Final Report
National Aeronautics
and Space Administration
Contract NSR-23-006-041

GPO PRICE $ _____

CFSTI PRICE(S) $ _____

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ff 653 July 65

Final Report on National Aeronautics

and Space Administration Contract NSR-23-006-041

for the period Jan. 1, 1968-April 1, 1968

Submitted by

Center for Application of Science and Technology
Division of Urban Extension
Wayne State University
Detroit, Michigan

Introduction - The purpose of the Highway Safety contract was to disseminate aerospace related science and technology to highway safety and highway transportation programs. During this reporting period the demands for information from CAST varied. Copies of lists of acquisition numbers and furnished abstracts are included in this report.

Work with American Academy of Transportation - The major effort was to be applied toward aiding the American Academy of Transportation (AAT), located in Ann Arbor, Michigan, in a research program to optimize existing mass transportation systems. The AAT sought the use of the John Lodge Freeway in Detroit for their experiment. However, the Texas Transportation Institute from Texas A & M was granted exclusive experimental use of the freeway. AAT then secured the use of the Grand Rapids freeway system for their work.

An introductory meeting was held in Ann Arbor on June 26, 1967. Attending from CAST were Professor Robert Jones, Director, and Elizabeth Monroe, Assistant to the Director.

The School of Medicine at Wayne State University was the site of a meeting between Midwest Research Institute, AAT, the School of Medicine, and CAST. The highway safety research program at the medical school, directed by Dr. Elisha Gurdjian, is concerned with head and body injuries. The meeting discussed the participation of each organization in the program.

Work with Detroit's Department of Streets and Traffic - CAST staff members also visited Stanley Gross of Detroit's Department of Streets and Traffic, and Herbert Craine, Equipment Research Engineer, of the National Proving Ground for Freeway Surveillance Control and Electronic Traffic Aids, Detroit. Mr. Gross is not doing any active research at the present time. Mr. Craine was impressed with CAST, but present budgetary limitations may make it difficult to utilize CAST in the near future should the need arise.

Work with Biomechanics Laboratory at Wayne State University - CAST provided search services for Mr. Jan Hirsch, Research Assistant, of the Biomechanics Laboratory at Wayne. He requested data on accidental and experimental whiplash, protective helmets, and body restraint systems. His interest areas also include head and knee injuries, windshields, steering wheels and columns, and driver and front seat passenger impacts on the instrument panel. Data on animals, cadavers, and dummies were relevant. He is presently working on determining the effective impact velocity from vehicular information.

In response to his request, two searches were run under the titles Biomechanics and Occupant Restraint Systems. Eighty-one abstracts were forwarded to Mr. Hirsch after screening. Twenty-two hard copy were ordered. These articles were incorporated in the reference library at

the Biomechanics Laboratory. A copy is attached. Thus, they were not ordered to aid in solving a particular research problem, but to provide reference data for the activities of the laboratory.

Dr. James Paulson, Chairman of Civil Engineering, Dr. William Taylor, Assistant Professor of Civil Engineering, and Elizabeth Monroe attended a demonstration of AAT's test vehicle in Grand Rapids. Dr. Taylor served as the liaison between CAST and AAT.

The topics enumerated in the Highway Safety contract were concerned with the interactions between the operator, the vehicle, and traffic. Hence CAST provided AAT with searches under the titles: Driving Task Performance, Fatigue and Biological Environment, Information Processing and Extraction, Information Acquisition, Stress and Performance, Eye Movement and Perceptual Saturation, and Decision Making. The searches were screened by CAST and a total of 298 abstracts were considered to be applicable. A copy of each article is attached. These abstractions were submitted to Dr. Taylor for his review. No hard copys were ordered. Herbert Norder, President of AAT, had decided to postpone his research on the areas covered by the searches until an indefinite later date.

Highway Safety and Transportation Digest - A project to create an experimental Highway Safety and Transportation Engineering Digest was undertaken by CAST. The digest presented a monthly listing of articles from the open literature, each entry being accompanied by a one or two sentence comment, plus selected abstracts from STAR and IAA. August, 1967, was selected as a sample month. A preliminary draft was completed in January and then underwent further study by Dr. Arthur Even, Assistant Director. After further analysis of its potential market, the digest was deemed to be financially unfeasible.

Work with Detroit Police Department - During the closing stages of the contract, Thomas Bercal of CAST worked with a study group interested in developing specifications for improved designs of current police vehicles, and, ultimately, to propose designs for future specially designed vehicles, i.e., not a modification of a civilian vehicle.

Their approach to the problem is along the lines of human engineering and system analysis. The study group requested information that would materially assist them in obtaining answers to such questions as:

1. What is the optimum mix of visual and auditory signals?
2. What is the upper limit of information the patrol is able to reliably receive and assimilate?
3. What is an optimal display panel?
4. How is information assimilation and decision making affected by stress conditions?
5. What are the design parameters for providing maximum comfort for the patrol officers?

By analyzing data relevant to these questions, new designs can be devised for incorporation in the police vehicle that will enhance operator performance. Since the police officer is considered to be a safe and efficient driver, the effectiveness of these designs can be studied and extrapolations made to the average driver. Selected features of these improvements can then be implemented in the design of a safer civilian vehicle.

It should be noted that several of these questions pertain directly to the searches run for AAT. Mr. Bercal's review of these searches resulted in the order of twenty-nine hard copy.

The police vehicle project is unique in that it has never before been studied in depth. Any recommendations and findings put forth by the study group will have great potential for stimulating further research in this area. NASA-based technology will play an integral part in such research by providing detailed engineering data on apparatus suggested for implementation in the vehicle. These may include a small computer, telemetry devices, visual displays, etc. Much of the groundwork has already been laid in these areas, with NASA technology generating more sophisticated models of these units.

Summary - The application of NASA literature to highway safety and transportation engineering was found to be feasible. NASA generates considerable data in biomechanics, restraint systems, psychology, human engineering, human transfer functions, probability, queueing theory, etc. They also provide engineering data on mechanical and electronic equipment that can be utilized in monitoring operator or vehicular motions.

Specific use of NASA literature can be found in the Biomechanics Laboratory where Mr. Hirsh utilized NASA data as a guide in his experimentation.

Mr. Craine of the National Proving Ground is in a position to utilize more sophisticated monitoring equipment in his work as well as theoretical data on probability, queueing theory, etc.

The Wayne State University group studying police vehicles will make use of the human engineering ideas presented by NASA research and may suggest the implementation of NASA hardware designs in future vehicles.

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A64-31176
A PHYSIOLOGICAL EFFECT OF COGNITIVE DISSONANCE UNDER STRESS AND DEPRIVATION.
Mary L. Brehm, Kurt W. Back, and Morton D. Bogdonoff (Duke U., Durham, N.C.)
Journal of Abnormal and Social Psychology, vol. 69, Sep. 1964, p. 303-310. 9 refs.
Life Insurance Med. Res. Fund, Duke U. Center for the Study of Aging, and Irwin Strasburger Mem. Fund supported research.
Contract No. Nonr-1131-11 and Grant No. NIH-G-M-5356.

An experiment and a partial replication were conducted to relate the change of motivation due to dissonance reduction and commitment to physiological changes. The experimental technique was based on food deprivation studies by Brehm which showed that already deprived individuals who committed themselves to further fasting under conditions of low reward decreased their self-estimate of hunger, while the reverse was true for those given high rewards. The data suggest that a person who has convinced himself that he is not so hungry tends to respond physiologically as if he were not hungry.

N64-14166 Washington School of Psychiatry, D. C.
THE EFFECT OF A PARTICULAR STRESS ON ONE MAN'S PERFORMANCE OF VARIOUS TRACKING TASKS Interim Report
Hamilton Mowbray, Lewis Durr (Applied Physics Lab.), Elizabeth De Socio, and Norman K. Walker Sep. 37 p refs
(Contract DA-49-193-MD-2369)
(AD-428112) OTS: $3.60

The present report investigates the effect for an acceleration control tracking task over a wide range of control stiffnesses (8.3 to 915.0 mils/sec^2) and control lag (0.0 to 1.255 sec). The results indicate, as a working hypothesis: (1) that the percentage increase in error due to control lag, and due to auditory shadowing is independent of control stiffness. (2) that the effect of auditory shadowing is small (40% to 50% increase in error) with no lag, but very great (over 200% increase in error) if the lag is 0.3 sec or more; (3) that under conditions where severe degradation of the tracking task occurs, the accuracy of the auditory shadowing is also seriously degraded.
Author

N64-16068 Massachusetts U., Amherst
INFORMATION PROCESSING UNDER TASK STRESS
Warren H. Teichner Bedford, Mass., Decision Sci. Lab., Nov. 1963 61 p refs
(Contract AF 19(628)-290)
(ESD-TDR-63-657; AD-430412)

This is the final report of studies of human information processing related to variables present in high-speed systems operations. Earlier reported data pertinent to the effects of informational input rates and related factors are reviewed. The report then presents experiments concerned with two other aspects of the problem: (1) the interaction of short- and long-term memories in human data handling; and (2) the effects of presented information rates on "subjective information," i.e., the amount of information in the operator's estimate of what is presented by the display.
Author

N64-21288 Joint Publications Research Service, Washington, D.C.
STRESS AND FATIGUE UNDER CONDITIONS OF ISOLATION FROM EXTERNAL STIMULI
F. D. Gorbov, V. I. Myasnikov, and V. I. Yasdovskiy 5 Jun. 1964 12 p refs Transl. into ENGLISH from Zh. Vysshei Nervnoi Deyatel'nosti (Moscow), v. 13, no. 4, 1963 p 585-592
(JPRS-24961; OTS-64-31422) OTS: $0.50

Experiments were conducted in which a man was confined to a small, especially equipped chamber for 10 to 15 days. Various sequences of tests to determine causes and degree of stress and fatigue were administered. These investigations showed that extreme restriction of general afferentation exercises a substantial influence on the subjects. The neuropsychological functional shifts were dissimilar at different stages of the experiment. Complex recording of psychological and physiological indicators enables determination of qualitative peculiarities of these shifts and, in particular, determination and differentiation of states of stress and fatigue. Monotony of the environment, lack of external impressions, and solitude emerged as factors of independent significance as conditions and causes of development of stress and fatigue. This indicates not only the necessity but also the possibility of preventing these states, on the basis of rational stimulation for the optimal interaction of afferent systems.
D.E.W.

A65-81207
A PROPOSED FRAMEWORK FOR THE ANALYSIS OF STRESS IN THE HUMAN ORGANISM.
Alan Howard and Robert A. Scott (Hawaii U., Honolulu; and Russel Sage Found., New York, N.Y.)
Behavioral Science, vol. 10, Apr. 1965, p. 141–160. 81 refs. Human Ecol. Fund supported research.

Stress comes from many different sources and affects us all in one way or another. Viewing human functioning as a problem-solving phenomenon, stress is here explained in terms of tension that results from the organism's inability to master problems present and its consequent need to devote excess energy and resources to maintenance activities. This encompassing theoretical scheme proposes to reduce the conceptual barriers between various biochemical, physical, psychological, and sociocultural models of stress.

A65-81579
MILD STRESS AND PROBLEM-SOLVING.
Wilbert S. Ray (Bethany Coll., W. Va.).
American Journal of Psychology, vol. 78, Jun. 1965, p. 227–234. 24 refs. Contract Nonr 2315(00).

Three experiments are described. One was a repetition of a previously reported experiment in which a personal condition interfered with problem solving as compared with an impersonal condition. The replication failed to find a difference between the conditions. In other experiment a set for speed inhibited problem solving, as did frustration in the third. It was suggested that, above a minimal level necessary to produce work at the problem, further increase of drive-level would produce increasing inhibition of problem-solving, the effect being greater with complex problems. Our experiments contradict the first half of the inverted-bow-shaped relation between motivation and problem-solving which has been postulated by previous theorists.

A65-81753
FURTHER DATA ON A STRESS SYNDROME RELATED TO ACHIEVEMENT MOTIVATION: RELATIONSHIPS WITH AGE AND BASAL SERUM CHOLESTEROL LEVEL.
J. Warren Thiesen, Kenneth D. Brown, Ronald H. Forgus, Silas M. Evans, Gene M. Williams, and Jerome Taylor (Veterans Admin. Hosp., Downey, Ill.)
Perceptual and Motor Skills, vol. 20, Jun. 1965, Part 2, p. 1277–1292. 13 refs.
Veterans Admin. supported research.

A cross-validation of a standard method of measuring striving-induced stress is described. The sensitivity of the previously reported stress measures, based on heart-rate elevation, is verified. The procedure is demonstrably applicable to more varied populations than those used in the original standardization. While a tendency toward higher over-all heart rates with increased age was observed, the principal specific finding was a positive association of basal serum cholesterol level with post-stress heart rate, independent of age. Individuals with higher serum cholesterol levels showed less complete recovery following stress and higher initial heart rates, but they did not necessarily show a stronger immediate response to the stressors. Psychosomatic implications are discussed.

N65-14679# Washington School of Psychiatry, D.C.
FURTHER WORK ON THE USE OF TRACKING TASKS AS INDICATORS OF STRESS Final Report, Jul. 1962–Jan. 1964
Norman K. Walker, Fred Shectman, and Elizabeth De Socio
Oct. 1964 141 p refs
(Contract DA-49-193-MD-2369)
(AD-450861)

It is shown that zero input tracking analysis provides a reliable measure of tracking performance, that tracking degrades severely under the stress of auditory shadowing, but that the sensitivity of subjects differs considerably. Auditory shadowing appears to produce similar effects as in combat, possibly in both cases due to an information overload, and hence auditory shadowing may well be a suitable laboratory substitute for combat. Auditory shadowing can thus be used to define the sensitivity of any control system to combat degradation using a given group of subjects, or using a given system to examine the sensitivity of the subjects. Mild electric shocks on the other hand were quite ineffective stressors. Author

N65-32928# Purdue Univ., Lafayette, Ind.
MOTIVATIONAL CORRELATES OF INDIVIDUAL DIFFERENCES IN PERFORMANCE Technical Report, May 1961–Jan. 1965
Mark W. Stephens and K. M. Michels Wright-Patterson AFB, Ohio. AMRL. May 1965 151 p refs
(Contract AF 33(616)-7962)
(AMRL-TR-39; AD-618895)

A three-year program of research was directed at the development of "paper and pencil" measurement techniques that would permit the assessment of the potential "motivatability" of subjects in experiments concerning the effects of environmental stress on human performance. A largely empirical approach was used in this research. Performance measures of a large number of subjects on several different tasks were used as the criterion measures in item analyses of several personality inventory tests. The resultant pool of cross-validated items will, it is hoped, represent a step toward increasing the precision of performance research. Author

A66-12355
MEASURE OF SUSCEPTIBILITY TO PSYCHOLOGICAL STRESS.
Patrick M. Curran and Robert J. Wherry, Jr. (U.S. Naval School of Aviation Medicine, Pensacola, Fla.).
(Aerospace Medical Association, Annual Meeting, 36th, New York, N.Y., Apr. 26-29, 1965, Paper.)
Aerospace Medicine, vol. 36, Oct. 1965, p. 929-933.

Study to determine if experimenters can actively manipulate environmental cues in order to control subjects' perceptions of such determiners of anticipatory physical threat stress (APTS) as the perceived probability of unpleasant events (P'), the perceived proximity of unpleasant events (X'), and the perceived degree of unpleasantness of possible events (U'). For this purpose 64 naval and marine cadet pilot trainees served as experimental subjects, and 24 control subjects were selected from the same group. A 4-choice, color discrimination task was employed. Instructions for experimental and control subjects structured the situation as involving information processing in a simulated aircraft mission emergency. A "subject's panel" and a "probability generator" were used to show levels of P' and U'. X' was also displayed on the panel. The threatening event was the possible occurrence of electric shock. Three 5-minute test sessions or "missions" were given each subject. It was found that systematic changes in environmental cues resulted in significant performance changes for the subjects, which tends to confirm previous studies. F.R.L.

A66-32150 #
DEVELOPMENT OF A STANDARD PROLONGED WORK TEST FOR THE EVALUATION OF FATIGUE AND STRESS IN MAN.
J. Shapira, D. R. Young, B. Datnow, and R. Pelligra (NASA, Ames Research Center, Biotechnology Div., Moffett Field, Calif.). IN: AEROSPACE MEDICAL ASSOCIATION, ANNUAL SCIENTIFIC MEETING, 37TH, LAS VEGAS, NEV., APRIL 18-21, 1966, PREPRINTS. [A66-32134 17-04]
Washington, D.C., Aerospace Medical Association, 1966, p. 50, 51. Abridged.

Development of a standard work regime consisting of walking on a treadmill at an elevation and speed that requires about 33% of an individual's maximal work capacity and which can be endured without untoward effects for prolonged periods. It was found that such a regime could be well tolerated in human male subjects for up to 24 hr. Arrythmia is a contraindication to such a test, whereas depression of the ST segment of the ECG is not. Only after about 9 hr do blood values for glucose and free fatty acids attain equilibrium values. The reserve of carbohydrate in the body appears to be greater than previously suspected. Utilization of large amounts of reserve fat, as reflected by high serum values for free fatty acids and rapid turnover of injected radioactive palmitic acid, is not detrimental. Reduction of serum glucose to very low levels by the injection of insulin did not hinder the ability to continue work. F.R.L.

A66-39425
A SYSTEMS TASK USED IN THE STRESS TESTING OF SPECIAL MISSION PERSONNEL.
Richard E. McKenzie (USAF, Systems Command, Aerospace Medical Div., School of Aerospace Medicine, Brooks AFB, Tex.).
Human Factors, vol. 7, Dec. 1965, p. 585-590.

One aspect of a psychologic evaluation program for special mission personnel was structured within a concept of competing tasks, requiring two operator signal-display sources. One source produced an array of discrete, discontinuous signals. The other produced a continuous input for the operator to monitor and process. The evaluation was made with reference to the performance of an "ideal" subject. The results indicate that a criterion group of those finally selected for the special mission was better able to adapt to the two competing tasks and was less susceptible to the signal/noise ambiguity and the induced task stress than the special mission personnel group as a whole.
(Author)

N66-14315# Systems Research Labs., Inc., Dayton, Ohio.
INTEGRATED DATA COLLECTION, MONITORING, CONVERSION, AND ANALYSIS SYSTEM FOR PSYCHOPHYSIOLOGICAL STRESS RESEARCH Final Report, 1 Jul. 1961–31 Dec. 1963
D. H. Brand, R. M. Linhart, and C. A. Burns Wright-Patterson AFB, Ohio, AMRL, Jun. 1965 103 p refs
(Contract AF 33(657)-9810)
(AMRL-TDR-64-64; AD-623126) CFSTI: HC $4.00/MF $0.75

The details involved in designing and executing a large-scale psychophysiological stress experiment are summarized. Design criteria and changes in experimental processes necessitated by preliminary, concurrent studies as well as instrumentation and data conversion problems are also presented. Emphasis is placed on description of the data processing routes, each of which consisted of analog tape formating, analog to digital conversion, data reduction and editing, and data analysis techniques. Flow diagrams, computer program writeups, and examples of pictorial output formats for general, automatic, biological data handling utility are appended. Author (TAB)

N66-15760* System Research, Ltd., Richmond (England).
A STUDY OF GROUP DECISION MAKING AND COMMUNICATION PATTERNS UNDER CONDITIONS OF STRESS AND OVERLOAD, WHEN THE PARTICIPANTS ARE PERMITTED TO FUNCTION AS A SELF-ORGANISING SYSTEM Quarterly Technical Status Report, 1 Apr.–30 Jun. 1965
[1965] 5 p
(Contract DA-91-591-EUC-3607)
(QTSR-2; AD-624597) CFSTI: HC $1.00/MF $0.50

Individual adaptive subsystems (as assigned to each of two participants) were provided to maintain optimum performance conditions for the participants concerned. An overall control system was provided to adjust the parameters of each of the subsystems to optimize group performance. The participants are continuously engaged in the conjoint skill of detecting and intercepting one of eight different trajectories. Experimental work is summarized. TAB

N66-29173# Naval Training Device Center, Port Washington, N.Y.
AUGMENTING FEEDBACK AND TRANSFER OF TRAINING
Gene Micheli Mar. 1966 92 p refs
(NAVTRADEVCEN-1H-41; AD-631405) CFSTI: HC $9.60/MF $0.75

The major finding of the study which was not expected on the basis of previous studies of augmenting feedback was that increasing amounts of information in the augmenting feedback paired with primary feedback conditions that presented little information resulted in positive transfer effects. Specifically, it was found that subjects learned something about the difficult auditory tracking task which persisted following removal of highly informative visual augmenting feedback. This indicates the need to extend the range of task difficulty in augmenting feedback studies to account for tasks presenting very little informative feedback. Author (TAB)

N66-30791*# Texas Christian Univ., Fort Worth.
THE EFFECTS OF STRESS ON SMALL GROUP PERFORMANCE
Fred E. Fiedler 8 Dec. 1965 33 p refs
(Grant NGR-44-009-008)
(NASA-CR-76333) CFSTI: HC $2.00/MF $0.50 CSCL 05J

The results are presented of a study on the effects of stress on leadership and group performance. The study consisted of two phases: one dealt with the contribution which the leader and the members of a group make in performing a task under varying conditions of stress, while the other concerned the type of leadership style which is most appropriate to group performance. R.N.A.

N66-34511# Joint Publications Research Service, Washington, D. C.

ON THE PROBLEM OF PROFESSIONAL FITNESS AND HANDLING CAPACITY OF THE OPERATORS

K. M. Gurevich and L. M. Edel'man *In its* Cybernetics and Automation 17 Aug. 1966 p 232-236 (See N66-34486 20-05) CFSTI: $6.00

This study examines the professional fitness of personnel handling the control desks of electric power installations in terms of their behavior under emergency conditions. Simulated emergency exercises were conducted to observe and evaluate the ability of operators to eliminate an emergency condition. No connection was found between the success of eliminating an emergency and the length of service or special skills of an operator. The repeatedly observed cases of a loss of composure by workers in which grossly mistaken actions were performed indicate that these workers must have some individual peculiarities which to a certain degree predetermine such behavior. R.N.A.

N66-39474# Kansas State Univ., Manhattan. Dept. of Psychology.

STUDY OF VISUAL PERCEPTION IN HUMANS AND ANIMALS. LABORATORY STUDIES OF THE EFFECTS OF STRESS ON VISUAL FUNCTION

John Lott Brown Aug. 1966 33 p refs

(Contract Nonr-3634(04))

(TR-1; AD-637553) CFSTI: HC $2.00/MF $0.50

The study is concerned primarily with three general classes of stress: (1) unusual patterns of motion to which an observer may be subjected; (2) various agents which may be ingested, inhaled, or contacted; and (3) aspects of the visual world itself, such as excessively high light levels. Emotional stresses are of obvious importance, but these are not treated extensively in the report. TAB

A67-23817 *

DEVELOPMENT OF A STANDARD PROLONGED WORK TEST FOR THE EVALUATION OF FATIGUE AND STRESS IN MAN.

J. Shapira, D. R. Young, B. Datnow, and R. Pelligra (NASA, Ames Research Center, Moffett Field, Calif.).

Aerospace Medicine, vol. 38, Mar. 1967, p. 268-272. 9 refs.

Determination of the rate at which the human body reestablishes homeostasis when required to work for a prolonged period at about one-third maximal work capacity. The results, particularly those related to serum glucose and free fatty acids for 20 subjects, are given. It is concluded that a postabsorptive work situation that requires about one-third of their maximal work capacity can be tolerated in human male subjects for up to 24 hr. B.B.

N67-18572# Institute for Research, State College, Pa. Div. of Psychobiology.

DRUG EFFECTS UPON COGNITIVE PERFORMANCE UNDER STRESS

Paul M. Hurst and Marianna F. Weidner Aug. 1966 165 p refs

(Contract Nonr-4423(00))

(ONR-H-66-3; AD-643022) CFSTI: HC $3.00/MF $0.65

Three experiments were conducted to test an hypothesis concerning drug enhancement of performance under task-induced stress. Cognitive abilities subjected to examination were highly paced short-term memory and simple arithmetic skill. Changes in mood state, judgment of performance and perception of time passage completed the behavioral characteristics assessed. Author (TAB)

N67-20499# Georgia Univ., Athens.

PSYCHOPHYSIOLOGIC VARIABLES AS INDICATIONS OF EMOTIONAL STRESS Final Report, Apr. 1964-Jul. 1965

Herbert Zimmer Griffiss AFB, N. Y., RADC, Sep. 1966 622 p refs

(Contract AF 30(602)-3380)

(RADC-TR-65-296; AD-641814) CFSTI: HC $3.00/MF $0.65

The report covers the physiological responses of the human and means of achieving maximum discrimination between critical and neutral stimuli. Consideration is given to the social context in which the response is solicitated, the selection of the most useful psychophysiologic variable, methods of recording and analyzing the data by computers and the limits imposed by the existing knowledge. The appendix contains a rationale of those physiologic measures which have been employed by other investigations to study emotional reactions to stimuli of short duration. Author (TAB)

A66-81962

HUMAN MAZE LEARNING AS A FUNCTION OF STRESS AND PARTIAL REINFORCEMENT.

P. E. Freedman (U.S. Army Natick Labs., Pioneering Res. Div., Natick, Mass.)

Psychological Reports, vol. 18, Jun. 1966, p. 975–981. 10 refs.

Ninety-six subjects learned a 23-row button maze under one of three stress conditions and partial or continuous reinforcement. Stress conditions were error, error and speed instruction, or error and speed instruction plus irrelevant shock. Numbers of errors were an increasing function of stress, but rate (responses per second) suggested a nonmonotonic function. Reinforcement schedule was not an effective variable. Results are discussed with relation to competing response tendencies associated with motivation.

A66-81523

INVESTIGATIONS REGARDING STRESS ON FLYING PERSONNEL IN LONG-DISTANCE JET FLIGHTS [UNTERSUCHUNGEN ZUR BELASTUNG DES BORDPERSONALS AUF FERNFLUGEN MIT DUSENMASCHINEN].

K. E. Klein, H. Bruner, and S. Ruff (Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Inst. fur Flugmed., Bad Godesberg, West Germany).

Zeitschrift fur Flugwissenschaften, vol. 14, Feb. 1966, p. 109–121. 41 refs. In German.

The following data were determined on crew members of German transatlantic airliners, over a period of twenty-five scheduled flights: pulse and blood pressure, electrocardiogram, oral temperature, eosinophil count, hematocrit, hand coordination ("Klopftest"), psychomotor performance ("Eutaxia Test"), and optical reaction time. In addition, each test subject answered a questionnaire regarding personal discomfort (headaches, etc.), thirstiness, fatigue, etc. Results were tabulated and are graphically represented. It is shown that the diurnal performance rhythm can be modified by motivational factors. E.g., landing and take-off have reactivating effects even on fatigued crews. Such effects are the more pronounced the closer they are to the peak values on the diurnal activity curve. This should have some bearing on the scheduling of long-distance flights.

A64-80017

HUMAN BEHAVIOR UNDER STRESS—FROM COMBAT TO SOCIAL PSYCHIATRY.

Kenneth L. Artiss (Walter Reed Army Inst. of Res., Div. of Neuropsychiatry, Washington, D.C.)

Military Medicine, vol. 128, Oct. 1963, p. 1011–1015. 26 refs.

Certain trends have evolved in American psychiatry through experiences in World War II. Socioenvironmental variables were recognized as determinants of behavior. According to these principles, behavior disruptions were best treated immediately, in close proximity to the place of their occurence, and within the customary milieu, with full expectation of a recovery of function in a short time. Research at Walter Reed Army Institute of Research has since substantiated the empirical concepts by showing a large response of 17-hydroxycorticosteroids to social stimuli. Also, following an exorbitant demand, the endocrine system may take several days to recover. This finding may be related to the empirical 3 days required for the recovery of the disabled combat soldier.

A66-81973

EVALUATION OF MENTAL STRESS DURING WORK [K PROBLEMU POSUZOVANI PSYCHICKE ZATEZE PRI PRACI].

O. Matousek and J. Stikar.

Ceskoslovenska Psychologie, vol. 10, no. 3, 1966, p. 256–267. 42 refs. In Czech.

From the point of view of working activity, stress means disproportion between the requirements and the average capacity for task solution. The human organism is capable of mobilizing sources of reserve in exacting conditions, of maintaining for a certain period equivalence between the internal state and external conditions, and of passing beyond the borderline of the "average capacity". This dynamic process, the basis of which is homeostasis, may be called adjustment. The adjustment syndrome is under these conditions an indirect indicator of psychic stress. There is no method which could be reliably applied as a matter of routine for the evaluation of psychic stress in working activity. The survey of the methods used so far have a rather laboratory-model character, and are predominantly indirect methods. Further research of psychic stress problems and the possibilities of stress evaluation and comparison must be preceded by successful attack on three complexes of problems: research into informational capacity of man, his limits of adjustment, and research of fatigue from the point of view of subjective expression and functional changes in the organism.

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A63-[illegible]
PERCEIVED MOVEMENT IN DEPTH AS A FUNCTION OF STIMULUS SIZE.
William C. Sheridan and Charles A. Bauer (USAF, Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio).
Human Factors, vol. 4, Dec. 1962, p. 349-354.

Experimental investigation of man's ability to perceive movement in depth of flat, circular, luminous objects of various angular subtenses in an otherwise stimulus-free field. The experimental apparatus and procedure are described. A method of constant stimuli is used to determine threshold values for the perception of movement. The results, listed graphically and in tables, are discussed.

A63-[illegible]
THE EFFECT OF RATE AND DIRECTION OF DISPLAY MOVEMENT UPON VISUAL SEARCH.
Leon G. Williams and Marion S. Borow (Minneapolis Honeywell Regulator Co., Minneapolis, Minn.).
Human Factors, vol. 5, Apr. 1963, p. 139-146.

Study for the determination of the effects of rate and direction of display movement upon the time to find alphabetical targets. Subjects searched for targets which always remained present in a display which moved but did not change. Display speeds somewhat faster than 6°/sec angular velocity (4 in./sec viewed at 15 in.) were associated with decrements in performance. At higher rates of movement, search times for horizontally-moving displays were lower than those for vertically-moving displays. It is recommended that high-speed displays move horizontally when compatible with other system needs.

N63-18715 . Courtney and Co., Philadelphia, Pa
THE PILOT'S VISUAL TASK: A STUDY OF VISUAL DISPLAY REQUIREMENTS
[illegible] G. Pfeiffer, W. Crawford Clark, and James W. Dananer. Mar. 1963. 123 p. 33 refs
(Contract [illegible]; 61339-783)
(NAVTRADEVCEN 783-1)

[illegible] was made of the perceptual characteristics of the [illegible] world while performing various flight tasks. These [illegible] with the perceptual characteristics made available by [illegible] nonprogramed visual displays attached to flight trainers. [illegible] then conducted in the F-100 simulator equipped [illegible] visual attachment to determine training effects. It was determined that, even among experienced subjects, performance significantly improved, both with regard to (1) the detection of [illegible] emergencies and (2) the maintenance of aerodynamic stability. Recommendations are made for improvements in external visual displays to enhance the training value of flight simulators.
Author

A64-12969
A STUDY OF PHOTOSTRESS AND FLASH BLINDNESS.
Sanford L. Severin, Norris L. Newton, and James F. Culver (USAF, Systems Command, Aerospace Medical Div., School of Aerospace Medicine, Brooks AFB, Tex.).
American Journal of Ophthalmology, vol. 56, Oct. 1963, p. 589-595.

Results are reported of a study designed to evaluate the problem of flash blindness. Fifteen subjects were exposed to light flashes ranging over three levels of corneal illuminance; 86,000 lux, 150,640 lux, and 242,100 lux, using two different pupil conditions and two testing luminances. Analysis of the results demonstrates that: (1) A linear plot describes the relationship between time required for recovery and flash intensity over the range tested. (2) There is a significant difference in recovery rate between subjects. This variation is demonstrated by an actual change in the slope of the recovery function. (3) Pupillary size has a significant effect upon the time required for recovery from dazzle. The operational significance of these observations is implied.

A64-19526

COMBINATION OF INFORMATION IN SUPERIMPOSED VISUAL FIELDS.

J. M. Naish (Ministry of Aviation, Royal Aircraft Establishment, Farnborough, Hants., England).

Nature, vol. 202, May 16, 1964, p. 641-646. 9 refs.

Investigation of the influence of position and form on combined information in superimposed visual fields. The results are summarized by treating superimposed fields as a single field of visual information. This process is [illegible] by the use of a common field position and comfortable presentation within a common framework. It is stated that, in the aeronautical application, a reflecting collimator may be used (with relevance to safety) to present steering information during visual flight and improved tracking accuracy. Application is also possible, in principle, to televised presentation of superimposed fields. It is noted that errors and limitations have also been studied and the results do not influence the findings of this investigation.

A64-[illegible]

FLASHBLINDNESS - A PROBLEM OF ADAPTATION.

J. H. Hill and Gloria T. Chisum (U.S. Naval Air Development Center, Aviation Medical Acceleration Laboratory, Johnsville, Pa.).

Aerospace Medicine, vol. 35, Sept. 1964, p. 877-879. 10 refs.

Discussion of the temporary reduction in visual sensitivity due to exposure to a high-intensity flash, which is a potential problem to pilots of modern high-performance aircraft. A brief description of the visual processes affected is given. The relation of light adaptation and dark adaptation of the eye to the changing lighting conditions and the recovery of sensitivity to a functional level are discussed. The suitability of fixed-density goggles as a protective system is examined, and the results of the simulation of protective devices with closing times of 33 and 165 μsec and 9.8 ms are reviewed. Eye-patch studies are also discussed.

A64-[illegible]737

THE ILLUSION OF MOVEMENT.

Paul A. Kolers.

Scientific American, vol. 211, Oct. 1964, p. 98-106.

Brief discussion of the general subject of illusions and description of some experiments with the illusion of movement that can be created under controlled conditions with a suitably timed [illegible] of lights. It is concluded that, in addition to several [illegible] criteria that distinguish real [illegible] apparent movement, the experiments reveal that the "mechanism" for illusory movement [illegible] more in common with the "mechanism" controlling the formation of simple visual figures than it has with real movement. It is stated [illegible] the experiments also support a hypothesis recently advanced [illegible], namely that perceptions are constructed by means of a number of different operations occurring at different times and places in the nervous system. It is noted that this could be called an "assembly line" model of visual perception. M. M.

A64-27604

VISUAL FIELD CHANGES DURING POSITIVE ACCELERATION.

E. A. Jaeger, R. J. Severs, S. D. Weeks, and T. D. Duane (Jefferson Medical College, Dept. of Ophthalmology, Philadelphia; U.S. Naval Air Development Center, Johnsville, Pa.).

Aerospace Medicine, vol. 35, Oct. 1964, p. 969-972. 17 refs.
Grant No. NB 04233-02.

Investigation of the pattern of visual-field loss by means of a special plethysmographic goggle-type ophthalmodynamometer. It is stated that the molecular pattern of visual field closure is the same whether due to ophthalmodynamometry, positive acceleration, or a combination of both. It consists of an initial selective nasal field defect which approaches a hemianopic character before marked temporal field loss begins. The last remaining visual field is not at fixation but is confined to an island located temporarily between fixation and the blind spot. The belief is expressed that this pattern is best explained by the anatomic arrangement of the retinal arteriolar system. (Author) M. M.

A64-60214
VISUAL PERCEPTION OF MOVEMENT.
T. C. D. Whiteside (R.A.F. Inst. of Aviation Med., Farnbo[illegible]h, Eng.)
Annals of the Royal College of Surgeons of England, vol. 33, Nov. 1963, p. 287–301. 23 refs.

Visual perception of motion is considered in terms of movement in the visual field; and movement of the visual field. The former encompasses a discussion of the Phi movement, saccadic movement of the eyes; light threshold during the saccade; retinal inhibition; threshold for visual perception of movement with respect to horizontal or vertical axis and background texture; learning and inferred movement. Movement of the visual field is associated closely with the interplay between the extraocular muscles and neural transmission of information. Oculogyral, oculogravic, and autokinetic illusions are considered separately because of their special interest to aviation medicine. Several practical considerations of these illusions arise in connection with collision hazards in the air or [illegible] attempted rendezvous of spacecraft.

A64-60215
STUDIES ON KINETIC VISUAL ACUITY: THE IMPORTANCE OF KINETIC VISUAL ACUITY AS AN ABILITY OF PILOT.
Akihiro Suzumura.
Annual Report of the Research Institute of Environmental Medicine, Nagoya University, vol. 11, 1962, p. 9–18. 10 refs. (Published 1963.)

A new apparatus, the A-S Kinetic Vision Tester, is introduced for measurement of kinetic visual acuity. Several experiments were conducted on the relations between kinetic and static visual acuity, and between the former and object velocity, and on the effects of fatigue and jet flight. The smallest differences between the static and kinetic visual acuities were obtained in occupational groups (pilots, highway patrol police) where they were closely related to their proficiency. Kinetic visual acuity decreases as the velocity of the moving visual object increases. This decrease is influenced by individual differences, physical exertion, mental exhaustion, or insomnia. It is concluded that kinetic visual acuity is (1) controlled by a physiological eye mechanism different from that for static visual acuity; (2) closely related to [illegible] in accommodative function; (3) a valuable indicator for qualifying pilots, highway patrol officers, and other traffic operators; and (4) an aid in evaluating fatigue.

A64-60379
[illegible]MAN PERCEPTION.
Richard L. Gregory (Cambridge U., Dept. of Psychol., Cambridge, England).
British Medical Bulletin, vol. 20, Jan. 1964, p. 21–26. 64 refs.

Research on perceptual processes, particularly in visual perception, is reviewed with respect to the following criteria: innate versus learning contributions, relation between retinal image and perception, perceptual constancy and inferences of visual space, perception of movement, and sensory discrimination—concept of threshold as limited by signal-to-noise ratio.

A64-60381
INFORMATION PROCESSES IN HUMAN SKILL.
E. R. F. W. Crossman (Oxford U., Inst. of Expt. Psychol., Oxford, England).
British Medical Bulletin, vol. 20, Jan. 1964, p. 32–37. 67 refs.

Information theory is applied to the analysis of the development of skills in adult human behavior. The systematic approach to this problem in the last 15 years has assimilated engineering concepts of control and communication. The discussion is oriented around topic headings of information theory; receptor processes covering sensory filtering and memory, recognition and absolute judgment, perceptual integration, and temporary storage for perceptual responses; central processes including the habitual choice-responses, central channeling, prediction and planning, and temporary storage for effector commands; effector processes covering their organization and peripheral motor control; and the relative timing of information processes.

A64-30525
DISTANCE PERCEPTION IN DARKNESS.
Linda G. Eisenbush, Robert E. Taylor, and Donald H. Thor (Georgia U., Dept. of Psychol., Athens).
Science, vol. 145, Jul. 17, 1964, p. 294–295.

Human subjects viewed round stimuli located equidistantly in the horizontal and vertical planes of vision under conditions where presumed cues to size were present and where they were systematically eliminated (artificially induced "moon illusions"). Two experiments revealed a consistent tendency for the horizon object to be judged the closer. Cues introduced reduced the effect.

A64-30526
PERCEPTUAL AND MOTOR SKILLS: XIV, PSYCHOLOGICAL INDEX, NO. 11, 1964.
R. B. Ammons and C. H. Ammons (Mont. State U., Missoula).
Perceptual and Motor Skills, vol. 19, Aug. 1964, p. 172–174. 76 refs.
An annotated listing of 76 references to work in perception in the Psychological Index, No. 11, 1964.

A64-30532
TARGET VELOCITY, EXPOSURE TIME AND ANTICIPATORY TRACKING TIME AS DETERMINANTS OF DYNAMIC VISUAL ACUITY (DVA).
Edwin H. Ekin (Dunlap and Assoc., Inc., Washington, D.C.)
Aerospace Medical Association, 35th Annual Scientific Meeting, Americana Hotel, Fal Tabour, Fla., May 11–14, 1964. Preprints of Scientific Program, p. 52–53.
ONR Contract.

Studies of the effects of increasing target velocity, and decreasing exposure time, and anticipatory tracking time on dynamic visual acuity are presented. Results of these studies are outlined. The following conclusions were reached: (1) Visual acuity deteriorates as target velocity increases; deterioration is substantial when measured under relatively restricted acuity test conditions, but becomes less marked as test conditions become less restricted. (2) Measures of static and dynamic acuity correlate positively and significantly under favorable target tracking conditions, good static acuity being a necessary but insufficient condition for dynamic visual acuity.

A64-30905
CONTROL OF EYE FIXATION BY AUDITORY FEEDBACK.
William M. Smith (Dartmouth Coll., Hanover, N.H.)
Psychonomic Science, vol. 1, Aug. 1964, p. 233–234.
Grant No. NSF-G-GE-1110.

Two subjects maintained eye fixation under four different experimental conditions with and without auditory feedback. All observations were made with the left eye. The results indicate that auditory information can be utilized in controlling eye fixation, particularly as normal visual control of fixation is decreased. The retinal component of the normal visual feedback loop is not a necessary condition for maintaining eye position.

A64-81033
INVESTIGATIONS ON VISUAL ACUITY FOR MOVING OBJECTS. I. THE EFFECTS OF EYE DISEASES ON VISUAL ACUITY FOR MOVING OBJECTS (UNTERSUCHUNGEN UBER SEHSCHARFE FUR BEWEGTE OBJEKTE). I. PERTINENZ VON AUGENKRANKHEITEN AUF DIE SEHSCHARFE FUR BEWEGTE OBJEKTE).
Wolfgang Jaeger and Heinrich Honegger (Heidelberg U., U.-Augenklin., Germany).
Albrecht von Graefes Archiv fur Ophthalmologie, vol. 166, 1964, p. 583-600. 10 refs.

