in RT. These divergent effects on these two rhythms in internal desynchronization and performance decrement during the 15 ft. c. exposure. The data emphasize the need for establishing accurately the minimal lighting requirements for the maintenance of circadian rhythmns of humans in confined environments.

2037.
Winget, C. M., D. F. Rahlmann, and N. Pace. Phase relationships between circadian rhythms and photoperiodism in the monkey. In: Circadian Rhythms in Non-human Primates, Bibliotheca Primatologica, no. 9. New York: S. Karger, 1969, pp. 64-74.

The areas under the DBT wave forms (figs. 1, 4 and 5) are proportional to the energy produced by the individual animals. The finding that the wave form areas were unchanged when the monkeys were shifted from 12L:12D to 24L:0D may indicate that within each animal, energy expenditures are constant, at least under the experimental conditions utilized here.

In conclusion, although the results do not indicate which physiological mechanisms are responsible for the circadian rhythms of DBT, locomotor activity and heart rate in the non-human primates, they do indicate that the relationships involved are nonlinear. These data do not permit a definitive statement concerning the length of time required for the ryhthm to phase back on to a secondary 'Zeitbeger'. The asymmmetry of the data, the differences in the rates of change, the consistent location of the minima (in the dark period), the variability of the maxima, and the correlation of the rhythms all point to the existence of at least two unequal control menchanisms.

2038.
Winget, C. M., J. Vernikos-Danellis, and H. R. Beljan. Synchrony of physiological rhythms is regulated by social Zeitgebers. Physiologist 18: 954, 1975.

Although circadian rhythms in man are endogenous and persist under constant conditions, environmental correlates have been shown to synchronize physiological functions. The possibility that social stimuli may also have synchronizing properties was determined by analyzing the circadian rhythm characteristics of nine healthy male subjects confined singly or in groups of three under regulated or constant light conditions. Heart rate (HR), body temperature (BT), activity, urine volume, and urine excretion of certain metabolites were measured frequently each experimental day. The two groups of three subjects each were confined in rooms where the environment was regulated; the third group served as controls, were not confined, but were exposed to ambient experimental conditions. During the first 24-day control period when all three groups were in 16L:8D the BT and HR rhythms remained stable and circadian in the confined subjects, as they did in the controls throughout the study. The photo period was then changed to 24L:0D in both confinement rooms. Under these conditions period lengths increased and considerable phase shifting occurred in all six confined subjects. However, although the rate of this increase in period and phase shift was identical for the three subjects within a room they differed greatly between the two rooms. One confined group desynchronized with respect to sidereal time at the rate of 12 min/day whereas the other group shifted by 60 min/day, in spite of the fact that both groups were under identical environmental conditions. These free-running periods differed from those of the same subjects under the same conditions when confined singly. The data provide evidence that social interaction may act as a Zeitgeber to synchronize endogenous rhythms.

2039.
Winget, C. M., J. Vernikos-Danellis, S. E. Cronin, C. S. Leach, P. C. Rambaut, and P. B. Mack. Circadian rhythm asynchrony in man during hypokinesis. J. Appl. Physiol. 33: 640-643, 1972.

Posture and exercise were investigated as synchronizers of certain physiologic rhythms in eight healthy male subjects in a defined environment. Four subjects exercised during bed rest. Body temperature (BT), heart rate (HR), plasma thyroid hormone (T_3 T_4) and plasma steroid (CS) data were obtained from the subjects for a 7-day ambulatory equilibration period before bed rest, 46 days of bed rest, and a 10-day recovery period after bed rest. During bed rest mean HR increased while BT decreased. Heart rate rhythm remained more stable throughout bed rest than the other rhythms studied. The results indicate that the mechanism regulating the circadian rhythmicity of the cardiovascular system is rigorously controlled and independent of the endocrine system, while the BT rhythm is more closely aligned to the endocrine system.

2040.
Winget, C. M., J. Vernikos-Danellis, C. W. DeRoshia, S. E. Cronin, C. Leach, P. C. Rambaut. Rhythms during hypokinesis. In: Biorhythms and Human Reproduction, edited by M. Ferin, F. Halberg, R. M. Richart, and R. L. Van de Wiele. New York: John Wiley and Sons, 1974, pp. 575-587.

Asynchrony of the body temperature (BT) and heart rate (HR) circadian rhythms in man was achieved without changing the photoperiod by complete bed rest without exercise. This asynchrony was characterized by marked phase-shifting and a decrease in amplitude of

BT and HR which returned to normal in the post-bed rest period. Bed rest also resulted in hypothermia and a transient bradycardia which were evident within the first 2 days of bed rest. Although the asynchrony of the rhythms was also present at this time, it became most marked on the 23rd day of bed rest. On this day, sudden phase-shifting occurred in all subjects at 0045 hours and was accompanied by a 50% increase in HR. Neither the prolonged inactivity nor the confinement associated with bed rest were responsible for these effects. It is proposed that reduction of stimuli to proprioceptive receptors requires a compensatory increase of to the environmental synchronizers in order to maintain rhythm synchrony.

2041.
Winget, C. M., J. Vernikos-Danellis, C. S. Leach, and P. C. Rambaut. Dissociation of effects of prolonged confinement and bedrest in normal human subjects: heart rate and body temperature. In: Proc. of the 1971 Manned Spacecraft Center Endocrine Program Conf., 1972, 13 pp. Houston, Tex: National Aeronautics and Space Administration, Lyndon B. Johnson Space Center.

2042.
Winget, C. M., J. Vernikos-Danellis, C. S. Leach, and P. C. Rambaut. Phase relationships between circadian rhythms and the environment in humans during hypokinesis. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J. E. Pauly. Tokyo: Igaku Shoin, Ltd., 1974, pp 429-434.

The effect of restricted activity (bed-rest) on certain physiologic rhythms in eight healthy male subjects maintained in a defined environment was investigated. A photoperiod of 16L:8D was maintained for a six day ambulatory, pre-bed-rest equilibration period, 56 days of bed-rest and a 10-day post-bed-rest recovery period. Four of the subjects exercised during bed-rest. Body temperature (BT) data were obtained using ear thermistors and heart rate (HR) was measured from pulse rates and by EKG sensors connected to a cardiotachometer. Circulating cortisol, triiodothyronine (T_3) and thyroxine (T_4) concentrations were determined in the blood samples drawn at four hourly intervals for 48-hour periods before, 10, 20, 30, 42, and 54 days during, and 10 days post-bed-rest. During bed-rest mean HR increased while BT and steroid outputs decreased. Neither exercise nor the 10-day post-bed-rest ambulatory period prevented or corrected this effect. HR remained more stable throughout bed-rest than the other rhythms studied. In contrast, the amplitude of the T_4 rhythm appeared to increase as bed-rest progressed and the total serum T_3 concentrations increased during the latter part of the bed-rest. The data indicate the daily change in phase and amplitude of BT, T_3, and T_4 rhythms are due to the position of the body. The observed low grade hypothermia and minor tachycardia are characteristic of the hypokinetic syndrome in man.

2043.
Wojtczak-Jaroszowa, J. Health and shift work. Discussion II. In: Shift Work and Health, edited by P. G. Rentos, and R. D. Shepherd. Washington, D.C.: U.S. Dept. of Health, Education, and Welfare, H.E.W., Publ. No. 76-203, 1976, pp. 72-86.

2044.
Wojtczak-Jaroszowa, J. Physiological and Psychological Aspects of Night and Shift Work. Washington, D. C. : U. S. Dept. of H.E.W., No. 78-113, 1977, 88 pp.

In this review, the results of physiological and psychological studies related to night and shfit work have been collected. They are discussed mainly from the standpoint of their possible utilization in industry, in understanding the problems of shift work, the sources of possible troubles and complaints connected with shift work, and in the alleviation of the problems. The variety of jobs involving shiftwork in modern industry indicates the need for this review. Circadian rhythms in biological functions are reviewed with the purpose of drawing the reader's attention to the variations in the organism's functional capacities during day and night, and as a result of that, variations in responsiveness to environmental factors, as well as to work-responsiveness to environmental factors, as well as to work. It is not the intention of the author to suggest that all night-day variations observed in physiological function, sensory-motor performance, and work efficiency reflect only the circadian rhythm. The problems related to physical work, mental and sensory motor performance and some aspects of night work in hot environments are reviewed. The main objective is to attempt an answer to the question: Is it appropriate to impose the same demands on a worker employed at night as those required of a worker during the day and, if not, to what degree and in what respect should the requirements be modified? Special attention is paid to the importance of sleep after night duty. Data are presented on various arrangements of shift systems, as well as on organization of the working time and breaks during the night shift.