Visual acuity for moving objects was studied by means of an apparatus projecting letters and numbers on a screen moving perpendicularly to the visual axis. Visual acuity decreases with increasing speed of the object. The normal curve was obtained from 120 subjects with normal vision and compared to those obtained from subjects with various visual anomalies. Visual acuity for moving objects relative to visual acuity at rest is lowered in advanced age, [illegible], concentric losses of the visual field, hemianopsia with a vertical division between the lost and preserved areas of the visual field, and oculomotor incoordination paralysis in multiple sclerosis. It is increased relative to visual acuity at rest in [illegible] corrected errors of refraction (myopia, hyperopia), central scotoma, and paresis of individual eye muscles. Absolute improvement of visual acuity for objects in motion over that of the normal individuals occurs in cases of nystagmus. In aphakia visual acuity for moving objects corresponds to the normal, taking into account the age factor. These results are discussed in relation to traffic problems.

A64-81060
THE SPEED OF RESPONSE IN MAN AS AFFECTED BY THE TEMPO OF THE PRESENTATION OF ALTERNATIVE SIGNALS (ZAVISIMOST' SKOROSTI OTVETNYKH REAKTSII CHELOVEKA OT TEMPA PREDIAVLENIIA AL'TERNATIVNYKH SIGNALOV).
O. A. Konopkin.
Voprosy Psikhologii, vol. 1964, Jan.-Feb. 1964, p. 45-60. 11 refs. In Russian.

Light flickers at the rate of 0.25 per second, flashed repetitively at different locations on the screen, were employed in testing the speed of perception and response to visual signals, in subjects who reacted by pressing a button. The results indicated that an increase in speed of signal presentation, within certain limits, stimulated the speed of response, without lowering the degree of accuracy. Extreme speed decreased the degree of accuracy of response. Verbal coaching and a set pattern of flickers led the subject to develop his own pattern of response which enhanced his speed and accuracy. These findings can be taken as evidence that perception of information may involve the conscious-voluntary mechanism of action.

A64-81076
PROLONGING VISUAL AFTER IMAGES.
R. J. Hall (Philco, Aeronutronic Div., Washington, D.C.) and W. E. Wilsoncroft (Claremont Graduate School, Claremont, Calif.)
Psychonomic Science, vol. 1, Sep. 1964, p. 267-268. 8 refs. Hughes Aircraft Corp. supported research.
Grant DAS-C-M-5207-3.

The study indicates that supplying stimulus changes (flickering on-off [illegible] of the visual field following initial stimulation of the retina can prolong the duration of visual afterimages. Although most current research on afterimages has focused on the biochemical and neural basis of this phenomenon, [illegible] noted that post-stimulation conditions in the visual field as well as [illegible] simple "changes" as blinking may also be significant parameters.

A64-81191
VISUAL AND AUDITORY VIGILANCE DURING EXPOSURE TO HOT AND HUMID CONDITIONS.
C. R. Bell, (London School of Hyg. and Trop. Med.; Med. Res. Council Environ. Physiol. Res. Unit, England). K. A. Provins (Adelaide U., Dept. of Psychol., South Australia), and R. W. Hiorns
Ergonomics vol. 7, Jul. 1964, p. 279-288. 12 refs.

The effect of exposure to climatic conditions ranging in severity from 29.5/24.5° C to 63/47° C on the performance of (1) a visual and (2) an auditory vigilance task was studied separately in two series of experiments on fit young men. Exposure time decreased with increasing climatic severity. When performance was examined in terms of the proportion of signals missed to signals given, there was no evidence of a change in vigilance with different climatic conditions; but in both experimental series, a greater proportion of signals was missed as body (oral) temperature increased.

N64-[illegible] Douglas Aircraft Co., Inc., Long Beach, Calif.
DYNAMIC VISION. THE LEGIBILITY OF ALPHANUMERIC SYMBOLS MODERATELY SPACED
D. M. Lee. 30 Jul. 1963. 102 p. refs
(LB-31403; AD-425036)

Targets subtended an angle of 39 min. at the observer's eye, and were spaced from each other at a distance which subtended 7.5° at the observer's eye. The targets were black on white and moved vertically in the frontal place, from top to bottom. Experiments were as follows: (1) Equally spaced alphanumeric symbols randomly ordered in three columns, each column containing 26 symbols, were used as stimulus material. It was shown that no significant increase in performance, measured in angular velocity of the stimulus material, was obtained with serial presentation of the columns. (2) Individual criteria and sample means for 100-percent legibility were determined. (3) The stimulus material was presented both by television and by direct viewing. Performance, based on angular velocity at which 100 percent could be scored, was approximately 30 percent lower for television viewing. (4) Individual criteria and sample means for zero legibility were determined.
Author

N64-21381 Princeton U., N.J.
ON THE VISUAL DETECTION OF ACCELERATED MOTION
Ross D. L. Filion (Ph.D. Thesis). Sep. 1963. 84 p. refs
(Contract AF 49(638)-381; Grant AF-AFOSR-441-63)
(AFOSR-64-0189; AD-433109)

The absolute threshold for acceleration in the motion of a seen object was investigated. Subjects were presented with constant velocity or positively accelerated motions of the CRT (cathode ray tube) beam on an oscilloscope screen; their task was to judge whether the pip achieved a final velocity greater than or equal to its initial velocity. The main conclusions drawn were: (1) Subjects' judgments concerning the presence or absence of acceleration in a stimulus motion are based on information deriving from within the motion itself and not on external aspects. (2) Subjects apparently detect acceleration by some procedure of estimating and comparing earlier and later average velocities in the motion display. (3) Effects analogous to the velocity transposition phenomenon occur in the detection of acceleration when viewing field dimensions are changed and when spatial or temporal size of the motion path is changed. (4) The human organism's performance in dealing with the second-time derivatives of visual stimulus magnitudes is not as good as performance in dealing with first-time derivatives of the same stimulus magnitudes.
R.T.K.

N64-25842 Flying Personnel Research Committee (Gt. Brit.)
VISUAL PERCEPTION OF MOVEMENT
T. C. D. Whiteside (Inst. of Aviation Med., RAF). Air Ministry. 23 Aug. 1963. 16 p. refs. An Edridge Green Lecture Presented at the Roy. Coll. of Surgeons of Engl. See A64-[illegible]
(FPRC MEMO-191)

Human visual behavior is discussed generally, with special attention given to motion perception. It is suggested that the concepts discussed could be applied in the use of a stable observer's [illegible] for the airborne avoidance of collisions, and to the [illegible] space-vehicle rendezvous systems.
D.E.W.

N64-25847 Flying Personnel Research Committee (Gt. Brit.)
VISUAL ILLUSIONS OF MOVEMENT
T. C. D. Whiteside (Inst. of Aviation Med., RAF), A. Graybiel, and J. I. Niven (Naval School of Aviation Med.). Air Ministry. Jun. 1963. 20 p. refs
(FPRC/1207)

Visual illusions are related to involuntary eye movements, occurring either spontaneously as in the autokinetic illusion, or in response to the special stimuli associated with the other two illusions. During fixation, the visual sensation of movement seems to be produced by, or related to, the pattern of efferent activity aimed at the group of extraocular muscles that will act as antagonists to the involuntary eye movement referred to. Under certain circumstances, when the stimulus change is rapid, an eye movement may be detected before the fixation reflex has time to operate. Since the sensation can be caused by the pattern of antagonist efferent activity, it can arise during fixation with no demonstrable responsible eye movement. The displacements of a visual afterimage as a result of the involuntary eye movements, are predominantly in the direction of agonist activity.
Author

N64-27433 Aerospace Research Labs., Wright-Patterson Air Force Base Behavioral Sciences Lab.

THE USE OF AUDITORY FEEDBACK IN SIMPLE REMOTE-HANDLING TASKS

William N. Kama, Louis T. Pape, and D. Frederick Baker May 1964 13 p refs

(AMRL-TDR-64-45; AD-603407)

A study was conducted to investigate the effect of auditory feedback upon performance of a remote handling task. Forty-five subjects, divided into three groups of 15 subjects each, used a Central Research Laboratory's model 8 master-slave manipulator to perform a simple remote handling task. One group performed the task under a no-sound condition; the second performed under a white-noise-only condition; the third group was provided with task-relevant auditory information. The results of this study suggest that, in the operation of this manipulator, supplementing visual, tactual, and proprioceptive information with task-relevant auditory information had little or no effect on performing simple remote handling tasks. Author

N64-30323 Joint Publications Research Service, Washington, D.C.

EXPERIMENTAL METHODS: AN EXPERIMENTAL APPARATUS FOR STUDYING THE INFLUENCE OF VARIOUS VISUAL SIGNALLING PARAMETERS ON THE EFFECTIVENESS OF MOTOR REACTIONS

V. N. Antonov, V. V. Lepeshkin, and A. Ye. Ol'shannikova *In its* Transl. from Vopr. Psikhologii (Probl. of Psychol.), No. 3, 1963 p 7-11 (See N64-30321 22-14) OTS: $3.00

An apparatus is described that is intended for the following purposes: (1) a study of the dependency of time of motor reactions upon the intensity of visual stimulants under different conditions, comparable with industrial ones, and (2) a study of the relationship between time characteristics of motor reactions (magnitude of time of reaction, its duration, etc.) and their other quantitative characteristics (degree of intensity of pressure on push button, form of curve of pressure, etc.).

P.V.E.

N64-30469 Ohio State U. Research Foundation, Columbus

VISUAL RECOVERY FROM BRIEF EXPOSURES TO VERY HIGH LUMINANCE LEVELS, PART I Final Report

Norma D. Miller Brooks AFB, Tex., School of Aerospace Med. May 1964 78 p refs

(Contract AF 33(657)-9229)

(TDR-2; AD-450072)

Maximum flash field luminances of 5.4×10^5L were produced by a xenon-filled discharge tube seen by maxwellian view. The field diameters were varied from 10° to 20 min of arc, and the flash exposures were varied from 0.04 msec to 1.4 msec. The maximum flash energy was 0.042 cal/cm^2 at the retina, neglecting losses in the ocular media. During most of the experimental work, the maximum flash energy was reduced to 0.012 cal/cm^2 at the retina by the use of an infrared blocking filter. The flash luminances were varied over a 30 to 1 range. The criterion measure for recovery times following the flashes was the correct identification of Sloan-Snellen test letters viewed as bright letters against a dark background.

Author

A65-10533

RELATION BETWEEN VISUAL SEARCH TIME AND PERIPHERAL VISUAL ACUITY.

Ronald A. Erickson (U.S. Naval Ordnance Test Station, Aviation Ordnance Dept., China Lake, Calif.).

Human Factors, vol. 6, Apr. 1964, p. 165-177. 6 refs.

Investigation, carried out at the US Naval Ordnance Test Station, of the relationship between peripheral visual acuity and time required to locate a target in a static structured display. Sixteen male observers were used in the tests. Peripheral acuity measured as 3.6° and 4.8° off the visual axis correlated significantly at the 0.01 level with time required to find a target in displays containing 16 or 32 rings and correlated at the 0.05 level with search time on displays of 16 and 32 blobs. Almost all correlations involving search times from object densities of 48 and/or acuity measurements made at 6.0° off the visual axis were not significant. In addition to the results concerning peripheral visual acuity, other relationships between variables were suggested by an analysis of the data. An analysis of variance established that the shape of the objects in the display (blobs or rings) and the number of objects in the display (16, 32, or 48) had a significant effect ($p < 0.01$) upon search time. The interaction of shape and object density was also found to be significant at the 0.01 level. There were no significant intercorrelations between observer age, foveal acuity as measured in a naval eye examination, and peripheral acuity. Furthermore, age and foveal acuity did not correlate significantly with search performance.

(Author) D. H.

A65-22032

MANUAL CONTROL OF AN UNSTABLE SYSTEM WITH VISUAL AND MOTION CUES.

Laurence R. Young and Jacob L. Levy (Massachusetts Institute of Technology, Dept. of Aeronautics and Astronautics, Cambridge, Mass.).

(Institute of Electrical and Electronics Engineers, International Convention, New York, N.Y., March 22-25, 1965.)
IEEE International Convention Record, vol. 13, pt. 6, 1965, p. 123-127.
Grant No. NsG 577.

Investigation of the control characteristics of the human operator in control situations where he is limited to the use of visual, vestibular-tactile, or combined visual-vestibular sensing of motion. A moving-base flight simulator programed as an unstable system of varying divergence frequencies is the controlled element of the loop. The performance of the operator is compared in a series of increasingly difficult control tasks which require more lead compensation to achieve stable closed-loop operation. It is shown that the range of control is extended to higher divergence frequencies with the presence of motion cues, which enable the operator to develop a greater amount of phase lead than under visual tracking. The general function of the vestibular apparatus in dynamic orientation and its importance in vehicle control are discussed.

(Author) A.B.K.

A65-26421 #

PRELIMINARY REPORT CONCERNING PERIPHERAL DYNAMIC VISION.

J. Hoogerheide.

Aeromedica Acta, vol. 9, 1963-1964, p. 139-145. 13 refs.

Experimental investigation of peripheral dynamic vision. A figure shows static visual acuity expressed in minutes of arc as a function of the nasal-retinal position of the test-object image, expressed in degrees of periphery. It is noted that, although the viewing time was varied from 0.1 to 1.0 sec, the experimental results did not show any evidence that lengthening the viewing time improved the static peripheral visual acuity. For purposes of comparison, Wertheim's (x) measurements (1894), with which the present measurements show fair agreement, are also given.

M.M.

A65-26427

CAN A SENSORY SYSTEM BE SPECIFIED BY ITS INTERNAL NOISE?

D. Elkman and A. J. H. Vendrik (Nijmegen, Roman Catholic University, Dept. of Medical Physics, Nijmegen, Netherlands).

Optical Society of America, Journal, vol. 37, June 1965, p. 422-429. 8 refs.

Use of the detection model to describe the detection of scarcely discernible noiseless signals by human observers. Detection is hampered by an internal noise generated by the sensory system itself. In the present study, it appears that increments of loudness of a tone and increments of intensity of a light can be detected independently and simultaneously. Here, the internal noise is apparently for the system responsible for this detection. On the other hand, detection of an increment in duration of visual and auditory signals is completely correlated. This correlation and the similarity of the detectability of the two kinds of signals indicate that a "duration center" exists, serving to estimate the duration of both visual and auditory signals. The methods developed are useful for the identification of separate or common parts of sensory systems.

(Author) M.M.

A65-29058

EFFECTS OF SLEEP DEPRIVATION ON VISUAL FUNCTION.

A. Paul.

Aerospace Medicine, vol. 36, July 1965, p. 617-620. 10 refs.

Study of effects on 20 students, 18 years of age, who were deprived of sleep for 50 hr. Before, during, and after this period of sleep deprivation visual examinations were repeated at intervals, testing visual acuity, muscle balance, stereoscopic vision, tachistoscopic perception, and color vision. Only after 46 hr of sleeplessness was a very small decrement noticed. After a short period of sleep (five hr) visual function returned to its original state.

(Author) F.R.L.

A65-81434

DIFFERENTIAL VISUAL FEEDBACK OF COMPONENT MOVEMENTS.

John P. Gould (IBM Watson Res. Center, Yorktown Heights, N.Y.)

Journal of Experimental Psychology, vol. 69, Mar. 1965, p. 265–268. 5 refs.

New closed-circuit television techniques allowed the joint action of the subject's hand, control-instrument, and operational effects to be visually fed back singly or in combination. Four visual feedback conditions and two levels of task precision were used. The results showed that the effects of visual feedback were determined by the component motions fed back, with the operational effects being the most important followed by control-instrument and hand-arm movements. A significant interaction between visual feedback and precision of movement occurred, where feedback of the operational component became more important as more overall precision of movement was demanded.

A65-81433

THE EFFECTS OF SMOKING ON NIGHT VISION.

Kyoung Uk Rhee, Dae Soo Kim, and Yong Sic Kim.

IN: FOURTEENTH PACAF MEDICAL CONFERENCE: PROFESSIONAL PAPERS, TOKYO, JAPAN, NOV. 30–DEC. 2, 1964.

[n.p.], [1965], separately paged. 6 refs.

A study has been carried out to discover any decrement of night vision in airmen due to the effects of smoking. Forty airmen were used (20 smokers and 20 nonsmokers). After a period of dark adaptation, the men stayed in a dark room and read a set of letters flashed on a screen. The subjects then smoked a cigarette within 10 minutes and were retested for reading distance of the letters. The after-smoking distance in both groups was significantly shorter. The distance shortened in smokers was 10% and 15% in non-smokers. Total recovery was the same in both groups and occurred in about 30 minutes.

A65-81634

KINETIC VISUAL ACUITY: THE EFFECT OF INCREASED LEAD-IN TIME ON KINETIC VISUAL ACUITY.

Sally I. Miller and Carolyn E. Reeder (Northampton Coll. of Advanced Technol., London, Great Britain).

British Journal of Physiological Optics, vol. 22, 1965, p. 46–52. 10 refs.

The effect of variations in "lead-in" period on kinetic visual acuity was studied in subjects seated with the eye level just above a mirror used in the experiment and screens viewed binocularly. Free head movement was allowed. Kinetic visual acuity was measured at each angular velocity at "lead-in" times of 0.2 sec., and 0.4 sec. The maximum value of kinetic visual acuity was obtained after about 20 runs. The kinetic visual acuity was measured at 0.2 sec. viewing time of the target for speeds from 10°/sec. to 140°/sec. The results indicate that an increase in the "lead-in" time from 0.2 sec. to 0.4 sec. is followed by overall improvement in kinetic visual acuity. This improvement may be largely due to increased target travel time and greater "lock" on the target by the eyes. The latter suggests that maximal visual acuity would be obtained maximally if the arc over which the target travels is unrestricted. The method of tracking was of importance. Head movement was not necessary for tracking a target moving at less than 30°/sec. because at such low speed saccadic eye movement was minimal. Above 60°/sec. both, saccadic eye movements and head movements were employed, and kinetic visual acuity fell off markedly, until a new head and eye movement technique was learned. An improved level of kinetic visual acuity was maintained when readings at the lower velocities were repeated.

A65-81978

RELATIONSHIP BETWEEN STATIC AND DYNAMIC VISUAL ACUITY.

Seymour Weissman and C. M. Freeburne (Bowling Green State U., Ohio).

Journal of Experimental Psychology, vol. 70, Aug. 1965, p. 141–146. 6 refs.

Research in the area of dynamic visual acuity (DVA) has pointed out a controversy as to the nature of the relationship between DVA and static acuity. This study tried to answer the following questions. (a) Is there a relationship between static acuity and DVA at any speed? (b) If there are relationships at different speeds, are they different kinds of relationships? Thirty women, college students, were given six speed (20, 60, 90, 120, 150, and 180°/sec) and one static measure of acuity. Thresholds for the first 4 speeds were found to show a significant linear relationship with the static acuity thresholds. The relationship disappeared at the two higher speed thresholds.

A65-82025

THE [illegible]NDENCE OF VISUAL [illegible] UPON THE AMOUNT OF INFORMATION IN THE [illegible] ZÁVISLOSŤ [illegible]TUROVEJ [illegible]ZRAKOVEJ DISKRIMINACIE OD MNOŽSTVA INFORMACIE [illegible].

Ivan S[illegible] (Sav, Ustav expti. psychol., [illegible]tislava, Czechoslovakia).

Studia Psychologica, vol. 7, 1965, p. 20-30. 15 refs. In Czech.

[illegible] subjects viewed four series of the Landolt ring presented tachistoscopically. From the first to the fourth series the number of possible gap positions gradually increased from 2 to 4, 8 and 1[illegible] [illegible]ysis of variance and t-tests confirmed a significant increase of the amount of transmitted information in individual series. There were two different trends in performance where [illegible] limits were set by the discriminating ability of the eye on the one hand and by the transmitting capacity of the sensory channel on the other. In the fourth [illegible], a high and significant correlation was obtained between [illegible] acuity [illegible] vision and performance. It is proposed that tests of this type be employed to select individuals from candidates with normal visual acuity for tasks with high visual requirements.

A65-82202

EFFECT OF TARGET SIZE, LUMINANCE, AND COLOR ON MONOCULAR FIXATION.

Robert M. Steinman (Md. U., Dept. of Psychol., College Park).

Journal of the Optical Society of America, vol. 55, Sep. 1965, p. 1158-1165. 15 refs.

Soc. of Sigma Xi and RESA Fund supported research.

A contact-lens technique was used to record eye movements made by two subjects attempting to maintain fixation at the center of concentric round targets of several sizes (1.9'- 87.2' diam.) and luminances (2.8, 7.8, and 21.5 mL). Fixation of red, blue, and white 1.9' diam. targets was also examined. Analysis of variance designs were employed to remove variability arising from sources other than these stimulus variables. Statistically reliable differences in mean fixation position were found with targets of different size, luminance, and color. The largest difference observed was less than 4 and under most conditions was less than 2. The bivariate dispersion of the eye about its mean position varied in a complex manner with the size and luminance of the target object. No statistically reliable effects of stimulus variables were found on drifts. Saccade frequency was considerably reduced with the largest targets. Results are discussed in terms of a "fixed error-signal system" for the control of eye position.

[illegible]5-82201

[illegible]AL NOISE CAUSES TUNNEL VISION.

[illegible] H. Mackworth (Harvard U., Cambridge, Mass.)

[illegible] Science, vol. 3, Jul. 15, 1965, p. 67-68. 12 refs.

[illegible] Grant NsG-718 and Contract OE-4-10-136.

Subjects had to detect quickly similarities between two uppercase letters presented peripherally and one other central letter falling on the fovea. The legibility of the three characters made the task very easy when the three letters were flashed on by themselves. The addition of extra letters to this display seriously impaired performance. The periphery of the retina could no longer accurately detect at a glance whether items were similar. Foveal performance was also affected to some extent by extra items in the periphery of the retina.

A65-82289

STEREOSCOPIC ACUITY AND OBSERVATION DISTANCE.

James P. Brown, Kenneth N. Ogle, and Louise Reiher (Mayo Clin. and Mayo Found., Sect. of Biophys. and Mayo Graduate School of Med., Dept. of Ophthalmol., Rochester, Minn.)

Investigative Ophthalmology, vol. 4, Oct. 1965, p. 894-900. 10 refs.

Grant Inst. of Neurol. Diseases and Blindness B-1852.

Because of the contradictory evidence as to whether stereoscopic acuity varies with observation distance, this study was undertaken to investigate the problem, with the utmost care being taken to maintain constant experimental conditions and to eliminate empirical clues to depth perception. By means of a haploscopic apparatus, which allowed careful control of all parameters, the stereoscopic acuity of three subjects with full accommodation was determined in prolonged experiments for seven observation distances from 6 m. to 40 cm. Standard psychophysical methods were used. The results indicated that stereoscopic acuity remains essentially constant, at least for observation distances beyond 50 cm. For one subject there was no change in stereoscopic acuity in distances from 6 m. to 40 cm. Two subjects showed essentially no change from 6m. to 50 cm., but they did show a small decrease at the distance of 40 cm. It was found also that controlling pupil size was unnecessary with a constant level of adapting luminance of about 50 millilamberts.

[illegible] BioTe[illegible]
[illegible]CTIVENESS OF [illegible] VISUAL CUES IN THE DETEC[illegible]
[illegible] OF RATE OF CLOSURE AT NIGHT
[illegible] F. Parker, Jr., Robert R. Gilbert, and Richard F. Dillon
[illegible] 1964 51 p
[illegible] CPR 11-8683)
([illegible]TI-64-1)

This study was concerned with an evaluation of the visual cues used at night by a driver when he decides he is overtaking the vehicle in front of him. The basic paradigm was one in which, for any given experimental trial, two of three visual cues (area, brightness, and visual angle) were manipulated so as to maintain an apparent constancy, while the third, the one on which the overtaking decision had to be made, was varied. The effectiveness of each cue was tested at three levels of cue intensity and at three speeds of approach. The following conclusions were drawn: (1) The control condition, in which normal taillights were used, is significantly superior to the operation of any single cue. (2) Both the visual-angle cue and the brightness cue are superior to the area cue. (3) The level of visual angle and of brightness was significant, whereas the level of area was not. (4) Approach speed did not influence effectiveness. (5) Sensitivity to change in visual-angle cue appears to conform to the Weber psychophysical function. D.S.G.

N65-1[illegible]7# Mount Holyoke Coll., South Hadley, Mass.
THE RANGE OF VISUAL SEARCH Final Report
John Volkmann, Horace H. Corbin, Nancy B. Eddy, and Carol Coonley Bedford, Mass., AFSC, Electron. Systems Div., Nov. 1964 105 p refs
(Contract AF 19(604)-3037)
(ESD-TDR-64-535; AD-608810)

The process of visual search in its early phases was studied. Individual human subjects searched in a projected matrix of elements for one element unlike the rest, e.g., for a triangle in a matrix otherwise composed of circles. In the method of lasting exposure, the matrix was exposed until the subject responded, and the dependent variable was the latency of the response. In the method of brief exposure, the exposure time was limited, and the dependent variables were the percentage of positive responses and the latency of the positive responses. Among the independent variables in various experiments were the following: (1) the total number of elements in the matrix; (2) the type of discrimination (form, area, color); and (3) the external form and internal pattern of the stimulus array. In analyzing the results of a typical experiment, the medium latency is plotted as a function of the number of elements in the stimulus array. Author

N65-32733# Boeing Scientific Research Labs., Seattle, Wash.
THE LIE ALGEBRA OF VISUAL PERCEPTION
William C. Hoffman Apr. 1965 55 p refs *Its* Math. Note No. 408
(D1-82-0432)

The familiar perceptual constancies of image location in the field of view, image orientation, size constancy, shape constancy, binocular distortion, and motion, have their natural mathematical expression in terms of Lie groups of transformations over the visual manifold. If Lie's three fundamental theorems are to be satisfied, three additional perceptual invariances must also be present: time, efferent binocularity, and what apparently constitu[illegible] some sort of circulating memory in space-time. This Lie alg[illegible] of visual perception admits ready [illegible]ons for the following visual phenomena: the develop[illegible] sequence of infant vision; orthogonal after-images; [illegible]cts of seen movement; the spiral after-effect and the [illegible]ges sometimes evoked under flicker; reading re[illegible], and the visual analogue of the Fitzgerald contraction. The theory also predicts certain new complementary (orthog[illegible]) after-images, the existence of which have been verified experimentally. Author

N65-33012# Indiana Univ., Bloomington.
AN INVESTIGATION OF VISION DURING INVOLUNTARY SACCADIC EYE MOVEMENTS
Robert Wesley Ebbers (M.S. Thesis) Jun. 1965 42 p refs
(Contract AF 33(608)-1070)
(AD-617409)

A study designed to determine the presence or absence of vision during involuntary saccadic eye movements is reported. Considered are involuntary movements occurring during normal steady fixation. Studied were male graduate students with 20/20 vision. It was shown that vision is present during the involuntary saccade, and that while vision is present, it is dependent in part upon stimulus intensity. Results indicate quite consistent, and large magnitude, intensity threshold differences between subject and observer. Differences were further reflected by an impairment of suprathreshold vision during the involuntary saccade, shown by blip-counting experiments and by measurements of visual acuity. This impairment was shown to be related to the optical smear of the retinal image, the greater the speed of movement of the retinal image, the greater the visual impairment. It is concluded that, contrary to findings of other investigators, vision does exist, though impaired, during involuntary saccadic eye movements, as well as during voluntary saccadic eye movements. S.C.W.

N65-34603 Naval Ordnance Test Station, China Lake, Calif.
VISUAL SEARCH EXPERIMENTS: ACUITY, RESPONSE TIME, NOISE PERSISTENCE
Ronald A. Erickson Jul 1965 51 p refs
(NAVWEPS-8731; NOTS-TP-3737, AD-619507)

This experiment demonstrated the degradation in search performance resulting from a decrease in the frame rate of a static, structured display containing television-type visual "noise". The display was produced by projecting moving pictures of the static, structured scene, the noise in the scene was obtained by the double exposure and special printing of the film. Results indicate that restricted usefulness of a low frame rate, television-type display may be expected in a low signal-to-noise ratio condition. Neither peripheral and foveal acuity nor eye dominance scores correlated significantly with search time. There was a significant correlation between response time and search time; this is attributed to the mental image processing and decision time common to both tasks. Author

A66-10461 #
FLASH BLINDNESS.
James F. Parker, Jr. (BioTechnology, Inc., Arlington, Va.).
Naval Research Reviews, vol. 18, Aug. 1965, p. 1-7.

Discussion of a program to investigate the impairment of vision which occurs when airmen and other military personnel are exposed to intense visible radiation. The measures being taken to protect men against this type of vision impairment are described. The comprehensiveness of the Navy program to develop devices and procedures to guard against temporary losses of vision becomes apparent when it is noted that the efforts range from laboratory investigations of flash blindness involving high-intensity light sources to the preparation of training and indoctrination materials for pilots. A prototype version of the flash-blindness training and indoctrination equipment being developed is shown. It consists of a high-intensity flash source which presents light comparable to that emitted by a nuclear weapon detonated at some distance in front of a pilot flying a low-level attack mission. By means of this source, it should be possible to produce all the effects of flash blindness, such as startle, intense afterimage, and visual incapacitation, without the risk of causing permanent damage to the visual system. By actually experiencing flash blindness, a pilot will better appreciate the need for protective devices and should be more highly motivated to use them correctly. M.M.

A66-13793
VISUAL ACUITY.
Lorrin A. Riggs (Brown University, Walter S. Hunter Laboratory of Psychology, Providence, R.I.).
IN: VISION AND VISUAL PERCEPTION.
Edited by C. H. Graham.
New York, John Wiley and Sons, Inc., 1965, p. 321-349. 146 refs.
Navy-supported research.

Review of visual acuity, defined as the capacity of the human eye to discriminate the fine details of objects in the field of view. Visual acuity is specified in terms of the minimum dimension of some critical aspects of a test object that a subject can correctly identify, such that good visual acuity implies that a subject can discriminate fine detail, and poor acuity implies that only gross features can be seen. The specification of acuity and the means of quantitatively measuring it are described. The types of acuity task and the factors underlying acuity are discussed at length, including receptive resolution, pupil size, and retinal illuminance. Data concerning acuity as a function of pupil size, intensity of illumination, and the relation between retinal illuminance and resolution are reviewed and discussed. The importance given to the relation between eye movement and acuity is emphasized, as it is pointed out that the eye is never motionless, even when fixing on an object. It is concluded that acuity is optimal only when test objects are seen within a distance of 5 min of arc from the point of fixation, and that acuity is relatively poor for a moving test object even when the eyes appear to be successfully pursuing it. It is noted that the interdependence of eye movements and visual acuity is obviously dependent on a servomechanism of incomparable efficiency and precision among human perceptual systems. M. L.

A66-13794
AFTERIMAGES.
John Lott Brown (Kansas State University of Agriculture and Science, Graduate School, Manhattan, Kan.).
IN: VISION AND VISUAL PERCEPTION.
Edited by C. H. Graham.
New York, John Wiley and Sons, Inc., 1965, p. 479-503. 120 refs.
Navy-supported research.

Review of the available data on afterimages, defined as the visual effects that arise when the eye is illuminated, but which do not terminate immediately on cessation of stimulation, persisting, instead, for a definite time interval. It is noted that it is this persistence of vision that causes a moving light source to be seen as a line of light or a flashing light source to be seen as steady when the flash rate is sufficiently high. The evidences of past stimulation of the eye that continue for a relatively long time are identified as afterimages, which appear as a form of the original image and go through a wide range of qualitative changes. The characteristics of afterimages are described, including those of color and motion, and the details of the quantitative study of them are reviewed. The variables influencing the appearance of afterimages are considered, including duration of the primary stimulus, and the luminance of the projection and adjacent fields, area effects, and adaptation of the eye. Several theoretical interpretations of afterimage phenomena are discussed, but it is concluded that no one interpretation is adequate. M. L.

A66-13797
PERCEPTION OF MOVEMENT.
C. H. Graham (Columbia University, Dept. of Psychology, New York, N.Y.).
IN: VISION AND VISUAL PERCEPTION.
Edited by C. H. Graham.
New York, John Wiley and Sons, Inc., 1965, p. 575-588. 59 refs.
Navy-supported research.

Comprehensive review of the research to date on the perception of both real and apparent movement. It is emphasized that an adequate theory of movement must include both types of movement perception, but that, so far, little more can be done than systematize and summarize experimental results. For real movement, the absolute, differential, and displacement thresholds are discussed. It is noted that one chief difficulty in the experimental situation is that the subject may change the basis of his discrimination in different circumstances, making difficult or impossible the analysis of the cue variables. The approach of restricting variables to the irreducible minimum in order to be able to state the rule of discrimination as unequivocally as possible is favored over a statistical approach. The extensive work on apparent movement is summarized, including the important type of apparent movement observed when two adjacent lights are successively turned on and off. Depth cues and motion are discussed, especially in connection with Ames' trapezoid window. M.L.

A66-26916
INFORMATION DISPLAY.
Frederick A. Muckler and Richard W. Obermayer (Bunker-Ramo Corp., Defense Systems Div., Canoga Park, Calif.).
International Science and Technology, Aug. 1965, p. 34-40.

Discussion of information displays, which are intended to provide a human operator with the kind of information that he can transform into useful decisions or control actions. Present technology can present qualitative, quantitative, symbolic, and pictorial data, but it is not always certain how these forms are best used to assure that the human receiver is getting clear, unambiguous information that can lead to the desired output of the total man-machine system. Although man is a unique information processor, his processing ability is limited by data load and speed stresses to which he adapts remarkably in ways that are not fully understood. The context in which information has value is in a man's head, and this context is in a machine only to the degree that some human has put it there as prior contextual rules of how a system should operate. Combining several types of data on one display indicator does not assure the integration of information, which really occurs in the context of man's interpretation of the display. It is considered that most display design has suffered from a preoccupation with hardware, rather than developing better communication with man. F.R.L.

A66-31833 *
INFLUENCE OF THE SCRATCH ON THE WIND SHIELD UPON THE VISUAL FUNCTIONS TO THE MOVING OBJECT.
Keiichiro Suzumura (Nagoya University, Research Institute of Environmental Medicine, Nagoya, Japan).
The Japanese Journal of Aerospace Medicine and Psychology, vol. 3, Dec. 1965, p. 13-20. 11 refs. In Japanese.

Experimental study of the effects of a windshield scratch on depth perception, visual acuity, and fatigue. It was found that, even though visibility of a stationary object was not affected by a windshield scratch, such a scratch noticeably lowered the visibility of a moving object. Fatigue was induced to a remarkable extent when the moving object was observed through a scratched windshield. F.R.L.

A66-33993
POSITIVE AFTERIMAGE FOLLOWING BRIEF HIGH-INTENSITY FLASHES.
Norma D. Miller (Ohio State University, School of Optometry, Columbus, Ohio).
Optical Society of America, Journal, vol. 56, June 1966. p. 802-806. 9 refs.
USAF-supported research.

The time course of the decay of the positive afterimage following high-intensity flashes was measured by monocular and binocular brightness matching. The comparison field luminance was adjusted by means of crossed neutral wedges driven by a reversible motor. Density of the wedges was continuously recorded and the afterimage was tracked up to seven minutes following the flashes. Flash durations of 0.24 to 1.4 msec were used with a flash luminance of 4×10^5 lumens. With a 10° monocular bipartite photometric field, the afterimage brightness 5 sec following a 3×10^7 troland-sec flash was matched by a 10^5 troland comparison field. Photometric matches made monocularly or binocularly with an annular afterimage, 10° OD and 5° ID, concentric with a 2° centrally fixated comparison field required approximately 10^4 trolands. A 2° central afterimage matched with an annular comparison field showed no significant difference from the annular afterimage. The results for the first two minutes following the flashes for all conditions showed a linear relationship between the logarithm of the comparison field luminance and the logarithm of the time measured from the flash. (Author)

A66-35023
FEEDBACK AND PSYCHOPHYSICAL VARIABLES IN SIGNAL DETECTION.
Edward C. Carterette, Morton P. Friedman, and Melvin J. Wyman (California, University, Los Angeles, Calif.).
Acoustical Society of America, Journal, vol. 39, June 1966, p. 1051-1055. 19 refs.
Research supported by the U.S. Department of Health, Education and Welfare, the Navy, and NASA.

144 observers, divided into eight groups of 18 each, were run in a two-alternative, temporal, forced-choice auditory-signal-detection task. At each of two signal intensities, four levels of information feedback were used: no feedback (NF); correct feedback on every trial (F100), on three-fourths (F75), or half (F50) of the trials, with incorrect feedback on remaining trials. The results were that (1) NF and F100 led to higher probability of correct responding P(C) than either F75 or F50 for both signal intensities; (2) P(C) for NF was higher under the higher intensity but lower under the lower intensity than for F100; (3) on trials immediately following trials on which observer's response and feedback agreed, detection rates were higher and false-alarm rates were lower than following disagreement trials, whereas these differences were close to zero for F50. It is argued that feedback leads the observer to change his criterion following disagreements. The effect of this variability is to depress the mean detectability index d' of signal-detectability theory. (Author)

A66-39421
SEARCH PERFORMANCE AS A FUNCTION OF PERIPHERAL ACUITY.
Dorothy M. Johnston (Boeing Co., Seattle, Wash.).
Human Factors, vol. 7, Dec. 1965, p. 527-535. 14 refs.

This study was made to investigate the relationship between the size of visual fields of observers and time required to locate targets on static displays. The findings, which indicate that people with large visual fields can find targets more rapidly than observers with small fields, have practical selection and training application. Equations are presented which can be used to determine search time that can be expected as a function of the size of the visual field of the observer and the apparent size of the area being searched. (Author)

A66-30120
GLARE: A STUDY INTO GLARE RECOVERY TIME WITH NIGHT DRIVING SPECTACLES.
A. J. Phillips and Alan Rutstein (Northampton Coll. of Advan. Technol., London, Great Britain).
The Journal of Physiological Optics, vol. 22, 1965, p. 156-164. 29 refs.
A portion of 18 subjects expressed an increase in comfort during glare [illegible] night-driving glasses. This agrees with results found by other [illegible] should explain their continued popularity. All 18 subjects showed [illegible] in glare recovery time, the mean value being 54 per cent. Thus [illegible] the 18 were more comfortable their visual performance was inferior. [illegible] glare source was brought much nearer than encountered in [illegible] conditions, this was done only to determine the effect of wearing the [illegible] vehicles under the severest of conditions. No attempt was made to determine results under actual driving conditions.

A66-30674
VISUAL RECOVERY FROM BRIEF EXPOSURES TO HIGH LUMINANCE.
Norma D. Müller (Ohio State U., School of Optometry, Columbus).
Journal of the Optical Society of America, vol. 55, Dec. 1965, p. 1661-1669. 5 refs.
AF Systems Command supported research.

The maxwellian-view optical system provided a circular flash field of 10^0 diam, and at the peak of the flash, the field luminance was 5.4×10^5 L. A rotating-mirror shutter system permitted flash durations of 1.4 to 0.64 msec. with constant pulse shapes for all durations. The maximum flash energy was 4×10^7 td-sec. or 0.042 cal./cm.^{2} at the retina, neglecting losses in the ocular media. With the infrared removed by filtering the beam, the maximum energy was reduced to 3×10^7 td-sec. or 0.012 cal./cm.^{2}. The criterion measure for visual performance following the flashes was the identification of Sloan-Snellen letters of different sizes. The letters were transilluminated with luminances from 130 to 0.03 mL. The effect of removing the infrared portion of the flash radiance on the recovery times for a given level of visual performance was tested and found negligible. The other variables studied were the size of the flash field and the duration of the flash. The time course of recovery following various flash energies was investigated by varying the letter size and the letter luminances.

N66-12015# Mount Holyoke Coll., South Hadley, Mass.
FURTHER EXPERIMENTS ON THE RANGE OF VISUAL SEARCH Final Report
John Volkmann and Horace H. [illegible] Bedford, Mass., Electron. Systems Div., Jan. 1965 100 p refs
(Contract AF 19(628)-2443)
(ESD-TDR-65-169; AD-622414)

The report describes six experiments on visual search. Two operational terms in the report are critical number and basal time, defined by the following operations. Median latency of search is plotted as a function of the number of elements in the matrix, for each subject and experimental condition. At low numbers of elements the latency is nearly constant; this is the basal time. Then there occurs a transition to longer latencies. The critical number is the number of elements at which the transition occurs. The aim of the first experiment was to discover whether the critical number varies with the density of the stimulus matrix. Over the entire range of densities employed, it does. Nevertheless, the area corresponding to the critical number is apparently constant over a range of low densities. (This is the area of fast search.) Over a range of high densities, this area decreases considerably. Basal time does not vary with density. The second experiment aimed to check the first one, and to provide evidence on the shape of the area of fast search. The analysis was in terms of the location of the critical elements in the matrix. The constancy of area at low densities was confirmed, although the check was very insensitive. Basal time is constant. The shape of the area appears to be as previously described: ovaloid, with the longer axis horizontal. Author (TAB)

N66-13990*# Texas Univ., Austin. Defense Research Lab.
[STUDIES OF AUDITORY INFORMATION PROCESSING EMPHASIZING THE APPLICATION OF SIGNAL DETECTABILITY THEORY TO THE AUDITORY SENSORY RESPONSES] Fifth Quarterly Progress Report, 1 Jun.–31 Aug. 1965
L. A. Jeffress 15 Oct. 1965 6 p
(NASA Order R-129; Contract Nonr-3579(04))
(NASA-CR-68881) CFSTI: HC $1.00/MF $0.50 CSCL 05H

The status of work progress in studies of auditory information processing emphasizing the application of signal detectability theory to the auditory sensory responses is reported. A simpler method for averaging receiver operating characteristic data for visual detection, and a method of measuring the galvanic skin response of a subject to various stimuli are described. Other studies mentioned include psychophysical and physiological investigations of brightness. L.S.