2045.
Wojtczak-Jaaroszowa, J. Influences of long-lasting physical work upon mental and psychomotor performance in relation to the time of day. Acta Physiol. Pol. 29: 325-334, 1978.

2046.
Wojtczak-Jaroszowa, J., and A. Banaszkiewics. Physical working capacity during the day and night. Ergonomics 17: 193-198, 1974.

2047.
Wojtczak-Jaroszowa, J., A. Makowska, H. Rzepecki, A. Banaszkiewica, and A. Romejko. Changes in psychomotor and mental task performance following physical work in standard conditions, and in a shift-working situation. Ergonomics 21: 801-809, 1978.

Ten shift workers and 43 students were tested on a battery of psychological tests at different time of day within prolonged sessions of activity. It was shown that performance levels were determined by three factors: circadian flucuations, elapsed time since the beginning of a session, and physical work done prior to testing. Visual-motor coordination was enhanced by the latter, but efficiency at purely mental tasks was degraded.

2048.
Wolcott, J. H., W. D. Foster, R.R. McMeekin, and R. E. Yanowitch. Correlation of biorhythm with accident occurrence and choice-reaction time performance. Aerosp. Med. Assoc. Preprints, 1977, pp. 183-184.

Analysis of 880 USAF aviation accidents showed no significant deviation of observed accident frequencies from those expected by chance on biorhythm critical days. Combination of this data with 4279 other aviation accidents revealed that the number of accidents occuring on biorhythmic triple critical days was exactly the number expected by random.

A study of choice reaction time in 224 trials with 6 subjects was related to biorhythm cycle criticality (on a scale of 1-6). T-tests were computed for 24 or 48 hour critical periods and revealed no trend toward below average performance with increasing cycle criticality, as the theory predicts. Chi square analysis revealed no significant relationship between biorhythm phase and performance levels. (For more extensively analyzed accounts of these experiments, see Wolcott, H. H. et al. 1979 Aviat. Space Environ. Med. 50: 34-39, 1979, Aviat. Space Environ. Med. 48: 976-983, 1977).

2049.
Wolcott, J. H., C. A. Hanson, W. D. Foster, and T. Kay. Correlation of choice reaction time performance with biorhythmic criticality and cycle phase. Aviat. Space Environ. Med. 50: 34-39, 1979.

Choice reaction time (CRT) was measured in 10 subjects at 7 different pressure levels (4 trials each). The frequency of performance scores above or below the mean were compared with expected frequencies at different biorhythm cycle phases, given the definition of critical day as being 24 or 48 hours in length. By selecting very best or worst performance scores in one analysis the authors biased the performance samples in favor of the biorhythm theory. Chi square analysis and linear and multiple regression analysis did not show deviation of performance scores from random for phases and combined phases of biorhythm cycles. No significant deviation of performance from expected levels was found using 24 or 48 hour critical day definitions or very best and worst performances. Performances were better on critical than on noncritical days, but the differences were not significant. The authors conclude that the CRT task was not significantly influenced by biorhythm. However, their conclusion would be enhanced if they performed some longitudinal studies on individual subjects daily over a long time period, utilizing periodicity analyses.

2050
Wolcott, J. H., R. R. McMeekin, R. R. Burgin, and R. E. Yanowitch. Biorhythms - are they a waste of time? TAC Attack 15: 4-9, 1975.

A study was conducted on 3253 pilot-involved aircraft accidents from the National Transportation Safety Board, along with 1026 pilot-involved accidents from the U. S. Army Aviation Center and 4346 pilot-involved Naval aircraft accidents. Various statistical analyses of these data sets, conducted singly or in combination, yielded no significant differences from those used in the study by Weaver (U. S. Army Aviation Digest 20 (1): 13-17, 1974) who found 49% of accidents occurred on critical days. THe authors in this study criticize Weavers paper as having a smaller sample size and in not defining the time period of the critical day.

2051.
Wolcott, J. H., R. R. McMeekin, R. E. Burgin, and R. E. Yanowitch. Correlation of Occurrence of aircraft accidents with biorhythmic criticality and Cycle Phase. In: Recent Experience/Advances in Aviation Pathology, Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, 1976, 14 pp.

The occurrence of aircraft accidents on various biorhythmic phases of cycles was studied. Aircraft accident data were obtained from the National Transportation Safety Board for general civil aviation and from the U. S. Army Agency for Aviation Safety for military accidents. The accidents were divided into two group, pilot and non-pilot involved cases, using the causal factors given by the respective accident boards. No correlation was found between the occurrence of aircraft accidents and either the critical period, the negative phase or the peak days of the negative phase of the biorhythm cycles. Data were evaluated by chi-square analysis. The authors advise that pilots should not be given biorhythm briefings since biorhythm theory could induce pilots to adjust their feelings to phases of the biorhythm cycles.

2052.
Wolcott, J. H., R. R. McMeekin, R. E. Burgin, and R. E. Yanowitch. Correlation of general aviation accidents with the biorhythm theory. Hum. Factors 19: 283-293, 1977.

A total of 4008 general aviation accidents from the National Transportation Safety Board (for either 24 or 48 hour critical day definition) were analyzed with respect to biorhythm cycle phases using chi square goodness of fit for various combinations of critical days and biorhythm high or low phases or combinations of phases. In general, no significant deviation from expected frequencies as found, although there was a significantly higher level of accidents on intellectual critical or physical-intellectual double critical days. The authors assume that 5-10% of individual chi square analyses could exceed significance levels by chance without voiding the hypothesis of no accident-biorhythm relationship. However, the significance between accidents and critical days found here supports biorhythm theory even though none of the other accident-critical day relationships were significant. Perhaps a re-analysis of this data should have been performed, using exact biorhythm phase position data instead of coding the cycles as positive, negative or critical.

2053.
Wolcott, J. H., R. R. McMeekin, R. E. Burgin, and R. E. Yanowitch. Correlation of occurrence of aircraft accidents with biorhythmic criticality and cycle phase in U. S. Air Force, U. S. Army, and civil aviation pilots. Aviat. Space Environ. Med. 48: 976-983, 1977.

Chi square analyses (300) were performed on the relationship between biorhythm cycle criticality and phase and 5159 accidents from the U. S. Air Force, U. S. Army and National Troansportation Safety Board. USAF pilot involved and total pilot accidents revealed that more accidents than expected occurred on some noncritical days and fewer than expected occurred on some critical days. The authors claim that analysis of data in terms of number of accidents occurring on various types of critical days fails to indicate a role for biorhythm, although the occurrence of accidents on intellectual critical days exceeded expectations significantly. When they added additional accidents from Navy files to create a total of 9505 accidents, analysis revealed no significant deviations from expected accident frequencies. THe authors conclude that the data do not support the biorhythm theory in terms of expecting significantly high accident frequencies on biorhythm critical days or low phase. They caution that use of biorhythm theory could produce a "psychosis by association" that would make pilots reluctant to fly on critical days. The authors' conclusions are somewhat compromised by the finding of accident-intellectual critical day significance, even though some chi-square significance levels would be expected by chance. Further analysis utilizing multiple regression of accident frequencies with exact biorhythm cycle phase calculations could perhaps resolve this problem.

2054.
Wood, G. A. Electrophysiological correlates of local muscular fatigue effects upon human visual reaction time. Eur. J. Appl. Physiol. 41: 247-257, 1979.

2055.
Wood, L. A., D. W. Krider and K. D. Fezer. Emergency room data on 700 accidents do not support biorhythm theory. J. Safety Res. 11: 172-176, 1979.

2056.
Wood, R. H. Can you punish an accident? Forum - The International Society of Air Safety Investigators 13: 5-7, 1980.