N66-14780# ITT Federal Labs., Nutley, N. J.
HUMAN FACTORS RESEARCH IN 3-D DATA PRESENTATION Final Report, Sep. 1962–May 1965
Raymond C. Bassett, Morton H. Kahn, Moira La May, Joel Levy, and Donald E. Page Bedford, Mass., AFSC, Electron. Systems Div., Jun. 1965 83 p refs
(Contract AF 19(628)-274)
(ESD-TR-65-462; AD-623028) CFSTI: HC $3.00/MF $0.75

A series of experiments was performed to evaluate some of the operating characteristics and potential utility of a volumetric (i.e., real) three-dimensional display produced by projection of a CRT image onto a rotating translucent screen. Some of the variables tested were perceptibility of relative location of test targets in close proximity, perception of location of point targets relative to display boundaries and perception of absolute and relative motion of targets in the volume. Estimation of location and motion were found to be highly accurate and quite rapid. While the results do not point conclusively to specific applications, the utility of volumetric 3-d in making fine position and motion discriminations has been demonstrated. Further study would be required to ascertain utility in practical situations such as air traffic control, space surveillance, etc. Author (TAB)

N66-15431# Massachusetts General Hospital, Boston. Stanley Cobb Labs. for Psychiatric Research.
RESEARCH ON INFORMATION PROCESSING IN THE CENTRAL NERVOUS SYSTEM Scientific Report No. 1
Frank R. Ervin 23 Jul. 1965 26 p refs
(Contract AF 19(628)-408)
(AFCRL-65-580; AD-621277) CFSTI: HC $2.00/MF $0.50

A system of automatic receptive field mapping for visual cortical neurons by a digital computer. It consists of (1) stimulus display by a digital CRT, simultaneous data sampling and on-line data processing into a post-stimulus time histogram and an averaged evoked potential, and (2) offline readout of numerical values and tabulation. Several problems lying between the neurophysiological or statistical nature of the response and data processing techniques are also described and discussed. Author (TAB)

N66-15509# BioTechnology, Inc., Arlington, Va.
THE TRANSLATION OF VISUAL INFORMATION INTO VEHICULAR CONTROL ACTIONS
Raymond E. Reilly, Robert R. Gilbert, Richard F. Dillon, and James F. Parker, Jr. Oct. 1965 64 p refs Sponsored by Va. Dept. of Highways
(BTI-65-2)

The use of visual information from a land vehicle tail-light system is studied in relation to specific vehicular control actions by the driver. Particular attention is given to the angular velocity cue provided by the increase in vehicle visual angle provided by the two tail lights as the driver approaches the rear of a vehicle. It appears that a driver uses both the angular velocity cue as well as the [illegible] of his own vehicle in making the decision to stop. Other cues appear to give important perceptual information, although individuals operate within the entirety of the visual environment rather than from separate cues. It is concluded that all the visual information available to a driver is used in a highly systematic manner to effect control actions. Specific characteristics of tail-light systems were found to have a significant effect on braking behavior, and a system with large, bright lights separated by 60 inches consistently produces better braking responses from drivers. M.W.R.

N66-21472# General Electric Co., Oklahoma City, Okla.
A MATHEMATICAL MODEL OF FLASHBLINDNESS Final Report, 1 Nov. 1964-31 Aug. 1965
Robert S. Czeh, Arthur W. Casper, and Ernest C. Segraves, Jr. Brooks AFB, Tex., School of Aerospace Med., Oct. 1965 68 p refs
(Contract AF 41(609)-2644)
(AD-627332) CFSTI: HC $3.00/MF $0.75

In planning certain military missions it is desirable to know the extent to which vision may be impaired by the flashblindness that can result from the intense light of a nuclear explosion. This report describes an attempt to provide assistance to such planning by constructing a mathematical mode of flashblindness. The literature was surveyed to determine whether or not the construction of a model was feasible. Using selected data, two equations were developed for predicting recovery time from flash energy, display luminance, and display visual acuity. The prediction errors made were determined in a few situations and compared with the errors made by other prediction techniques. Limitations of the applicability of the equations were noted. Author (TAB)

N66-22316# Naval Air Development Center, Johnsville, Pa. Aviation Medical Acceleration Lab.
FLASHBLINDNESS: THE EFFECTS OF PREFLASH ADAPTATION AND PUPIL SIZE Phase Report
J. H. Hill and Gloria T. Chisum 30 Jun. 1965 20 p refs
(NADC-ML-6508; AD-629569) CFSTI: HC $1.00/MF $0.50

A question of considerable operational importance is the extent to which the blinding effect of a flash from a nuclear weapon will vary with the ambient light level. Under conditions of darkness, the size of the pupil and the sensitivity of the eye are maximized. With an increase in the ambient light level both the sensitivity of the eye and the pupil size decrease. Data are presented on the independent effects of pupil size and receptor adaptation level on the production of flashblindness by high intensity, short-duration flashes. Author (TAB)

N66-22783# School of Aerospace Medicine, Brooks AFB, Tex.
F-101/F-106 FLIGHT SIMULATOR FLASHBLINDNESS EXPERIMENT, MARCH-JUNE 1965
James E. Hamilton Dec. 1965 17 p refs
(SAM-TR-65-82; AD-628552) CFSTI: HC $1.60/MF $0.50

An investigation was made to determine the effect of flashblindness on aircraft control in the F-106A and the F-101B flight simulators. In addition, a study was made to determine how much cockpit illumination is required to reduce flashblindness to minimum recovery time. It was found that approximately 42% of the flashblinded pilots tested did not accomplish a programmed escape maneuver. Instrument panel floodlighting immediately after the flash significantly reduced recovery time. Floodlighting the panel with 300 ft.-c. illumination did not significantly reduce recovery time more than illumination with 100 ft.-c. Author (TAB)

N66-28531# Ohio State Univ. Research Foundation, Columbus.
VISUAL RECOVERY FROM HIGH INTENSITY FLASHES
Interim Report, 15 May 1964–15 May 1965
Norma D. Miller. Brooks AFB, Tex., School of Aerospace Med., Jul. 1965. 90 p. refs
(Contract AF 41(609)-2426)
(ITR-1, AD-627325) CFSTI: HC $3.00/MF $0.75

High intensity flashes of 0.04 msec to 1.4 msec duration were used to determine the afterimage brightness as a function of time following the flash. Six human subjects made continuous matches of the afterimage for periods up to six minutes following the flashes. The flash energies ranged from 3×10^{-7} to 800,000 td sec or from 0.012 to 0.0003 cal/cm sq. at the retina, neglecting losses in the ocular media. The mean afterimage brightness, 5 sec following the highest intensity flashes, was 100,000 td. The afterimage brightness data were correlated with recovery time measurements for Sloan-Snellen letters presented at luminance levels from 280 mL to 0.07 mL. The reciprocity relationship between the duration and luminance of flashes subtending 7.5 degrees visual angle was investigated for constant flash energy of 3×10^{-7} td.sec. Seven flash durations from 0.5 to 5.0 msec were tested. The recovery times for the Sloan-Snellen letters at various luminance levels increased approximately 30% following 1.5 msec flashes compared with the 0.5 msec flashes. There was no apparent change for the mean recovery times for four subjects following flashes from 1.5 msec in duration.

Author (TAB)

N66-28826# Istituto Nazionale di Ottica, Florence (Italy).
PROBLEMS RELATED TO VISUAL PERFORMANCE OF PILOTS Annual Summary Report, 1 Dec. 1964–30 Nov. 1965
Adriana Fiorentini and Lucia Ronchi. 20 Dec. 1965. 119 p. refs
(Contract AF 61(052)-850)
(AD-630475) CFSTI: HC $4.00/MF $0.75

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N66-29653*# California Univ., San Diego. Visibility Lab.
EXPERIMENT S-8/D-13, VISUAL ACUITY AND ASTRONAUT VISIBILITY
S. Duntley, Roswell W. Austin, John H. Taylor, and [illegible] Harris *In* NASA. Manned Spacecraft Center Gemini Midprogram Conf. Including Expt. Results 1966 p 329-346 (See N66-29626 16-31) GPO: HC $2.75; CFSTI: MF $2.00

Preflight, inflight, and postflight test of the visual acuity of the members of the Gemini V and Gemini VII crews showed no statistically significant change in their visual capability. Observations of a prepared and monitored pattern of rectangles made at a ground site near Laredo, Tex., confirmed that the visual performance of the astronauts in space was within the statistical range of their respective preflight thresholds, and that laboratory visual acuity data can be combined with environmental optical data to predict correctly man's limiting visual capability to discriminate small objects on the surface of the earth in daytime. Author

N66-32141*# Texas Univ., Austin. Defense Research Lab.
[STUDIES OF AUDITORY INFORMATION PROCESSING EMPHASIZING THE APPLICATION OF SIGNAL DETECTABILITY THEORY TO THE AUDITORY SENSORY RESPONSES] Semiannual Report, 1 Dec. 1965–31 May 1966 and Eighth Quarterly Status Report, 1 Mar.–31 May 1966
L. A. Jeffress. 27 Jun. 1966. 10 p
(NASA Order R-129; Contract Nonr-3579(04))
(NASA-CR-76560) CFSTI: HC $1.00/MF $0.50 CSCL 05H

Research progress is reviewed on several studies pertaining to auditory information processing, adaptation to brightness of flashed incremental and decremental stimuli, and effects of chromatic adaptation on color naming. Experiments conducted on listener's free response to auditory signal detection, human performance and response were measured by randomly spacing 10 signals of low detectability, 150 msec in duration, 500 Hz, within each five-minute listening period; 10 noise-alone intervals were also defined in each period. Distributions of these response latencies were separately constructed for signal-plus-noise intervals. In other experiments on signal detection versus duration for an electric ear model, a fixed-bandwidth filter was used in combination with changing time constants of the detector. The filter was followed by a linear (half-wave) detector and by an integrator with a decay time of 100 msec. A similar experiment employing a square-law rectifier (energy detector), and the same integration time constants, was somewhat more successful. R.Li.

N66-34350# Joint Publications Research Service, Washington, D. C.

SEVERAL PROBLEMS IN RECOGNIZING ACOUSTIC SIGNALS

D. N. Kartashov, A. A. Nigay, and V. Ya. Petrov *In its* 22nd All-Union Sci. Session Devoted to Radio Day: Cybernetics Sect. 1 Aug. 1966 p 35-38 (See N66-34353 20-10) CFSTI: $3.00

The feasibility of designing units to recognize various acoustic signals whose characteristics possess certain stationary parameters is reported. Technical methods used in the experiment are briefly described, and the development of acoustic signal representations is presented. The algorithms of recognition are shown, and test results are diagrammed. It is concluded that for a number of comparatively simple problems linear methods of space representations can be used rather effectively. A.G.O.

N66-39655# Cambridge Univ. (England) Psychological Lab.

VISUAL PERCEPTION OF MOVEMENT Interim Scientific Report No. 1, 1 Apr. 1965-31 Mar. 1966

R. L. Gregory and J. A. M. Howe 21 Jun. 1966 77 p refs (Grant AF-EOAR-65-62)

(AFOSR-66-1532; AD-637510) CFSTI: HC $3.00/MF $0.75

The research includes: (a) investigation of the use of pitch of a sound as a distance cue; (b) investigation of the maintenance of retinal fusion as an object moves in depth; (c) description of the apparatus developed for moving observers at constant velocity; (d) investigation of apparent depth and perspective set up by a line at different inclinations from the vertical; and (e) measurements of the magnitude of the Ponzo illusion for different positions of the horizontal lines within the oblique lines. Author (TAB)

A67-21723

EFFECT OF BLUR AND SIZE ON TARGET RECOGNITION.

C. [illegible] Hoffman and C. P. Greening (North American Aviation, Inc., A[illegible]ics Div., Anaheim, Calif.).

Aerospace Medicine, vol. 38, Feb. 1967, p. 150-158. 5 refs.

A study was performed to determine the effect of blur and size on target recognition. Films of six different clock orientations of Landolt C's were made. Blur and size were varied by varying the angular velocity of the camera across the target field and the distance of the camera from the targets. The subjects were required to identify an assigned target orientation on each trial. The results were: (1) the effect of image smear on target recognition is dependent upon the ratio of smear in inches to the critical dimension of the target, in comparable units. If the amount of smear is less than twice the critical dimension, target recognition accuracy is unaffected. At a ratio of 2.0, performance begins to drop off rapidly until it levels off at a near chance level and (2) time to recognize targets falls off rapidly when the amount of blur equals the critical dimension. (Author)

A67-26925

FLASHBLINDNESS - THE EFFECTS OF PREFLASH ADAPTION AND PUPIL SIZE.

Gloria T. Chisum and J. H. Hill (U.S. Naval Material Command, Naval Air Development Center, Aerospace Medical Research Laboratory, Johnsville, Pa.).

Aerospace Medicine, vol. 38, Apr. 1967, p. 395-399. 7 refs.

Examination of the extent to which the blinding effect of a flash from a nuclear weapon will vary with the ambient light level. Under conditions of darkness, the size of the pupil and the sensitivity of the eye are maximized. With an increase in the ambient light level both the sensitivity of the eye and the pupil size decrease. Data are presented on the independent effects of pupil size and receptor adaptation level on the production of flashblindness by high intensity, short-duration flashes. M.M.

N67-11553# Joint Publications Research Service, Washington, D. C.

THE INFLUENCE OF BRIEF INTENSIVE LIGHT FLASHES ON ADAPTATION TO DARKNESS AND ON VISUAL ACUITY

P. A. Korzun *In its* Probl. in Aerospace Med. 21 Oct. 1966 p 286-287 refs (See N67-11401 02-04) CFSTI: $3.40

The effect of the color nature of brief intensive flashes on light sensitivity and visual acuity of the human eye was examined. The flashes were produced with an impulse lamp, and red, blue, and green flashes were obtained with the use of filters. The following patterns were established: (1) After brief intensive illumination of the periphery of the retina with blue and green flashes, light sensitivity was reduced by 5 to 30 times, and the duration of this reduction varied from 15 to 30 min. (2) After illumination of the retina with red flashes, the light sensitivity was the same as after readaptation. (3) In the case of illumination of the macular area of the retina the light sensitivity is restored just as quickly as after readaptation to the sphere. (4) Visual acuity is reduced the least and returns most quickly to the initial level after illumination with flashes of blue light. L.E.W.

N67-15360# Ohio State Univ. Research Foundation, Columbus.

VISUAL RECOVERY FROM HIGH INTENSITY FLASHES II Final Report, 15 May 1965-15 May 1966

Norma D. Miller Brooks AFB, Tex., School of Aerospace Med., Jul. 1966 65 p refs

(Contract AF 41(609)-2426)

(AD-64231) CFSTI: HC$3.00/MF$0.65

Some new instrumentation was developed and a number of refinements were made in the existing special test equipment for investigating the visual recovery following high intensity flashes. The primary areas of apparatus modification were (1) increased capability for the measurement of source energy in absolute units, (2) increased precision in the measurement of recovery times, (3) extended range of flash durations for recovery measurements, and (4) inclusion of pupillographic recording as a measure of flash effect. The consensual pupil reflex was measured for six subjects for flash energies from 150,000 to 30,000,000 td.sec. The flash durations were varied from 250 microsec to 1.5 sec. Flash fields subtended a visual angle of 7.5 degrees in most of the work with a 2 degree centrally fixated field used in one part of the study. Author (TAB)

N67-18072# Institute for Perception RVO-TNO, Soesterberg (Netherlands).

THE EFFECT OF SUCCESSIVE EXPOSURES UPON DYNAMIC VISUAL ACUITY

L. F. W. de Klerk, J. P. van de Geer, and C. A. J. Vlek [1966] 20 p refs

(TDCK-46503; IZF-1966-10) CFSTI: HC$3.00/MF$0.65

This study concerns the effect of manner of presentation of moving Landolt rings upon dynamic visual acuity. Two types of presentation are used: one single exposure and two successive exposures. The total exposure time has been kept equal for both conditions. From the results of the experiments it appears that for an angular target velocity of 70°/sec two successive exposures, separated by a time interval of .2 sec, lead to better performance than one single exposure of double duration. These results were explained in terms of the sampled data theory. Recordings of eye movements do reveal that there is a rather good correlation between dynamic visual acuity and accuracy of ocular pursuit. However, the sampling hypothesis did not receive much support from the analysis of eye movements. Some factors are discussed which may account for this lack of confirmation. Author

N67-24879# Army Medical Research Lab., Fort Knox, Ky.

CORRELATION OF PERFORMANCE IN DETECTING VISUAL AND AUDITORY SIGNALS Final Report

Walter J. Gunn and Michel Loeb 20 Jan. 1967 16 p refs

(AMRL-713; AD-647539) CFSTI: HC$3.00/MF$0.65

Two experiments were performed in which Os were to detect which pulses of noise or pulses of light were slightly more intense than others in a train. It was found in the first experiment that both sensitivity (d) and degree of conservatism in responding (beta) were correlated for the two tasks. The auditory task was more difficult than the visual under the chosen conditions. Higher betas were noted for Os first performing on the visual task. In the second experiment, the tasks were more closely equated in difficulty, and Os performed both the auditory and the visual task twice. The effect of order previously noted for beta was not obtained. Beta and d were again significantly correlated for the first session; for the second session significant correlations were obtained for d but not beta. The results suggest that not only are there response biases common to detection in different modalities but also common factors affecting sensitivity. Author (TAB)

N67-24712# Eye Research Foundation of Bethesda, Md.

THE EFFECT OF WAVELENGTH ON VISUAL ACUITY Final Report, Oct. 1, 1965-Sep. 31, 1966

Carl Richard Cavonius Jan. 1967 22 p refs

(Contract DA-49-193-MD-2839)

(ERF-RR-1/67-Cr; AD-646575) CFSTI: HC$3.00/MF$0.65

Visual acuity was measured in monochromatic light at wavelengths between 440 and 660 nm. The test objects were gratings which filled a 1.5 degree circular field centered in a 30 degree neutral surround. Luminance contrast between adjacent bars was adjustable, and acuity thresholds were determined for different contrasts. It was found that acuity depends primarily on luminance contrast and only slightly on wavelength, so that the same luminance contrast yields similar acuity thresholds at all wavelengths provided that the test objects are equated in luminance. It is suggested that the dominant wavelength of a visual display system (such as a cathode ray screen) is relatively unimportant in the perception of fine detail. Instead, criteria such as grain size and available luminance are more important. Author (TAB)

A64-30164
THE EFFECT OF WARNING SIGNALS ON REACTION TIME IN YOUTH AND OLD AGE.
George A. Talland (Harvard U., Boston, Mass.)
Journal of Gerontology, vol. 19, Jan. 1964, p. 31–38. 6 refs.
Grant No. M-859.

Eighteen men in the twenties and 18 men aged 77 to 88 years were tested for speed for manual response under instructions of simple and choice reaction time (RT), varying modality, duration of signals, and length of alerting interval. The RT, between-subject and within-subject variances increased significantly with age; errors were few and about the same in youth and in old age. Warning signals speeded up RT in youth but had no reliable effect in old age. Latencies tended to increase with the length of alerting interval except for choice reaction times in older men. Optimal condition for old age was an auditory warning followed by a visual response signal; in youth the reverse produced the fastest response. The younger men confirmed the general rule that responses tend to be faster to auditory than to visual signals; the older men showed the opposite trend. Several hypotheses are examined to account for the failure of warning signals to speed up response in old age.

A64-31643
WIND SHIELD: INFLUENCE OF THE SCRATCH ON THE WIND SHIELD UPON THE VISUAL FUNCTIONS TO THE MOVING OBJECT.
Akihiko Sakumura (Nagoya U., Res. Inst. of Environmental Med., Japan).
Journal of Aerospace Medicine and Psychology, vol. 3, Dec. 1965, p. [illegible] Journal of Aerospace Medicine and Psychology, 11 refs. In Japanese.

The influence of a scratched wind shield on the visual function of pilots was investigated. Depth perception and visual acuity of moving objects were measured under several conditions. Measurement of fatigue was also carried out by determining the accommodation of the eye as one of the indicators. The scratch on the wind shield did not affect the visibility to the [illegible] object, it markedly lowered the visibility to the moving object. [illegible] was induced when the moving object was seen through the scratched [illegible].

[illegible] 1034
[illegible]UITY OF VISUAL PERCEPTION OF DIRECTION IN THE DARK FOR VARIOUS POSITIONS OF THE EYE IN THE ORBIT.
Leonard Matin (Columbia U., New York, N. Y.) and George R. Pola (Johns Hopkins U., Baltimore, Md.)
Perceptual and Motor Skills, vol. 22, Apr. 1966, p. 407–420. 12 refs.
Grants NSF G-18120, GB-944, and GB-4263.

Viewing monocularly in a dark room, subjects reported the location of a 4' 100-msec. flash relative to the location of a fixation target extinguished 3 sec. earlier. In one experiment the flashes were randomly preselected from a horizontal array centered on the fixation target and the subject reported the horizontal displacement of the flash (left, right, same); fixation was either in primary position or in secondary position 34-1/2° to the right or to the left of primary position. In a second experiment the flashes were randomly preselected from a vertical array centered on the fixation target and the subject reported the vertical displacement of the flash (above, below, same); fixation was either in primary position or in a secondary position 34-1/4° above or 23-1/4° below the fixation target. JNDs (just noticeable differences) were about 20' of arc in primary position and increased considerably in all secondary positions of fixation. In the first experiment PSEs (points of subjective equality) shifted to the right as fixation position was shifted to the left; in the second experiment PSEs shifted upward as fixation position shifted downward.

A66-81876
VISUAL DETECTION OF COMPOUND MOTION.
L. T. Alexander and A. S. Cooperband (System Develop. Corp., Santa Monica, Calif.)
(Western Psychol. Assn., Honolulu, Jun. 14–19, 1965).
Journal of Experimental Psychology, vol. 71, Jun. 1966, p. 816–821. 8 refs.

Results of previous studies suggest that under certain geometric conditions the rate of change of the relative bearing (ω) between two moving objects is used as a cue to predict their future positions in space. Four subjects were studied in four situations representing an abstraction of these geometric conditions. Their task was to detect a rotary motion superimposed on translational motion. The results indicate that ω was the primary cue used in this task; detection performance was a linear function of ω.

A66-82039
NEW THEORY ON APPARENT MOVEMENT.
Martha J. Guastella.
Journal of the Optical Society of America, vol. 56, Jul. 1966, p. 960–966. 8 refs.

A theory is presented to explain the difference between the true motion of a figure and its apparent motion, as in the Ames trapezpoid illusion. Of central importance are the changes in geometric relationships between the boundaries of a figure as they project on the retina. The changes in retinal image that accompany rotation of the figure have been analyzed by use of a unique picture-plane model, to which the dimension of depth is added. The only assumption necessary to predict the perceived effect from the geometry of the illusion is that the observer will be most affected by whatever element of the retinal image is changing at the greatest rate. Apparent size, displacement, and rates of change are quantified. The interrelationship of the horizontal and vertical edges are shown. The projection of the edge of the figure farthest from the observer recedes in an opposite direction and at varying speed and size from the true edge. The lack of a perfect one-to-one relationship between the physical and psychological stimulus is determined by the nature of the projection of the physical stimulus. While other theories based their explanations on past experience, this theory designates the mechanisms underlying the illusion.

A66-82178
VISUAL PERCEPTION OF DIRECTION IN THE DARK: ROLES OF LOCAL SIGN, EYE MOVEMENTS, AND OCULAR PROPRIOCEPTION.
Leonard Matin, Ethel Matin (Columbia U., Dept. of Psychol., New York City, N. Y.), Douglas Pearce (Defence Res. Med. Labs., Toronto, Canada), and George Kibler (Johns Hopkins U., Baltimore, Md.).
Vision Research, vol. 6, Aug. 1966, p. 453–469. 25 refs. Grants NSF G-13120, GB-944, and GB-4263.

Subjects performing monocularly in an otherwise dark room reported the direction at which a flash (6 msec. duration, 3–5 min. visual angle, randomly located along the horizontal in the frontal parallel plane) appeared relative to a fixation target extinguished 3 sec. earlier. Although the subjects attempted to maintain the eye in the same position as during the prior fixation period, large involuntary eye movements (monitored by a contact-lens technique) during the 3 sec. dark interval caused a given flash target to strike the retina to the left of the fovea on some trails, and to the right on others. The report of flash direction depended strongly on the sign and magnitude of this varying retinal signal independently of the physical location of the flash target. The standard deviation of the function relating report of flash direction to the retinal signal was approximately half of the standard deviation of the function relating the report of the physical target location. No evidence was found that proprioceptive signals regarding the eye movements systematically influenced the reports of flash direction. The accuracy of the report of the physical location of the target was thus limited by the subject's ability to maintain his eye close to the original fixation position.

A66-82203
SEARCH PERFORMANCE AS A FUNCTION OF PERIPHERAL ACUITY.
Dorothy M. Johnston (Boeing Co., Seattle, Wash.).
Human Factors, vol. 7, Dec. 1965, p. 527–535. 14 refs.

This study was made to investigate the relationship between the size of visual fields of observers and time required to locate targets on statistic displays. The findings, which indicate that people with large visual fields can find targets more rapidly than observers with small fields, have practical selection and training application. Equations are presented which can be used to determine search time that can be expected as a function of the size of the visual field of the observer and the apparent size of the area being searched.

A66-82378
EXPERIMENTAL ISOLATION OF THE DRIVER'S VISUAL INPUT.
Donald A. Gordon (U.S. Dept. of Com., Bur. of Public Roads, Washington, D. C.).
Human Factors, vol. 8, Apr. 1966, p. 129–137. 8 refs.

A technique for isolating the operator's visual input is presented. The method involves decreasing the visual field so that the essential information is obtained by the operator in separate visual fixations. A continuous film record is made to indicate the center of visual aim and the content of each fixation. Using this aperture device, visual positional data were obtained on ten drivers on a two-lane low traffic density road. The essential information was found to be the road edges and center lane marker. The manner in which this information was obtained differed from driver to driver. The film records refute the notion that the driver has a fixed point of forward reference, or that a common pattern of viewing is shared by all drivers. The hypothesis is presented that the persistent pattern of fixation movements forward to the limits of the road, and back again to the vehicle are explained by the contradictory requirements of perceptual anticipation and vehicular alignment with the road.

A67-80292
SIGNAL PRESENTATION RATE, AUDITORY THRESHOLD, AND GROUP VIGILANCE.
Richard L. Martz (U.S. Naval Submarine Med. Center, Auditory Res. Div., U. S. Naval Submarine Base, New London, Groton, Conn.).
Perceptual and Motor Skills, vol. 23, Oct. 1966, p. 463–469. 5 refs.

Auditory thresholds were obtained during the course of a single, two-hour vigilance session from eight groups of 11 to 14 rated and non-rated Navy enlisted men each, to one of four signal rates: 1/2 hr., 2.5/hr., 7.5/hr., and 15/hr. Subjects of each group were tested together in a dark, unlighted, noise-homogeneous' room in close physical (and possibly tactile and vibratory) proximity but without visual or acoustic interaction. Each subject wore earphones and pressed a microswitch to report, single tones in trains of 12 successive tones ranging in 2-db. steps from roughly 14 db. below to 10 db. above the average subject's threshold. Results showed (a) a positively accelerated linear relation between auditory detection and log signal rate, (b) decrements of 1 to 10 db. occurring early in the first half of the watch in all groups' (and virtually all 'subjects') performance at all signal rates, and (c) large individual differences permitting an arbitrary, significant separation of "better" and "poorer" performers.

A67-80737

SERIAL REACTION-TIME AND THE TEMPORAL PATTERN OF PRIOR SIGNALS.

William Bevan, Lloyd L. Avant, and H. G. Lankford (Kan. State U., Manhattan).

American Journal of Psychology, vol. 79, Dec. 1966, p. 551–559. 23 refs.

Contract Nonr-3634(01).

This experiment examined the relationship between response-latency to serially-presented simple visual signals and the frequency-distribution of presentation-intervals within the stimulus-series, when mean duration, range of duration, and the number of different sized intervals was held constant. A total of 200 men were tested with the following types of distributions: constant interval; normal variable interval; skewed variable interval; bimodel variable interval, and rectangular interval. No differences among the series means were obtained for any of the distributions. Response-times were shortest, however, for the mean as compared to the other intervals used in the adaptation-series. The subjects also were given one additional test-trial. Response-latencies were shortest when this test-interval corresponded to the mean of the series, and was longer as the test-interval deviated from the mean. Again, the statistical structure had no relationship to response on the test-trial. Variability of response differed among the several types of distribution, but the significance of this variability is obscure. These results emphasize the role of the mean interval—in contrast to the statistical shape of the interval program—as a determinant of the occurrence of signals on successive trials.

A67-80791

EXPERIMENTAL RESEARCH ON FAR POINT OF SCOTOPIC VISION [RICERCHE SPERIMENTALI SUL PUNTO REMOTO NELLA VISIONE SCOTOPICA].

R. Neuschüler and C. Terrana (Rome U., Eye Clin. and Aldo di Loreto Inst. of Legal Med., Italy).

Rivista di Medicina Aeronautica e Spaziale, vol. 29, Apr.–Jun. 1966, p. 167–180. 8 refs. In Italian.

Using the subjective optometer of Cialdea and Bagolini persons between 18–40 years of age were exposed to a visual perception experiment at various light intensities. The subjects did not know the given distance of the object seen and could not distinguish changes in the object unless it was shifted to a near or distant point. Polychromatic light (white) or monochromatic light (obtained by filters of red, green or blue) were used. Using an artificial pupil system to estimate pupillary diameter changes revealed no changes in the luminosity of retinal images. Luminosity of retinal images were variable for levels obtained by apposition of filters of various optic densities, giving a minimum value corresponding to 0 density to a maximum value corresponding to 2.9 density. By introducing the artificial pupil system the spherical aberrations were eliminated since the most peripheral part of the crystalline lens was not used. Using monochromatic light resulted in the elimination of the Purkinje effect. The results did not provide univocal responses, indicating two groups of data; some for which the distance point was far (hypermetropia), others in which it was near (myopia). Atropinized subjects were exposed to the artificial pupil and monochromatic light with unsatisfactory results, sometimes hypermetropic and other times myopic. Aphakic subjects showed results similar to those atropinized and those with normal pupil. Possibly the changes found were due to interpretive factors rather than to optic or physiological factors. It was postualted that nocturnal myopia may be an optic phenomenon.

A67-80793

DIFFERENTIAL EFFECTS OF CENTRAL AND LATERAL FIXATION ON AFTER-EFFECTS OF EXPANSION AND CONTRACTION.

Herman H. Spitz.

American Journal of Psychology, vol. 79, Dec. 1966, p. 618–622. 9 refs.

After-effects of expansion of a centrally fixated spinning spiral are known to persist longer than after-effects of contraction. It was hypothesized that this difference results from adaptation to the frequent natural occurrence of small, perhaps subliminal, after-effects of contraction. The finding that the after-effects of expansion and contraction do not differ under lateral fixation is congruent with this hypothesis.

A67-80800

MEASUREMENT OF STAPEDIAL-FOOTPLATE DISPLACEMENTS DURING TRANSMISSION OF SOUND THROUGH THE MIDDLE EAR.

M. Rubinstein (Govt. Hosp., Otolaryngol. Dept., Tel Hashomer, Israel), B. Feldman, H. Fischler, E. H. Frei, and D. Spira (Weizmann Inst. of Sci., Rehovoth, Israel).

Journal of the Acoustical Society of America, vol. 40, Dec. 1966, p. 1420–1426. 10 refs.

Ford Found. supported research.

The frequency response of stapedial-footplate vibration during sound conduction was measured on fresh cadaver specimens. Specially designed and adapted instruments made these measurements possible at sound levels lower than those causing discomfort to living subjects (86–114 dB.) and with a continuous frequency sweep between 100 c.p.s. and 10 k.c.p.s. The results show a similarity with the curves of subjective ear sensitivity, suggesting a dependence of the over-all sensitivity of the ear on the middle-ear frequency response. Linear increase of vibration amplitude with sound level was found to exist up to around 104 dB.; above this sound level, there is a gradual limiting of the stapedial excursions. Speculations on energy transfer from the middle to the inner ear showed nearly optimal matching between them. The influence of the aging process of the specimens is discussed.

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A SIMPLIFIED METHOD FOR MEASURING HUMAN TRANSFER FUNCTIONS

James J. Adams. Apr 1963. 37 p. 10 refs.
(NASA TN D-1782) OTS: $1.00

An investigation has been made with a nonmoving simulator to determine the effectiveness of a simplified method of measuring human transfer functions. The method is based on an adaptive autopilot scheme. In this method an analog pilot, which contains three variable gains, is automatically adjusted to match the human pilot. The gains are adjusted so as to minimize the root-mean-square difference between the analog pilot and the human pilot. The dynamics that the pilot controlled were varied. The tests demonstrated that stable determination of the transfer-function gains could be achieved. Tests in which the adjustable analog pilot was required to match a fixed-gain analog pilot resulted in accurate determination of the gains. Tests made with human subjects resulted in gains which are in general agreement with previous studies, in that the lead of the pilot is increased as the lag of the controlled dynamics is increased. Author

A64-24125

THE HUMAN OPERATOR AS A MONITOR AND CONTROLLER OF MULTIDEGREE OF FREEDOM SYSTEMS.

John W. Senders (Bolt Beranek and Newman, Inc., Cambridge, Mass.).
(National Symposium on Human Factors in Electronics, Washington, D. C., May 2, 1963.)
IEEE Transactions on Human Factors in Electronics, vol. HFE-5, Sept. 1964, p. 2-5. 19 refs.

Analysis of the sampling process exhibited by a human operator. A model is presented that attempts to predict the relation between the kind and rate of information displayed on any display and the frequency and duration of samples made of that display. The approach utilizes the notion that it is possible to quantify the attentional demand or work load placed on the monitor or controller by each source of information in a complex man-machine system. The attentional demand is calculated on the basis of the bandwidth and required precision of readout of the signal presented by an information source. It is measured by the frequency and duration of fixations on an information source. The results of theoretical calculations compare favorably with experimental results.

A64-24126

OPERATOR DECISION PERFORMANCE USING PROBABILISTIC DISPLAYS OF OBJECT LOCATION.

Louis M. Herman, George N. Ornstein (North American Aviation, Inc., Columbus Div., Columbus, Ohio), and Harry P. Bahrick (Ohio Wesleyan University, Delaware, Ohio).
(International Congress on Human Factors in Electronics, Long Beach, Calif., May 3, 1962.)
IEEE Transactions on Human Factors in Electronics, vol. HFE-5, Sept. 1964, p. 13-19. 8 refs.

Comparison of the relative effectiveness of a conventional display of object location with the effectiveness of various probabilistic displays of object location. Several display possibilities for presenting probabilistic information to a system operator are discussed, and an experiment is performed to the potential usefulness of selected probabilistic display types in improving operator performance. Performance evaluation metrics include the degree of accuracy achieved by the operator in estimating probabilities of events and the expected value of his decisions within a simulated search-attack mission. The effectiveness of operators using a nonprobabilistic (conventional) display also is tested by these same metrics. In general, probabilistic information processing appears to offer an improved alternative to nonprobabilistic information processing. With premission training and definitively presented probability information, probabilistic displays can be interpreted accurately by the operator and employed effectively by him within a system.

A64-24841

AN ADAPTIVE MODEL OF THE HUMAN OPERATOR IN A CONTROL SYSTEM.

D. E. Knoop and K. S. Fu (Purdue University, School of Electrical Engineering, Control and Information Systems Laboratory, Lafayette, Ind.).
IN: NATIONAL SYMPOSIUM ON HUMAN FACTORS IN ELECTRONICS, 5TH, SAN DIEGO, CALIF., MAY 5, 6, 1964, PROCEEDINGS. Sponsored by the Professional Technical Group on Human Factors in Electronics of the Institute of Electrical and Electronics Engineers. North Hollywood, Calif., Western Periodicals Co., 1964, p. 252-265. 6 refs.
NSF Grant No. GP 2183; Contract No. AF AFOSR 62-351.

Study of the problem of having a human operator controlling a time-varying plant. Adaptation of the human operator to both discrete and continuous plant variation is investigated. A nonlinear system is proposed as a mathematical model to explain the manner by which a human operator controls a time-varying plant. It is proposed that the human controller is a model adaptive system and used a series of predicted "control intervals" based on the model state. A GEDA/IBM 1710 hybrid system has been employed to aid in experimental verification of the proposed model. Results of typical experiments using second-order plants with one time-varying parameter are presented in graphical form. Time and frequency response curves of operator parameter variations due to plant variations are presented to illustrate the adaptive nature of the human operator.

A64-00315

STUDIES ON KINETIC VISUAL ACUITY: THE IMPORTANCE OF KINETIC VISUAL ACUITY AS AN ABILITY OF PILOT.

Akihiro Suzumura.

Annual Report of the Research Institute of Environmental Medicine, Nagoya University, vol. 11, 1962, p. 9–18. 10 refs. (Published 1963.)

A new apparatus, the A-S Kinetic Vision Tester, is introduced for measurement of kinetic visual acuity. Several experiments were conducted on the relations between kinetic and static visual acuity, and between the former and object velocity, and on the effects of fatigue and jet flight. The smallest differences between the static and kinetic visual acuities were obtained in occupational groups (pilots, highway patrol police) where they were closely related to their proficiency. Kinetic visual acuity decreases as the velocity of the moving visual object increases. This decrease is influenced by individual differences, physical exertion, mental exhaustion, or insomnia. It is concluded that kinetic visual acuity is (1) controlled by a physiological eye mechanism different from that for static visual acuity; (2) closely related to variations in accommodative function; (3) a valuable indicator for qualifying pilots, highway patrol officers, and other traffic operators; and (4) an aid in evaluating fatigue.

N64-30018 Purdue U., Lafayette, Ind. Control and Information Systems Lab.

AN ADAPTIVE MODEL OF THE HUMAN OPERATOR IN A CONTROL SYSTEM

K. S. Fu and D. E. Knoop Sep. 1964 141 p refs

(Grants AF-AFOSR-62-351; NSF GP-2183; NSF GP-1872)

(TR-EE64-15; PRF-3810)

The input-output data are analyzed of a human operator engaged in a time-varying control situation. A mathematical model, functionally equivalent to the subject's performance, is synthesized. The type of control situation considered was that of one-dimensional, compensatory visual-manual tracking.

A.W.

A65-22033

A THEORY FOR OPTIMAL DETERMINISTIC CHARACTERIZATION OF TIME-VARYING HUMAN OPERATOR DYNAMICS.

Walter W. Wierwille (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.).

(Institute of Electrical and Electronics Engineers, International Convention, New York, N.Y., Mar. 22-26, 1965.)

IEEE International Convention Record, vol. 13, pt. 6, 1965, p. 128-142. 15 refs.

Contract No. NAS 1-3485.

Description of a deterministic theory of characterization which can be used to determine the time-varying dynamics of a human operator engaged in a tracking task. With this theory it is possible to obtain a time-varying impulse-response function and a time-varying transfer function which represent the action of a human operator in an open- or closed-loop control system. No special form of input is required. The characterization, which may be in either real-time or nonreal-time, is based upon an exact theory of fixed-form optimization. A strongly convergent, definitely stable, iteration technique can be used to realize the optimal characterization in use. The theory takes the time variation of the impulse-response or transfer function into account, so that it is unnecessary to make the assumption of slowly varying dynamics.

(Author) A.B.K.

A65-25203

APPLICATIONS OF MODERN METHODS TO AEROSPACE VEHICLE CONTROL SYSTEMS.

R. A. Nesbit (Beckman Instruments, Inc., Santa Monica, Calif.).

IN: MODERN CONTROL SYSTEMS THEORY.

Edited by C. T. Leondes.

New York, McGraw-Hill Book Co., 1965, p. 463-482. 26 refs.

Discussion of problems involved in the design and operation of aerospace-vehicle control systems and of the ways in which these problems have been solved. The general properties of the dynamic equations governing the motion of aerospace vehicles are considered. Certain general problems of control, such as attitude, trajectory, power-plant, and support-system control, are described. Recommendations are made concerning methods of analysis and solution of problems. The use of adaptive gain adjustment systems in aircraft attitude control is suggested. Various types of flare-control systems for automatic landing are described.

A.B.K.

A65-35474
MATHEMATICAL MODELS OF HUMAN OPERATORS IN SIMPLE TWO-AXIS MANUAL CONTROL SYSTEMS.
G. A. Bekey (Southern California, University, Los Angeles, Calif.), H. F. Meissinger, and R. E. Rose (Space Technology Laboratories, Inc., Redondo Beach, Calif.).
IEEE Transactions on Human Factors in Electronics, vol. HFE-6, Sept. 1965, p. 42-52. 10 refs.
Contract No. NAS 1-2582.

Application of continuous parameter optimization techniques to the synthesis of a model of human tracking behavior in a simple two-axis task. Considerable emphasis is placed on the measurement of performance criteria for estimating the relative difficulty of single-axis and two-axis tasks as well as for evaluation of the validity of mathematical models. It is shown that the modeling technique can be used to yield a quantitative indication of the degree of cross coupling between axes introduced by the operator.

(Author) M. F.

A65-80347
DRIVERS' GALVANIC SKIN RESPONSE AND THE RISK OF ACCIDENT.
D. H. Taylor (Road Res. Lab., Dept. of Sci. and Ind. Res., Great Britain).
Ergonomics, vol. 7, Oct. 1964, p. 439-451. 12 refs.

Galvanic skin responses (GSR) of 20 drivers were measured in two studies covering a wide range of roads and road conditions. Accident histories were obtained for the roads in one of the studies. It is shown that the level of GSR activity does not depend primarily on the nature of the road or conditions. Consistent sources of variations in the GSR are observed, one of them apparently being the subject's driving experience. The distribution of GSR per unit distance sampled was found to be similar to the distribution of accidents per unit total distance of vehicle travel (the accident rate). Results support a view that driving is a self-paced task governed by the level of emotional tension or anxiety which the driver wishes to tolerate. The possible effects of this on the distribution of accidents is discussed.

N65-17626*# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
A THEORY FOR THE OPTIMAL DETERMINISTIC CHARACTERIZATION OF THE TIME-VARYING DYNAMICS OF THE HUMAN OPERATOR
Wallace W. Wierwille and Gilbert A. Gagne Washington, NASA, Feb. 1965 88 p refs
(Contract NAS1-3485)
(NASA-CR-170) OTS: HC $3.00/MF $0.75

A deterministic theory of characterization is presented which can be used to determine the time-varying dynamics of the human operator engaged in a tracking task. With this theory, it is possible to obtain a time-varying impulse response and a time-varying transfer function which represent the action of a human operator in an open- or closed-loop control system. No special form of input is required. The characterization, which may be developed for either real-time or nonreal-time computation, is based upon an exact theory of fixed-form optimization. A strongly convergent, definitely stable, iteration technique can be used to realize the optimal characterization filter. The theory takes the time variation of the impulse response or transfer function into account, so that it is unnecessary to make the assumption of slowly varying dynamics.