2057.
Wood, W. C. Implementation of a divisional aviation program to decrease flight crew fatigue. In: Operational Helicopter Aviation Med. Neuilly-sur-Seine: NATO, Advisory Group for Aerospace Research and Development, 1978, 7 pp.

A vigorous and continuing program to recognize aviator fatigue implemented in the U. S. First Armored Division in Europe is described. Aviators are given lectures which review the various stresses inherent in aviation. The two types of aviator fatigue, acute skill fatigue and chronic skill fatigue, are discussed in detail The emphasis is on recognition by the aviators themselves of symptoms and signs of fatigue. Flight hour limitation is an important part of a crew rest program, but does not replace the other elements as presented. Prevention of fatigue and recognition of fatigue which has developed is an essential component of an aviation safety program.

2058.
Woodward, D. P., and P. D. Nelson. A user oriented review of the literature on the effects of sleep loss, work-rest schedules and recovery on performance. Arlington, VA: Office of Naval Research , AD-A009778, 1974, 40 pp.

This review provides a brief systematically organized account of the information from the scientific literature on the effects of sleep loss and work-rest schedules on performance. The orientation is practical, but consistent with the available data. A brief narrative description and a series of summary statements about the effects of sleep loss and work-rest schedules on human performance as they apply to operational settings is presented. Recovery from sleep loss effects as well as costs related to sleep loss effects are discussed briefly. Suggestions for future research are presented.

2059.
Wright, M. L. Biorhythms: fact and fancy. Proceedings of the Annual Meeting of the Human Factors Society, 21st, San Francisco, 1977, pp. 193-196.

Biological rhythms in physical, emotional and intellectual states in humans are discussed. Both popular and scientific views of biorhythms are given and compared. The popular view is found to be inconsistent with scientifically-collected data. Data on real biological cycles and examples of individual biorhythms are given. The significance of accepting and using biorhythmic phenomena is briefly discussed.

2060.
Wunder, C. C. Gravitational considerations with animal rhythms. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J. Pauly. Tokyo: Igaku Shoin Ltd., 1974, pp. 460-465.

2061.
Wurtman, R. J. Effects of light on man. In: Phototherapy in the Newborn: An Overview, edited by G. B. Odell, et. al. Washington, D. C.: National Academy of Sciences, 1974, pp. 161-171.

2062.
Wurtman, R. J. The effect of light on the human body. Sci. Am. 233(1): 66-77, 1975.

2063.
Wurtman, R. J. The effects of light on man and other mammals. Ann. Rev. Physiol. 37: 467-483, 1975.

The present article describes the best-studied extravisual effects of visible and ultraviolet light on humans and other mammals. It also considers the possible biological consequences to man of living in artificially lighted environments that differ significantly from the milieu in which he evolved.

2064.
Wurtman, R. J. Food for thought. Sciences 18: 6-9, 1978.

2065.
Wynn, C. T. Measurements of small variations in 'absolute' pitch. J. Physiol. 220: 627-636, 1972.

Longitudinal studies on absolute pitch (musical tone) estimates were carried out on one male and 2 females an average of 12 times/day for up to 18 months. In the females a bimodal curve (circa 14 days) was obtained in pitch estimation in close association with the menstrual cycle. The male exhibited a rhythm of about 20 days.

2066.
Wynn, V. T. Study of rhythms in auditory perception and simple reaction times. J. Interdiscipl. Cycle Res. 4: 251-260, 1973.

2067.
Yamaguchi, N., et al. Sleep deprivation therapy for depression and diurnal rhythm of serum cortisol. Horumon To Rinsho 26: 457-463, 1978.

2068.
Yates, M. M. A Study of Biorhythms with Students in Four Fraternities and Four Sororities at the University of Wyoming (Ph.D. Thesis). University of Wyoming, 1975.