N65-25770# Pittsburgh Univ., Pa. Engineering Psychology Lab.
INVESTIGATION OF MACHINE-ASSISTS TO OPERATOR PERFORMANCE: SIGNAL DETECTION AND TASK COMPLEXITY Final Report
Richard A. Regan and Wilson A. Judd Jan. 1964 31 p refs
(Contract Nonr-624(11))
(AD-605713)

A review was made of the human engineering literature to isolate general machine-assist principles and to determine implications for application to the machine-aiding of human performance. Investigations were carried out in the general area of signal detection to study the facilitating properties of overt observing responses, artificial signals and display, and control complexity on operator performance. The effects of task complexity on decrement over time in the performance of a signal detection task were investigated. The independent variables consisted of variation in signal rate, the number of signal sources, and the complexity of the required post-detection response. Signals consisted of changes in repeatedly presented alphabetical characters. Contrary to previous investigations, detection performance was not significantly influenced by variations in task complexity. Results are discussed in terms of arousal theory and of possible performance-facilitating properties of familiar symbolic stimuli. Author

A66-11633 #

HUMAN TRANSFER FUNCTIONS FOR MULTI-AXIS AND MULTI-LOOP PROBLEMS.

James J. Adams (NASA, Langley Research Center, Hampton, Va.).

IN: AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS, MANNED SPACE FLIGHT MEETING, 4TH, ST. LOUIS, MO., OCTOBER 11-13, 1965, TECHNICAL PAPERS. [A66-11613 02-05]

New York, American Institute of Aeronautics and Astronautics, 1965, p. 197-202.

Data on multiaxis pilot response to illustrate an upper limit on response that is felt to be a limit on the pilot's information-processing capacity. The application of the data to a multiloop command maneuver is also presented. The measurements of the pilot's transfer function were made by matching an analog model to the pilot by automatically adjusting three gains in the model. The multiaxis data were obtained by using a fixed-base simulator. A three-axis artificial horizon, eight-ball instrument was used for the display, and a two-axis sidearm controller and rudder pedals were used to exercise control. The tests are described, and multi-loop problems and the damper failure problem are considered. The model is applied to the design of the drive systems for a full-scale lunar landing simulator. As a result of the work, it is considered that constant coefficient transfer function can give a good representation of human pilot response in closed-loop control systems, even multiloop command guidance systems. F.R.L.

A66-23374

PERFORMANCE SHARING IN AN AUDIO-VISUAL VIGILANCE TASK.

James J. McGrath (Human Factors Research, Inc., Los Angeles, Calif.).

Human Factors, vol. 7, Apr. 1965, p. 141-153. 16 refs.

Army-Navy-supported research.

Verification of the phenomenon of performance sharing, discovered in an earlier experiment. This phenomenon is attributed to differences in signal detectability when two vigilance tasks are performed concurrently. Performance on a vigilance display presenting easily detectable signals was shown to be enhanced by requiring the observer to monitor simultaneously another display, presenting difficult signals via a different sensory modality. Several theoretical approaches to the explanation of the phenomenon are discussed, and implications for display design and research are suggested. M.F.

A66-36233

MATHEMATICAL THEORY OF VISUAL AND TELEVISUAL DETECTION LOBES.

E. Heap (Ministry of Aviation, Royal Aircraft Establishment, Farnborough, Hants., England).

Institute of Mathematics and Its Applications, Journal, vol. 2, June 1966, p. 157-165. 16 refs.

Review of recent developments in the application of mathematics to the evaluation of human visual performance. Although the spread of automation is proceeding fast in the modern world of technology there remains a continual need for the human being to monitor and supervise many system processes. Also the human eye is still the best detection device in many circumstances, some of which, it is shown, can be represented mathematically. Thus, the visual aspects of man's capability are inevitably involved as part of current man-machine systems. Furthermore, television is coming into wider usage as an aid to detection and supervision, since it enables the observer to sit remotely from the direct viewing situation, which might be either dangerous or inconvenient. Mathematical extensions of visual detection models into the television mode are also given, showing the advantages which can be obtained from magnification and contrast enhancement effects in comparison with the disadvantages of restricted fields of view and limited resolution. A first step is taken, therefore, toward expressing some important human factors in mathematical form. M.F.

A66-36861 #

SYSTEM PERFORMANCE AND OPERATOR STATIONARITY IN MANUAL CONTROL SYSTEMS.

D. T. McRuer, D. Graham (Systems Technology, Inc., Hawthorne, Calif.), E. S. Krendel, and W. C. Reisener, Jr. (Franklin Institute, Philadelphia, Pa.).

International Federation of Automatic Control, Congress, 3rd, London, England, June 20-25, 1966, Paper. 11 p. 14 refs.

Contracts No. AF 33(616)-7501; No. AF 33(657)-10835.

Treatment of a simple quasilinear mathematical model for systems comprising a human operator controlling elementary but typical controlled elements which is representative of models data derived from experiments. Pertinent data are adduced to justify the model; in particular, it is shown that for trained and motivated operators, the variability in behavior which might influence overall performance is actually quite small. The model is used to estimate a performance measure, the mean-squared error in tracking, and there is close agreement between these estimates and measured results in tracking tasks. B.B.

A66-37236

A CRITICAL RE-EVALUATION OF THE HUMAN TRANSFER FUNCTION PROBLEM.

Arthur Kahn and Aleeza Gerl Boare (Westinghouse Electric Corp., Atomic, Defense and Space Group, Aerospace Div., Baltimore, Md.).

(Institute of Electrical and Electronic Engineers, Aerospace Systems Conference, Seattle, Wash., July 11-13, 1966, Paper.) IEEE Transactions on Aerospace and Electronic Systems, Supplement, vol. AES-2, July 1966, p. 711-718. 11 refs.

Description of an approach to obtaining fundamental data which could be used to improve information handling and control by a human operator in a closed-loop tracking situation. An experiment was performed, using an analog computer, to develop the functional relationships that exist when the human operator is an integral part of the tracking loop in one dimension. The experimental design consisted of a 4x6x4x3x3x2 analysis of variance model in which the variables of frequency, amplitude, and stick sensitivity were systematically varied to yield 30 average rates of required stick motion. Four operators performed 288 trials, tracking sine waves with and without the presence of noise. A total of 1152 data readings were subject to an analysis of variance performed on a digital computer. The analysis yielded detailed information on operator error and gain.

M. M.

A66-40253

A PRELIMINARY STUDY OF HUMAN OPERATOR BEHAVIOR FOLLOWING A STEP CHANGE IN THE CONTROLLED ELEMENT.

J. D. McDonnell (Systems Technology, Inc., Hawthorne, Calif.).

IEEE Transactions on Human Factors in Electronics, vol. HFE-7, Sept. 1966, p. 125-128. 7 refs.
Contract No. AF 33(657)-10407.

Description of an experimental investigation aimed at understanding human operator behavior following a step change in the controlled element and the determination of limitations on operator descriptions and measurement methods which might be employed. A fixed-base simulator was used in which the subject was presented with a 2-in.-long "horizon bar" on a cathode ray tube displaying the system error as a role angle. The system motion quantities and the time of the change introduction were recorded. The resulting time histories serve as the data source for subsequent analyses, where an attempt is made to uncover clues to human operator transitional behavior. An evaluation of the conventional quasi-stationary model of an operator for transitional behavior description is made via data from the time histories. The model proves unsatisfactory, in general, although interesting observations on operator stationarity are noted.

S. Z.

A66-41574

NONLINEAR AND TIME-VARYING DYNAMICAL MODELS OF HUMAN OPERATORS IN MANUAL CONTROL SYSTEMS.

Walter W. Wierwille and Gilbert A. Gagné (Cornell Aeronautical Laboratory, Inc., Avionics Dept., Buffalo, N.Y.).

Human Factors, vol. 8, Apr. 1966, p. 97-120. 5 refs.
Contract No. NAS 1-4920.

Application of a deterministic theory for characterizing or modeling the dynamics of a human operator in a manual control system. Linear time-varying, nonlinear time-varying, and nonlinear constant-coefficient models are obtained by applying the theory to tracking data taken for one- and two-axis tasks with various displays. The accuracy and fidelity of these advanced models are explored in detail. New information about time-variability and nonlinearity of the human operator, obtained by studying the models and the manual control system signals, is included.

(Author)

A66-80149

MATHEMATICAL MODELS OF HUMAN OPERATORS IN SIMPLE TWO-AXIS MANUAL CONTROL SYSTEMS.

G. A. Bekey (Southern Calif. U., Los Angeles), H. F. Meissinger, and R. E. Rose (TRW Space Technol. Labs., Redondo Beach, Calif.)

IEEE Transactions on Human Factors in Electronics, vol. HFE-6, Sep. 1965, p. 42-52. 16 refs.
NASA/Langley Contract NAS1-2582.

An application of continuous parameter optimization techniques to the synthesis of a model of human tracking behavior in a simple two-axis task is presented. Considerable emphasis is placed on the measurement of performance criteria for estimating the relative difficulty of single-axis and two-axis tasks as well as for evaluation of the validity of mathematical models. It is shown that the modeling technique can be used to yield a quantitative indication of the degree of cross coupling between axes introduced by the operator.

A66-80419
SPATIAL VISUAL FEEDBACK OF COMPONENT MOTIONS AS A FUNCTION OF DIFFICULTY OF MOTOR CONTROL.
John D. Gould and Amy Schaffer (IBM Watson Res. Center, Yorktown Heights, N.Y.)
Journal of Experimental Psychology, vol. 70, Dec. 1965, p. 564–569. 16 refs.

This research studied the interrelations of visual perception and movement. Closed-circuit television techniques allowed the joint action of subject's hand, control instrument, and operational effects to be visually fed back singly or in various combinations. Two levels of difficulty of each of the three task components responsible for the types of visual feedback were varied independently of feedback in a task where subject steered a ball through a maze. Results showed vision of the tool to be most important followed by vision of operational effects and hand-arm movements. No significant difference was found on the task-difficulty variable which may have influenced the absence of a significant interaction between type of visual feedback and movement difficulty.

N66-15003 Joint Publications Research Service, Washington, D. C.
STATISTICAL METHODS OF EVALUATING THE EFFECTIVENESS OF A HUMAN OPERATOR'S TRANSFER FUNCTION
G. A. Sergeyev and A. F. Romanenko *In its* Cybernetic Appl. in Psychological and Med. Probl. 13 Oct. 1965 p 39–52 refs (See N66-15004 05-04) CFSTI: $3.00

Variations in productivity of human operators are considered too great for use in average productivity estimates based on the assumption of the steady-state nature of input errors. The human operator is shown to master the stochastic structure of input errors. Calculation of possible relative limits of productivity variation, determined with the aid of the information transfer function, is considered to reflect the self-adjustment function of the human servo system under the action of input signals of the transient type. A statistical approach is used to investigate the errors made by human operators; and in one series of experiments with a homogeneous group of operators, considerable variation is found in the frequency structure of individual errors. Correlation functions are determined in both the frequency and time domains. M.W.R.

N66-15500# BioTechnology, Inc., Arlington, Va.
THE TRANSLATION OF VISUAL INFORMATION INTO VEHICULAR CONTROL ACTIONS
Raymond E. Reilly, Robert R. Gilbert, Richard F. Dillon, and James F. Parker, Jr. Oct. 1965 64 p refs Sponsored by Va. Dept. of Highways
(BTI-65-2)

The use of visual information from a land vehicle taillight system is studied in relation to specific vehicular control actions by the driver. Particular attention is given to the angular velocity cue provided by the increase in vehicle visual angle provided by the two tail lights as the driver approaches the rear of a vehicle. It appears that a driver uses both the angular velocity cue as well as the speed of his own vehicle in making the decision to stop. Other cues appear to give important perceptual information, although individuals operate within the entirety of the visual environment rather than from separate cues. It is concluded that all the visual information available to a driver is used in a highly systematic manner to effect control actions. Specific characteristics of tail-light systems were found to have a significant effect on braking behavior, and a system with large, bright lights separated by 60 inches consistently produces better braking responses from drivers. M.W.R.

N66-21119# North American Aviation, Inc., Columbus, Ohio.
EFFECTS OF DISPLAY QUICKENING ON HUMAN TRANSFER FUNCTIONS DURING A DUAL-AXIS COMPENSATORY TRACKING TASK Final Report, May 1963–Jun. 1964
Angelo P. Verdi, George N. Ornstein, Richard P. Heydorn, and George Frost (AMRL) Wright-Patterson AFB, Ohio, AMRL, Nov. 1965 220 p refs
(Contract AF 33(657)-11102)
(AMRL-TR-65-174; AD-627671) CFSTI: HC $6.00/MF $1.25

The research was concerned with the human's behavior in adapting his response mode to variations of certain conditions of a compensatory tracking task. The task conditions evaluated were quickening level, system gain, task load, and task complexity. The results of the studies show good agreement with the transfer function 'adjustment rules' developed by other investigators. When quickening is introduced, the human adjusts his transfer function in a systematic and predictable manner in response to variations of the quickening level. As the amount of quickening increases the operator increases gain and lag but decreases lead. The human adjusts his equalizing parameters to achieve stable loop performance for all quickening levels. Man's ability to reduce the system error is significantly affected by the distribution of gains in the overall man-machine system. The human's transfer function for single and dual task load conditions probably differs. Tracking error was found to be least when the quickening level used in the second axis is identical to that in the axis of primary interest; error increased as the quickening levels for the two axes became more dissimilar. Author

N66-32959*# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
CHARACTERIZATION OF TIME-VARYING HUMAN OPERATOR DYNAMICS
G. A. Gagne and W. W. Wierwille Washington, NASA, Aug. 1966 87 p refs
(Contract NAS1-4920; Proj. ICARUS)
(NASA-CR-539) CFSTI: HC $3.00/MF $0.75 CSCL 05H

Linear time-varying, nonlinear time-varying, and nonlinear constant coefficient models of the human operator in tracking tasks were determined. The experiments were to characterize the human operator. The deterministic time varying characterization theory was used, and a set of rules by which each operator responds to the displayed signals was devised. The determination of the causes of the time-variations in the transfer characteristics was emphasized. Three experienced pilot-engineers and one non-pilot engineer were the subjects. Linear time-varying models were obtained for tracking tasks with various one- and two-axis displays with corresponding one- and two-axis dynamics. Follow-up dynamics were the same for all experiments and were identical for both axes. They were chosen so as to be similar to the pitch and roll dynamics of a jet fighter aircraft. An attempt was made to develop a "logic model" of the operators, which was to simulate their logic strategy while tracking in a control system. Instrument arrangements and data processing methods are included. The studies indicate that logic models with accuracies of 15% to 20% N.I.S.E. are theoretically possible. K.W.

N66-35213*# Stanford Univ., Calif.
EFFECTS OF TIME DELAY IN THE VISUAL FEEDBACK LOOP OF A MAN-MACHINE SYSTEM
John Mc Lean Leslie Washington, NASA, Sep. 1966 121 p refs
(Grant NsG-111-61)
(NASA-CR-560) CFSTI: HC $3.00/MF $1.00 CSCL 05H

This thesis was aimed at studying the effects of time delay in the visual feedback loop of a man-machine system. A one-dimensional, step-type input, pursuit tracking experiment was developed to study these effects with transmission-type delays of zero to ten seconds. Thirty-six subjects participated in a series of tests that covered: seven different delays, two different levels of course complexity for each delay, learning, and open-loop conditions. It was found that tracking performance deteriorates non-linearly with increase in delay and that the magnitude of this performance degradation is a function of course complexity. Author

N66-33893*# Systems Technology, Inc., Hawthorne, Calif.
A "CRITICAL" TRACKING TASK FOR MAN-MACHINE RESEARCH RELATED TO THE OPERATOR'S EFFECTIVE DELAY TIME. PART I: THEORY AND EXPERIMENTS WITH A FIRST-ORDER DIVERGENT CONTROLLED ELEMENT
R. R. Bourassa, D. D. Mc Donnell, and A. V. Phatak Washington, NASA, Nov. 1965 116 p refs
(Contract NAS2-2288)
(NASA-CR-515) CFSTI: HC $3.00/MF $0.75 CSCL 05H

A first-order divergence is used as the controlled element to obtain certain theoretical advantages. Based on recent human response research, a theoretical analysis of this man-machine system is performed, and an experimental program is described which enables describing function and critical task measures to be computed. A specific critical task mechanization and operating procedure is developed which yields consistent and reliable measurements of the critical levels of instability. An analysis of the describing function results shows that, when operating near criticality, the subject's behavior is adequately represented by recently developed human operator describing function models and adaptation laws. Further, the extrapolation of describing function data to the critical level of instability shows that the operator consistently loses control at small, but finite, mean stability margins. The just-controllable first-order divergence is shown to be related dominantly to the operator's effective time delay, and secondarily to the nominal variations of his average tracking characteristics and to mid-frequency phase lags due to long period kinesthetic adaptation effects. Author

A67-15402 #
REVIEW OF MATHEMATICAL MODELS WHICH DESCRIBE HUMAN RESPONSE TO ACCELERATION.
Verne L. Roberts, C. T. Terry (Wayne State University, Biomechanics Research Center, Detroit, Mich.), and Ernest L. Stech (Frost Engineering Development Corp., Englewood, Colo.).
American Society of Mechanical Engineers, Winter Annual Meeting and Energy Systems Exposition, New York, N.Y., Nov. 27-Dec. 1, 1966, Paper 66-WA/BHF-13. 12 p. 58 refs.
Members, $0.75; nonmembers, $1.50.
U.S. Public Health Service Grant No. AC-00054-08.

Review of the models which have been proposed to describe both the reaction of the human body as well as the specific response components of the body when placed in a dynamic environment. The response of bone and soft tissue as predicted by rheological models is first considered. Models have also been constructed for joints, appendages, the head and neck, the spine, and abdominal organs. Whole body models are described which fit experimental data reasonably well and are of use in engineering design calculations. F.R.L.

A67-19194 *

ADAPTIVE FUNCTIONS OF MAN IN VEHICLE CONTROL SYSTEMS.

Y. T. Li, L. R. Young, and J. L. Meiry (Massachusetts Institute of Technology, Dept. of Aeronautics and Astronautics, Cambridge, Mass.).

IN: THEORY OF SELF-ADAPTIVE CONTROL SYSTEMS; INTERNATIONAL FEDERATION OF AUTOMATIC CONTROL, SYMPOSIUM, 2ND, TEDDINGTON, MIDDX., ENGLAND, SEPTEMBER 14-17, 1965, PROCEEDINGS. [A67-19192 07-10]

Symposium sponsored by the International Federation of Automatic Control and the United Kingdom Automation Council.

Edited by P. H. Hammond.

New York, Plenum Press, Division of Plenum Publishing Corp., 1966, p. 43-55. Discussion, M. V. Meerov (National Committee on Automatic Control, Moscow, USSR), P. H. Hammond (Ministry of Technology, National Physical Laboratory, Autonomics Div., Teddington, Middx., England), R. J. A. Paul, and B. R. Gaines, p. 55, 56. 14 refs.

Grant No. NsG-577.

Examination of the principles and compositions of existing automatic adaptive control systems. On these bases the human adaptive as well as primary control functions are analyzed. In general, the human operator outshines the automatic system with his huge capacity of open loop or programed control, but he lacks the capacity and speed for making on-line computations needed in the operation of active continuous adaptive system. The human operator can also perform some passive type or very simple active type adaptation but would require complicated active adaptation.

M. F.

A67-20173

AN INCLUSIVE CLASSIFIED BIBLIOGRAPHY PERTAINING TO MODELING THE HUMAN OPERATOR AS AN ELEMENT IN AN AUTOMATIC CONTROL SYSTEM.

R. G. Costello (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.) and T. J. Higgins (Wisconsin, University, Dept. of Electrical Engineering, Madison, Wis.).

(Institute of Electrical and Electronics Engineers, Symposium on Human Factors in Electronics, 7th, Minneapolis, Minn., May 5, 6, 1966, Paper.)

IEEE Transactions on Human Factors in Electronics, vol. HFE-7, Dec. 1966, p. 174-181.

Bibliography of some 200 entries, selected from a total collection of almost 500 references pertaining to the human operator. These references are concerned specifically with modeling the human operator as an element in an automatic control system.

M. F.

A67-22374 *

DELAYED FORCE FEEDBACK.

William R. Ferrell (Massachusetts Institute of Technology, Cambridge, Mass.).

(Human Factors Society, Metropolitan Chapter, Annual Meeting, New York University, New York, N.Y., June 12, 1965, Paper.)

Human Factors, vol. 8, Oct. 1966, p. 449-455.

Grant No. NsG-107-61.

Observation that, in master-slave manipulators, forces encountered by the remote hand are transmitted back to the operator. At very great distances there will be a transmission delay between an operator's movement and a resulting force. Investigation was made of the effect of long delays and differences in strategy on positioning time with force feedback alone. Positioning could be accomplished, but delay coupled with high loop gain creates serious instability. Experimental results suggest that alternative displays of the feedback force can overcome the stability problem. M. F.

A67-20923

CRITICAL RE-EVALUATION OF THE HUMAN TRANSFER FUNCTION PROBLEM. II.

Aleeza Cerf Beare and Arthur Kahn (Westinghouse Electric Corp., Atomic, Defense and Space Group, Human Factors Laboratory, Baltimore, Md.).

Aerospace Medicine, vol. 38, Apr. 1967, p. 383-389. 12 refs.

A study of compensatory tracking was performed on an analog computer simulation to test the application of the superposition theorem to human tracking performance. Four subjects participated in a 4x4x4x3x3x2 analysis of variance design in which the input variables of frequency, amplitude, stick and scope sensitivity and noise conditions were varied systematically. The performance data of error and stick movement and the ratio of these two measures - i.e., the gain - were subjected to an analysis of variance performed on a digital computer. The results showed that the linearity assumption is not a valid assumption. The variable underlying performance is the average rate of stick motion. Using the rate variable, a transfer function was derived which provides an adequate fit between the empirically derived and the theoretically calculated data. The conclusions show that error increases and gain decreases as a direct function of average rate of stick motion and that the presence of noise has an effect similar to that of increasing the rate. (Author)

N67-10157# Joint Publications Research Service, Washington, D. C.

THE SUBJECT MATTER OF SEMIOTICS

A. A. Vetrov. *In its* Some Aspects of Inform. Theory and its Relation to Living Organisms. 16 Nov. 1965 p 1-16 refs (See N67-10156 01-04) CFSTI: $2.00

A definition of the science of semiotics is proposed, and its three divisions (pragmatics, semantics, and syntactics) are discussed. It is considered that semiotics is the general science of signs (both language and non-language), the meanings of signs, and those properties of sign systems in which the specific nature of the functioning of signs in those systems is revealed. It is suggested that this definition of semiotics establishes a precise boundary between semiotics as a special science, and other sciences (logic, mathematics, linguistics, etc.). R.Ll.

N67-11664# Joint Publications Research Service, Washington, D. C.

SOME INDICES OF THE ACTIVITY OF AN OPERATOR IN THE PROCESS OF TRACKING

G. V. Knlyustikov and S. D. Khoruzhaya. *In its* Probl. in Aerospace Med. 21 Oct. 1966 p 492 (See N67-11401 02-04) CFSTI: $3.40

Experiments on tracking performance, based on error compensation, are briefly reviewed. It was found that the quality of tracking depended on the characteristics of both the input signal and the regulated object. N.E.N.

N67-11675# Joint Publications Research Service, Washington, D. C.

ALGORITHMS AND DIAGRAMS OF THE ACTIVITY OF THE OPERATOR OF A SYSTEM OF AUTOMATIC CONTROL AND MANAGEMENT

A. I. Galaktionov, I. M. Panasenko, and L. V. Fatkin. *In its* Probl. in Aerospace Med. 21 Oct. 1966 p 136-137 (See N67-11401 02-04) CFSTI: $3.40

A method of constructing and analyzing an algorithm is proposed as a solution to the problem of the correct distribution of the functional duties between the operator and the automatic apparatus of a control and management system. Optimum coordination of the operator with the automatic apparatus and technical components of the system is also considered. A brief outline of the approach used is presented. M.G.J.

N67-12080*# University of Southern Calif., Los Angeles. Dept. of Electrical Engineering.

AN ASYNCHRONOUS PULSE-AMPLITUDE PULSE-WIDTH MODEL OF THE HUMAN OPERATOR

M. J. Merritt. Mar. 1966 42 p refs

(Grant NGR-05-018-022)

(NASA-CR-79760; USCEE-128) CFSTI: HC $2.00/MF $0.50 CSCL 06D

Details are given on the development of a human operator model which produces discrete pulse outputs in response to continuously presented Gaussian random inputs. The parameters of the model were identified from experimental data taken from a subject in an advanced state of training. Computer procedures for the complete identification of all model parameters are described. Results indicate: (1) The human operator reaction time of 200 milliseconds is in excellent agreement with other data. (2) Pulse amplitude and pulse width models for negative pulses produce better correlations with experimental data than for positive pulses. (3) Pulse amplitude models for positive and negative pulses are similar, despite considerable asymmetry in pulse amplitude distributions. (4) Human operators use pre-programmed pulse sequences. However, it is pointed out that it is not feasible to determine whether the model errors observed are random or functionally dependent on the human operator inputs and input-output history. M.G.J.

N67-15855*# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
PROCESS OF ADAPTATION BY THE HUMAN CONTROLLER

Jerome I. Elkind and Duncan C. Miller *In* NASA, Washington Manual Control 1966 p 47-63 refs (See N67-15850 06-05) GPO: HC $2.50; CFSTI: MF $0.65
(Contract AF 33(657)-10124)

A model is presented for the detection, identification, and modifications phases of the process by which the human operator adapts to changes in dynamics. The model contains (1) an internal adjustable portion for the plant dynamics, (2) a threshold detector compares change in error rate due to control movement with that predicted by the internal portion, (3) a decision tree that identifies change in dynamics by sequentially determining modifications in the internal portion that must be made for observed and predicted error rates to correspond, and a switching tree that permits rapid and sequential changes in human controller characteristics. The detection and identification models accurately predict the time at which the human controller will detect a change in plant, and the dependence of identificaton time on plant change uncertainty and complexity is predicted. The mode-switching adjustment was verified by analysis of the adjustment process of well-trained controllers who exhibit very rapid changes in characteristics when they have detected a change in plant dynamics. M.W.R.

N67-15856*# Systems Technology Inc., Inglewood, Calif.
MODEL OF HUMAN-OPERATOR RESPONSE TO STEP TRANSITIONS IN CONTROLLED ELEMENT DYNAMICS

D. H. Weir and A. V. Phatak *In* NASA, Washington Manual Control 1966 p 65-83 refs (See N67-15850 06-05) GPO: HC $2.50; CFSTI: MF $0.65
(Contract NAS2-1868-4)

A critical control problem involving the vehicle/controlled-element system results from a step transition (sudden change) in the controlled element. Practical examples include failure of a manned aircraft stability augmenter, or the large changes in center of gravity which might occur during staging in the manual control of boost. Derivation of an analytical model useful in predicting operator transition response is summarized. Extensive use is made of experimental data from a variety of sources. Topics such as detection criteria and the effects of learning, alerting, and uncertainty about the new dynamics are included by reference only. Author

N67-15857*# Purdue Univ., Lafayette, Ind.
ADAPTIVE MODEL OF THE HUMAN OPERATOR IN TIME-VARYING CONTROL TASK

E. E. Ward and K. S. Fu *In* NASA, Washington Manual Control 1966 p 85-97 refs (See N67-15850 06-05) GPO: HC $2.50; CFSTI: MF $0.65

A model is presented for the human operator engaged in one-dimensional, compensatory, visual-manual tracking. Instead of a lumped input-output model, the human operator is considered as a system consisting of an input device (visual stimulus), an adaptive controller (central nervous system), and an actuator (arm and muscle mechanism). The main concern of this paper is modeling the strategy of the adaptive controller section. Pattern recognition techniques, which usually attempt to mimic human behavior are used in the model to identify the type of plant being controlled. This basis for a model is then augmented by more conventional techniques to more closely approximate human behavior. The model has been simulated and is presently undergoing extensive tests. Author

N67-15862*# TRW Systems, Redondo Beach, Calif.
HUMAN PERFORMANCE IN SINGLE-AXIS AND TWO-AXIS TRACKING SYSTEMS

E. P. Todosiev, R. E. Rose, and L. G. Summers *In* NASA, Washington Manual Control 1966 p 143-158 refs (See N67-15850 06-05) GPO: HC $2.50; CFSTI: MF $0.65
(Contract NAS1-4419)

A compensatory tracking experiment was performed on single and uncoupled two-axis tracking systems to determine the effects of training and task difficulty on the parameters of a describing function model of the human operator. The plant dynamics were identical in both the single-axis system and the symmetrical two-axis system. Second-order dynamics consisting of a pure integration and first-order lag were used. Task difficulty was varied by changing the magnitude of the lag time constant and the frequency bandwidth of the input disturbance. Analysis of system tracking error showed that the rate at which error decreased with training was dependent upon task difficulty. The amplitude ratio and phase lead of the model describing function increased with training, indicating an increase in open-loop bandwidth and a decrease in phase margin. Increasing the plant lag time constant resulted in an increase in the model lead time constant and a decrease in the zero frequency gain. No significant difference was found to exist in the tracking error per axis between the two-axis tasks and the single-axis tasks. However, the model lead time constant was significantly greater in two-axis tracking. Author

N67-15874* Battelle Memorial Inst., Columbus, Ohio.
HUMAN DECISION-MAKING IN MANUAL CONTROL SYSTEMS
R. E. Thomas and J. T. Tou. *In* NASA. Washington. Manual Control. 1966. p 325-334. refs (See N67-15850 06-05) GPO HCS2.50, CFSTI: MFS0.65

A model is proposed to describe human decision making in manual control systems. The human operator in the control loop is represented by a model which will generate an output consisting of (1) operational control actions as a result of sequential decision-making and (2) verbal statements or heuristics of how to achieve optimal control. The operational control actions are generated by a search algorithm, and the verbal statements are determined through detection of invariance of variables associated with minimum incremental cost. At high levels of generality and verbal prescriptions for obtaining optimal control are called heuristics. By using heuristics adaptive features can be introduced into the search algorithm. The proposed model will carry out sequential evaluation of the validity of the heuristics which are derived on the basis of past experience. By associating a Bayesian probability with the derived heuristic, this model simulates the evolution of a heuristic to a high subjective probability of being valid, even though the controller may have difficulty in executing the heuristic as shown by control actions which do not optimize the criterion function. An experiment is suggested for testing the validity of the proposed model. Author

N67-16312* Systems Technology, Inc., Hawthorne, Calif.
A "CRITICAL" TRACKING TASK FOR MAN-MACHINE RESEARCH RELATED TO THE OPERATOR'S EFFECTIVE DELAY TIME. PART II: EXPERIMENTAL EFFECTS OF SYSTEM INPUT SPECTRA, CONTROL STICK STIFFNESS, AND CONTROLLED ELEMENT ORDER
J. D. McDonnell and H. R. Jex. Washington, NASA, Jan. 1967. 56 p. refs
(Contract NAS2-2238)
(NASA-CR-674) CFSTI: HC$3.00/MF$0.65 CSCL 05H

The Critical Task consists of a closed-loop tracking task in which an increasingly unstable controlled element is used to yield a measure of the operator's effective time delay while tracking. In this part of the report, the task has been further developed through the analysis of additional data. In a series of experiments, it was found that the human operator's characteristics do not change as the system input level is decreased; hence, the critical task yields a valid limit when excited solely by the operator's remnant. The effects on the operator of different control stick types are investigated, and the differences in critical task scores are related to the operator's describing function characteristics. Step reaction time data are compared with the continuous measures of effective time delay and the autopacer scores. A sample analysis to determine the number of autopacer trials necessary to achieve a confident measure is made. Finally, data are presented for a second-order critical task in which on integrator precedes the first-order divergence. Author

N67-18410* Battelle Memorial Inst., Columbus, Ohio.
DEVELOPMENT OF A MATHEMATICAL MODEL OF THE HUMAN OPERATOR'S DECISION-MAKING FUNCTIONS Final Report
J. T. Tou, R. E. Thomas, and R. J. Cro... 31 Oct. 1966. 233 p. refs
(Contract NAS12-37)
(NASA-CR-80008) CFSTI: HC$3.00 CSCL 05H

Attempts are made to formulate a mathematical model describing the human operator's decision-making functions in a control system. The model simulates the evolution of control strategies selected by a human operator and the prediction of verbal heuristics used by such an operator. The proposed model consists of four modes of control: heuristic, gradient, terminal, and pruning modes. The operator is assumed to be engaged in the optimal control of a dynamic system described by an ordinary linear differential equation subject to initial and final boundary conditions. The task consists of moving the system from the initial state to the terminal state and minimizing a quadratic performance criterion using information concerning state variables and cost variables which is obtained from meter readings available at discrete time during the control operation. The approach used was to allow 14 subjects to solve 23 first-order control problems (Mark I model) and allow 14 additional subjects to solve 12 second-order control problems (Mark II model). Results from the computer simulation and those from tests of subjects are analyzed. S.P.

N67-22718* Royal Aircraft Establishment, Farnborough (England).
SOME CHARACTERISTICS OF THE HUMAN OPERATOR AND HIS MATHEMATICAL REPRESENTATION IN THE TRACKING ROLE
W. F. Fielding. Aug. 1963. 29 p. refs
(RAE-TN-WE-38) CFSTI: HC$3.00/MF$0.65

The physiological factors which affect a human operator's performance of a tracking task are discussed, together with the limitations of mathematical representations of the human operator, sufficient to enable a nonpsychologist to obtain a reasonable picture of how a human operator works. Factors affecting control design, system response and display are discussed, together with some suggestions for evaluation of the constants in the operator's equation. A bibliography of some relevant papers is given as an appendix. Author

A64-80092
OPERATION TIME AS A FUNCTION OF FOOT PEDAL DESIGN.
Don Trumbo (Kansas State U., Manhattan) and Morris Schneider (Texas Technol. Coll., Lubbock).
Journal of Engineering Psychology, vol. 2, Oct. 1963, p. 139–143.

Response times in depressing 5-ft pedals were compared for 10 subjects in a replicated 5 x 5 Latin square design. Foot pedals varied in the location of the fulcrum and the presence or absence of a heel rest, but were alike ... spring constant and the angular movement required to complete the response. The results show a consistent relationship between response time and placement of the fulcrum with pedals pivoted at the heel and requiring a downward movement of the toes yielding the best performance.

A67-80180
EFFECT OF SWIT... FIGURATION ON THE OPERATION OF A SWITC... MATRIX.
R. S. Lincoln and S. A. Konz (Lockheed Missiles and Space Co., Sunnyvale, Calif.).
Journal of Applied Psychology, vol. 50, Oct. 1966, p. 375–382. 5 refs.
Contract AF 04(...)-207.

In a series of ... rce experiments the speed and accuracy of switch-matrix operations were determined for five different matrix configurations. Factors influencing performance included switch orientation (whether row or column), reach distance, and the type of symbol with which the switches were labeled. Response time was the only important performance measure. Error rates were negligible for all configurations.

A67-80227
HORIZONTAL VERSUS VERTICAL DISPLAY OF NUMBERS.
C. M. Williams (Bell Telephone Labs., Inc., Murray Hill, N. J.).
Human Factors, vol. 8, Jun. 1966, p. 237–238.

A task was constructed to compare performance on a horizontal to that of a vertical array of 3-digit numbers. Sixteen subjects were required to scan arrays of pairs of numbers and mark the pairs that contained nonidentical members. The average time required to complete the vertical array was 73 sec. and 44 sec. for the horizontal. The finding that an average of 66% more time was spent on the vertical than on the horizontal array is significant at the .005 level.

A67-80780
DELAYED FORCE FEEDBACK.
William R. Ferrell (Mass. Inst. of Technol., Cambridge).
(Human Factors Soc., Metropol. Chapter, Ann. Meeting, New York, Jun. 12, 1965).
Human Factors, vol. 8, Oct. 1966, p. 449–455.
NASA Grant NsG-107-61.

In master-slave manipulators, forces encountered by the remote hand are transmitted back to the operator. At very great distances there will be a transmission delay between an operator's movement and a resulting force. Investigation was made of the effect of long delays and differences in strategy on positioning time with force feedback alone. Positioning could be accomplished, but delay coupled with high loop gain creates serious instability. Experimental results suggest that alternative displays of the feedback force can overcome the stability problem.

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A65-80440

DRUGS AND JUDGMENT: EFFECTS OF AMPHETAMINE AND SECOBARBITAL ON SELF-EVALUATION.

Gene Marshall Smith and Henry K. Beecher (Mass. Gen. Hosp., Dept. of Anaesthesia, Boston).

Journal of Psychology, vol. 58, Oct. 1964, p. 397-405. 18 refs.
Mallinckrodt Chemical Works supported research.
Contracts No. PHS-M-987 and DA-49-007-MD-2136.

Each of 78 graduate and undergraduate college students attempted to solve 25 [illegible]lus problems and afterward estimated the number of his correct solutions. Subjects did this on each of five occasions: twice after taking amphetamine sulfate (14 mg. per 70 kg. of body weight), once after taking secobarbital sodium (50 mg. per 70 kg. of body weight), and twice after taking a placebo. After taking placebo the subject overestimated, to a significant degree, the number of problems solved correctly. After taking amphetamine or secobarbital the overestimation tendency, or judgment error, was still greater. The increase in judgment error was statistically significant with amphetamine but not but only suggestive with secobarbital. Implications of the findings concerning the effect of amphetamine on judgment are discussed.

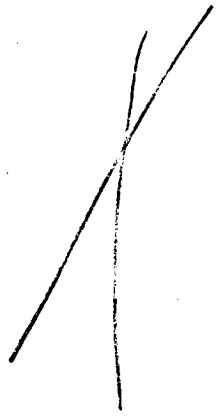
A65-80440

EXPERIMENTAL RESULTS OF IMPACT STRESS ON THE ANIMAL ORGANISM DURING LANDING [illegible] OF ISSLEDOVANIIA VLIIANIIA UDARNYKH PEREGRUZOK PRIZEMLENIIA NA ORGANIZM ZHIVOTNYKH.

S. A. Cozulov, G. P. Mirolubov, N. N. Popov, and N. I. Frolov.

Kosmicheskie Issledovaniia, vol. 2, Sep.-Oct. 1964, p. 805-811. 11 refs.
In Russian.

An impact of an aircraft or of any part of it (such as the space cabin or the escape capsule) with a land or water surface during forced landing, was simulated in the laboratory on experimental animals. The results disclosed considerable damage to the internal organs followed by disturbances in the physiological functions. The character of changes depended on the degree of the acceleration stress. No bone fractures were noted.



A65-80[illegible]7

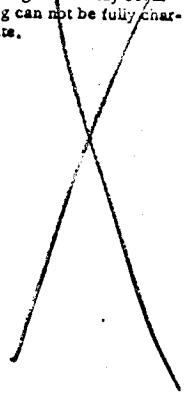
[illegible]ROKE VOLUME AND CARDIAC OUTPUT AFTER SMOKING [illegible] THE POSTPRANDIAL AND IN THE FASTING STATE.

[illegible]ouis A. Soloff and Donald V. Powers (Temple U. Med. Center, Div. of Cardiol., Philadelphia, Pa.)

American Journal of the Medical Sciences, vol. 248, Dec. 1964, p. 693-696. 5 refs.

Arline Dickler Grass Chapter of the Heart Assoc. of Southeastern Pennsylvania (Cardiovascular Res. Center HE 06313-03); and Tobacco Industry Res. supported research.

Eight habitual smokers were studied to learn if glucose by mouth, as has been demonstrated after intravenous glucose, can block the increase in the stroke volume and in cardiac output provoked by smoking. In all instances, peroral glucose blocked the increase in stroke volume and cardiac output provoked by smoking. A volume of water equal to the volume of glucose solution has no effect on cardiac output or stroke volume nor did this amount of water inhibit the increase in stroke volume and cardiac output provoked by smoking. These studies suggest that the physiological act of eating (sugar) prevents the cardiac effects of smoking which may occur in the fasting state. The cardiac response to smoking can not be fully characterized by studies limited to the postabsorptive state.



A65-81578

SEEKING INFORMATION TO REDUCE THE RISK OF DECISIONS.

Ward Edwards and Paul Slovic (Mich. U., Ann Arbor).

American Journal of Psychology, vol. 78, Jun. 1965, p. 188-197.
Contracts DA-36-039-SC-78601; and AFOSR 192-63.

Undergraduate subjects were asked to perform information-seeking tasks of two types. In standard tasks, a subject paid for looks at the cells of a 16-cell matrix and was rewarded if he found the unique cell. In inverse tasks, the subject was fined for finding the unique cell and rewarded for each cell investigated which was not the unique one. The basic dependent variable, strategy-score, was the number of cells the subject looked at for tasks in which he did not find the unique cell. For tasks in which he did find it, elaborate rules were used to infer what he would have done had he not found it. The subjects performed remarkably well; about half the strategies used were optimal or approximately so, and serious divergences from the optimum were very rare. Performance was less good on standard than on inverse tasks, and slightly less so on tasks with more complex costs and payoffs than on tasks with simpler costs and payoffs. Half the subjects were too cautious and half were too incautious in tasks for which both were possible. Individual subjects usually were consistent in being cautious or incautious.

A65-81886
RISK-TAKING SET AND TARGET DETECTION PERFORMANCE.
Gary W. Evans (Human Resources Res. Office, Fort Bliss, Tex.)
Journal of Applied Psychology, vol. 49, Aug. 1965, p. 243-244.

An experiment tested the hypothesis that an observer's risk-taking set is related to his target-detection performance on a radar display. Subjects were given an equal number of trials under neutral, risky, and cautious sets, where differential sets were produced by instructions. As hypothesized, when instructed to adopt a risky set, subjects made earlier detections of targets and had a higher false-positive identification rate than the same subjects when instructed to adopt a cautious set. These findings support the contention that radar detection performance can be regarded as a decision task.