A group of 80 subjects randomly selected from college fraternities and sororities were given performance tests with 6 instruments (unspecified) on both a biorhythm cycle critical day and biorhythm peak day. A two by two related measures factorial analysis of variance procedure was used and revealed no relationship between performance and biorhythm 23 and 28 day cycle peaks and critical days. However the data analysis revealed three gender main effects which were significant (0.05). The use of specific biorhythm testing days in this study raises the question of whether the subjects may have had any knowledge or suspicion that the biorhythm theory was being tested. The results would have been more conclusive if longitudinal studies had been performed on a small sample of individuals over a period of a few biorhythm cycles.

2069.
Yevtsikhevich, A. V. Sutochniye (Tsirkadnye) Ritmi Fiziologicheskikh Protsessov Pri Pereletakh V Shirotnom Napravlenii. (Daily (circadian) Rhythms of Physiological Processes in Flights in a Latitudinal Direction.) Diss. Cand. Med. Science, Novosibirsk, 1970.

Body temperature, arterial pressure, uropepsin, blood leucocytes, absorptivity of phagocytes, and muscular function were studied in a series of time zone flights. Time shifts of 4-11 hours resulted in readaptation times of 4-15 days, including 2 days for 4 hour change, up to 5 days for a 5 hour change, up to 10 days for a 6hour change, and greater than 10 days for a 7 hour time zone change.

2070.
Yokobori, S. Local time displacement and the measures for coping with its effects. J. Natl. Def. Med. Coll. 1: 7-19, 1976.

2071.
Yoshitake, H. Trois patterns caracteristiques des symptomes subjectifs de fatigue (Three characteristic patterns of subjective fatigue symptoms). Le Travail Humain. 40: 279-282, 1977.

An extensive field survey of subjective symptoms of fatigue revealed three characteristic patterns. One, in which 'drowsiness and dullness predominated, was frequent both among those who reported many symptoms and those who reported few and was not characteristic of any particular type of work. A second in which "inability to concentrate" was prominent, was more frequent among those who reported many symptoms and was characteristic of mental workers, especially after night work. A third pattern, in which awareness of physical discomfort was characteristic, was found mainly among those who reported few symptoms and were engaged in physical work.

2072.
Yunis, E. J., O. Fernandes, W. Nelson, and F. Halberg. Circadian temperature rhythms and aging in rodents. In: Chronobiology, edited by L. E. Scheving, F. Halberg, and J. E. Pauly. Tokyo: Igaku Shoin, Ltd., 1974, pp. 358-363.

2073.
Yunis, E. J., F. Halberg, A. McMullen, B. Roitman, and G. Fernandes. Model studies of aging, genetics and stable versus changing living routines - simulated by lighting regimen manipulation on the mouse (abstract). Int. J. Chronobiol. 1: 368-369, 1973.

2074.
Zantinge, G. Het Goede Moment: Bioritmeik: Drie Bioritmen Bepalen Onze Ups en Downs (The good moment: biorhythmic: three biorhythms determine our ups and downs). Deventer, Holland: Ankh-Hermes, 1976, 80 pp.

2075.
Zatz, M. Photoentrainment, pharmacology and phase shifts of the circadian rhythm in the rat pineal. Fed. Proc. 38: 2596-2601, 1979.

Photoentrainment of circadian rhythms in mammals is mediated by the retinohypothalamic projection to the suprachiasmatic nucleus of the hypothalamus. It should therefore be possible to mimic or block the effects of light on the circadian pacemaker with appropriate pharmacological agents. Such agents and their effects should be useful in identifying the neurotransmitters involved in photoentrainment and their mechanisms of action on the circadian pacemaker. The effects of light on the circadian rhythm is rat pineal serotonin N-acetyltransferase activity are described. Carbachol, a cholinergic agonist, was found to mimic the effects of light on this rhythm, including the acute reduction of nocturnal activity and phase-shifting of the free-running rhythm. These results raise the possibility that acetylcholine is involved in the photoentrainment of mammalian circadian rhythms.

2076.
Zatz, M., and M. J. Brownstein. Intraventricular carbachol mimics the effects of light on the circadian rhythm in the rat pineal gland. Science 203: 358-361, 1979.

Environmental lighting regulates numerous circadian rhythms, including the cycle in pineal serotonin N-acetyltransferase activity. Brief exposure of rats to light can shift the phase of this enzyme's circadian rhythm. Light also rapidly reduces nocturnal enzyme activity. Intraventricular injections of carbachol, a cholinergic agonist, can mimic both of these effects. Light and carbachol presumably act on the suprachiasmatic nucleus of the hypothalamus. These experiments demonstrate the feasibility of using a neuropharmacologic approach to the mechanisms underlying mammalian circadian rhythms.

2077.
Zavia'ci'c, M., and M. Brozman. Effects of feeding a single daily meal and of changes in lighting schedule on the circadian rhythms of oxidoreductases in the rat gastric mucosa. Acta Histochem. 65: 58-69, 1979.

2078.
Zetzmann, H. J. "Workload" and "performance limiting factors" of air traffic control radar operators. In: Rest and Activity Cycles for the Maintenance of Efficiency of Personnel Concerned with Military Flight Operations. Neuilly- sur-Seine: NATO, Advisory Group for Aerospace Research & Development AGARD-CP-74, 1970, pp. 9-1 - 9-12.

In the 'servo loops' of the man-machine system of Air Traffic control man continues to play a decisive role in ensuring safe and expeditious running of traffic. An important source of information in this system is the radar equipment whose display gives the controller and important basis for evaluating the air situation. These displays are discussed form the aspect of 'human engineeriing'. Where traffic is dense, particularly high demands are placed on correctness and rapidity of controller decisions to ensure a safe dispatch of traffic. The paper deals further with the physiological environment of ATC activities and points out how readily human beings may here be subject to 'stress'. The definitions of the terms 'workload' and 'stress' are discussed; it is shown that, and why, all efforts towards an exact assessment of controller capability under peak loads have failed to lead to fully satisfactory resluts so far. Further research work has to be done.

2079.
Zimmerman, J. C., C. A. Czeisler, S. Laxminarayan, R. S. Knauer, and E. D. Weitzman. REM density is dissociated from REM sleep timing during free-running sleep episodes (submitted for publication).

2080.
Zito, T. Body rhythm and dog days. Airline tests a theory. The Washington Post, Feb. 2, 1975.

The author reports that United Air Lines ground crews have used biorhythm charting at National Airport, Washington, D. C. since 1973, resulting in an accident reduction of over 50%. However, a distinguished expert on biological rhythms, Colin Pittendrigh, considers biorhythms to be an "utter, total, unadulterated fraud". Studies by D. Neil at the Monterey, Cal. Naval Postgraduate School, however, support Neil's contention that bioryhthms can be predictable. (However, Neil's work had been criticized by A. Ahlgren in Aviat. Space Environ. Med. 48: 678, 1977).

2081.
Zucker, I. Light, behavior, and biologic rhythms. Hosp. Pract. 11: 83-91, 1976.

The most potent environmental synchronizer of "biologic clocks" in mammals is the light-dark cycle. The author describes experiments that identify a particular pathway - a direct connection between retina and hypothalamus - as the main route by which such biologic rhythms as the daily activity cycle, the estrous cycle, and the annual reproductive cycle are entrained to the external environment.

2082.
Zucker, I., and F. K. Stephan. Light-dark rhythms in hamster eating, drinking and locomotor behaviors. Physiol. Behav. 11: 239-250. 1973.

2083.
Zulley, J. Schlaf und temperatur unter freilaufenden Bedingungen. Congr. Dtsch. Ges. Psychol. 30: 398-399, 1976.

2084.
Zykova, A. A., L. A. Lugovoy, and V. P. Krotov. Diurnal dynamics of potassium excretion in human urine during prolonged wakefulness. Kosm. Biol. Med. 6(1): 62-66, 1972.

Diurnal variations in human urine potassium excretion were investigated in ten test subjects confined to an isolation chamber but adhering to a normal work-rest cycle during a 72-hour period of continuous wakefulness. Sleep deprivation brought about considerable disturbances in diurnal potassium excretion which varied in their pattern and level from subject to subject. In some cases a displacement of minimum and maximum points prevailed; in others there was a decrease in the amplitude of diurnal variations. The results reveal an appreciable variability in functioning of circadian periodic systems in different subjects. This result can be applied in spacecrew selection with respect to biorhythmological parameters.