A65-82294
DOGMATISM AND PREDECISIONAL INFORMATION SEARCH.
Barbara H. Long and Robert C. Ziller (Goucher Coll., Baltimore, Md.; and Del. U., Newark).
Journal of Applied Psychology, vol. 49, Oct. 1965, p. 376-378. 16 refs.
Grant AF-AFOSR-62-95.

Rokeach's Dogmatism Scale and four decision measures of tendencies to reserve judgment were administered to 72 freshmen women. A significant negative relationship was found between dogmatism and each of the four decision measures. The nondogmatic individual tended to delay decision and engage in predecisional search, to require more time for psychophysical judgments, and to respond "don't know" to statements of opinion under conditions of inadequate information. Accordingly, dogmatism was interpreted as a defense mechanism which interferes with processing of predecisional information.

A66-11603 #
HUMAN TRANSFER FUNCTIONS FOR MULTI-AXIS AND MULTI-LOOP PROBLEMS.
James J. Adams (NASA, Langley Research Center, Hampton, Va.).
IN: AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS, MANNED SPACE FLIGHT MEETING, 4TH, ST. LOUIS, MO., OCTOBER 11-13, 1965, TECHNICAL PAPERS. [A66-11613 02-05]
New York, American Institute of Aeronautics and Astronautics, 1965, p. 197-202.

Data on multiaxis pilot response to illustrate an upper limit on response that is felt to be a limit on the pilot's information-processing capacity. The application of the data to a multiloop command maneuver is also presented. The measurements of the pilot's transfer function were made by matching an analog model to the pilot by automatically adjusting three gains in the model. The multiaxis data were obtained by using a fixed-base simulator. A three-axis artificial horizon, eight-ball instrument was used for the display, and a two-axis sidearm controller and rudder pedals were used to exercise control. The tests are described, and multiloop problems and the damper failure problem are considered. The model is applied to the design of the drive systems for a full-scale lunar landing simulator. As a result of the work, it is considered that constant coefficient transfer function can give a good representation of human pilot response in closed-loop control systems, even multiloop command guidance systems. F.R.L.

A66-39145
A SYSTEM FOR THE AUTOMATIC RECOGNITION OF MOVING PATTERNS.
L. F. Turner (International Telephone and Telegraph Corp., Standard Telecommunication Laboratories, Ltd., Harlow, Essex, England).
(Institute of Electrical and Electronics Engineers, International Symposium on Information Theory, University of California, Los Angeles, Calif., Jan. 31-Feb. 2, 1966, Paper.)
IEEE Transactions on Information Theory, vol. IT-12, Apr. 1966, p. 195-205. 6 refs.

A system for the automatic recognition of two-dimensional patterns is described; recognition taking place as images of the patterns move in a rapid nonstop manner across a stationary scanning unit which takes the form of a bank of photodiodes. Although emphasis is placed on the recognition of alphabetic and numeric characters, the principles developed are applicable to the recognition of more general types of two-dimensional patterns. The theoretical principles on which the system is based are developed and experimental and computer simulation results are given and discussed. The difficulties involved in the manual design of the recognition "logic" are considered and reference is made to a machine algorithm for the automatic design and testing of a complete recognition system. Some results obtained when using the algorithm are presented. (Author)

A66-80274
EFFECTS OF TWO SOURCES OF UNCERTAINTY IN DECISION MAKING.
James M. Driscoll and John T. Tanzetta (Dartmouth Coll., Hanover, N. H.)
Psychological Reports, vol. 17, Oct. 1965, p. 635–648. 9 refs.
Grant NSF GS-311 and Contract AF 49(638)-1441.

The effects of variation in the stimulus and response uncertainty of a decision task on the decision maker's subjective uncertainty, amount of information search, and information processing were examined. Results indicated that: (a) information search tended to continue until one bit of stimulus and/or response uncertainty remained, independent of the level of initial uncertainty; (b) the higher the stimulus uncertainty of the decision task, the faster the subject began seeking information; and (c) subjective uncertainty increased with both stimulus and response uncertainty. Unfortunately, the data precluded adequate examination of the possible relationship between subjective uncertainty and search behavior, but the latency of search was negatively correlated with the magnitude of subjective uncertainty across subjects, suggesting that a more extensive examination of the motivational effects of subjective uncertainty would be of value.

A66-80355
JUDGMENTS OF SAMENESS AND DIFFERENCE: EXPERIMENTS ON DECISION TIME.
Dalbir Bindra, Judith A. Williams, and Jack S. Wise (McGill U., Dept. of Psychol., Montreal, Canada).
Science, vol. 150, Dec. 17, 1965, p. 1625–1627. 5 refs.
Grant Defence Res. Board of Canada 9425-10.

When asked to judge whether two stimuli (tones) were the "same" or "different," subjects took longer to decide that two identical stimuli were the same than to decide that two dissimilar stimuli were different. Thus these judgments are not equivalent obverse aspects of a unitary judgmental process. While decision theory can be extended to deal with the obtained data, a model based on an analogy with a statistical computer is more directly applicable.

A66-80636
A STUDY OF HUMAN CONTROL IN A STOCHASTIC MULTISTAGE DECISION TASK.
Amnon Rapoport (N. C. U., Chapel Hill).
Behavioral Science, vol. 11, Jan. 1966, p. 18–32. 11 refs.
Grants NIH M-4238-05 and AFOSR-85-63.

Models of decision making can be grouped into two general classes: static and dynamic decision making. The first consists of those tasks where a single decision is made, the subject is told of the results of his decision, and no further application is made. In dynamic decision making, subsequent decisions depend in part on past experience in the task and thus learning is involved in the act. The latter sort of decisions can be further broken down into two types: those that do not affect the environment in which the decision maker is behaving, and those involving the future environment. A decision maker who can actively manipulate the environment by his decisions is conceived of as a controller. This article considers a dynamic programming model for this type of decision-making task.

A66-80788
TASK CHARACTERISTICS IN SEQUENTIAL DECISION BEHAVIOR.
William C. Howell (Ohio State U., Columbus).
Journal of Experimental Psychology, vol. 71, Jan. 1966, p. 124–131. 12 refs.
Contract AF 33(657)-11718.

Optional stopping behavior was studied for a task in which multiple perceptual discriminations were required and payoff declined with sequential information gathering. Thirty-six experienced subjects served under four levels of difficulty (defined psychophysically) for riskless and risky problems; they were assigned randomly to four groups for investigation of monetary vs. nonmonetary incentives and two modes of varying difficulty. Findings indicate that decisions approximate maximum expected values (EVs) over a wide range of task situations but are most efficient for intermediate levels of difficulty and riskless conditions. Contrary to earlier reports, neither the kind of incentive nor the difficulty mode appears to have an appreciable effect on performance. It is suggested that subtle aspects of EV functions may have an important bearing upon optional stopping behavior.

N66-28662# Aircraft Armaments, Inc., Cockeysville, Md.
A STUDY OF TACTICAL DECISION MAKING BEHAVIOR
Final Report, Nov. 1964–Nov. 1965
Robert G. Kinkade, Jerry S. Kidd, and Maurice P. Ranc Bedford, Mass., AFSC, Electron. Systems Div., Nov. 1965 85 p refs
(Contract AF 19(628)-4792)
(ESD-TR-66-61; AD-478769)

A study program was conducted to investigate tactical decision making behavior. One aspect of the program involved defining a conceptual view of tactical decision making behavior. The other aspect of the program consisted of performing five experiments related to the conceptual view. A conceptual view is not uniquely different from existing views. It represents a combination of concepts which have been described by other people. The view provides a framework for categorizing research findings and investigating the operations of a command post. The experiments concerned investigating the effect of feedback factors, situation factors and task factors on tactical decision making performance. An artificial task, placed in an Air Defense context, was used as a research vehicle in these experiments. The results of the experiments have implications for training tactical decision makers and for designing command-control systems. Author (TAB)

N66-31444# Kansas State Univ., Manhattan. Dept. of Psychology.
THE EVOLUTION OF PERCEPTUAL FRAMES OF REFERENCE
William Bevan et al May 1966 66 p refs
(Contract Nonr-3634(01))
(TR-37; TR-38; TR-39; TR-40; AD-632854) CFSTI: HC $3.00/MF $0.75

Contents: Serial Reaction Time and the Temporal Pattern of Prior Signals; Color Coding and the Potency of Anchors and Residuals in the Judgments of Size; A Quantitative Study of Relevance in the Formation of Adaptation Levels; Some Problems in Motivation from the Point of View of the Theory of Adaptation Level. TAB

N66-33640# Research Analysis Corp., McLean, Va.
EVALUATION OF MULTIPLE-CRITERIA ALTERNATIVES USING ADDITIVE UTILITY MEASURES
Peter C. Fishburn Mar. 1966 35 p refs
(Contract DA-44-188-ARO-1)
(RAC-TP-200; AD-633595) CFSTI: HC $2.00/MF $0.50

This paper explains two theories behind additive methods of using human value judgments in the evaluation of multifactor alternatives and describes how these methods may be used. The alternatives to be evaluated in such situations may be, for example, people, performances, plans, policies, products, or systems. The two additivity theories presented come from utility theory, which is concerned with people's preferences. One of these theories is nonprobabilistic; the other uses probabilities. Among the methods discussed for obtaining an evaluator's utility functions for the criteria in a multifactor or multiple-criteria situation are a number of indifference-judgment methods, a method that uses probabilities (the gambles method), and a class of direct numerical-assignment methods. Author (TAB)

N66-34358# Joint Publications Research Service, Washington, D. C.
GENERALIZED PREDICATES AND DECISION MAKING
B. M. Fitingof *In its* 22nd All-Union Sci. Session Devoted to Radio Day: Cybernetics Sect. 1 Aug. 1966 p 24–27 (See N66-34353 20-10) CFSTI: $3.00

The problem of decision making is considered in a general intermediate case for arbitrary probability predicates on the states of nature which may be obtained from practical experience. It is shown that such predicates are represented by convex polyhedrons of arbitrary form, and that probability predicates which usually occur in known mathematical theories are reduced to a narrow class representing only a specific type of simplexes. The report also shows that the results of the effects of disjunction and conjunction distributions correspond to the formation of combinations, hulls, or intersections of polyhedrons representing the original predicates. A.G.O.

...[illegible]* George Washington Univ., Washington, D. C.
...[illegible] Research Office.
ATTENTATIVE ORGANIZATIONAL SCHEMA FOR DECISION-MAKING PROBLEMS
William C. Osborn and Barbara Ettinger Goodman Jul. 1966 2[illegible] refs *Its* Exploratory Study 12
(Contract DA-44-188-ARO-2)
(GWU-ARO-TR-66-14; AD-638724) CFSTI: HC $2.00/MF $0.50

To take into account the psychological complexity of most real-life decision problems, and to develop a tentative organization of decision behavior that will embrace the many, highly diverse types of problems which are presumed to result in 'decision,' an attempt was made to delineate the component response processes that lead to these decisions. The procedure followed was (a) to identify and descriptively define the relevant stimulus and organismic factors, and (b) especially to schematize the response dimensions involved, in such a way as to derive a tentative response matrix. The result is an organizational schema for use in analyzing the response aspects of the decision-making process in terms of the pertinent psychological dimensions of decision behavior. Author (TAB)

N67-15874*# Battelle Memorial Inst., Columbus, Ohio.
HUMAN DECISION-MAKING IN MANUAL CONTROL SYSTEMS
R. E. Thomas and J. T. Tou *In* NASA. Washington Manual Control 1966 p 325 334 refs (See N67-15850 06-05) GPO: HC $2.50; CFSTI: MF $0.65

A model is proposed to describe human decision making in manual control systems. The human operator in the control loop is represented by a model which will generate an output consisting of (1) operational control actions as a result of sequential decision-making and (2) verbal statements or heuristics of how to achieve optimal control. The operational control actions are generated by a search algorithm, and the verbal statements are determined through detection of invariance of variables associated with minimum incremental cost. At high levels of generality and verbal prescriptions for obtaining optimal control are called heuristics. By using heuristics adaptive features can be introduced into the search algorithm. The proposed model will carry out sequential evaluation of the validity of the heuristics which are derived on the basis of past experience. By associating a Bayesian probability with the derived heuristic, this model simulates the evolution of a heuristic to a high subjective probability of being valid, even though the controller may have difficulty in executing the heuristic as shown by control actions which do not optimize the criterion function. An experiment is suggested for testing the validity of the proposed model. Author

N67-18416* Battelle Memorial Inst., Columbus, Ohio.
DEVELOPMENT OF A MATHEMATICAL MODEL OF THE HUMAN OPERATOR'S DECISION-MAKING FUNCTIONS Final Report
J. T. Tou, R. E. Thomas, and R. J. Cress 31 Oct. 1966 233 p refs
(Contract NAS12-37)
(NASA-CR-80009) CFSTI: HC $3.00 CSCL 05H

Attempts are made to formulate a mathematical model describing the human operator's decision-making functions in a control system. The model simulates the evolution of control strategies selected by a human operator and the prediction of verbal heuristics used by such an operator. The proposed model consists of four modes of control: heuristic, gradient, terminal, and probing modes. The operator is assumed to be engaged in the on-line control of a dynamic system described by an ordinary linear differential equation subject to initial and final boundary conditions. The task consists of moving the system from the initial state to the terminal state and minimizing a quadratic performance criterion using information concerning state variables and cost variables which is obtained from meter readings available at discrete time during the control operation. The approach used was to allow 14 subjects to solve 23 first-order control problems (Mark I model) and allow 14 additional subjects to solve 12 second-order control problems (Mark II model). Results from the computer simulation and those from tests of subjects are analyzed. S.P.

N67-24972# Stanford Univ., Calif. Systems Theory Lab.
SEQUENTIAL DECISION FEEDBACK USING ORTHOGONAL SIGNALING
Anthony J. Kramer Aug. 1966 28 p refs
(Contract Nonr-225(83))
(SEL-66-076; TR-7050-10; AD-647044) CFSTI: HC $3.00/MF $0.65

Viterbi previously considered the effect of sequential decision feedback on communication over an additive white gaussian noise channel. In particular, he analyzed a suboptimum transmission scheme using M orthogonal signals and obtained an upper bound on the error probability. The present presentation proposes a different suboptimum system for the same problem and obtains an exact expression for the error probability. The error probability for the suboptimum scheme is always less than that for Viterbi's scheme and in fact shows significant improvement for rates near channel capacity. Author (TAB)

N67-25851# Institute for Perception RVO-TNO, Soesterberg (Netherlands).
DECISION MAKING DURING PACED ARRIVAL OF PROBABILISTIC INFORMATION
A. F. Sanders and W. ter Linden [1966] 14 p refs
(IZF-1966-17; TDCK-47115) CFSTI: HC $3.00/MF $0.65

Four exploratory experiments are described in which the basic assumptions for decision making in probabilistic sequential tasks are tested. The assumptions are: (1) continuing revision of the likelihoodratio on the basis of incoming data, and (2) a fixed decision criterion on the basis of costs and payoffs. The results suggest that the decision criterion shifts from rather strict to quite risky as clear evidence is postponed, so that the criterion is certainly not fixed. The findings were not contrary to the idea of revision of the likelihoodratio. Author

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N67-25955*# Massachusetts Inst. of Tech., Cambridge. Instrumentation Lab.
SENSORY, DECISION AND CONTROL SYSTEMS, 1 OCT. 1965–15 JUL 1966
Louis L. Sutro Nov. 1966 50 p
(Contracts NSR-22-009-138; AF 04(695)-917)
(NASA-CR-83392; R-548) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Two system concepts were developed for the transmission of video data from a remote location to Earth. In the simpler system, a stereoscopic outline together with other data such as reflectance and possibly the texture of objects will be transmitted to Earth. From the stereoscopic outlines the operator will decide what objects he would like pictured in full TV frames and order these transmitted. In the more elaborate system, TV cameras will be carried on a vehicle and the direction in which the vehicle moves will be chosen by an onboard decision computer. Photosensors for this robot are television cameras, the first models of which have been tested under computer control. A model of both the perceptual computer and the decision computer has been simulated. It consists of 12 modules which guess as to what the response to incoming data should be. Each takes the data from all other modules and combines it in a nonlinear fashion with the data coming directly into it to arrive at a mixed guess as to what act should be performed. When 60% of the modules vote 0.5 probability for one act, that act is performed. The model of the frog's retina previously reported is extended to the tectum, where the frog begins to respond to objects detected by the retina. Author

A66-81089
CONTEXT EFFECTS IN PROBABILITY LEARNING AND DECISION-MAKING.
Lowell M. Schipper (Pa. State U., University Park).
Psychological Reports, vol. 18, Feb. 1966, p. 131–138. 5 refs.
Pa. State U. and Boeing Co. of Seattle, Wash. supported research.

Separate groups of subjects were trained in multiple probability-learning situations where sets of probabilities were (a) .10, .20, .30, .40, .50, (b) .50, .60, .70, .80, .90, and (c) .10, .30, .50, .70, .90, respectively. Subsequent to the training session subjects received test trials on all combinations of the five probabilities. Differential training with equal probabilities in different contexts gave different learning curves. Subjects' uses of these probabilities in the test situations also varied as a function of prior training.

A66-81357
STIMULUS VERSUS RESPONSE DECISIONS AS DETERMINANTS OF THE RELATIVE FREQUENCY EFFECT IN DISJUNCTIVE REACTION-TIME PERFORMANCE.
P. John Dillon (McGill U., Montreal, Canada).
Journal of Experimental Psychology, vol. 71, Mar. 1966, p. 321–330. 12 refs.
Grant Defence Res. Board, Canada 9425-10.

In a typical disjunctive reaction-time (DRT) task, one cannot separate the relative contributions of stimulus and response events to decisions underlying performance. In the present study, use of a conditional DRT technique permitted independent variation of stimulus and response frequencies. The effects of these variations on response latency and galvanic skin response (GSR) were studied in 4 experiments, on a total of 96 subjects. An inverse relation between RT (and GSR) and frequency of the response alternatives, but not of the corresponding stimulus alternatives, was demonstrated. It is suggested that models of DRT performance should stress response-selection rather than stimulus-identification factors in decision processing.

A66-81495
DECISION QUALITY AS A MEASURE OF VISUAL DISPLAY EFFECTIVENESS.
Carl A. Silver, James M. Jones, and Daniel Landis (Franklin Inst. Res. Labs., Philadelphia, Pa.).
Journal of Applied Psychology, vol. 50, Apr. 1966, p. 109–113. 8 refs.
Contract AF 30(602)-3302.

A new gaming technique was employed in an attempt to evaluate more accurately the effectiveness of visual displays. Eighteen male university students acted as traffic managers for a hypothetical trucking concern. Trucking information was presented in map-plus-overlay displays and the subjects manipulated trucks, drivers, and loads within the framework of the economic rules governing the trucking operation. A computer program was written which determined the profit in dollars of each subject's performance. Three independent variables (a) use of color, (b) fact density, and (c) compression (ratio of symbols to facts) were used in this repeated measures design. The analysis of variance indicated that profit was a positive function of increasing fact density ($p < .001$), and that there was a significant interaction between fact density and color ($p < .001$), and fact density and compression ($p < .05$). The usefulness of this technique in differentiating among structurally different visual displays is discussed.

A66-81493
USE AND EVALUATION OF DISCRETE TEST INFORMATION IN DECISION MAKING.
Richard B. Darlington and Glenn F. Stauffer (Cornell U., Ithaca, N.Y.).
Journal of Applied Psychology, vol. 50, Apr. 1966, p. 125–129. 5 refs.

Elementary decision theory is applied to the problems of evaluating discrete tests or test items used to classify people into several categories, and choosing which of several treatments is best for persons falling within each response category. The technique explicitly considers the base rates of the various criterion groups and the relative seriousness of different types of errors of classification, as well as the proportion of each criterion group falling in each response category.

A66-81513
OPTIMALITY OF PERCEPTUAL DECISION CRITERIA.
Z. Joseph Uhlaha (Colo. U., Boulder and Denver).
Journal of Experimental Psychology, vol. 71, Apr. 1966, p. 564–569. 7 refs. Natl. Inst. of Mental Health supported research.

Statements of signal detectability theory have implied that subjects place their decision cutoffs in such a fashion as to maximize the expected value (EV) of their decisions. Using a 2-choice discrimination task involving judgment of the tilt of lines, the decision cutoffs of naive subjects were evaluated in different situations requiring different cutoffs for the maximization of EV. Although subjects' cutoff placement was influenced by the relevant factors, i.e., by the relative payoff yielded by the alternative decisions and by the relative probability of the stimulus alternatives, the influence was not sufficiently strong to maximize EV.

A66-81656
PERSONALITY VARIABLES IN PROBABILITY-LEARNING, DECISION-MAKING, AND RISK-TAKING.
J. Ronald Gentile and Lowell M. Schipper (Pa. State U., University Park).
Perceptual and Motor Skills, vol. 22, Apr. 1966, p. 583–591. 8 refs.
Grant PHS 1:F1 MH-21,734-01.

College students were preselected on the personality variables need Achievement (nAch) and manifest anxiety (Anx) to form a 3 by 3 factorial arrangement and to relate these measures to probability-learning decision-making, and risk-taking behaviors. After receiving 90 training trials on each of three green lights which had probabilities of 1/6, 1/2 and 5/6 of being followed by a red event light (probability-learning), subjects were asked to make decisions about the predictive reliabilities of these lights when they occurred in combinations or singly, while the red light was covered (decision-making). Subjects were then given a zero expected value gambling game and a double-or-nothing final bet. Neither personality variable showed a consistent relationship to probability-learning, decision-making, or risk-taking behavior according to various criteria.

A66-81785
ABSOLUTE JUDGMENT OF DISTANCE AS A FUNCTION OF INDUCED MUSCLE TENSION, EXPOSURE TIME, AND FEEDBACK.
N. McK. Agnew, Sandra Pyke, and Z. W. Pylyshyn (Saskatchewan U., Canada).
Journal of Experimental Psychology, vol. 71, May 1966, p. 649–654. 17 refs.
Grant NIMH MY-3612 and Can. Natl. Res. Council supported research.

With knowledge of results as a between-group variable, and with two levels of induced muscle tension and two levels of exposure time as within-group variables, 36 subjects were tested for accuracy and response bias in an absolute judgment of distance task. Both knowledge of results and long exposure time significantly facilitated accuracy of judgments and reduced response bias. Induced muscle tension significantly facilitated accuracy of judgments, and interacted with knowledge of results yielding greatest facilitation under the no-feedback condition.

A66-81791
INFLUENCE OF LUMINANCE ON A TWO-CHOICE DECISION TASK.
James R. Nazzaro and João Claudio Todorov (Brasilia U., Brazil).
(Congr. of Psychol., Miami, Dec. 1964).
Journal of Experimental Psychology, vol. 71, May 1966, p. 886–889. 12 refs.

The influence of differing levels of luminance on probability of response was investigated. Sixty-three subjects were given 200 trials in a two-choice guessing task. The lights appeared according to a random schedule. Two groups were used, one receiving reinforcement in the proportions 70:30 and the other 50:50. Within each group three different luminance conditions were used: right light brighter than left, right light dimmer than left, and both lights equal. Greater luminance with the more frequent light produced greater response frequency than when both lights were equal. Lower luminance with the more frequent light produced lower response frequency. When both lights appeared equally often, luminance had no effect on response frequency. The data were interpreted in terms of magnitude of reinforcement, and in the increased formation of response sets.

A66-81793
INFORMATION ENCODING AND DECISION TIME AS VARIABLES IN HUMAN CHOICE BEHAVIOR.
Louis M. Herman (Queens Coll., New York, N. Y.) and Harry P. Bahrick (Ohio Wesleyan U., Delaware).
Journal of Experimental Psychology, vol. 71, May 1966, p. 718–724. 10 refs.

Paired-comparison wagers were offered to subjects under two different methods of encoding decision-parameter information. Method 1 provided subject with a set of four elements of nonindependent parameter information. Method 2 with a subset comprised of two independent elements. Subjects' choices showed significantly closer correspondence to an expected value-maximization decision rule under Method 2, for both independent groups and repeated-measures designs. With repeated measures, given sufficient decision time, Method 2 transferred positively to Method 1, with the opposite true (negative transfer) when order of administration was reversed. It is concluded that the basic problem for subject in choice situations is the selection of decision rules rather than of decision alternatives. Decision rules may then by asymmetrically transferrable across different encoding methods.

A66-81915
A SYSTEMS ANALYSIS OF THE DECISION-MAKING PROCESS: PSYCHIATRY'S "BASIC SCIENCE".
Charles E. Goshen (W. Va. U., School of Med., Morgantown).
American Journal of Psychotherapy, vol. 20, Apr. 1966, p. 235–251.

The human decision-making process is portrayed in this report as the fundamental "basic science" of psychiatry, and it has been subjected to a systems analysis. Variations of the ordinary, rational thinking processes are further analyzed as examples of complex systems, and variants of the rational process. The results of this study are graphically portrayed as flow diagrams. It is proposed that the systems analysis presented lends itself to an orderly and remarkably simple way of understanding, teaching, and communicating ideas about human behavior in general and psychiatric problems in particular. Although it was not the intention of the study, the process of ordering the knowledge of human thinking in this way has the effect of contradicting many of the concepts ordinarily taught in psychiatry and psychology. There is no necessity, for instance to postulate an "unconscious" as is necessary in certain theories of human behavior, except that unconsciousness concerning certain ideation in a patient might well be a property of the observer concerning the patient. Another common concept in conflict with the material presented sees uncomfortable emotional states solely as the motive for thought or action and not as the result of thought. The understanding of phobias is a rather simple process as presented in this report, far different from the complicated theories often used to explain them.

A66-82020
INFLUENCE OF ALCOHOL ON TIME JUDGMENT [O VLIIANII ALKOGOLIA NA OTSCHET VREMENI].
D. G. El'kin and T. M. Kozina (I. I. Mechnikov Odessa U., UkrSSR).
Voprosy Psikhologii, no. 2, Mar.–Apr. 1966, p. 147–152. 9 refs. In Russian.

The effect of alcohol on time judgment was studied in one subject. After ingestion of 100.00 cc. of 96% alcohol, there was a tendency to overestimate the time interval. This effect, which can be due to changes in the nervous system, consisted of two stages, excitation and suppression. The number and type of errors depended on the stage of intoxication. In another experiment with four subjects, the effects of 150 cc. of 40% alcohol on the auditory discrimination threshold were studied. In all subjects the threshold was increased shortly after the alcohol intake, but it was slightly decreased an hour after the beginning of the experiment.

A66-82236
THE EFFECTS OF AMOUNT OF INFORMATION PROVIDED AND FEEDBACK OF RESULTS ON DECISION MAKING FREQUENCY.
Charles H. Hammer (U.S. Inform. Agency, Washington, D. C.) and Seymour Riegel, (U.S. Army Personnel Res. Office, Washington, D. C.).
Human Factors, vol. 7, Dec. 1965, p. 513–519.

Sixty subjects worked a series of sequential decision making tasks in which the amount of information provided and feedback of results were the independent variables. Data were collected on decision accuracy, confidence in decision accuracy and judged sufficiency of the information provided. Accuracy, confidence in accuracy, and ratings of sufficiency increased as amount of information provided was increased. Feedback produced increases in decision accuracy only. For 40% of all correct responses, subjects judged the information provided to be insufficient as a basis for taking action. These data strongly suggest that lack of confidence in their ability to make accurate decisions may cause some decision makers to delay taking action even when they are able to make an accurate decision on the basis of the information available.

A66-82279
A STUDY OF A MULTISTAGE DECISION MAKING TASK WITH AN UNKNOWN DURATION.
Amnon Rapoport (N. C. U., Chapel Hill).
Human Factors, vol. 8, Feb. 1966, p. 54–61. 13 refs.

Thirteen college students participated individually in a multistage decision making task. The task consisted of eight different computer-controlled problems. The duration of each problem was not known to the decision maker. A dynamic programming model employing Bayesian notions was constructed for the adaptive decision making task, tested, and confirmed. An alternative explanation is discussed briefly.

A67-80401
FAST GUESSES IN CHOICE REACTION TIME.
Robert Gilmour (Pa. U., Philadelphia).
Psychonomic Science, vol. 6, Oct. 5, 1966, p. 155–156.
Grant NSF GB-1462.

A model which describes the effect fast guesses must have on observable choice latencies and probabilities is developed, strengthened, and tested with encouraging results. With the model, it is possible to estimate "true" decision times and probabilities without requiring error-free performance in discrimination reaction time.

A67-80560
SOME DETERMINANTS OF INDIVIDUAL DIFFERENCES IN PREDECISION INFORMATION-PROCESSING BEHAVIOR.
Joan E. Sieber (Stanford U., Calif.) and John T. Lanzetta (Dartmouth Coll., Hanover, N. H.).
Journal of Personality and Social Psychology, vol. 4, Nov. 1966, p. 561–571. 22 refs.
Contracts NONR 3397(07) and AF 49(638)-1614.

Individual differences in information processing before decision making were shown to be related to differences in the complexity of decision makers' conceptual structure. Two sets of process variables were postulated to underlie these individual differences: differences in the number and the distribution of response strengths of the decision alternatives (hence differences in response uncertainty), and differences in tendency to differentiate and encode information inherent in a decision problem and to produce controlled associations to this information. The relationship between these variables and style of decision making was examined in two ways: (a) Groups of individuals categorized on the basis of test scores as structurally complex or simple were compared with respect to the following measures-degree of subjective uncertainty experienced when making decisions, and degree of differentiation and encoding of aspects of decision problems and production of controlled associates to these differentiated categories; (b) groups of individuals categorized as structurally simple or complex were given two different training procedures, and their posttraining behavior on decision problems was compared with a control (no training) group and with each other. The training procedures were designed to increase subjective response uncertainty, and stimulus differentiation, encoding, and production of controlled associates, respectively, to this differentiated material. It was assumed that these training procedures would modify some of the initial differences in conceptual structure and thus change predecision behavior. The findings were generally in accord with the predictions advanced, but consistently favored the differentiation, encoding, and controlled associations processes as the variables along which decision makers vary most markedly.

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FATIGUE, WORK DECREMENT, AND ENDURANCE OF WOMEN IN A SIMPLE REPETITIVE TASK.

William R. Pierson and Aileene Lockhart (Lockheed Aircraft Corp., Lockheed-California Co., Burbank; Southern California, University, Dept. of Physical Education, Los Angeles, Calif.).

Aerospace Medicine, vol. 35, Aug. 1964, p. 724, 725. 11 refs.
Research supported by the University of Southern California.

Investigation of the relationships between fatigue, work decrement, and isotonic endurance for women performing a simple stimulus-response task. Fifteen women of mean age 19.5 years were tested. Each subject was instructed to release a microswitch and extend her hand through a photoelectric beam upon presentation of a visual stimulus. The reaction time (RT) from the onset of the stimulus to the release of the switch, and the movement time (MT) from the release of the switch to the interruption of the beam were recorded, as were the isotonic endurance limits beyond which the subjects could not continue. The results are compared with those for men under similar conditions. It is found that the RT is greater and the MT smaller for men. In addition, men have a greater endurance.

A64-23099

ON THE USE OF ADENOSINETRIPHOSPHORIC ACID AND COCARBOXYLASE IN THE TREATMENT OF PILOTS AFFLICTED WITH MILD OR INITIAL FLYING FATIGUE [SULL' IMPIEGO DELL' ACIDO ADENOSINTRIFOSFORICO E DELLA COCARBOSSILASI IN PILOTI AFFETTI DA LIEVE O INIZIALE FATICA DI VOLO].

G. Rotondo (Padova, Università, Istituto di Medicina Legale e delle Assicurazioni, Padua; Primera Regione Aerea, Direzione di Sanità, Milan, Italy).

Rivista di Medicina Aeronautica e Spaziale, vol. 27, Apr.-June 1964, p. 176-192. 19 refs. In Italian.

Investigation of the effectiveness of the combined treatment of flying fatigue by means of cocarboxylase and adenosinetriphosphoric acid, administered orally to 20 jet pilots, with mild or initial forms of this syndrome. It is stated that the results, consisting in the appreciable improvement in the symptoms and operational efficiency, in nearly all subjects, point to the necessity for further and wider testing. This treatment could be useful, from a medico-legal standpoint, in preventing flying accidents and prolonged disability, by bringing about the prompt recovery of the stricken personnel. It is suggested that the prompt and complete treatment of these mild and initial forms is necessary to avoid more severe and less recoverable forms. A survey is provided of the physiological and pharmacological mechanisms of the above-mentioned drugs in the satisfactory treatment of operational fatigue, particularly on the basis of modern etiopathogenetic vies on this syndrome.

A64-80383

FATIGUE, WORK DECREMENT, AND ENDURANCE OF WOMEN IN A SIMPLE REPETITIVE TASK.

William R. Pierson and Aileene Lockhart (Lockheed-Calif. Co., Spacecraft Organ., Burbank; and Southern Calif. U., Dept. of Physical Education, Los Angeles).

Aerospace Medicine, vol. 35, Aug. 1964, p. 724-725. 11 refs.
Southern Calif. U.-supported research.

Fifteen college women were measured for reaction time and speed of arm movement in a simple repetitive stimulus-response task under normal, fatigued, decrement, and endurance conditions. For the population represented by the sample it may be concluded that fatigue (as a subjective expression of performance) is an important correlate of speed and isotonic endurance. Comparisons of the data were made with those obtained for men on the same apparatus and under similar conditions. From these comparisons the following conclusions appear justified: (1) men are faster than women in speed of arm movement but not in reaction time to a visual stimulus and (2) men can perform a simple repetitive task for a longer period of time than women but there is no difference in their subjective opinion as to when their performances are becoming slower.

A64-80930

ON PHYSIOLOGICAL AND PATHOGENIC ASPECTS OF FATIGUE [O FIZJOLOGICZNYCH I PATOGENICZNYCH ASPEKTACH ZMECZENIA].

Wl. Missiuro (Inst. Naukowy Kultury Fizycznej, Warszawa, Poland).

Wychowanie fizyczne i sport, vol. 8, 1964, p. 75-89. In Polish.

Three basic types of fatigue are identified: (1) acute, (2) subacute, and (3) chronic. They produce different effects in different individuals. Fatigue may result from physiological exhaustion or psychogenic causes. The effect of the former may be superimposed by emotional stress. The importance of adequate rest accomplished in various ways as the final solution of the problem is stressed.

N64-12506 Joint Publications Research Service, Washington, D.C.

DECREASE IN THE VISUAL FACULTY UNDER CERTAIN CONDITIONS OF FATIGUE

M. P. Shek *In its* Transl. from Vopr. Psikhologii [Moscow] no. 1, 1963 10 Jun. 1963 p 17-20 (See N64-12504 04-16) OTS: $0.75

The effect of auditory fatigue on the visual capability of human subjects was determined, using correction charts consisting of rings with breaks in their circumference. Preliminary studies indicated that general fatigue, induced by comparatively light laboratory work, leads to an increase in auditory and visual capabilities toward the end of a working day as compared to morning data. Isolated fatigue of the auditory and, especially, the visual faculty against a background of ordinary laboratory work, however, was accompanied by a marked decrease in visual perception at the end of a working day. A loss of sensory capability was also noted in subjects placed for a long time in an area having reduced air circulation. M.P.G.

N64-14409 Federal Aviation Agency, Oklahoma City, Okla. Civil Aeromedical Research Inst

THE MITIGATION OF PHYSICAL FATIGUE WITH "SPARTASE"

Francis J. Nagle, Bruno Balke, Richard V. Ganslen, and Audie W. Davis, Jr. Jul. 1963 12 p refs

(CARI-63-12)

Pharmacological and clinical observations have indicated that Spartase—the aspartic acid salts of potassium and magnesium—takes part in the intermediary metabolism and moderates physical fatigue. In this study, attempts were made to evaluate effects of the drug on work capacity before and after episodes of physically fatiguing exercises. Work capacity was determined by a standardized treadmill test. The test was repeated after the subject had been running cross-country for a period of 60 min, and again after another such period of 40 min. In this way, effects of fatigue upon functional adaptability to stress became apparent. Spartase was taken orally in a prescribed dose for 2 weeks, whereupon the same testing procedure was reapplied. The results indicated that Spartase improved the endurance performance of untrained individuals engaging in extremely fatiguing physical work. It appeared to have no effect on highly trained individuals. Author

N64-21288 Joint Publications Research Service, Washington, D.C.

STRESS AND FATIGUE UNDER CONDITIONS OF ISOLATION FROM EXTERNAL STIMULI

F.D. Gorbov, V. I. Myasnikov, and V. I. Yasdovskiy 5 Jun. 1964 12 p refs Transl. into ENGLISH from Zh. Vysshei Nervnoi Deyatel'nosti (Moscow), v. 13, no. 4, 1963 p 585-592 (JPRS-24961; OTS-64-31422) OTS: $0.50

Experiments were conducted in which a man was confined to a small, especially equipped chamber for 10 to 15 days. Various sequences of tests to determine causes and degree of stress and fatigue were administered. These investigations showed that extreme restriction of general afferentation exercises a substantial influence on the subjects. The neuropsychological functional shifts were dissimilar at different stages of the experiment. Complex recording of psychological and physiological indicators enables determination of qualitative peculiarities of these shifts and, in particular, determination and differentiation of states of stress and fatigue. Monotony of the environment, lack of external impressions, and solitude emerged as factors of independent significance as conditions and causes of development of stress and fatigue. This indicates not only the necessity but also the possibility of preventing these states, on the basis of rational stimulation for the optimal interaction of afferant systems. D.E.W.

A65-17837

AUDITORY FATIGUE - INFLUENCE OF MENTAL FACTORS.

Mary Jayne Capps and William E. Collins (Federal Aviation Agency, Aeromedical Service, Civil Aeromedical Research Institute, Oklahoma City, Okla.).

National Academy of Sciences, Proceedings, vol. 52, Nov. 1964, p. 1271-1276. 17 refs.

Grant No. NsG 479.

Experimental test of a biological protein synthesis model in which growth is inhibited and an incomplete peptide chain is liberated into the soluble phase by the attachment of amino acid-nucleotide fragments to the C-terminal end of the growing chain. Escherichia coli strain B was grown in peptone broth and sRNA was prepared from the cells by the method of Zubay. The sRNA preparation was incubated with an E. coli enzyme fraction, ATP, and amino acids under conditions optimal for the incorporation of the latter. It was found that T1-ribonuclease digests of the AA-sRNA brought about the release of incomplete chains in a manner analogous to the action of puromycin. The digests were presumed to contain oligonucleotide fragments, some of which terminated with -CCA carrying an amino acid esterified to the terminal adenosyl group. Evidence was found suggesting that amino acids were transferred from the aminoacyl-oligonucleotides to the released chains. W. M. R.

A65-23930
FATIGUE AND THE CONTROLLER.
John G. Wilson (Toronto Air Traffic Control Centre, Toronto, Canada).
The Controller, vol. 4, Jan. 1965, p. 14, 15.

Discussion of the effects of fatigue on the work of air traffic controllers. Causes of fatigue are identified as environmental, or related to the work itself, and personal, or related to internal stresses on the individual. When fatigue develops, motor responses suffer, careless attitudes are produced, actions tend to be based on habit rather than on the necessities of the situation, and all control factors may not be properly checked. It is considered that thorough training and competent supervision are the best methods of minimising the effects of fatigue.

F. R. L.

A65-80028
FATIGUE: VISUAL CONSIDERATIONS, (II).
R. H. Beck.
Pilot, vol. 20, Oct. 1964, p. 10–20. 35 refs.

The emergence into the jet age has intensified many old problems of flight fatigue, and has presented a host of new ones, many of which have yet to be solved satisfactorily. Visual problems inducing fatigue include glare, solar radiation, space myopia caused by loss of background reference at high altitudes, hypoxia or low oxygen intake, and insufficient cockpit lighting. It is strongly suspected that glaucoma may be prematurely induced by a reduction of atmospheric pressure. Among the factors that affect jet crew fatigue are: (a) extremes of temperature and humidity, (b) workloads, (c) increased responsibility, (d) intensified scrutiny of pilot personnel, (e) family and personal problems, and (f) apprehension. Fatigue produces a willingness to accept lower standards of accuracy and performance, which in turn create potentials of reduced safety.

A65-80341
THE INFLUENCE OF TASK COMPLEXITY AND PRACTICE ON PERFORMANCE AFTER LOSS OF SLEEP.
D. R. J. Gordon (Med. Res. Council, Appl. Psychol. Res. Unit, Cambridge, Great Britain).
Journal of Applied Psychology, vol. 48, Dec. 1964, p. 339–343. 9 refs.

An experiment was conducted to assess the effects of degrees of task complexity and practice on performance after loss of sleep. The subjects were automatically presented with cards containing 6 symbols every 7 secs. for 23 mins. A symbol had to be chosen on the basis of certain rules. Some cards required one rule, some two, some three, and some four. Group I was practiced after normal sleep and tested after 22 and 46 hours without sleep. Group II was tested without sleep and without previous practice. Group III was practiced and tested after normal sleep. Loss of sleep had a greater effect after practice, but no clear differences emerged between the different levels of task complexity.

A65-80906
PHYSICAL WORK CAPACITY OF MAN AND ITS DIMINUTION BY HEAT STRESS.
E. A. Muller (Max-Planck-Inst. for Arbeitsphysiol., Dortmund, Germany).
IN: ENVIRONMENTAL PHYSIOLOGY AND PSYCHOLOGY IN ARID CONDITIONS.
(Arid Zone Research. XXIV. Proceedings of the Lucknow Symposium, 1962). Symposium sponsored by Central Drug Research Institute, India, and UNESCO. Paris, France, UNESCO, 1964, p. 221–225.

Physical work capacity of man is discussed with regard to concepts of maximum work time, endurance limit, fatigue and recovery, maximal oxygen intake, and occupational work capacity. Up to 30 years of age there is a perfect 1:5 relationship between occupational work capacity and maximal work capacity. Both age and physical inactivity will lead to dissociation between occupational and maximal work capacity. Determination of the recovery pulse sum (i.e., the sum of all the pulse rates above rest frequency) is a direct way of measuring pulse debt incurred in a given amount of work. Experiments investigating the effect of different water temperatures on work endurance (maximum work time) showed that endurance increases as the water temperature decreases. Pulse rate and recovery pulse sum also increase under heat stress. The course of pulse rate may be used to assess heat stress taking into account the special pattern of work, endurance limit, and recovery from fatigue.

A65-81573
DRUG-INDUCED FATIGUE DECREMENT IN AIR TRAFFIC CONTROL.
L. R. C. Haward (Graylingwell Hosp., Chichester, Great Britain).
(Brit. Psychol. Soc., Conf., London, Dec. 1964).
Perceptual and Motor Skills, vol. 20, Jun 1965, Part 1, p. 952.

Investigation of a newly synthesized central stimulant (5-phenyl-2-imino-4-oxo-oxazolidin) in the context of the air traffic control procedure (ATC) indicated that: (1) vigilance in an ATC task became progressively impaired after 90 min., (2) a placebo had no significant effect upon this impairment, (3) the stimulant in 20 mg. doses significantly reduced this impairment, and was more effective at a higher level of impairment, (4) no side effects were noted at 20-mg. doses, and (5) doses above 20-mg. eventually exacerbated the condition.

N65-13711* National Aeronautics and Space Administration. Washington, D C
THE LATENT FORM OF MOTION SICKNESS
V. I. Kopanev *In its* Aviation and Space Med. Dec 1964 p 238-240 (See N65-13626 04-04) OTS: HC S7.63/MF S2.25

Experiments are reported in which subjects were placed in a darkened room for over 50 minutes. After stabilization of the excitability and lability indices of their visual analyzers was attained, various subjects were swayed at the rate of 16 to 17 per minute with an intensity of less than 0.15 g. Most subjects with the latent form of motion sickness exhibited a decrease in excitability and lability of the visual analyzer and slight changes in blood pressure and the cardiac rate. A definite relationship was detected between these changes and the degree of statokinetic tolerance.
D.E.W.

N65-13595* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
STUDY OF EFFECTS OF CARBOHYDRATES ON THE BODY UNDER STRESS AND FATIGUE
Donald R. Young *In* NASA, Washington Conf. on Nutr. in Space and Related Waste Probl. 1964 p 323-328 refs (See N65-13578 03-04) GPO: HC S2.75; OTS: MF S2.00

Evaluation of dietary effects on performance was obtained through experimentation with male, pure-bred beagle dogs, approximately 2 years of age and weighing 8 to 12 kg. The performance tests followed a common plan of exhaustive treadmill running at a speed of 3.6 mph, the grade varying between 9 and 13 degrees of incline. Maximum work capacity was expressed as energy expenditure measured in kilocalories. Also, a program was undertaken with human subjects to further test the hypothesis of glucose synthesis. Male subjects, varying in age from 22 to 40 years of age, were tested on the treadmill for periods of 24 hours or until the onset of exhaustion. The pace varied between 2.5 and 2.7 mph and the degree of incline varied between 0 and 2 degrees. Data from these tests are included.
E.E.B.

N65-29792# Federal Aviation Agency. Oklahoma City, Okla. Civil Aeromedical Research Inst.
FATIGUE IN AVIATION ACTIVITIES
Stanley R. Mohler Mar. 1965 17 p refs
(AM-65-13)

This report gives a comprehensive survey of work in the field of aviation fatigue. Both current work still in process and earlier work are surveyed. The nature of fatigue itself is discussed, along with all possible factors that contribute to both physical and mental fatigue. Topics covered include flight-time limitations, indicators of excessive fatigue, new developments related to intercontinental flight and Forest Service flights, and the author's detailed comments and recommendations.
Author

A66-16829
EFFECTS OF ADRENALIN OR INSULIN ON THE PERFORMANCE OF WORKING AND RESTING SUBJECTS.
Clayton R. Coler, William A. McLaurin, and Donald R. Young (NASA, Ames Research Center, Moffett Field, Calif.).
Aerospace Medicine, vol. 36, Dec. 1965, p. 1181-1186.

Experimental investigation of the performance and physiological effects of adrenalin or insulin in human subjects. After approximately 8 hr of enforced work or rest, one group of nine subjects received insulin, and another group of nine subjects received adrenalin. The subjects in each drug group participated in both a working condition and a resting condition on separate occasions. Short-term memory, choice reaction time, and steadiness tests were used to evaluate subject performance. Ten preinjection and seven postinjection sessions of performance testing were given. Postinjection performance decrements occurred in all three tests for all subjects, both working and resting, in the insulin group. Fewer decrements occurred in the adrenalin group. For the insulin group, postinjection decrements were most frequent in the working condition. However, for the adrenalin group, postinjection decrements were most frequent in the resting condition. M. M.

A66-32150 #
DEVELOPMENT OF A STANDARD PROLONGED WORK TEST FOR THE EVALUATION OF FATIGUE AND STRESS IN MAN.
J. Shapira, D. R. Young, B. Datnow, and R. Pelligra (NASA, Ames Research Center, Biotechnology Div., Moffett Field, Calif.).
IN: AEROSPACE MEDICAL ASSOCIATION, ANNUAL SCIENTIFIC MEETING, 37TH, LAS VEGAS, NEV., APRIL 18-21, 1966, PREPRINTS. [A66-32134 17-04]
Washington, D.C., Aerospace Medical Association, 1966, p. 50, 51.
Abridged.

Development of a standard work regime consisting of walking on a treadmill at an elevation and speed that requires about 33% of an individual's maximal work capacity and which can be endured without untoward effects for prolonged periods. It was found that such a regime could be well tolerated in human male subjects for up to 24 hr. Arrythmia is a contraindication to such a test, whereas depression of the ST segment of the ECG is not. Only after about 9 hr do blood values for glucose and free fatty acids attain equilibrium values. The reserve of carbohydrate in the body appears to be greater than previously suspected. Utilization of large amounts of reserve fat, as reflected by high serum values for free fatty acids and rapid turnover of injected radioactive palmitic acid, is not detrimental. Reduction of serum glucose to very low levels by the injection of insulin did not hinder the ability to continue work. F.R.L.

A66-36383
FATIGUE IN AVIATION ACTIVITIES.
Stanley R. Mohler (Federal Aviation Agency, Office of Aviation Medicine, Aeromedical Applications Div., Washington, D.C.).
Aerbspace Medicine, vol. 37, July 1966, p. 722-732. 105 refs.

This paper provides a survey of work in the field of aviation fatigue. Early work and studies now in progress are included. The nature of fatigue itself is discussed, along with possible factors that contribute to both physical and mental fatigue. Topics covered include flight-time limitations, indicators of excessive fatigue, new developments related to intercontinental flights and Forest Service flights. (Author)

A66-36932 #
HUMAN PERFORMANCE AS A FUNCTION OF CHANGES IN ACOUSTIC NOISE LEVELS.
Richard W. Shoenberger and Charles S. Harris (USAF, Systems Command, Aerospace Medical Div., Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio).
Journal of Engineering Psychology, vol. 4, no. 4, 1965, p. 108-119. 19 refs.
USAF-sponsored research.

Experimental examination of the effect of noise on the performance of people. The specific hypothesis examined was that the greater the magnitude of the change in intensity, the greater will be the decrement in performance produced. Sixteen male subjects performed a relatively simple task involving ordered sequences of numbers under four acoustic conditions: 85, 95, 110 db, and complete quiet. Test conditions are detailed, instruments and procedures are described, and white noise bands specified. It is concluded that the results indicate a partial support for the original hypothesis and are of theoretical importance with regard to the influence of prevailing stimulation levels on the reticular activating system. However, in spite of the noted decrement in performance with increasing noise intensity, the difference observed between the worst and best performance is very small, and thus, the practical importance of this particular phenomenon may not be very great. M. L.

A66-37108
THE EFFECT OF THE SQUARE ROOT OF TIME ON CONTINUING PERCEPTUAL TASKS.
M. M. Taylor (Defence Research Board, Defence Research Medical Laboratories, Toronto, Canada).
(AGARD, Symposium on Natural and Artificial Logic Processors, Athens, Greece, July 19[illegible], Paper.)
Perception and Psychophysics, vol. 1, 1966, p. 113-119. 20 refs.

Documentation of several types of change in the human perception of a stimulus pattern that itself does not change over time. It is observed that in spite of the fact that the pattern, or some aspect of it, does not change, the perception of the pattern by an observer does change - linearly with the square root of the observing time. Examples considered are drawn from studies of figural after-effects, motion after-effects, vigilance, motion neutralization, visibility of the stabilized retinal image, effects of contours on visibility, and fluctuations in the perceptual organization of ambiguous figures. It is not at all clear why the perceptual efficiency of the human organism should decrease linearly with the square root of time, although it makes adaptive sense. The consistency of the decline over so varied a range of perceptual tasks suggests that it is a fairly general property of natural information processing devices, at least in so adaptable a machine as the human. M. L.

A66-38481 #
HUMAN ENGINEERING AND ACOUSTICAL FATIGUE.
Gilbert C. Tolhurst (U.S. Navy, Office of Naval Research, Washington, D.C.).
American Society of Mechanical Engineers, Design Engineering Conference and Show, Chicago, Ill., May 9-12, 1966, Paper 66-MD-25. 10 p. 23 refs.
Members, $0.75; nonmembers, $1.50.

Study of a few of the many ways acoustic fatigue can be made less stressful. For purposes of discussion, system parameters and methods of alleviating fatigue are dichotomized into physiological and psychological factors. It would be preferable if all approaches to acoustic stress problem solutions could be resolved by a psychophysiological integral. The theories and techniques so derived would then only need to be applied by the human engineer. The human engineer must become aware of and know how to utilize the acoustic signal and to manipulate the environmental noise background in order to (1) enhance message transmission and reception, (2) maintain the man-machine system at an expedient level of performance, and (3) protect from overload and/or trauma. M. F.

A66-80[illegible]
SPECIFICITY OF INDIVIDUAL DIFFERENCES IN ARM MOVEMENT FATIGUE WITHIN TWO LEVELS OF WORK LOAD.
Richard B. Alderman (Calif., U., Berkeley).
Research Quarterly, vol. 36, Oct. 1965, p. 227-232. 5 refs.

Fifty subjects were given fatiguing tests at two work loads on a horizontal arm-crank friction ergometer. The initial speed was 120 r.p.m.; the test continued for 10 min. Both fatigue curves were S-shaped—the rate of work dropped off slowly at first, then went through a rapid drop-off phase followed by a slow drop-off phase that approached an asymptotic steady state. The mathematical form was a two-component exponential equation which fitted the observed data very closely. Using a 2-kg. work load, there was 22 percent decrement at the end of the test. Using a 3.45 kg. work load (1 week later) the decrement was 48 percent. Test-retest reliability of individual differences in drop-off was moderately high (r = .86 and .85 for the two work loads). However, the correlation between drop-offs for the two work loads was only r = .61 and even after correction for attenuation was only .71. Thus only 50 percent of the individual difference variance in fatigability was common to the two work loads, while 50 percent was specific to a particular work load.

A66-80811
FATIGUE: MECHANISM AND MANAGEMENT.
S. Howard Bartley (Mich. State U., East Lansing).
Springfield, Ill, Charles C. Thomas, 1965, xv+ 96 p. 63 refs.
$5.00.

Physiological and psychological aspects of fatigue are examined in terms of typically fatigue-producing situations (pacing, prolonged or demanding activity, remoteness of goals, etc.); clinical syndromes (hypothyroidism, hypochondria, neurasthenia, diabetes, etc.); physical, physiological, homeostatic, and sensory-cognitive organism-environment relationships as mechanisms underlying fatigue; role of body chemistry in fatigue and inadequacy; pharmaceutical agents used to relieve fatigue (analgesics, caffeine, central nervous system stimulants, anabolic energizers, vitamins, minerals, etc.); and methods of long-term fatigue management.

N66-13397# Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.

FATIGUE IN AVIATION ACTIVITIES

Stanley R. Mohler Mar. 1965 19 p refs

(AM-65-13; AD-620022) CFSTI: HC $1.00/MF $0.50

The report gives a comprehensive survey of work in the field of aviation fatigue. Both current work still in process and earlier work are surveyed. The nature of fatigue itself is discussed, along with all possible factors that contribute to both physical and mental fatigue. Topics covered include flight-time limitations, indicators of excessive fatigue, new developments related to intercontinental flights and Forest Service flights, and the author's detailed comments and recommendations. Author (TAB)

N66-37186# Institute for Research, State College, Pa. Div. of Psychobiology.

DRUG EFFECTS UPON PERFORMANCE UNDER TASK-INDUCED STRESS

Paul M. Hurst and Marianna F. Weidner Jan. 1966 32 p refs

(Contract Nonr-4423(00))

(ONR-H-66-1; AD-635947) CFSTI: HC $2.00/MF $0.50

An experiment was performed to test the interaction between drug/placebo effects and incentive conditions under task-induced stress. Sixty-three student volunteers served in a factorially designed experiment varying level of incentive, drug condition, and placebo condition (whether or not the subject was led to believe he had received a drug). All active drugs were given in disguised form. These included *d*-amphetamine sulfate (10 mg), chlordiazepoxide HCl (10 mg), and methylphenidate HCl (10 mg). Neither the incentive nor the placebo condition factor had a significant effect upon performance. *D*-amphetamine showed a significant superiority to other drug conditions early in the session. Most of this superiority derived from the high stress condition. Mood effects were also noted. Results were interpreted as favoring a mood-related component in performance enhancement rather than the psychoanalytic factor. Author (TAB)

N67-17932# Federal Aviation Agency, Washington, D. C. Aeromedical Applications Div.

RECENT FINDINGS ON THE IMPAIRMENT OF AIRMANSHIP BY ALCOHOL

Stanley R. Mohler Sep. 1966 12 p refs

(AM-66-29) CFSTI: HC $3.00/MF $0.65

A significant number of fatal general aviation accidents have definitely been associated with the effects of consumed alcohol. These effects can markedly impair the judgment and proficiency of airmen. Aspects of this subject are explored in depth. Author

N67-13572# Institute for Research, State College, Pa. Div. of Psychobiology.

DRUG EFFECTS UPON COGNITIVE PERFORMANCE UNDER STRESS

Paul M. Hurst and Marianna F. Weidner Aug. 1966 165 p refs

(Contract Nonr-4423(00))

(ONR-H-66-3; AD-643022) CFSTI: HC $3.00/MF $0.65

Three experiments were conducted to test an hypothesis concerning drug enhancement of performance under task-induced stress. Cognitive abilities subjected to examination were highly paced short-term memory and simple arithmetic skill. Changes in mood state, judgment of performance and perception of time passage completed the behavioral characteristics assessed. Author (TAB)

A66-81551
O-BENZOYLTHIAMINE DISULFIDE: STUDIES ON ANTI-FATIGUE EFFECTS OF THE CONCOMITANT USE OF O-BENZOYLTHIAMINE DISULFIDE WITH L-K, MG-ASPARTATE.
Hiroshi Fujioka, Osamu Noguchi, Mikio Nagamori, and Takeshi Asai.
Journal of Science of Labour (Rōdō Kagaku), vol. 42, Feb. 1966, p. 103–107. In Japanese.

Ground Self Defense Force personnel in training for marathon racing were given L-K,Mg-aspartate either alone or concomitantly with O-benzoylthiamine disulfide (BTDS). The anti-fatigue effects of administration were evaluated by means of several easily-measurable fatigue indices, such as muscular strength. The results obtained are summarized as follows: (1) The concomitant use of BTDS with L-K,Mg-aspartate showed the most remarkable effect at an early stage. (2) Next to the combined use, the simple administration of the salts exerted a moderate anti-fatigue effect, but the effect of the administration of BTDS alone was somewhat inferior.

A66-81631
PERFORMANCE ON A SKILLED TASK AFTER PHYSICAL WORK OR IN A HIGH ALTITUDE ENVIRONMENT.
Wayne O. Evans (Fitzsimons Gen. Hosp., U. S. Army Med. Res. and Nutr. Lab., Denver, Colo.)
Perceptual and Motor Skills, vol. 22, Apr. 1966, p. 371–380. 15 refs.

The purpose of this experiment was to examine the effects of heavy physical work and of a high terrestrial environment on the complex psychomotor skill of pistol firing. Six subjects walked on a treadmill using the titration procedure, to four different degrees of fatigue. With instructions for either rapid or accurate firing, the subject on a light signal, got off the treadmill and fired six shots. Scores were analyzed in terms of time from the turning on of the light until the pistol was picked up, time to fire the first shot, time to fire the remaining five shots in a series, and the accuracy of all six shots. Time to fire the pistol on the first shot and time to fire the remaining five shots were affected by treatments. The effects on pistol shooting of a high terrestrial environment were studied in eight men taken rapidly from sea level to an altitude of 14,110 ft. The same general procedures were used but no fatigue was induced. High altitude increased speed of firing and decreased accuracy.

A66-81810
BEHAVIOR OF THE CO-ORDINATION OF MOVEMENTS OF THE LOWER EXTREMITY UNDER THE ACTION OF FATIGUE AND LOAD [ZACHOWANIE SIE ZBORNOSCI RUCHOW KONCZYNY DOLNEJ POD WPLYWEM ZMECZENIA I OBCIAZENIA].
M. Golema and E. Ziobro.
Wychowanie Fizyczne i Sport, vol. 10, no. 1, 1966, p. 93–97. 5 refs. In Polish.

The coordination of movements of the lower extremities was measured in 54 students from the Wroclaw Higher School of Physical Education. The coordination was assessed according to the size of the fields of deviation, which are formed when a lower extremity follows the diagonals and the sides of a 50×50 cm. square. The coordination deteriorated visibly when the extremity in question was weighted with a 9.9-kilogram weight. This enlarged the deviation fields by 50%. Fatigue caused by the execution of 20 full squats and vertical movements of the legs in the lying position (so-called "scissors") did not change significantly the co-ordination of movements. After the calculation of correlation coefficients between measurements made before and after effort, first when the extremity was weighted and then not, it appeared that measurements made when the extremity was weighted were correlated most strongly ($r=0.643$). The conclusion is drawn that measurements made under these conditions are best for [illegible] of coordination of movements.

A67-80076
EFFECTS OF LOAD-CARRYING ON PYSCHOMOTOR PERFORMANCE.
Paul S. Strauss and Jack Carlock (Picatinny Arsenal, Dover, N. J.).
Perceptual and Motor Skills, vol. 23, Aug. 1966, p. 315–320. 10 refs.

Previous studies have indicated that performance after load-carrying may be related to psychological fatigue rather than physiological impairment. This study measured performance on a battery of psychomotor tests and subjective fatigue ratings after ten subjects carried loads of 14 and 34 lb. over a two-mile test course. These scores are compared with those obtained after several periods of inactivity. Subjective fatigue was significantly related to all test scores but not to time required to walk the course. Although performance was poorer after load-carrying than after inactivity, scores for load-carrying conditions were higher for the 34-lb. load than they were for the 14-lb. load when both were carried in a comfortable position. This is taken to suggest that, under some conditions, carrying greater weights may have an activation effect on psychomotor performance and may even reduce subjective fatigue.

A67-80562
MECHANICAL IMPACT: A MODEL FOR AUDITORY EXCITATION AND FATIGUE.
H. D. Crane (Stanford Res. Inst., Menlo Park, Calif.).
Journal of the Acoustical Society of America, vol. 40, Nov. 1966, p. 1147–1159. 27 refs.

An auditory model is developed in which hair-cell excitation is based on mechanical impact of the cochlear hairs against the tectorial membrane, and auditory fatigue is based on a relatively slow mechanical bending of the tectorial membrane to conform to the deflection envelope. In this model, the cochlear system is treated basically as a spatially distributed, mechanical, envelope-detection system. Some novel mechanical vibration and impact devices that led to the development of this picture of hair-cell excitation are discussed. It is shown that the model can explain, and is consistent with, a relatively wide range of auditory data such as pitch and threshold shifts with pure-tone fatigue, modulation of a steady high-frequency tone by a simultaneous low-frequency tone, and very rapid high-frequency cutoff in "tuning curves" recorded from single auditory fibers. The model leads to a reinterpretation of such features as pitch sharpening, mission fundamentals, and fatigue. No new data are presented, although new experiments are suggested by the model.

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EYE MOVEMENT AND PERCEPTUAL SATURATION

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A63-13832
PERCEIVED MOVEMENT IN DEPTH AS A FUNCTION OF STIMULUS SIZE.
William C. Steedman and Charles A. Baker (USAF, Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio).
Human Factors, vol. 4, Dec. 1962, p. 349-354.

Experimental investigation of man's ability to perceive movement in depth of flat, circular, luminous objects of various angular subtenses in an otherwise stimulus-free field. The experimental apparatus and procedure are described. A method of constant stimuli is used to determine threshold values for the perception of movement. The results, listed graphically and in tables, are discussed.

A63-13833
MAXIMUM INFORMATION-HANDLING RATES FOR SEQUENTIALLY PRESENTED VISUAL STIMULI.
Robert M. Nicholson (Minneapolis-Honeywell Regulator Co., Aeronautical Div., Life Sciences Group, Minneapolis, Minn.)
Human Factors, vol. 4, Dec. 1962, p. 367-373.

Examination of the maximum human-operator handling rate of information displays consisting of colored lights. The following aspects of this problem are considered: (1) information-handling rates for sequentially presented stimuli; (2) the relationship between information-handling rate and the size of the surface that the operator must monitor; and (3) the effect of variations in duration of stimulus exposure. The apparatus and procedure are described, and the results are shown graphically. All performance curves indicate a monotonic decrease as the speed of presentation was increased. The method of randomly presented stimuli resulted in significantly better performance than the method of sequentially varied stimuli.

A63-15581
HEAD MOUNTED ELECTROCULAR DISPLAY: A NEW DISPLAY CONCEPT FOR SPECIALIZED ENVIRONMENTS.
Robert J. Hall and James W. Miller (Hughes Aircraft Co., Fullerton, Calif.)
(Aerospace Medical Association, Annual Meeting, Atlantic City, N. J., Apr. 9, 1962.)
Aerospace Medicine, vol. 34, Apr. 1963, p. 315-318.

Description and experimental evaluation of a new display system termed the Electrocular Display. The development of the instrument is traced from the psychological studies which determine the feasibility of the concept to the evaluation of the current prototype. The device possesses many advantages including the removal of postural constraints, large-screen display capabilities, space and weight savings, the superposition of the display on the surrounding environment, and its applicability to special environments.

A63-21822
OPERATOR LOADING TASKS.
W. B. Knowles (Hughes Aircraft Co., Culver City, Calif.).
Human Factors, vol. 5, Apr. 1963, p. 155-161.

Discussion of the rationale of measuring operator workload in terms of auxiliary, or secondary, task performance scores. The important characteristics of suitable loading tasks are summarized. Described are several loading tasks which have been used or which are potentially useful. It is suggested that a set of standardized tasks be developed which would be useful in obtaining more nearly comparable measures over a wide range of primary tasks.

A64-80203
MAINTENANCE OF VIGILANCE IN AN AUDITORY MONITORING TASK.
J. S. Kidd and Angelo Micocci (Ohio State U., Columbus).
Journal of Applied Psychology, vol. 48, Feb. 1964, p. 13–15.
Contract No. AF 33(616)-6166.

Four levels of critical signal frequency and three levels of task complexity were compared for their effect on vigilance in an auditory monitoring task. Proportionate omission errors increased as the frequency of signals decreased, as expected. However, complexity (defined as the number of categories of critical signals) had an unexpected effect in that relatively poor performance occurred with increased complexity. The results were interpreted as suggesting caution in the use of artificial signals as a means to overcome loss of vigilance in monitoring tasks.

A64-80622
MECHANISM OF VISUAL AUTOKINESIS.
F. J. Verheijen and H. Oosting (Utrecht U., Lab. of Comp. Physiol., Zonnenburg, Netherlands).
Nature, vol. 202, Jun. 6, 1964, p. 979–981. refs.

The hypothesis that the eye should move in a direction opposite to that in which the fixation light appeared to move during the previous autokinetic illusion is investigated in two series of experiments. In 11 subjects (2 female, 9 male), each eye was tested separately. Results of the first series of experiments can be summarized as follows: (1) the significant mean directions of autokinesis were all upward (17 eyes); (2) in 11 eyes the movement in darkness was in a direction opposite ($180^{\circ} \pm 60^{\circ}$) to that of the preceding autokinesis (8 eyes $P \leq 0.05$; 3 eyes $P > 0.05$); (3) in 9 eyes the movement in darkness was in a direction identical ($0^{\circ} \pm 60^{\circ}$) to that of the preceding autokinesis (7 eyes $P \leq 0.05$; 2 eyes $P > 0.05$); (4) only in 2 eyes did both directions seem to be independent of each other ($P > 0.05$) and (5) in 6 eyes out of 8 mentioned under (2) with $P \leq 0.05$, the mean direction of the eye movement in the dark was in a direction opposite to that of autokinesis for this eye. The most important results in the second series was that both eyes of one subject that had moved in the direction of the previous autokinesis in the first series now moved in the opposite direction ($P \leq 0.05$) of the mean direction of autokinesis. Results in (2) and (5) are consistent with the oculomuscular theory of autokinesis stating that variations in the efficiency of the extraocular muscles produce the illusion. Explanations of the other findings are attempted as the latter related to results of other investigators.

A64-80662
THE ALERTED EFFECTIVE THRESHOLD IN AN AUDITORY VIGILANCE TASK.
Charles F. Gettys (Louisville U., Ky.)
Journal of Auditory Research, vol. 4, Jan. 1964, p. 23–28. 20 refs.
US Army-supported research.

The effective difference limen intensity threshold for 24 subjects was determined by an ascending method of limits for alerted and unalerted signals in four conditions. The alerted effective threshold increased with time on task. It was suggested that the factor of temporal uncertainty did not influence the course of vigilance decrement, although a large and significant difference was found between alerted and unalerted thresholds. No significant differences were found between the alerted thresholds obtained when the subject was searching for unalerted signals and alerted thresholds obtained when the subject was told that he would be warned prior to the onset of each signal. This result tentatively suggests that the continuous search that is characteristic of most vigilance tasks is not a necessary condition for the vigilance decrement to occur. The increase with time on task of the unalerted effective threshold was consistent with the findings of the majority of other studies measuring the course of the effective difference limen threshold. No effect due to signal frequency was found.

A64-80795
EYE MOVEMENTS DURING VIGILANCE.
N. H. Mackworth (Harvard Sch. of Pub. Health, Boston, Mass.), I. T. Kaplan (Dunlap and Associates, Inc., Stamford, Conn.), and W. Metlay (U. S. Naval Training Device Center, Port Washington, N.Y.)
Perceptual and Motor Skills, vol. 18, Apr. 1964, p. 397–402. 8 refs.
Grant No. PHS-G-B-2875.

Eye movements were observed in six subjects watching for signals, which were 0.5 second pauses in the motion of a slowly revolving pointer. The following results were obtained: (1) Detection probability for two dials was approximately half the detection rate for one dial. (2) Analysis of eye-movement records showed that in the one-dial situation every missed signal was fixated without being recognized. (3) In the two-dial condition, signals were not only either fixated or unfixated, but some were fixated for part of their duration; approximately one-third of the signals fell into each fixation category. (4) In contrast to the one-dial condition, the largest proportion of unreported signals for two dials were not fixated at all; nearly as many unreported signals were partially fixated; about one-quarter of the unreported signals were fixated for their full duration. (5) Individual subjects differed with respect to the time they paused on one dial before shifting to the other; those who shifted more frequently detected more signals.

A64-31032
RECORDING OF EYE MOVEMENTS AS A CONTRIBUTION TO THE INVESTIGATION OF VISUAL ACUITY FOR MOVING OBJECTS [REGISTRIERUNG VON AUGENBEWEGUNGEN ALS BEITRAG ZUR UNTERSUCHUNG DER SEHSCHARFE FUR BEWEGTE OBJEKTE].
Heinrich Honegger and Wolf Dieter Schaf[illegible]ugenklinik U., Heidelberg, Germany).
Albrecht von Graefes Archiv für Ophthalmologie, vol. 166, 1964, p. 601–616. 18 refs.

Eye movements were traced by means of a light ray reflected from a mirror fastened by means of a suction cup on one eye. The other eye executed (a) horizontal movements of the saccadic type with fixation and interfixation pauses and of the pursuit type, and (b) circular movements of the saccadic and pursuit type. The different types of movement are described in detail. Inexactness observed in the performance of the movement seems to be related to the intricate balance among all eye muscles. With increasing speed, circular pursuit movements become increasingly inaccurate until they deteriorate into saccadic jumps at a speed at which the visual signal is barely recognizable. The lack of exactness in execution of eye movements may be one of the more important limiting factors in recognition of moving objects.

N64-28636 Educational Research Corp., Cambridge, Mass.
JAMES J. GIBSON ON VISUAL PERCEPTION: ANALYSIS OF SELECTED PAPERS
Milton W. Horowitz Feb. 1964 43 p refs
(Contract N 61339-294)
(NAVTRADEVCEN-294-5; AD-602283) OTS: S1.25

This paper is an analysis of Gibson's point of view in psychology. It is primarily based on 50 scientific papers published in scholarly journals by him and his colleagues, but to some extent it also mirrors the research of other writers in the field of perception. Although these papers cover 20 years of Gibson's life, and hence reveal his evolution as a scientist to some extent, the great majority of them have been published in the last 10 years, when his work had become programatic, and reveal a systematic progress in the field of visual perception. The report indicates the general principles of visual perception that have been explicated by Gibson with a view toward the eventual utilization of these principles in the construction of visual displays for training purposes. Author

A65-80338
E COMBINATION OF INFORMATION FROM DIFFERENT SOURCES.
R. Davis (Reading U., Dept. of Psychol., England).
Quarterly Journal of Experimental Psychology, vol. 16, Nov. 1964, p. 332–339. 17 refs.

In this experiment subjects were presented with visual information from two different sources and were required to combine it in order to make the correct response. The time interval between the two signals was varied in two different ways (a) regularly and (b) randomly. Reaction times were measured from the moment of occurrence of the second signal. By this means the time course of the decision procedure involved in combining the information from the two sources was analyzed. Results indicate that subjects may deal with the situation in two ways (1) by means of a perceptual classification in which the individual elements are not analyzed separately, or (2) by means of an intellectual classification in which each signal is analyzed sequentially. The two methods correspond to the experimental conditions of (a) regular intervals and (b) random intervals. It is argued that when subjects use the latter strategy the results are consistent with the conception of the human operator as an intermittent analyzing system.

A65-80594
MEASUREMENT OF EYE MOVEMENTS DURING A MICHOTTE LAUNCHING EVENT.
Gunnar Jansson (Uppsala U., Psychol. Lab., Sweden).
Scandinavian Journal of Psychology, vol. 5, 1964, p. 153–160. 14 refs.

The verbal responses and the eye movements of subjects viewing a Michotte launching event (disc method) were recorded. The subjects were divided into two main groups: those reporting launching on every exposure and those giving no launching response at all. These two groups were compared with regard to several eye movement variables. They did not differ on the first exposure but did so on repeated exposures, indicating that what a subject perceives on the first exposure influences his eye movements on the following exposures.

A65-80645
EVOKED RESPONSES IN RELATION TO VISUAL PERCEPTION AND OCULOMOTOR REACTION TIMES IN MAN.
John S. Barlow (Mass. Gen. Hosp., Neurophysiol. Lab., Boston; and Mass. Inst. of Technol., Res. Lab. of Electronics, Cambridge).
Annals of the New York Academy of Sciences, vol. 112, art. 1, May 8, 1964, p. 432–467. 77 refs.
Army and AF supported research.
Grant PHS 5-K3-NB-9201; Grant B-3752 from Natl. Inst. of Neurol. Diseases and Blindness; Grant NSF B-16526; Grant NIH MH-04737-02.

Averages of parieto-occipital evoked potentials were obtained from recordings made during visual tracking of a light spot on an oscilloscope screen and from recordings carried out while gaze was maintained fixed at the center of the oscilloscope screen. Averaged responses, with eyes closed, to flashes of light were also obtained. Oculomotor reaction times were determined by averaging of electro-oculographic potentials, and by cross-correlation of the latter with the spot-position signals. Potentials evoked by shifting light spot were smaller and greater in latency than those evoked by light flash with the eyes closed. Consideration of the latencies of the components of the former suggests that they may represent nonspecific rather than specific evoked responses in the visual system. Psychophysical experiments give evidence that the subjective perception of spot-shifts takes place within 40 msec. or less. This finding points to specific visual pathways for perception of simple stimuli. The findings from these electrophysiological and psychophysical experiments are discussed in relation to the question of quantization of time in the nervous system.

A65-81694
SPATIAL AND DYNAMIC ASPECTS OF VISUAL FIXATION.
G. M. Jones and J. H. Milsum (McGill U., Montreal, Canada).
IEEE Transactions on Bio-Medical Engineering, vol. BME-12, Apr. 1965 p. 54–62. 36 refs.

The physiological processes concerned with the difficult dynamic task of fixating the retinal image during normal body and head movement are examined with control engineering perspective. Spatial relationships between the two main system inputs (visual and vestibular) and three main outputs (operating on the eye-in-skull, skull-on-body, and body-in-space platforms) are examined in the context of the geometry of the environment with the aid of an information flow diagram. From dynamic considerations a picture emerges in which the visual tracking system had adequate accuracy and dynamic range for following most naturally moving objects when the head is still. But with the head free, the added perturbations of natural movement exceed these tracking capabilities. However, over the frequency range 0.1–5.0 c.p.s. the semicircular canal subsystem then provides angular velocity information for powerful complementary servostabilization.

A65-82202
EFFECT OF TARGET SIZE, LUMINANCE, AND COLOR ON MONOCULAR FIXATION.
Robert M. Steinman (Md. U., Dept. of Psychol., College Park).
Journal of the Optical Society of America, vol. 55, Sep. 1965, p. 1158–1165. 15 refs.
Soc. of Sigma Xi and RESA Fund supported research.

A contact-lens technique was used to record eye movements made by two subjects attempting to maintain fixation at the center of concentric round targets of several sizes (1.9'–87.2' diam.) and luminances (2.8, 7.8, and 21.5 mL). Fixation of red, blue, and white 1.9' diam. targets was also examined. Analysis of variance designs were employed to remove variability arising from sources other than these stimulus variables. Statistically reliable differences in mean fixation position were found with targets of different size, luminance, and color. The largest difference observed was less than 4 and under most conditions was less than 2. The bivariate dispersion of the eye about its mean position varied in a complex manner with the size and luminance of the target object. No statistically reliable effects of stimulus variables were found on drifts. Saccade frequency was considerably reduced with the largest targets. Results are discussed in terms of a "fixed error-signal system" for the control of eye position.

N65-36786# Honeywell, Inc., St. Paul, Minn.
VISUAL SEARCH: EYE FIXATIONS AS DETERMINED BY INSTRUCTED TARGET CHARACTERISTICS Semi-annual Report, 1 Jan.–30 Jun. 1965
L. G. Williams 12 Aug. 1965 7 p ref
(Contract Nonr-4774(00))
(T-125; AD-620336)

With prior instruction about single target characteristics, searcher's eye fixations tended strongly to fall on objects of instructed color, but tended less to fall on instructed size or shape. In general, when instructed about multiple target characteristics, fixations were related to a single characteristic, color if provided, otherwise size. Author (TAB)

A66-24937
ALERTNESS MANAGEMENT IN INDUSTRY.
J. A. Moody and B. C. Duggar (Bio-Dynamics, Inc., Cambridge, Mass.).
(American Industrial Hygiene Association, Annual Meeting, 26th, Houston, Tex., May 3-7, 1965, Paper.)
American Industrial Hygiene Association, Journal, vol. 27, Jan.-Feb. 1966, p. 17-24. 35 refs.
Contract No. NASw-904.

Study of alertness management which is critical to production rate, quality control and operator safety. Alertness management includes (1) elimination of factors conducive to alertness decrement, (2) addition of conditions or procedures which enhance alertness, (3) reduction of the consequences of alertness decrements, and (4) personnel monitoring when necessary. The criteria for evaluating the controlling elements in the task, physical environment, social environment, and procedures which may lead to decrements in alertness are discussed. Monitoring procedures are described and recommendations suggested which should lead to improved alertness management in the industrial situation. An alertness checklist is presented for use in analyzing particular job situations. M.F.

A66-25012
LIMITATIONS AND RELIABILITY OF THE HUMAN OPERATOR OF CONTROL SYSTEMS TO PROCESS INFORMATION.
Jacek Szafran (Lovelace Foundation for Medical Education and Research, Dept. of Experimental Psychology, Albuquerque, N. Mex.).
(Aerospace Medical Association, Annual Meeting, 36th, New York, N.Y., Apr. 26-29, 1965, Paper.)
Aerospace Medicine, vol. 37, Mar. 1966, p. 239-242. 35 refs.
U.S. Public Health Service Grant No. HD-0518.

The theory of human skill is briefly reviewed. It is argued that, within certain well-defined limits, the extent to which man can extract information from sensory inputs is impressive, even if for some purposes intensive training has to precede efficient performance. It is concluded that one of the key notions in the appraisal of operational reliability of man in space should be endurance - in the sense of a capacity to adapt rapidly to changing requirements and strange conditions (including those of reduced "signal-to-noise" ratio), as well as a general willingness to plan the effort so as to maximize the likelihood of sustained performance. (Author)

A66-34198
EYE AIMING BEHAVIOR DURING THE SOLUTION OF VISUAL PATTERNS.
Warren H. Teichner and Leah M. Price (Tufts University, Medford; Harvard University, Cambridge, Mass.).
Eastern Psychological Association, Meeting, Atlantic City, N.J., Apr. 1965, Paper.)
Journal of Psychology, vol. 62, 1966, p. 33-38.
Grant No. NsG-718.

Report on experimental studies to evaluate the possibility of using eye movement data as a means for studying nonvisual processes involved in ocular patterns. It is suggested that finding a visual pattern in an array of stimuli is a problem-solving or concept-forming task which involves successive data inputs represented by successive eye fixations. It also involves the development of a hypothesis or strategy or concept which is applied as a guide to data gathering by directing the position of the fixations. This in turn requires hypothesis testing, i.e., the subject's fixations may jump ahead or out of his data-gathering path to test a prediction, or they may retrace previous steps to verify the basis of the concept. If the subject has a perfect recall, it is assumed that he does not retrace at all, since he then verifies by memory. Thus it is suggested that eye movements that result in the obtaining of new data (forward fixations) represent a data-acquisition process, whereas recursive eye movements represent a forgetting process. The described experimental studies were conducted with and without speed stress. They also explored the effect of image blurring. The results suggest a narrowed attentional field and a heightened attention to detail with slight blurring and with mild speed stress. The same process seems to be associated with correct solutions even in the absence of stress. The results also suggest a systematic change in the problem-solving strategy from information gathering in the early time period to memory refreshing and verification in the later one. M. L.

A66-36944
EYE-MOVEMENT RESPONSES TO STEP AND PULSE-STEP STIMULI.
Leon L. Wheeless, Jr., Robert M. Boynton, and Gerald H. Cohen (Rochester, University, Rochester, N.Y.).
Optical Society of America, Journal, vol. 56, July 1966, p. 956-960.
Research supported by Bausch and Lomb; U.S. Public Health Service Grant No. NB-00624.

Experiments demonstrating that the visual system is sometimes able to cancel an eye-movement response to a pulse, on the basis of information contained in the subsequent step, to which it responds instead. As the step is delayed by progressively longer pulses, the probability increases that a response to the pulse will occur. If a response does occur in the direction of the step, it begins about 325 msec after the beginning of the step. This latency is independent of pulse time W and is about 40 msec longer than the latency of responses to steps presented alone. It is concluded that the visual system utilizes this 40 msec to operate upon a latent response to a pulse, and thereby to cancel its overt manifestation (eye movement) before initiating a response to the second, incompatible stimulus. M.F.

N66-24463# Honeywell, Inc., St. Paul, Minn. Research Dept.
A STUDY OF VISUAL SEARCH USING EYE MOVEMENT RECORDINGS First Annual Report, 1 Jan.-31 Dec. 1965
L. G. Williams 28 Feb. 1966 79 p refs
(Contract Nonr-4774(00))
(Rept.-12009-IRI; AD-629624) CFSTI: HC $3.00/MF $0.75

The object of study in the present program is visual search in crowded fields. The basic goal is to predict search times for arbitrary targets in arbitrary backgrounds. The basis of our framework is that the specific objects at which an observer looks depends on the specific targets for which he searches. The average time to find a given target depends on what types of objects he is likely to look at and the numbers and types of objects in the search field. The report contains three appendices. Appendix A describes the apparatus used in the present studies and the rationale for measuring eye fixations. Appendix B is a methodological study which establishes the validity of generalizing to the real world from the restrictive laboratory situation. Appendix C shows how eye fixation data can be used to predict search times for specific targets in arbitrary fields. TAB

N66-28826# Istituto Nazionale di Ottica, Florence (Italy).
PROBLEMS RELATED TO VISUAL PERFORMANCE OF PILOTS Annual Summary Report, 1 Dec. 1964-30 Nov. 1965
Adriana Fiorentini and Lucia Ronchi 20 Dec. 1965 119 p refs
(Contract AF 61(052)-850)
(AD-630475) CFSTI: HC $4.00/MF $0.75
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1. OCULAR MOVEMENTS AND APPARENT MOVEMENTS DURING ATTEMPTED MONOCULAR FIXATION OF A POINT IN A DARK FIELD A. Fiorentini p 1-33 refs (See N66-26827 16-05)
2. SOME ASPECTS OF THE PERCEPTION OF LIGHT SIGNALS L. Ronchi p 34-68 refs (See N66-28828 16-05)
3. ON THE VARIABILITY OF ELECTRORETINOGRAPHIC RESPONSE L. Ronchi p 69-86 refs (See N66-28829 16-05)
4. VISUAL PERFORMANCE IN THE PRESENCE OF A STEP PATTERN OF ILLUMINATION A. Fiorentini p 87-104 refs (See N66-28830 16-05)

N66-28827# Istituto Nazionale di Ottica, Florence (Italy).
OCULAR MOVEMENTS AND APPARENT MOVEMENTS DURING ATTEMPTED MONOCULAR FIXATION OF A POINT IN A DARK FIELD
Adriana Fiorentini *In its* Probl. Related to Visual Performance of Pilots 20 Dec. 1965 p 1-33 refs (See N66-28826 16-05) CFSTI: HC $4.00/MF $0.75

Motor and perceptual aspects of attempted monocular fixation of a bright point in a dark field are investigated. Eye movements during attempted fixation were studied: (a) when a bright point was fixed at the center of the dark visual field, (b) in the dark after extinction of the fixation point, and (c) when the image of a point was stopped with respect to the retina (stabilized point). Autokinetic movements of a bright point with and without stabilization of the retinal image were observed and compared with eye movements. Data reported on perceived direction of a point source as a function of retinal locus showed that the perceptual locus of a small light source is determined with great accuracy by its retinal locus. Test apparatus is described, and the experimental procedures used on the two subjects are detailed. Typical records of the eye movements are presented, the differences in response are assessed, and possible reasons for these variations are discussed. S.P.

N66-34511# Joint Publications Research Service, Washington, D. C.
ON THE PROBLEM OF PROFESSIONAL FITNESS AND HANDLING CAPACITY OF THE OPERATORS
K. M. Gurevich and L. M. Edel'man *In its* Cybernetics and Automation 17 Aug. 1966 p 232-236 (See N66-34486 20-05) CFSTI: $6.00

This study examines the professional fitness of personnel handling the control desks of electric power installations in terms of their behavior under emergency conditions. Simulated emergency exercises were conducted to observe and evaluate the ability of operators to eliminate an emergency condition. No connection was found between the success of eliminating an emergency and the length of service or special skills of an operator. The repeatedly observed cases of a loss of composure by workers in which grossly mistaken actions were performed indicate that these workers must have some individual peculiarities which to a certain degree predetermine such behavior. R.N.A.

A67-16309

HUMAN FACTORS IN AIRBORNE TELEVISION DISPLAYS.

Beverly Hillman (Radio Corporation of America, Burlington, Mass.).

IN: SOCIETY FOR INFORMATION DISPLAY, NATIONAL SYMPOSIUM ON INFORMATION DISPLAY, 7TH, BOSTON, MASS., OCTOBER 18-20, 1966, TECHNICAL SESSION PROCEEDINGS.

[A67-16305 05-14]

North Hollywood, Calif., Western Periodicals Co., 1966, p. 133-148. 11 refs.

Discussion of electrooptical imaging systems used in military aerial TV displays. Particular attention is given to the variables involved in TV viewing related to visual interpretation. The principal variables considered are: (1) the mission characteristics, (2) the imaging system, including contrast rendition, line coverage, and signal-to-noise properties, (3) human visual capabilities, in terms of resolution and contrast perception and search time, and (4) viewing conditions such as kinescope size and shape and the ambient environment. Performance capability related to the nature of the targets sought, altitude, and velocity conditions is discussed, and data are presented from simulation research showing how visual interpretation is influenced by the resolution and noise characteristics of the display system. Cockpit environmental factors such as the ambient illumination and space limitations are analyzed with respect to their influence on the display requirements. M. F.

N67-18072# Institute for Perception RVO-TNO, Soesterberg (Netherlands).

THE EFFECT OF SUCCESSIVE EXPOSURES UPON DYNAMIC VISUAL ACUITY

L. F. W. de Klerk, J. P. van de Geer, and C. A. J. Vlek [1966] 20 p refs

(TDCK-46508; IZF-1966-10) CFSTI: HC $3.00/MF $0.65

This study concerns the effect of manner of presentation of moving Landolt rings upon dynamic visual acuity. Two types of presentation are used: one single exposure and two successive exposures. The total exposure time has been kept equal for both conditions. From the results of the experiments it appears that for an angular target velocity of 70°/sec two successive exposures, separated by a time interval of .2 sec, lead to better performance than one single exposure of double duration. These results were explained in terms of the sampled data theory. Recordings of eye movements do reveal that there is a rather good correlation between dynamic visual acuity and accuracy of ocular pursuit. However, the sampling hypothesis did not receive much support from the analysis of eye movements. Some factors are discussed which may account for this lack of confirmation. Author

N67-24724# Antioch Coll., Yellow Springs, Ohio. Behavior Research Lab.

HUMAN FACTORS IN THE DESIGN OF ELECTROLUMINESCENT DISPLAYS FOR AEROSPACE EQUIPMENT Final Report, 1 May 1965-1 May 1966

Herbert H. Stenson Wright-Patterson AFB, Ohio, Aerospace Med. Res. Labs., Sep 1966 38 p refs

(Contract AF 33(615)-1086)

(AMRL-TR-66-130; AD-646459) CFSTI: HC $3.00/MF $0.65

The report presents an outline of a broad program of psychological research that will provide human engineering standards for the design of electroluminescent (EL) display devices. The physical characteristics of EL lighting are discussed, after which the possible types of EL displays are categorized as discrete or continuous displays, and as dynamic or static displays. Five types of perceptual tasks that might be required of an observer of an EL display are described, and each display category is then discussed in terms of the perceptual task(s) required to monitor the display in question. For each display-task combination, human factor research is proposed and some experiments are laid out in detail. The conventional variables such as intensity, contrast and viewing duration are considered for each display-task category as well as some less familiar variables based on the use of information theory. Examples of existing and proposed EL displays are given in connection with the proposed research. TAB

A64-80150
EFFECTS OF MEPROBAMATE ON CONTINUOUS ATTENTION BEHAVIOR.
Leonard Uhr, Arthur Platz, Stephen S. Fox, and James G. Miller (Mich. U., Mental Health Res. Inst., Ann Arbor).
Journal of General Psychology, vol. 70, Jan. 1964, p. 51–57. 15 refs.

The Michigan Continuous Attention Task was administered to twelve subjects under double-blind conditions of meprobamate and of placebo. Drug effects were evaluated in relation to assessed anxiety and to electric shock conditions. High performance, indicating maintained sustained attention and alertness, was significantly related to high anxiety, as measured by the Taylor Manifest Anxiety Scale. Meprobamate, in a single 1,600-mg dose, significantly improved performance on the entire task, including both shock and nonshock conditions. The two conditions did not yield different results, suggesting that the anticipation of shock may, in itself, arouse drive.

A66-81035
FINE EYE MOVEMENTS DURING INATTENTION.
Kenneth Gaarder (Chestnut Lodge Res. Inst., Rockville, Md.)
Nature, vol. 209, Jan. 1, 1966, p. 83–84. 5 refs.

The difference in fine eye movements during attention and inattention while a subject is directed to look at a target indicate the existence of a feedback control system. The fine eye movements invariably present, beyond voluntary control, consist of three components: rapid saccades, slow drift and waver, and fine fast tremor. When each subject, after a phase of inattention, was instructed to concentrate on eye fixation, the eye movement reverted to normal pattern, and the subject became retrospectively aware of his inattention. These changes were oscillatory. It is suggested that during attention there is a closed-loop feedback with a steady function, while during inattention the loop is open.

A66-81240
INVESTIGATIONS CONCERNING FIXATION AND TRACKING MOVEMENTS OF THE HUMAN EYE [UNTERSUCHUNGEN ZUR FIXATIONS- UND FOLGEBEWEGUNG DES MENSCHLICHEN AUGES].
H. Drischel (Karl-Marx-U., Physiol. Inst., Leipzig, East Germany).
Zeitschrift für Psychologie, vol. 171, 1965, p. 92–109. 10 refs. In German.

Fixation apparatus of the eye is conceived as a closed-loop feedback system, where the position of the eyeball to the object of fixation or the view-angle is the variable. Sensors are the light-sensitive elements of the fovea, cones in particular. These operate as proportional as well as differential ratio sensors. Visual cortex and central oculomotor switch mechanisms function as the regulator. Effectors are the six external eye muscles working a defined sequence, usually paired. A subordinate feedback system consists of stretch-sensitive muscle spindles. Their task is to transmit information on muscle tone to the oculomotor centers. The dynamics are those of an integral proportionate feedback system with a delay period. The author discusses within this framework continuous gliding eye movements and saccadic jumps, latency of the eye, phi phenomenon, optokinetic effect, Bode diagrams of human sinusoidal eye movements, alcohol effect on the tracking eye movements, unpredictable signal input, and other nonlinearities in the system.

A67-80538
INVOLUNTARY EYE MOVEMENTS DURING ATTEMPTED MONOCULAR FIXATION.
Adrianna Fiorentini and Anna Maria Ercoles.
Atti della Fondazione Giorgio Ronchi e Contributi dell' Istituto Nazionale di Ottica, vol. 21, Mar.–Apr. 1966, p. 199–217. 9 refs.
Contract AF 61(052)-850.

The horizontal and vertical components of the involuntary movements of the eye were recorded during attempted monocular fixation of a bright spot in a dark surround and after the extinction of the fixation spot, when the eye was in the dark or viewed a bright spot whose image was stabilized on the retina. The results obtained from two subjects confirm in part the findings of previous work in this field, but two unexpected facts have emerged from the analysis of the records. For one subject, the rate of occurrence of involuntary flicks is as high in the dark as in the presence of a fixation point, and most flicks in the dark seem to correct for a previous slow movement of the eye, as if they were under the control of a non-retinal servo system. For the other subject the rate of occurrence of flicks is exceedingly low during the fixation period, while it is quite normal in the periods of preliminary fixation that preceded the true fixation run. This subject seems to be able to avoid the so-called involuntary flicks when required to keep her eye as steady as possible, still she maintains the assigned direction of fixation with reasonable accuracy when the fixation spot is on.

A66-81019
EYE MOVEMENTS AND THE VISUAL AUTOKINETIC PHENOMENON.
John E. Marshall (U. S. Army Med. Res. Lab., Fort Knox, Ky.)
Perceptual and Motor Skills, vol. 22, Feb. 1966, p. 319–326. 13 refs.

The autokinetic reports of 64 male subjects reflected to a significant extent the direction of compensatory eye movements which had been experimentally manipulated using a retinal image displacement technique. A tracking device was used to record the seconds per trial that the stimulus appeared in each of four visual field quadrants, a temporal measure of magnitude, latency, and direction of initial movement. The results suggest compensatory eye movements associated with the maintenance of single-point binocular fixation and consequent reduction of the disruptive effects of heterophorically stimulated fixation disparity, as the visual mechanism primarily responsible for the autokinetic phenomenon.

A66-80089
EYE-MOVEMENT PATTERNS DURING VISUAL INFORMATION PROCESSING.
John D. Gould and Amy Schaffer (IBM Res. Center, Yorktown Heights, N. Y.)
Psychonomic Science, vol. 3, Oct. 15, 1965, p. 317–318. 5 refs.

Eye movement patterns were recorded while subjects visually scanned 5-cell patterns to compare the sum of the three digits in each of 4 peripheral cells with the sum of the 3 digits in the central "target" cell. Both larger target sums and greater target-non-target similarity caused significantly longer fixations; number and pattern of fixations were independent of experimental variables. Results supported predictions based upon previous studies correlating eye-movement patterns and visual stimuli.

A66-81317
THE EFFECTS OF DARKNESS AND OF OCCLUSION OF THE PUPILS ON CONTROL OF EYE MOVEMENTS [INFLUENCE DE L'OBSCURITE ET DE L'OCCLUSION DES PAUPIERES SUR LE CONTROLE DES MOUVEMENTS OCULAIRES].
M. Jeannerod, P. Gerin, and J. Mouret (Hop. neurol., Lab. d'E.E.G., Lyon, France).
Année Psychologique, vol. 45, no. 2, 1965, p. 309–324. 43 refs. In French.

Eye movement characteristics were recorded in visually deprived, normal individuals (condition of total darkness). The subjects had to reproduce, in darkness or with eyelids closed, some fixed or moving pattern recently observed. While the eye movements during observation were strictly adapted to the elements of the visual field, the eye movements during the reproduction were enhanced, more so with lids closed than with eyes open in darkness. The possible mechanisms of this phenomenon were studied in consideration of the conditions for eye-movement control.

A67-80827
SOME PATTERNS OF FIXATION SACCADIC EYE MOVEMENTS.
Kenneth Gaarder (Natl. Inst. of Mental Health, Saint Elizabeth's Hosp., Clin. Neuropharmacol. Res. Center, Washington, D.C.).
Psychonomic Science, vol. 7, Feb. 5, 1967, p. 145–146. 8 refs.

Fixation saccadic eye movements occur at a more rapid rate during non-alpha (aroused) intervals than during alpha (less aroused) intervals. Other specific patterns of eye movement are shown to be typical of individuals or to occur in periods combining visual fixation with auditory task instruction.

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A63-13683

MAXIMUM INFORMATION-HANDLING RATES FOR SEQUENTIALLY PRESENTED VISUAL STIMULI.

Robert M. Nicholson (Minneapolis-Honeywell Regulator Co., Aeronautical Div., Life Sciences Group, Minneapolis, Minn.)

Human Factors, vol. 4, Dec. 1962, p. 367-373.

Examination of the maximum human-operator handling rate of information displays consisting of colored lights. The following aspects of this problem are considered: (1) information-handling rates for sequentially presented stimuli; (2) the relationship between information-handling rate and the size of the surface that the operator must monitor; and (3) the effect of variations in duration of stimulus exposure. The apparatus and procedure are described, and the results are shown graphically. All performance curves indicate a monotonic decrease as the speed of presentation was increased. The method of randomly presented stimuli resulted in significantly better performance than the method of sequentially varied stimuli.

A64-80149

EFFECT OF CERTAIN NOISES UPON DETECTION OF VISUAL SIGNALS.

William H. Watkins (Electronic Systems Div., Decision Sci. Lab., Bedford, Mass.)

Journal of Experimental Psychology, vol. 67, Jan. 1964, p. 72-75. 10 refs.

The influence of auditory noise stimulation upon detection of a visual signal was investigated by manipulation of two variables: noise type and mode of presentation. Six trained observers each performed 1,200 forced-choice trials in which they were required to select one of four temporal observation intervals as that in which the visual signal occurred. It was found that detection performance was substantially better when noise was presented only during the observation intervals than when it was continuously present. Steady white noise and auditory flutter, both at 75-db sound pressure level, were equally effective in the apparent facilitation of visual detection.

A64-80289

PERCEPTUAL SPEED AND BEHAVIOR PROFICIENCY.

[illegible]. Dinnerstein, B. Blitz, and M. Lowenthal (N.Y. Med. College, New York, [illegible].)

Perceptual and Motor Skills, vol. 18, Feb. 1964, p. 59-62. 9 refs.

Vocational Rehabilitation Administration Grant No. RD-1196-M-63

Perceptual speed in specific sensory modalities should lead to efficiency in behaviors governed by these modalities. To test this hypothesis, correlations were computed between measures of perceptual speed and scores on a modified Stroop test for 10 subjects. Those correlations relevant to the hypothesis were all significant and in the expected direction. The pattern of results is thus reasonably consonant with the hypothesis. Reserpine, which might be expected to affect the above relationships, was ineffective.

A64-80290

INTERSENSORY AND INTRASENSORY EFFECTS IN SIMPLE REACTION TIME.

Leo Rubinstein (N.Y. State Psychiatric Inst., New York, N.Y.)

Perceptual and Motor Skills, vol. 18, Feb. 1964, p. 159-172. 24 refs.

Grant PHS-MY-03616.

Reaction time (RT) was measured as a function of the interval between an irrelevant stimulus and a reaction stimulus, for visual and auditory stimuli. Reaction time was inversely related to the length of the interval when both stimuli were in the same sense mode, but remained relatively constant for stimuli differing in sense mode. Both the absolute and the percentage change in RT were greatest when both stimuli were visual; in this case, the changes in reaction time resulting from the variation of interval length were independent of the luminances of both the irrelevant and the reaction stimuli.

A64-80377
VIGILANCE.
D. E. Broadbent (Med. Res. Council, Applied Psychol. Res. Unit, Cambridge, England).
British Medical Bulletin, vol. 20, Jan. 1964, p. 17–20. 49 refs.

Vigilance studies are reviewed beginning with the historical development of research in this area. An analysis is presented on the effects of the probability of signals, general state of alertness, distracting and competing stimulation, simultaneous use of different sensory modalities, and the caution-riskiness dimension in observer's reports. The emergent conclusion is that no one theory based on any of these variables explains poor vigilance performance since any given theory is inconsistent with some of the facts. A combination of various points of view into a single description using the statistical decision theory of Tanner and Swets (1954) may be the answer.

A64-80710
PERCEPTION BIBLIOGRAPHY: XIV. PSYCHOLOGICAL INDEX, NO. 11, 1904.
R. B. Ammons and C. H. Ammons (Mont. State U., Missoula).
Perceptual and Motor Skills, vol. 19, Aug. 1964, p. 172–174. 76 refs.

An alphabetical listing of 76 references to work in perception in the Psychological Index, No. 11, 1904.

N64-29766 Flying Personnel Research Committee (Gt. Brit.)
THE BISENSORY PRESENTATION OF INFORMATION. PART I: A REVIEW OF EXPERIMENTS ON SENSORY INTERACTION
John Brebner, (St. Andrews U.) London, Min. of Aviation, Apr. 1963 30 p refs
(FPRC/1209(a))

Investigations that have been carried out in the field of intersensory phenomena are reviewed, and areas of apparent conflict in results obtained and areas of agreement between disparate sets of results are pointed out. Topics covered include threshold and acuity alterations, auditory flutter and critical flicker fusion, dark adaptation, color vision, vigilance and simultaneous presentations, bisensory presentation of information, auditory localization, temporal considerations, and crossmodal comparisons. P.V.E.

N64-29767 Flying Personnel Research Committee (Gt. Brit.)
THE BISENSORY PRESENTATION OF INFORMATION. PART II: THE EFFECT OF SIMULTANEOUS AUDITORY STIMULATION ON THE DETECTION OF VISUAL SIGNALS
John Brebner (St. Andrews U.) London, Min. of Aviation, Jul. 1963 11 p refs
(FPRC/1209(b))

Experiments were conducted to ascertain whether the detection of weak visual signals was improved when they were accompanied by an auditory signal in a situation where a "liberal" strategy was inappropriate. The auditory signal was selected to have a detection probability of 1. Both auditory and visual signals were derived from the same source—a white-noise generator producing an output with a level spectrum over the audio band above 100 c/s. Three groups of six males acted as subjects. The mean-age of Group I was 20.5 years; that of Groups II and III was 20.3 years. In Group I, with signals 10 db down from their threshold level, bisensory presentation reduced the number of correct detections. In Group II, with signals 5 db down from their threshold level, the number of correct detections differed little between bisensory and unisensory detection. In group III, the detectability of visual signals was improved when they were accompanied by auditory signals at the suprathreshold level. I.v.L.

A65-22467
PERFORMANCE DECREMENT IN VIGILANCE, THRESHOLD, AND HIGH-SPEED PERCEPTUAL MOTOR TASKS.
Jane F. Mackworth (Defence Research Medical Laboratories, Toronto, Canada).
Canadian Journal of Psychology, vol. 18, no. 3, 1964, p. 209-223. 53 refs.

Consideration of the decrement in performance found in vigilance threshold determinations, and high-speed perceptual motor tasks, which appears to be a linear function of the square root of time on task; it is suggested that the common factor is a requirement for continuous attention. The decrement can be prevented in both active and passive tasks by rest pauses, knowledge of results, and amphetamine. (Author) M.M.

A65-81557
CORRELATION OF AUDITORY AND VISUAL AUTOKINETIC EFFECTS.
Theodore I. Anderson.
Perceptual and Motor Skills, vol. 20, Jun. 1965, Part 1, p. 697-707. 18 refs.

This study involved an investigation of the relationships between visual and auditory autokinetic phenomena. An apparatus was designed to obtain quantifiable records of the perceived auditory autokinetic loudness and pitch effects. Several methods were devised to score these records. When the auditory and visual autokinetic scores were correlated, all of the obtained coefficients were positive, four correlations were significant at the .05 level (only one was expected by chance), and one correlation at the .01 level. Some associated unanswered questions are discussed to indicate certain problems for future investigation. The statistical analyses indicate a tentative affirmation of the hypothesis that both the auditory and visual autokinetic phenomena are to a significant extent determined by a central, relatively stable perceptual style.

N65-19300# Massachusetts Inst. of Tech., Cambridge. Engineering Projects Lab.
HUMAN USE OF SHORT TERM MEMORY IN PROCESSING INFORMATION ON A CONSOLE
Bernard P. Zeigler and Thomas B. Sheridan Bedford, Mass., AFSC, Electron. Systems Div., Sep. 1964 47 p refs
(Contract AF 19(628)-3317)
(ESD-TDR-64-620; AD-609749)

It is assumed that an operator's console constitutes a third form of memory in addition to that integral to the human and that integral to the machine not directly accessible to the human. Questions are raised concerning the characteristic modes of human storage and retrieval of information from internal memory when such external memory is accessible. Storage structures characterizing internal human memory and external console memory in this task are postulated. A retrieval model implied by these structures is constructed to account for the effects of computation and learning upon the features of the experimentally obtained curves. Insufficient retrieval of required information from internal memory is assumed to necessitate external memory search. Computation increases the probability of insufficient retrieval and hence the frequency of external search. Learning decreases this probability. The effects of inducing alternate forms of internal storage are studied and found generally to result in increased storage and retrieval times. Author

N65-33012# Indiana Univ., Bloomington.
AN INVESTIGATION OF VISION DURING INVOLUNTARY SACCADIC EYE MOVEMENTS
Robert Wesley Ebbers (M.S. Thesis) Jun. 1965 42 p refs
(Contract AF 33(608)-1070)
(AD-617409)

A study designed to determine the presence or absence of vision during involuntary saccadic eye movements is reported. Considered are involuntary movements occurring during normal steady fixation. Studied were male graduate students with 20/20 vision. It was shown that vision is present during the involuntary saccade, and that while vision is present, it is dependent in part upon stimulus intensity. Results indicate quite consistent, and large magnitude, intensity threshold differences between subject and observer. Differences were further reflected by an impairment of suprathreshold vision during the involuntary saccade, shown by blip-counting experiments and by measurements of visual acuity. This impairment was shown to be related to the optical smear of the retinal image, the greater the speed of movement of the retinal image, the greater the visual impairment. It is concluded that, contrary to findings of other investigators, vision does exist, though impaired, during involuntary saccadic eye movements, as well as during voluntary saccadic eye movements. S.C.W.

A66-25012
LIMITATIONS AND RELIABILITY OF THE HUMAN OPERATOR OF CONTROL SYSTEMS TO PROCESS INFORMATION.
Jacek Szafran (Lovelace Foundation for Medical Education and Research, Dept. of Experimental Psychology, Albuquerque, N. Mex.).
(Aerospace Medical Association, Annual Meeting, 36th, New York, N.Y., Apr. 26-29, 1965, Paper.)
Aerospace Medicine, vol. 37, Mar. 1966, p. 239-242. 35 refs.
U.S. Public Health Service Grant No. HD-0518.

The theory of human skill is briefly reviewed. It is argued that, within certain well-defined limits, the extent to which man can extract information from sensory inputs is impressive, even if for some purposes intensive training has to precede efficient performance. It is concluded that one of the key notions in the appraisal of operational reliability of man in space should be endurance - in the sense of a capacity to adapt rapidly to changing requirements and strange conditions (including those of reduced "signal-to-noise" ratio), as well as a general willingness to plan the effort so as to maximize the likelihood of sustained performance. (Author)

A66-80279
IDENTIFICATION OF SEQUENTIAL AUDITORY AND VISUAL STIMULI.
Arthur S. Kamlet (Mich. U., Ann Arbor).
Psychonomic Science, vol. 3, Nov. 15, 1965, p. 419-420.
Contract AF 49(638)-1235.

Two subjects identified pairs of 15 msec. one-bit auditory and visual stimuli when the interval between the stimuli varied from 0 to 500 msec. The auditory judgments were better when the auditory and visual signals were separated by 500 msec. than when the two signals were presented simultaneously, and were also better when the auditory stimulus followed the visual stimulus than when the visual stimulus was delayed.

N66-11058# Sylvania Electric Products, Inc., Waltham, Mass. Sylvania Electronic Systems Div.
INTEGRATION OF CONCURRENT VISUAL AND AUDITORY MESSAGES Final Technical Report, 16 Mar. 1964-15 Jul. 1965
Donald B. Devoe Bedford, Mass., AFSC, Electron. Systems Div., Oct. 1965 65 p refs
(Contract AF 19(628)-4073)
(ESD-TR-65-461; AD-621278)

Two experiments were performed involving the concurrent presentation to human subjects of two messages, one auditory and one visual, followed by a question requiring information from both messages. The results indicated that bimodally-presented information can be integrated for decision making. However, there was no evidence of an advantage to bimodal presentation as a means of unburdening an overloaded sense. The implications of the results for displays and communications in complex control centers are discussed and directions for future research are suggested. Author (TAB)

N66-21392# Air Force Systems Command, Bedford, Mass. Decision Sciences Lab.
EFFECT OF INTENSITY CHANGES IN AUXILIARY STIMULI ON AUDITORY AND VISUAL SIGNAL DETECTION
William H. Watkins Dec. 1965 63 p
(ESD-TR-66-121; AD-628188) CFSTI: HC $3.00/MF $0.75

Results of automated tone detection experiments are reported. Subjects were required to identify one of four short intervals as having contained a weak, earphone-presented, auditory signal. These experiments involved approximately 20,000 trails. Each experiment employed at least two lighting conditions. In general, when the light source intensified during the intervals, detection was superior to that occurring when the light diminished at corresponding times. The findings are compared with the results of analogous experiments involving visual signal detection under several conditions of auditory stimulation. Some possible explanations for consistencies in the two kinds of experiments are considered, and individual differences are discussed. Author (TAB)

N66-34499# Joint Publications Research Service, Washington, D. C.

THE RATE OF THE RECEPTION OF INFORMATION BY MAN AND THE CONSCIOUS-VOLUNTARY CONTROL OF HUMAN ACTIVITY

O. A. Konopkin *In its* Cybernetics and Automation 17 Aug. 1966 p 121-129 (See N66-34486 20-05) CFSTI: $6.00

Consideration is given to determining the operator rate of transmitting information from the indicating elements to the control elements in a complex control system. The initial assumptions in studying man as a communication system are connected with the recognition of the amount of the stimulus information determined by the probability relationships in a series of signals. Data were obtained which indicate that the rate of the reception of information by man depends on the conscious-voluntary control by him of his activity. Two groups of experiments are emphasized: the first pertains to a study of the signal presentation rate, and the second is associated with the probability role of the signals. C.T.C.

N66-34500# Joint Publications Research Service, Washington, D. C.

A STUDY OF THE RATE OF INFORMATION PROCESSING BY HUMAN OPERATOR IN SOLVING THE PRACTICAL PROBLEMS OF ENGINEERING DIAGNOSTICS

A. I. Galaktionov *In its* Cybernetics and Automation 17 Aug. 1966 p 130-148 (See N66-34486 20-05) CFSTI: $6.00

An investigation was made of man's information processing rate in connection with a "man-machine" system in order to determine: (1) what portion of the information flow running from the controlled object has to be directed into the automatic device, (2) how many control boards are necessary for each specific production facility, and (3) how to evaluate quantitatively the methods and means of presenting the information. Relative to this an experiment was conducted in which K (number of components of an event) signals were presented simultaneously, one from each component; and the subject's task was to name all of the signals presented. Basic formulations were that each event was identified by several signs, and that each successive sign was dependent on the sign selected at the preceding step of a complex multi-step selection. A distinguishing aspect of the investigation was the approximation of the actual working conditions. C.T.C.

N66-34501# Joint Publications Research Service, Washington, D. C.

THE DEPENDENCE OF THE SELECTION REACTION TIME ON THE AMOUNT OF INDIVIDUAL AND AVERAGE INFORMATION

Ye. P. Krinch... *In its* Cybernetics and Automation 17 Aug. 1966 p 149-155 refs (See N66-34486 20-05) CFSTI: $6.00

A comparative study was conducted on the influence of two information measures, average information and amount of information, on the reaction time of selection by a human operator. Experimental data were obtained in 420 experiments with six subjects being tested, and a total of 240 reactions were measured in each experiment. The results indicate that the two information measures being compared produce an effect which is considerably different both in character and in magnitude. It is shown that the degree of selection complexity exerts a considerably more substantial influence on man's behavior in the situation of selection than the degree of signal unexpectedness. The study also has shown that two interconnected types of uncertainty, time uncertainty and alternative uncertainty, are contained in a situation simulating the process of information transmission, and that man copes with time uncertainty considerably easier than with alternative uncertainty. A.G.O.

N67-11527# Joint Publications Research Service, Washington, D. C.

THE SPEED OF THE PERCEPTION AND PROCESSING OF INFORMATION BY A PILOT UNDER ORDINARY AND EMERGENCY CONDITIONS

L. S. Isaakyan *In its* Probl. in Aerospace Med. 21 Oct. 1966 p 239-241 (See N67-11401 02-04) CFSTI: $8.40

Methods for calculating the throughput capacity of pilots are developed for normal and emergency flight conditions. It is also shown that from the information theory viewpoint, the throughput capacity of a flier necessary for the perception and comprehension of an emergency situation in the form of an engine failure can be calculated as the product of the objective probability of the given failure for the magnitude, return time, and comprehension of the situation. A.G.O.

N67-16971*# System Development Corp., Dayton, Ohio.
DEVELOPMENT AND APPLICATION OF COMPUTER SOFTWARE TECHNIQUES TO HUMAN FACTORS TASK DATA HANDLING PROBLEMS Final Report, 21 Jun. 1965–21 Jun. 1966

K. W. Potter, A. T. Tulley, and Lawrence E. Reed (AMRL) Wright-Patterson AFB, Ohio, AMRL, Dec. 1966 73 p refs
(NASA Order R-115; Contract AF 19(628)-3418)
(NASA-CR-82368; AMRL-TR-66-200) CFSTI: HC $3.00/MF $0.65 CSCL 09B

The application of techniques for handling data generated in support of aerospace system development programs is discussed. It is recognized that the techniques must be developed in context with their total operative environment. A concept of an operational data management system for storing, processing, and retrieving human factors task data in a government–contractor environment is discussed and illustrated. This concept is predicated on the assumption that a user-oriented computerized data system will help draw human factors specialists closer to their data. Five problem areas, considered to be fundamental to the development of data handling techniques, were researched. These areas are: (1) analysis of human factors task data, data relationships, and classification schemes; (2) application of vocabulary and thesaurus techniques to increase the effectiveness of communication among man–machine–software functions; (3) application of computer storage and retrieval techniques to human factors task data; and (4) application of current awareness techniques to provide notifications of data availability.

Author

N67-19902*# New York Univ., N. Y.
A DIFFUSION MODEL OF PERCEPTUAL MEMORY
R. A. Kinchla and F. Smyzer 30 Jan. 1967 34 p refs
(Grant NGR-33-016-067)
(NASA-CR-82958; I-67-1) CFSTI: HC $3.00/MF $0.65 CSCL 05J

A model is presented of the perceptual process through which an observer decides whether two stimuli are the same or different, with emphasis on the role of perceptual memory in such tasks. The results of two experiments, one visual and one auditory, are presented which illustrate the model's application and suggest its validity.

Author

A66-81611
AGE DIFFERENCES IN THE RATE OF GAIN OF INFORMATION, SIGNAL DETECTION STRATEGY AND CARDIOVASCULAR STATUS AMONG PILOTS.
J. Szafran (Lovelace Found. for Med. Educ. and Res., Dept. of Expti. Psychol., Albuquerque, N. Mex.)
Gerontologia, vol. 12, no. 1, 1966, p. 6–17. 23 refs.

A description is given of work in progress which aims to sketch an "aging profile" of capacities of professional pilots from the standpoint of cardiovascular and pulmonary physiology and of experimental psychology. The design of the psychological experiments is intended to reflect the fact that flying requires, inter alia, making high-speed decisions and detecting low probability and low intensity signals, as well as an ability to receive and retain significant amounts of information in the course of routine control procedures. Measures of "reserve channel capacity" and "threshold resistance" reveal that in a sample of some 200 active pilots, age differences are less impressive than would be expected from gerontological literature. The individual differences in some of the relevant modalities of performance are, however, related to cardiovascular status among perfectly healthy men. Some methodological implications of these data are briefly considered.

A66-82021
METHODS OF MEASURING THE VELOCITY OF INFORMATION TRANSMISSION OF VARIOUS VISUAL SIGNALS [METODY IZMERENIIA SKOROSTI PERENOSA INFORMATSII PRI RAZLICHENII ZRITEL'NYKH SIGNALOV].
Iaro Krzhivoglavy (Cnetral Profess. Union Soviet. Sci.–Res. Inst. of Ind. Safety, Prague, Czechoslovakia).
Voprosy Psikhologii, no. 2, Mar.–Apr. 1966, p. 160–165. 7 refs. In Russian.

A modified Landolt method is discussed in which the table is substituted by rings, each with 8 to 12 breakpoints. The method can be used in diagnostic psychology for measuring the effect of inadequate working conditions or for the appraisal of light and technical requirements. In general, this method can be used for determination of visual signals of various characters, applying only one-factor-information expressed in bits per second.

A66-82033
INTENSITY-TIME RELATIONSHIP AND PERCEIVED SHAPE.
H. W. Leibowitz, Sharon E. Toffey, and John L. Searle (Pa. State U., University Park).
Journal of Experimental Psychology, vol. 72, Jul. 1966, p. 7–10. 12 refs.
Grant NIMH MH06061.

The effect of exposure duration on perceived shape was determined for intensity-time combinations which were adjusted to produce an equal amount of effective photolytic energy in accordance with the reciprocity relationship. Matched shape tends to remain constant for the shorter exposure durations, but increases with exposure duration, particularly above the critical duration of 0.1 sec. The results are interpreted as reflecting the importance of temporal summation within the visual system in the perception of shape, and the critical contribution of time, independent of intensity, in the manifestation of the tendency toward shape constancy.

A66-82238
SEARCH PERFORMANCE AS A FUNCTION OF PERIPHERAL ACUITY.
Dorothy M. Johnston (Boeing Co., Seattle, Wash.).
Human Factors, vol. 7, Dec. 1965, p. 527–535. 14 refs.

This study was made to investigate the relationship between the size of visual fields of observers and time required to locate targets on statistic displays. The findings, which indicate that people with large visual fields can find targets more rapidly than observers with small fields, have practical selection and training application. Equations are presented which can be used to determine search time that can be expected as a function of the size of the visual field of the observer and the apparent size of the area being searched.

A66-82386
VISUAL AND AUDITORY STORES IN SHORT-TERM MEMORY.
Bennet B. Murdock, Jr. (Mo. U., Dept. of Psychol., Columbia).
Quarterly Journal of Experimental Psychology, vol. 18, Aug. 1966, p. 206–211. 12 refs.
Grant NIMH MH 10,882.

If retrieval in short-term memory can be either from a preperceptual sensory store or from a post-perceptual memory then recall should vary as a function of input into sensory store. To test this possibility two experiments with paired associates compared visual and auditory presentation under conditions as comparable as possible. In both experiments modality interacted with retention interval: more recency with auditory but, in Experiment I, more primacy with visual. The interaction was taken as support for the hypothesis. An alternative hypothesis (that storage is post-perceptual but not a-historical) is discussed and weak negative evidence is presented.

A67-80150
BISENSORY SIGNAL DETECTION.
Milton D. Suboski (Ind. U., Bloomington).
Psychonomic Science, vol. 6, Sep. 15, 1966, p. 57–58. 12 refs.
Grant NSF GB-2843.

In an experiment comparing unimodal with bimodal signal detection, groups of subjects performed a four-alternative spatial forced-choice visual and a "yes–no" auditory task either singly or simultaneously. The results showed a significant decrement in bisensory visual discriminability and a comparable decrement in bisensory auditory performance, with little evidence for other interactions between tasks.

A67-80289

THE HERITABILITY OF VISUALIZATION, PERCEPTUAL SPEED AND SPATIAL ORIENTATION.

R. Travis Osborne and A. James Gregor (Ga. U., Athens and Tex. U., Austin).

Perceptual and Motor Skills, vol. 23, Oct. 1966, p. 379-390. 50 refs.

Thirty-three pairs of MZ twins and 12 pairs of like-sexed DZ twins, 32 boys and 58 girls, 40 of whom were Negro and 50 white, whose ages ranged from 13 to 18, were given a battery of psychological tests which included (1) the Surface Development Test, (2) Porteus Mazes, (3) the Newcastle Spatial Test, (4) the Paper Folding Test, (5) the Identical Pictures Test, Perceptual Speed, (6) the Objective-Aperture Test, Form B, and (7) Cube Comparisons. Using three different heritability ratios, (1) The Holzinger heritability coefficient, (2) the Heritability ratio proposed by Nichols, and (3) the F ratio (Block), the relative intra-pair similarity of MZ and like-sexed DZ twins on the selected perceptual tasks was determined. All the MZ correlations were greater than the corresponding rs for the DZ twins. Four of the nine differences were significant (p .05). The range of heritability coefficient ratios (Holzinger) was from .15 to .89, with MZ intraclass rs ranging from .46 to .91 and DZ rs from .08 to .72. The agreement among tests suggests that the mental abilities represented are independently inherited with as much as 89% of the within-family variance accounted for by hereditary factors.

A67-80507

PRELIMINARY FINDINGS ON SOME EFFECTS OF VERY FAST SEQUENTIAL INPUT RATES ON PERCEPTION.

Im. S. Mayzner, M. E. Tresselt, and A. Cohen (N.Y. U., New York City).

Psychonomic Science, vol. 6, Dec. 25, 1966, p. 513-514. 7 refs.

A study was made of the effects of presenting to the visual system a string of very fast sequential inputs, employing computer-based CRT display system. The results showed that for either five or ten inputs (i.e., all Xs, random letters, letters forming a work, or small line segments) approximate the first half of these sequentially presented inputs were not perceived, if display order was irregular and display input rate was fixed at certain values between clear simultaneity and clear sequentiality.

A67-80599

VISUAL AND ACOUSTIC CONFUSABILITY IN A VISUAL SEARCH TASK.

G. A. Kaplan, A. Yonas, and A. Shurcliff (Cornell U., Ithaca, N. Y.).

Perception and Psychophysics, vol. 1, Jun. 1966, p. 172-174. 18 refs.

Grant U.S. OE 6-10-156.

Visual and acoustic confusability between a target item and background items was varied in a visual search task. Visual confusability was a highly significant source of difficulty while acoustic confusability had no effect. The results do not seem to be interpretable within a theory which assumes compulsory auditory encoding of visual information.

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A63-13640

DESIGN CONCEPTS FOR DOME TYPE HELMET IMPROVEMENTS. Roscoe G. Bartlett, Jr. (U.S. Naval School of Aviation Medicine, Pensacola, Fla.)

Aerospace Medicine, vol. 34, Mar. 1963, p. 213-217.

Proposed modification of the dome-type pressure-suit helmet based on an adaption of a device designed to conserve oxygen, prevent hyperventilation, and humidify the inspired dry oxygen. The design of the humidity exchanger of the helmet is described, including (1) the mouthpiece which can be used by the aviator if he wishes; (2) the breathing duct, which also acts as a condenser by serving as a heat exchanger between the expired gases and the atmosphere inside or outside the helmet; (3) the humidity collection chamber; (4) a valved expiratory duct which carries the last portion of each expiration into the pressure suit; (5) an inspiratory opening; (6) the wicking membrane, which - ideally - should not pass gases but should pass moisture freely by capillarity; (7) the bellows; (8) the vent duct for bellows movement; and (9) the oxygen delivery system.

N63-12844 National Academy of Sciences, Washington, D.C. IMPACT ACCELERATION STRESS. A SYMPOSIUM HELD AT BROOKS AIR FORCE BASE, SAN ANTONIO, TEXAS, NOVEMBER 27-29, 1961 [UNDER THE AUSPICES OF THE MAN IN SPACE COMMITTEE OF THE SPACE SCIENCE BOARD, NATIONAL ACADEMY OF SCIENCES]

Robert Hume, ed. 1962 494 p 1152 refs Contains a comprehensive chronological bibliography

(Supported by NASA Grant, AF, and Navy)

(NAS-NRC/Pub-977) Available from NAS: $3.00

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N63-12844 3074

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N63-12852 Cornell U. Automotive Crash Injury Research, New York, N.Y.

CAUSES OF IMPACT INJURY IN AUTOMOBILE ACCIDENTS

Robert A. Wolf *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 45-59 2 refs (See N63-12844 07-16) NAS: $3.00

A ranking procedure which provides a measure of the order of importance of ten causes of impact injury in automobile accidents is presented. The causes are discussed in terms of their variation with six categories of impact: all directions lumped, then front, side, rear, principal rollover, and other. Five of the ten features of automobile interiors emerge as consistent major causes of injury. They are: instrument panels, windshields, steering assemblies, door structures, and ejection. Some other causes appear dominant only under certain directions of impact; for example, top structures emerge as a strong cause only in rollover. These results are based on accident-injury experience in the pre-seat-belt era in the United States. The ranking procedure used here is not a substitute for detailed and controlled analysis, as it is essentially a tabulation process, but it has several important uses: (1) It provides an overview of the type of research which Automobile Crash Injury Research performs. (2) It provides some indication of an order or priority for automobile designer in his efforts toward building safer cars. (3) It provides clues for guidance of further study and research. I.v.L.

N63-12853 Wayne State U., Detroit, Mich.

HUMAN AND ANIMAL IMPACT STUDIES IN U.S. UNIVERSITIES

Herbert R. Lissner *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 61-67 (See N63-12844 07-16) NAS: $3.00

Human and animal impact studies in U. S. universities deal with the following three categories: (1) programed automobile crashes, either actual or simulated; (2) investigations of actual on-the-road automobile crashes after they have occurred; and (3) laboratory investigations which attempt to relate the extent and severity of the injury produced to the parameters of the impact responsible for the injury. I.v.L.

N63-12854 Ford Motor Co. Product Study Engineering Office, Detroit, Mich.

AUTOMOTIVE IMPACT

A. L. Haynes *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 69-82 (See N63-12844 07-16) NAS: $3.00

An outline is presented for some of the techniques employed for obtaining factual data on automotive impacts. These research studies have been conducted as part of an ever-expanding program to develop design features and methods for reducing occupant injuries in actual accidents. Some values of human tolerance to impact forces have been estimated by comparisons of actual accidents and occupant injury with the force and kinematic data obtained in research impact studies. Techniques have been developed for predicting the loading patterns and structural behavior characteristics which can be anticipated under particular crash-impact conditions. However, much less is known about the human response to impact loading. Studies in this field are underway at various medical centers, frequently with the financial sponsorship of automobile manufacturers. Statistical analysis of accidents involving late model cars have demonstrated that at reduction in occupant injuries already has been achieved. I.v.L.

N63-12855 Stanley Aviation Corp., Denver, Colo.

IMPACT STUDIES OF THE UNITED STATES AEROSPACE INDUSTRY

Galen A. Holcomb *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 83-119 31 refs (See N63-12844 07-16) NAS: $3.00

A survey of impact studies of the United States aerospace industry indicated the following needs: (1) Further animal studies and experiments, including a comprehensive study of comparative anatomy and tissue strength, to obtain valid endpoint data without the use of human subjects. Present human endpoint data in the impact regime is too sparse to be of statistical significance. (2) Studies to determine tolerance to complex accelerations, including abrupt pulses superimposed on sustained acceleration. (3) Intensive analytical studies to evolve usable mathematical techniques in order to facilitate design and reduce long, costly test-programs. I.v.L.

N63-12859 Harvard U. Medical School, Boston, Mass.

STEERING WHEEL IMPACT

Murray Burnstine *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 135-139 1 ref (See N63-12844 07-16) NAS: $3.00

(PHS Grant RG-6084)

The manner in which various automobile steering wheels have been observed to function as either injury-producing or protective structures is studied. The steering wheels were first studied at the scene of fatal collisions, where their deformation and deviation from the installed position was recorded. The steering wheels and often the complete steering-wheel mast-jacket assemblies were subsequently removed for more detailed laboratory analysis. Results indicated that the recessed-hub steering-wheel design functions as a load-limiting device while yielding. Its effectiveness is due in part to the ability of the human body to deform and distribute the total load among adjacent structures. When the load application is through the relatively large circumference rim as compared to the hub, the resulting shearing stress is reduced considerably. Bruising, due to local high unit bearing or contact pressures, can be reduced by increasing the projected area of the steering wheel rim. Most of the energy absorption characteristics of the wheel assembly are dependent on spoke design, and a thicker rim would reduce contact pressures for both the axial- and radial-impact modes. I.v.L.

N63-12860 General Motors Corp. Research Labs. Div., Detroit, Mich.

CRITERIA FOR INJURY POTENTIAL

Charles W. Gadd *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 141-144 3 refs (See N63-12844 07-16) NAS: $3.00

Criteria for injury potential of automotive instrument-panel paddings, visors, projections, etc., is presented. The three criteria for injury potential are: (1) the selection of a crushable material on the basis of its load deflection properties, obtained at some arbitrary rate of loading and unloading; (2) the rate of loading which may be taken into account only by selecting test impacting hammer velocity or velocities most representative of actual accidents, for which one must resort to statistics of accidents as well as studies of car and occupant kinematics in the accident; and (3) the yielding and energy absorption of the underlying or surrounding structure. I.v.L.

N63-12862 Michigan U., Ann Arbor

IMPACT DAMAGE TO INTERNAL ORGANS

Lawrence M. Patrick (Wayne State U., Detroit) and F. Gaynor Evans *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 159-171 7 refs (See N63-12844 07-16) NAS: $3.00

(PHS Grants RG-A-3865(C2) and RG-6384(C2))

Contusions, lacerations, and ruptures of the thoracic, abdominal, and pelvic viscera, arising from the various types of stresses and strains produced by impacts to different parts of the human body in automobile and aircraft accidents, are discussed. Results indicate that damage or injury produced in the human body by acceleration is due to the internal organs behaving as viscoelastic materials. Furthermore, the magnitude of the stress and acceleration, or dynamic response, can be increased by the elasticity of the human torso, as is known from the theory of elastic structures. I.v.L.

N63-12863 Aeronautical Systems Div. Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio

COMPARISON OF THE DYNAMIC CHARACTERISTICS OF DUMMIES, ANIMALS AND MAN

Rolf R. Coermann *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 173-184 6 refs (See N63-12844 07-16) NAS: $3.00

Man, animals, and dummies have different dynamic characteristics which can be determined by measurement of the mechanical impedance under steady-state vibration. While the parameters of the dummies are constant for a wide range of acceleration amplitude and pulse duration, the response of living organisms depends upon the magnitude of the applied force. The theory of impact explains the relationship of whole-body resonances to the response to impacts with varying pulse durations. By measuring the transmitted force to the body during impact, the change of the fundamental frequencies of the test subject can be detected. Transmission factor and phase shift are revealing criteria of this test method. Before using substitutes for man in dynamic tests, their dynamic characteristics for the type of excitation studied must be carefully tested, and any conclusion from such a dynamic test must be related to the proper parameters of man. I.v.L.

N63-12870 Royal Air Force. Inst. of Aviation Medicine, Farnborough (Gt. Brit.)

SOME CURRENT IMPACT STUDIES IN GREAT BRITAIN

J. C. Guignard *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 301-311 2 refs (See N63-12844 07-16) NAS: $3.00

This paper gives a general outline of some of the work which has been done in recent years or is currently in progress in Great Britain in the field of impact acceleration stress. Emphasis is on the work of the Royal Air Force Institute of Aviation Medicine, Farnborough. There is yet no official British-manned spaceflight program. Consequently, there is no work on impact or vibration being done in Government establishments which is specifically related to problems in space medicine. Acceleration research at I.A.M., for example, is directed solely to current problems in service aviation medicine. Author

N63-12871 Air Force Systems Command. Bioastronautics Office, Andrews AFB, Md.

USAF IMPACT ACCELERATION PROGRAM AND FACILITIES

Willard R. Hawkins and Rufus R. Hessberg *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 313-322 (See N63-12844 07-16) NAS: $3.00

The program and its facilities are discussed. The purpose of the program is to establish criteria for design of manned aerospace vehicles in which accelerations, decelerations, buffeting, impact, and pressure differentials are to be encountered during any normal or emergency phase of flight. I.v.L.

N63-12872 Harvard U. Medical School, Boston, Mass.

PATH OF BODY TRAVEL

Alfred L. Moseley *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 323-331 (See N63-12844 07-16) NAS: $3.00

(PHS Grant RG-6084)

General characteristics of the direction of motion of occupants inside vehicles involved in right-angle, rear-end, and fixed-object collisions are described. Three generalizations may be made from sample clinical cases illustrating factors concerned with the path of body travel in the case of sudden deceleration: (1) The design of structures for the purpose of protecting an occupant during deceleration must take into account the location of the impact site. (2) Since multiple impacts occur between vehicles and structures which they hit, deceleration protection must take into account, not only an initial impact, but also the series of impacts which follow between the occupants and the vehicle. (3) Since deaths occur from missiles, a factor which should be of concern in deceleration geometry is the design of enclosures for storage or transportation of equipment, for example the fixation of a tool box in the trunk of an automobile. I.v.L.

N63-12874 Minnesota U., Minneapolis

AUTOMOTIVE HUMAN CRASH STUDIES

James J. Ryan *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 345-353 6 refs (See N63-12844 07-16) NAS: $3.00

The purpose of automotive human crash studies was to invent and test mechanical designs to reduce the destructive forces of collision on automotive and airspace passengers. Developments which have been produced and tested in this laboratory include engineered automatic seat belts, hydraulic shock absorbing bumpers, a large padded steering post with a short travel absorber and a retracting steering wheel rim for the driver, and a dash recessed under the windshield in front of the passenger. With judicial padding, the flailing of the arms and the legs of the body held by the seat belts are further protected from injuries. I.v.L.

N63-12875

INVESTIGATIONS ON LONG-STRETCHING BODY RESTRAINTS

Bertil Aldman (Bromma, Sweden) *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 355-360 3 refs (See N63-12844 07-16) NAS: $3.00

The use of long-stretching straps for restraint in an automobile where the space is so limited that upper torso restraint is denied is discussed. The use of such straps means that even with very high rate-of-onset of deceleration for the automobile, the rate-of-onset of deceleration for the restrained body will be governed by the stretching properties of the straps. Neither the time delay nor the deceleration pattern of the automobile will be of much influence if if the stretching properties of the restraint are such that the deceleration of the occupant is tolerable under the worst possible conditions. I.v.L.

N63-20914 Deutsche Versuchsanstalt für Luft- und Raumfahrt, Porz (W. Germany)

THEORETICAL STUDIES OF THE TOLERANCE OF AUTOMOBILE SAFETY BELTS TO ABRUPT DECELERATIONS AND SHOCK TESTS [THEORETISCHE BETRACHTUNGEN UBER DIE VERTRAGLICHKEIT STOSSFURMIGER VERZOGERUNGEN UND STOSSVERSUCHE MIT ANSCHNALLGURTEN FUR AUTOS]

H. L. Vogt Apr. 1963 (51 p) 38 refs In GERMAN (DVL-266)

The theoretical basis of human tolerance to shock type deceleration forces is discussed. After a survey of the present use of safety belts in aircraft and automobiles, shock studies with safety belts were conducted in aircraft and automobiles at the Institute of Flight Medicine of the German Research Institute for Air and Space Travel. The deceleration was 3 to 4 g over a period of 0.1 sec. The behavior of the test subject in the belt was recorded by slow motion and by photographs. The shoulder-abdomen safety belt gave best support for sport pilots and sail planes. The three-point contact belt and the two-point contact belt gave the body good support in automobiles. The three-point contact belt is preferred because of the larger supporting area. Abdomen belts are not recommended for automobiles. The test results are discussed in the light of tests and experiences with safety belts in aviation. Trans. by I.v.L.

A64-25551

PATHOLOGY AND PHYSIOLOGY OF GUINEA PIGS UNDER SELECTED CONDITIONS OF IMPACT AND SUPPORT-RESTRAINT.

C. F. Lombard, S. Davis Bronson, F. C. Thiede, Perry Close, and F. M. Larmie (Northrop Corp., Northrop Space Laboratories, Biodynamics Laboratory, Hawthorne, Calif.).

(Aerospace Medical Association, Annual Meeting, 35th, Miami, Fla., May 11-14, 1964.)

Aerospace Medicine, vol. 35, Sept. 1964, p. 860-866. 6 refs.

Study of the use of guinea pigs to examine the problem of human tolerance to and survival under impact conditions. Guinea pigs oriented transversely to the forcing function ($\pm G_x$ and $\pm G_y$) and with a fully contoured rigid support-restraint system survived exposure to 240 G for 3 millisec at 100,000 G/sec onset. Recoverable pulmonary hemorrhage and shock were incurred. Some minor laceration of liver and spleen was infrequently observed, but this is apparently recoverable. However, if the head of the animal was not properly restrained, fatal injury resulted from (1) stretching of brain stem with no head restraint, (2) compression of brain stem with improper heat restraint permitting rotation of head on cervical spine at the atlanto-occipital joint, and (3) cerebral hemorrhage when head restraint was loose, permitting rebound of head against the rigid support. Without contoured support (flat) laceration of abdominal viscera was severe in the $+G_x$ orientation. Guinea pigs oriented headward or tailward ($\pm G_z$) to the forcing function at the 240-G level did not survive the severe visceral lacerations, although the pathology incurred indicates that the headward acceleration ($+G_z$) could be survived at a higher level than the tailward ($-G_z$) acceleration if the displacement of the abdominal viscera is minimized by proper containment.

A64-27026

BIODYNAMIC PROBLEMS OF AERONAUTICS AND ASTRONAUTICS [BIODYNAMISCHE PROBLEME DER LUFT- UND RAUMFAHRT].

Rolf Coermann (Max-Planck-Institut für Arbeitsphysiologie, Dortmund, West Germany; USAF, Systems Command, Aerospace Medical Div., Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio).

IN: WISSENSCHAFTLICHE GESELLSCHAFT FÜR LUFT- UND RAUMFAHRT E. V. (WGLR), JAHRESTAGUNG IN BRAUNSCHWEIG VOM 9. BIS 12. OKTOBER 1962, JAHRBUCH.
Edited by Hermann Blenk.
Braunschweig, Friedrich Vieweg und Sohn, 1963, p. 581-591; Discussion, p. 591, 592. 14 refs. In German.

Discussion of the dynamic factors of the human body and the space environment that affect pilot efficiency. The significance of the dynamic characteristics of the skin and muscular system for the protection of hearing is examined, as is the effect of mechanical vibrations of various frequencies upon human efficiency. Mechanical impedance curves for the entire human body are presented, and the variability of these curves is illustrated as a function of body position restraining-system effects. The relation between the dynamic behavior of the human body and the resistance to vibration is explained. The theoretical aspects of the effect of shocks upon a human body are outlined, the limits of human endurance are noted. Some results obtained with animals and anthropometric dummies are presented. V. P.

A64-80320

FUNDAMENTAL ASPECTS OF IMPACTS TO THE HUMAN BODY.

L. M. Patrick (Wayne State U., Detroit, Mich.)

IN: Conference on the Effects of Shock and Vibration on the Human Body, Denver, Colo., Mar. 13–14, 1964, p. 42–56. 9 refs.

The following list of conditions and contributing factors must be considered when the overall effect of impact to the human body is to be studied: (1) direction of impact; (2) duration of impact; (3) magnitude of acceleration induced by the impact; (4) size and shape of the impacting surface; (5) effects of acceleration on the organs and body components; (6) dynamics of the body component and the impacting device; and (7) interaction between the hydraulic surge and muscular and ligamentous attachments on remote areas. For injury prediction, the response acceleration is preferred over the input acceleration since the amplification due to the spring mass system is automatically included. Injury from impact cannot be predicted accurately from an analysis of a spring mass model. The strain in some parts of the vertebral column is far greater than indicated by the dynamic analysis. Cushions attenuate impact accelerations if the impact does not cause a relative displacement greater than the allowable cushion deflection. With larger displacement, cushions cause an overshoot of the acceleration response that can produce serious injury. Impacts can cause damage to organs and bones far from the point struck. Hydraulic surge from a chest impact can cause hemorrhaging in the eyes. Intracranial pressure caused by acceleration and skull deformation in head impacts produces shear strains in the brain stem area resulting in concussion.

A64-80557

"WHIPLASH" INJURIES.

John J. Dowling (Jefferson Med. School, Philadelphia, Pa.)

American Association of Industrial Nurses Journal, vol. 12, May 1964, p. 12–15, 34–35.

Various aspects of the mechanics of whiplash injury are discussed in the light of more recent information. Sites of injury in the neck and vertebral column are identified and discussed from a clinical point of view. Symptoms and specific effects in damaged areas are described. The significance of diagnosis by X-ray is stressed, and treatment by immobilization and rest recommended.

A64-80686

MOTOR VEHICLE ACCIDENTS OF FLYING AND NON-FLYING AIR FORCE PERSONNEL.

Martti J. Karvonen (Inst. of Occupational Health, Helsinki, Finland).

Aerospace Medicine, vol. 35, Aug. 1964, p. 739–740. 11 refs.

The hospital admissions and deaths from motor vehicle accidents in the United States Air Force were approximately 1.8 times as frequent among the nonflying as among the flying personnel. The rates for officers were from one half to one third of those of the corresponding total Air Force population. Even among the officers, the rates of the flyers tended to be lower than those of the nonflyers. Mortality from other injuries, i.e., primarily from aircraft accidents, is high among the flying personnel, but this is not reflected in the hospital admission rate. The mortality from motor vehicle accidents is compared with United States national figures for men of different ages. The effect of the age structure of the populations and of exposure is discussed. The conclusion appears valid that Air Force selection and/or flight training decrease the risk of motor vehicle accidents.

A65-10732 *
TUTORIAL SESSION IN BIODYNAMICS.
John P. Stapp (USAF, Brooks AFB, Tex.).
IN: ANNUAL ROCKY MOUNTAIN BIOENGINEERING SYMPOSIUM, FIRST, U. S. AIR FORCE ACADEMY, COLORADO SPRINGS, COLO., MAY 4, 5, 1964, PROCEEDINGS.
Symposium sponsored by the U. S. Air Force Academy and the Committee on Electrical Techniques in Medicine and Biology, Institute of Electrical and Electronics Engineers.
Edited by Grover J. D. Schock.
Colorado Springs, U. S. Air Force Academy, 1964, p. 113-122.

Study of the physiological effects of abrupt decelerations, such as those expected for the parachute landing impacts of the Apollo space capsule. Humans and anesthetized animals were studied on a sled accelerated on rails by a pneumatic catapult and stopped by a water inertia brake. Subjects were decelerated abruptly from brake entry velocities of 20 to 45 fps to stop in 4 to 34 in. The human subjects, in 16 body orientations, were exposed to stopping distances of 17 to 34 in. for seven different conditions of impact rate, duration, and magnitude simulating different types of landing surfaces. Autopsies on two of the animals (a black bear and a chimpanzee) are discussed, as are selected tests of the human subjects. The results indicate a safe limit of 25 peak G, provided body restraints minimize adverse displacements. It is recommended that inflatable air cushions be installed on either side of the head rest in the Apollo capsule to prevent hyperflexion of the neck.

P.K.

A65-11395
A COMPARISON OF METHODS FOR THE EVALUATION OF PROTECTIVE HEADGEAR.
J. B. Roberts and E. H. Hygh (U.S. Naval Ordnance Laboratory, Corona, Calif.; Utah, University, Physics Dept., Salt Lake City, Utah).
Aerospace Medicine, vol. 35, Nov. 1964, p. 1044-1047. 7 refs.

Mathematical analysis of the swingaway and rigid anvil systems for the impact testing of helmets used for vehicular and sports protection. It is noted that nonresilient helmet liners are apt to fare better on the swingaway device. As an illustration, it is assumed that the helmet liner is capable of absorbing a total of 120 ft-lb of energy. On a swingaway test in which the input energy is 120 ft-lb, the energy available for conversion to heat on the first blow is about 60 ft-lb, and the helmet quite likely will stand another blow of the same magnitude. On the other hand, if the same input energy is used in an anvil test, over 100 ft-lb is converted to heat on the first blow, and there is absolutely no chance for the nonresilient liner to withstand a second blow. This is seen to be an important consideration in the testing of any helmet destined for use in an environment where multiple blows are to be expected. Possible cavitation damage is also found to be best indicated by a fixed-anvil test.

W.M.R.

A65-30023
FUNDAMENTAL ASPECTS OF IMPACTS TO THE HUMAN BODY.
L. M. Patrick (Wayne State U., Detroit, Mich.)
Journal of Environmental Sciences, vol. 7, Oct. 1964, p. 25-29. 9 refs.
Grants No. PHS-G-AC-00054-05 and PHS-G-DE-01416-03.

The problem of determining human tolerance levels to impact injury is a difficult one to solve because of the limited amount of human experimental evidence and because of the number of variables involved. The use of cadavers and animals is suggested. The author discusses factors in the dynamics and responses of the human body to acceleration and impact on the head. Seat cushions and the dynamic load factor are related to jerk and mean acceleration levels. Factors to be studied when considering the overall effect of impact are the direction, duration, and magnitude of impact, the impacting surface, effects of acceleration, dynamics of the body and impacting device, and the interaction between the hydraulic surge and the muscular and ligamentous attachments on remote areas.

A66-30480
DESIGN OF A DEVICE TO TEST ABRUPT DECELERATIONS FROM HIGH VELOCITIES.
F. J. Fisch and L. M. McClernan (Aircraft Armaments, Inc., Cockeysville, Md.).
IN: INSTITUTE OF ENVIRONMENTAL SCIENCES, ANNUAL TECHNICAL MEETING, SAN DIEGO, CALIF., APRIL 13-15, 1966, PROCEEDINGS. [A66-30434 16-11]
Mt. Prospect, Ill., Institute of Environmental Sciences, 1966, p. 367-384. 14 refs.
Contract No. AF 33(615)-2961.

Development of a facility concept which would provide a device in which present-day and future air crash events can be simulated in order to permit evaluation of seating and restraint systems, structural dynamics, etc., for aircraft and spacecraft. The facility concept consists of a rail-guided test carriage which can be driven in a circular path, like a centrifuge, to develop long-term, relatively low-level acceleration or, in a linear manner, to simulate short-time, large-velocity-change impact-deceleration events. In addition, these two sections of the facility can be combined, through the use of a suitable switching mechanism, to provide the capability of simulating a situation, such as orbital reentry, which involves a long-term, low-level deceleration terminated by high-g impact. It is considered that a facility such as that described is needed to solve design and safety problems in the coming decade.

F.R.L.

A66-32146 #

CRASH AND BALLISTIC PROTECTIVE FLIGHT HELMETS.

Abraham L. Lastnik (U.S. Army, Natick Laboratories, Natick, Mass.).

IN: AEROSPACE MEDICAL ASSOCIATION, ANNUAL SCIENTIFIC MEETING, 37TH, LAS VEGAS, NEV., APRIL 18-21, 1966, PREPRINTS. [A66-32134 17-04]
Washington, D.C., Aerospace Medical Association, 1966, p. 38-40. 8 refs. Abridged.

Discussion of a new U.S. Army crash helmet which retains the configuration of the standard helmet but increases crash protection by using improved energy-dissipating materials. The shell of the new helmet is made of a laminated nylon fabric instead of glass cloth. Fabrication details are given. Impact and ballistic tests showed the new helmet to be consistent in design and construction.
F.R.L.

A66-32187 #

THE RESPONSE OF SQUIRREL MONKEYS TO HIGH ACCELERATIVE FORCES OF BRIEF DURATION.

Bruce W. Pinc and John N. Mehelas (Space/Defense Corp., Birmingham, Mich.).

IN: AEROSPACE MEDICAL ASSOCIATION, ANNUAL SCIENTIFIC MEETING, 37TH, LAS VEGAS, NEV., APRIL 18-21, 1966, PREPRINTS. [A66-32134 17-04]
Washington, D.C., Aerospace Medical Association, 1966, p. 189, 190. 9 refs. Abridged.

Survey of small simian response to very high g, demonstrating that the squirrel monkey is able to survive unconventionally high (up to 430 g) accelerative stress. Though the samples in each mode are not large enough for statistical proof, indications are that the G_x mode is more lethal than G_y and that there is a lethal "stress threshold" above 1×10^3 kg-g-sec. Three different lethal mechanisms seem to be present, related to the g level.
F.R.L.

A66-32188 #

SAFETY FACTORS IN THE DESIGN OF PROTECTIVE HELMETS.

J. M. Rayne and K. R. Maslen.

IN: AEROSPACE MEDICAL ASSOCIATION, ANNUAL SCIENTIFIC MEETING, 37TH, LAS VEGAS, NEV., APRIL 18-21, 1966, PREPRINTS. [A66-32134 17-04]
Washington, D.C., Aerospace Medical Association, 1966, p. 191, 192. Abridged.

Consideration of the fundamentals of the design of aircrew helmets with a view to reconciling the requirements for protection against buffeting in normal flight and possibly some protection against head impact in crash conditions. The amount and type of forces which a helmet must resist are discussed. It is considered that with a liner of the right stiffness and hysteresis, it may be possible to design a helmet giving both crash and buffet protection. A specification for a buffet helmet is suggested. For a crash helmet, the main function must be to prevent skull fracture by efficient load spreading. It must resist penetration and abrasion and reduce the transference of angular movement to the head as far as possible.
F.R.L.

A66-36373

CONSEQUENCE OF HEART-TO-FOOT ACCELERATION GRADIENT FOR TOLERANCE TO POSITIVE ACCELERATION.

J. W. Nyberg, R. H. Grimes, and W. J. White (Douglas Aircraft Co., Inc., Advance Biotechnology Dept., Santa Monica, Calif.).

Aerospace Medicine, vol. 37, July 1966, p. 665-668. 7 refs. Research supported by the Douglas Aircraft Independent Research and Development Program; Contract No. AF 04(695)-679.

Consequences of heart-to-foot acceleration gradients on tolerance to positive acceleration (+ G_z) were determined in three studies on a variable radius centrifuge. In the first, tolerance was measured at radii ranging from 172 to 30 in., corresponding to gradients of 20 to 116%, respectively. As the radius decreased, the tolerance increased. At the shortest radius, discomfort in the legs resulting from the high acceleration at the feet precluded tolerance determination. In the second and third studies, low-intensity bioassay lights were used as a means of determining tolerance at lower levels of acceleration. In the third study, a slow onset run to blackout was used as a means of reducing the number of runs. Radii of 156 and 16 in. and rates of onset of 0.2 G/sec and 3.0 G/sec were used. At the long radius, tolerance was +3.9 G_z during slow onset, and +3.8 G_z during fast onset. At the 16 in. radius, during fast onset, tolerance was +3.0 G_z and, during the slow onset, tolerance was +3.6 G_z, +3.3 G_z, and +3.4 G_z.
(Author)

A66-43137 #

IMPACT ACCELERATIONS - G-FORCES [UDARNYE USKORENIIA - PEREGRUZKI].

S. A. Gozulov.

IN: SPACE BIOLOGY AND MEDICINE [KOSMICHESKAIA BIOLOGIIA I MEDITSINA].

Edited by V. I. Iazdovskii.

Moscow, Izdatel'stvo Nauka, 1966, p. 138-157. 33 refs. In Russian.

Detailed study of the physiological and biomechanical reactions of human subjects exposed to the action of g-forces. The characteristics of impact accelerations and the special features of their action on human organisms are discussed. A number of test stands for simulating the action of g-forces are described; these include a vertical catapult, a horizontal catapult on rails, a rocket carriage on rails, a falling platform, and a landing test stand. The reactions of a human organism to the action of impact g-forces are considered. An attempt is made to ascertain the maximum g-forces that can be withstood by a human organism. A study is also made of the biomechanical reactions of the body at the moment of impact and of the changes occurring in the physiological functions. The mechanism of action of g-forces on a human organism is divided into four stages of functional disturbance, which are considered separately. Methods of increasing the ability of a human organism to withstand g-forces are suggested. A.B.K.

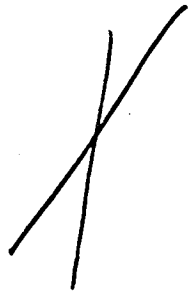
A66-80106

ANTHROPOMETRIC STUDY ON CRANIOMETRY OF FLIGHT PERSONNEL: APPLICATION TO THE STUDY OF A HELMET [ETUDE ANTHROPOMETRIQUE SUR LA CRANIOMETRIE DU PERSONNEL NAVIGANT: APPLICATION A L'ETUDE D'UN CASQUE].

M. H. Seris, A. Coblentz, and R. Auffret.

Revue de Médecine Aéronautique, vol. 4, May-Jun. 1965, p. 28-30. In French.

New measurements of head dimensions were made on French flight and ground personnel in order to obtain a more perfect fit for all types of headgear and especially for pressure-suit helmets. Significant measurements are tabulated. The figures were serve also as a base for the group of measurements required for the designing and engineering of safe and comfortable space cabin equipment.

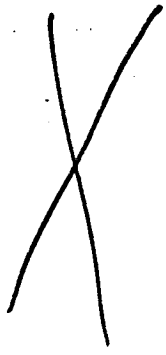


N66-16121* Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.

PRELIMINARY STUDIES OF VESTIBULAR DAMAGE IN GUINEA PIGS FOLLOWING HIGH ACCELERATION

Donald E. Parker, Henning E. von Gierke, and Walter P. Covell (Washington Univ., St. Louis, Mo.) *In* NSAM The Role of the Vestibular Organs in the Exploration of Space 1965 p 183-194 refs (See N66-16106 06-04) GPO: HC $2.25; CFSTI: MF $2.00

Guinea pigs were exposed to high impact deceleration on a sled and short-duration acceleration on a centrifuge. Behavioral examination of swimming ability and the righting reflex revealed evidence of vestibular damage following exposure to peak acceleration in the range of 200 to 400 g for periods of 14-20 sec. Histological examination of the temporal bones demonstrated extensive structural damage for the same animals which exhibited behavioral deficiency. No evidence of behavioral damage has been observed following exposure to impact deceleration. Also, histological evidence of damage is considerably less following impact deceleration than short-duration centrifugation. Author



N66-21330# Aviation Safety Engineering and Research, Phoenix, Ariz.

HELMET DESIGN CRITERIA FOR IMPROVED CRASH SURVIVAL Final Technical Report

J. L. Haley, Jr., J. W. Tornbow, S. Macri, and G. J. Walhout Ft. Eustis, Va., Army Aviation Mater. Labs., Jan. 1966 135 p refs

(Contract DA-44-177-AMC-254(T))

(USAAVLABS-TR-65-44; AD-628678) CFSTI: HC $4.00/MF $1.00

The major crash survival variables affecting the design and testing of U.S. Army aircrewmen helmets are presented and discussed in this report. Such factors as head acceleration limits, impact velocity, impact surfaces, impact sites, suspension and retention harnesses, helmet ventilation, impact test methods and structural concepts are considered. An examination of all available data on the tolerance of the human head to deceleration was conducted. Consideration was given to an analysis of acceptable design limits. A parallel study of head injuries occurring in aircraft accidents was conducted to determine the significant injury areas of the head and correlate this to protection area and techniques. A cockpit survey was conducted to develop criteria for testing the helmet and liner materials. Consideration was given during the program to a preliminary investigation of helmet retention systems and head cooling techniques. A series of instrumented drop tests was conducted to investigate various helmet design concepts and materials. Double-shell and single-shell helmets of nearly equal weight were analyzed. The advantages and disadvantages of three different methods of helmet impact testing are discussed. Author (TAB)

N66-21908# Aviation Safety Engineering and Research, Phoenix, Ariz.

IMPACT TEST METHODS FOR HELMETS. SUPPLEMENT 1 TO HELMET DESIGN CRITERIA FOR IMPROVED CRASH SURVIVAL

J. W. Turnbow Ft. Eustis, Va., Army Aviation Mater. Labs., Jan. 1966 24 p refs

(Contract DA-44-177-AMC-254(T))

(USAAVLABS-TR-65-44A, Suppl. 1; AD-628679) CFSTI: HC $1.00/MF $0.50

An analysis is presented on the primary methods of impact testing crash helmets and includes certain problems associated with each test method in interpreting test results. The three basic impact test methods employ impact of a movable head-helmet assembly with a movable striking mass, impact of a movable striking mass against a fixed head-helmet assembly, and impact of a movable head-helmet assembly against a fixed anvil. The evaluation and/or comparison of helmet performance is based on the measurement of head acceleration, energy absorption capacity, and resilence. The test method selected should permit these measurements to be made simply and without bias due to helmet weight and other possible variables unless the measured quantities can be readily and accurately corrected for such bias. These analyses illustrate the effect of two variables, the mass of the test components, and the coefficient of restitution upon the energy absorption and acceleration levels. R.N.A.

N66-26434# Aerospace Medical Div. Aeromedical Research Lab. (6571st), Holloman AFB, N. Mex.

AN INVESTIGATION OF THE RELATIONSHIP BETWEEN EXPERIENCE PARAMETERS AND SUBJECT ACCELERATION RESPONSE IN EXPERIMENTAL IMPACT

Peter Foster Mar. 1966 24 p refs

(ARL-TR-66-8; AD-630788) CFSTI: HC $2.60/MF $0.50

Studies of human test subjects undergoing sustained acceleration on the centrifuge have shown that tolerance increases with experience. This fact suggested the need for an investigation to determine if a similar relationship existed between certain impact experience parameters and subject acceleration response, which was used as an indicator of subject tolerance to impact exposure. A number of human test subjects having varying degrees of experience with experimental impact acceleration were exposed to identical impact profiles. Correlations of experience factors to indicated tolerance showed no significant relationship.

Author (TAB)

N66-27644# Aviation Safety Engineering and Research, Phoenix, Ariz.

IMPACT TEST METHODS AND RETENTION HARNESS CRITERIA FOR U.S. ARMY AIRCREWMAN PROTECTIVE HEADGEAR Final Technical Report

Joseph L. Haley, Jr. and James W. Turnbow Fort Eustis, Va., Army Aviation Materiel Labs., Mar. 1966 55 p refs

(Contract DA-44-177-AMC-254(T))

(AvSER-65-15; USAAVLABS-TR-66-29; AD-631493)

On the basis of simple analyses and some experimental testing, recommendations are made for the design and testing of helmet retention harnesses. A 'collar-type' retention harness is recommended, and two tests are suggested as a method of insuring a good design. Impact tests were conducted by an impactor-drop method and a head-form drop method. These test methods employ one movable piece and one fixed piece rather than two movable pieces as are currently used by most test agencies. On the basis of the impact test results, it is recommended that the impactor-drop method be used for the qualification of U. S. Army aircrew helmets. Probable head impact velocities and impact surfaces are discussed, and impact test conditions are specified.

Author (TAB)

N66-33748# Bureau of Medicine and Surgery, Washington, D. C.

DESIGN REQUIREMENTS FOR LIFE SUPPORT HELMETS

Roland A. Bosee *In* AGARD Collected Papers presented at the 22d Meeting of the AGARD Aerospace Med. Panel Sep. 1965 p 295–305 refs (See N66-33726 19-04) CFSTI: HC $5.93/MF $2.75

Impact accidents for all categories of Navy aircraft are summarized, and four helmets developed for pilot protection are shown. These are designed for use by attack and fighter pilots, patrol plane pilots, and helicopter crewmen. Development efforts on proposed life support helmets are discussed, in relation to the major research areas. These include (1) test methods for determining helmet displacement relative to the head; (2) impact resistance properties of lightweight materials suitable for shell construction; (3) test methods and apparatus for determining helmet center of mass; (4) head–neck dynamics under severe deceleration forces; and (5) helmet sizing or fit, and its influence on comfort. M.G.J.

N66-33753# Aerospace Medical Div. Aeromedical Research Lab (6571st), Holloman AFB, N. Mex.

BIOLOGICAL PARAMETERS OF IMPACT

W. K. Brown and R. F. Chandler *In* AGARD Collected Papers Presented at the 22d Meeting of the AGARD Aerospace Med. Panel Sep. 1965 p 395-407 refs (See N66-33726 19-04) CFSTI: HC $5.93/MF $2.75

The problems encountered, and the experimental approaches employed in establishing useful tolerance criteria to abrupt acceleration are discussed. Although a mathematical model which represents the dynamic system is considered necessary to understand the response of the system, only the most simple models have been investigated. This is due to the lack of definition of the physical characteristics of the body, and the complex mathematics needed to describe the dynamic reaction. The model most frequently used is a simple spring mass system, with the major elements of the biological system represented by equivalent mechanical elements. These elements appear as lumped masses in the model supported by springs and dashpots which represent the force transmission system (skeletal) and energy dissipation system (soft tissue) of the body. Details are also given on 288 human impact tests using 24 different subject orientations with respect to the force vector. The most significant physiological response was that of post-impact slowing of the heart rate. Graphical data are also included on other biological responses; these are considered promising as tolerance indicators. M.G.J.

N66-35739# Aviation Safety Engineering and Research, Phoenix, Ariz.

TEST RESULTS—HEMISPHERICAL SPECIMENS. SUPPLEMENT II TO HELMET DESIGN CRITERIA FOR IMPROVED CRASH SURVIVAL

J. W. Turnbow (Ariz. Univ.) and J. L. Haley, Jr. Jan. 1966 21 p (Contract DA-44-177-AMC-254(T))

(USAAVLABS-TR-65-44B, Suppl. 2; AD-628680) CFSTI: HC $1.00/MF $0.50

The results of impact tests on 27 different types of helmet construction are presented. Materials used in each specimen and the total weight of each are given in tabular form, as well as acceleration onset rate, maximum (peak) acceleration, rebound height, and deformation of the simulated scalp. The 90-degree corner impactor drops were compared at 6 and 4 ft, and the flat impactors at 5 and 6 ft. A comparison of the acceleration values indicated that only three specimens yielded acceptable acceleration values combined with reasonably low specimen weights (0.10 in. thick 8-ply nylon–epoxy, 0.40 annealed magnesium, and 0.40 annealed aluminum specimens). Two other specimens (0.04 magnesium and 0.04 aluminum) could be acceptable if the foam density were reduced. L.E.W.

A67-20609

SOCIETY OF AUTO...OTIVE ENGINEERS, STAPP CAR CRASH CONFERENCE, 10TH, HOLLOMAN AFB, N. MEX., NOVEMBER 8, 9, 1966, PROCEEDINGS.

Conference sponsored by the University of California, the University of Minnesota, and the Wayne State University.

New York, Society of Automotive Engineers, Inc., 1967. 210 p. $8.00.

CONTENTS:

A67-20612 #

IMPACT PROTECTION BY ISOVOLUMETRIC CONTAINMENT OF THE TORSO.

C. F. Lombard and S. H. Advani (Northrop Corp., Northrop Space Laboratories, Hawthorne, Calif.).

IN: SOCIETY OF AUTOMOTIVE ENGINEERS, STAPP CAR CRASH CONFERNECE, 10TH, HOLLOMAN AFB, N. MEX., NOVEMBER 8, 9, 1966, PROCEEDINGS. [A67-20609 08-05]

Conference sponsored by the University of California, the University of Minnesota, and the Wayne State University.

New York, Society of Automotive Engineers, Inc., 1967, p. 117-123. 13 refs.

Contract No. AF 29(600)-5184.

Study in which impact tests, using animals as subjects, at velocity changes comparable with those encountered in automobile accidents, reveal that isovolumetric containment of the torso greatly increases survival limits in most orientations. Analytical considerations also indicate the superior torso dynamic response of the isovolumetric system. This isovolumetric support-restraint system minimizes distortion and, in essence, allows the organs and bones to "float." Experimental verification has been obtained, using animals as test subjects, to indicate that survival limits may be considerably enhanced by this method of containment. M.F.

N67-24841# Federation of American Societies for Experimental Biology, Washington, D. C. Life Sciences Research Office.
A STUDY OF MILITARY IMPLICATIONS OF PROTECTIVE DEVICES DESIGNED TO PREVENT OR AMELIORATE HEAD AND NECK INJURIES
Sep. 1966 67 p
(Contract DA-49-092-ARO-70)
(AD-646841) CFSTI: HC $3.00/MF $0.65

The major crash survival variables affecting the design and testing of U.S. Army aircrewmen helmets are presented and discussed. Such factors as head acceleration limits, impact velocity, impact surfaces, impact sites, suspension and retention harnesses, helmet ventilation, impact test methods, and structural concepts are considered. An examination of all available data on the tolerance of the human head to deceleration was conducted. Consideration was given to an analysis of acceptable design limits. A parallel study of head injuries occurring in aircraft accidents was conducted to determine the significant injury areas of the head and correlate this to protection area and techniques. A cockpit survey was conducted to develop criteria for testing the helmet and liner materials. Consideration was given during the program to a preliminary investigation of helmet retention systems and head cooling techniques. A series of instrumented drop tests was conducted to investigate various helmet design concepts and materials. Double-shell and single-shell helmets of nearly equal weight were analyzed. The advantages and disadvantages of three different methods of helmet impact testing are discussed. Author (TAB)

N67-25135 Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.
EVALUATION OF VARIOUS PADDING MATERIALS FOR CRASH PROTECTION
John J. Swearingen Dec. 1966 13 p ref
(AM-66-40; AD-647048) CFSTI: HC $3.00/MF $0.65

Thirty-seven different materials and combinations of materials were impacted with an instrumented dummy head at 15 ft/sec and at 30 ft/sec. Peak g forces, rise times, and deceleration durations were determined for both impact velocities on each test specimen and compared to base line impacts on the rigid base structure to determine the degree of energy attenuation of each type of padding. As might be expected there was a progressive decline of peak g force with increased thickness of padding materials. None of the 1/4 inch, 1/2 inch, or 3/4 inch materials tested at 30 ft/sec and only one of the 1 inch materials had sufficient energy attenuation to bring the peak g force even close to survivable limits while all materials tested of 2 inch thickness or over reduced the impact force of 30 ft/sec impacts to 300g or less. At 15 ft/sec impact velocities all materials tested of 1 inch thickness and over and at 30 ft/sec materials of 2 inch thickness and over would probably offer some protection against fatal head injury. However, since in commercial crashes head impact velocities may be as high as 50 ft/sec and it is important that the passengers remain conscious to escape ensuing fire and smoke, padding per se (even six inches thick) is insufficient. A combination of deforming 'metal' to dissipate energy and firm padding to distribute pressure forces over the contour of the facial bones may be used successfully in preventing head injury and/or unconsciousness. Author (TAB)

N67-27372* Stencel Aero Engineering Corp., Asheville, N. C.
HUMAN SURVIVAL IN AIRCRAFT EMERGENCIES
Charles A. Yost and Ronald W. Oates [1966] 74 p refs
(Contract NASw-1530)
(NASA-CR-84413; Rept.-2) CFSTI: HC $3.00 CSCL 01B

A description and analysis are presented of some concepts for improving the probability of human survival in aircraft emergency conditions. The discussion covers internal and external survival improvement methods; aircraft structural factors; certified air carrier, general aviation, rotorcraft, and military accident statistics, and human tolerances. C.T.C.

N67-27432* Stencel Aero Engineering Corp., Asheville, N. C.
HUMAN SURVIVAL IN AIRCRAFT EMERGENCIES
Charles A. Yost and Ronald W. Oates 26 May 1967 100 p refs
(Contract NASw-1530)
(NASA-CR-84438; IR-3) CFSTI: HC $3.00/MF $0.65 CSCL 01B

Consideration is given to aircraft requirements and human physical limits in a study to improve human survival in an aircraft accident. Internal and external to fuselage survival improvement methods are discussed, along with aircraft structural factors and certified air carrier accident statistics. Also discussed are general aviation accident statistics, rotor craft accident statistics, military accident statistics, and human tolerances. C.T.C.