
Wednesday, June 11

518-53

074 327

Session WP1
Room 1
2:30 - 5:30 p.m.

**Human Behaviour in Long-Term
Missions**

Psychological Support for International Space Station Missions

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The exclusive use of multinational crews on the International Space Station requires that attention be directed to the increased role of psychological, social and cultural factors in influencing morale, performance and interpersonal and inter-group cooperation. The implementation of an effective Psychological Support (PS) system will be critical. PS is defined as a complex system of psychological methods, means and actions to be implemented preflight, inflight and postflight by the ground support team controlling the mission, with an objective to maintaining the crew in good health, optimal emotional and performance status, and effective interactions. A wide range of PS activities influence the crewmember's psychological status and adaptation, including, but not limited to, regulating the impact of information, teaching self-regulation and team behavior skills, compensation for insufficient social communication, 'reconstruction' of the ambient environment to prevent monotony, and provision of multicultural interaction skills.

The joint Mir-NASA program, which has been in place since 1995, adopted the fundamental principles of the Russian PS system and modified them for an international crew. This experience has resulted in a number of 'lessons learned' and demonstrated the effectiveness of psychological correction based on the PS system. A number of changes in the PS system were made over the course of the multiple joint missions. These are discussed, as are the methods and means needed to effectively address the larger number of cultures that will be working together on the International Space Station.

PSYCHO-SOCIAL TRAINING FOR MAN IN SPACE

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INTRODUCTION

In preparation for the international manned space station various international and national space agencies are already participating with the Russian MIR programme with short, medium, and long term presence on the MIR station. Although selection criteria for all crew include careful psychological screening, with some effort also regarding team build-up, little or no effort is expended in the area of psycho-social- or team training.

In this paper our thesis regarding psycho-social training for manned space flight shall be propounded, and it shall be argued why such training is necessary for long-duration flight. Furthermore, an overview will be presented of how such a training programme will look like with examples of past applications given.

THE PROBLEM

It has been observed in past long duration space missions that despite major effort expended regarding crew selection and teaming, compatibility statistics are at best mediocre. It has also been observed that this tends to impair the efficiency of work done on board, as well as increase operational errors. This not only has a deleterious effect on the scientific and technical work on board, but could endanger the safety of the station.

With the makeup of the crew becoming more and more multi-cultural, moreover coming from very differing professional backgrounds, the consequences of incompatibility and the accompanying costs in decreased effectivity and safety are aggravated as the potential for psyho-social problems increases, thus begging that this growing problem be addressed.

THE SOLUTION

To date, nothing much has been done on all sides in the area of psycho-social and team-work training. Our thesis is that training in Human Relations and team-work is important and should take place. Such training would provide the crew with tools to use during the mission as it unfolds and problems arise; it gives them skills that help them avoid the problems from arising in the first place, and then, if they do, to prevent them becoming acute. The training would focus on such areas as morale, norms, decision-making, handling conflicts, and leadership struggles. Moreover, such training increases the crew's effectiveness as a team both in the preparation and training phase as well as during the space mission.

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STUDY OF THE PSYCHOLOGICAL ADAPTATION OF THE CREW DURING A 135-DAY SPACE SIMULATION

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Three Russian subjects stayed in a chamber for 135 days during the HUBES space simulation held in Moscow in 1994-1995. Our purpose was to examine human adaptation to specific stress factors such as isolation and confinement and to compare and validate psychological methods for monitoring and support in flight.

Quantitative and qualitative psychological tests were completed before (baseline data), during and just after the simulation. These tests included free reports, free discussions, group problem solving, evaluation questionnaires on crew members, sociometric questionnaires, and the Matrix of Inter and Intra Processes in Group Test and Personal Choices Questionnaire. Content analysis was processed for the qualitative tests and statistical processes for repeated measures, when possible, for the quantitative tests.

The main findings concern i) the sensitivity of the subjects to the stress factors, ii) the interrelations within the crew and between the crew and the ground support, and iii) the consequences of individual reactions upon the group behavior. Surprisingly, isolation was not a key factor for the subjects who were more concerned by recreational activities, family, and work. When difficulties occurred, individuals chose to project their problems on the others ("I'm well, but the others don't see me that way"). At the end of the simulation, one of the crew members was considered as less integrated to the group by the other two subjects, who, however, acted to protect (successfully) the general cohesion and mood of the crew. The three subjects developed a weak tendency to "group thinking." There was an opposition with one ground support team member, although this conflict was rather limited and didn't seem to have any consequence on the crew efficiency.

Baseline data predicted that difficulties could occur in the crew member who did not integrate well into the group. Both quantitative and qualitative tools were adequate, although qualitative tests gave a closer approach to the actual situation that developed during the simulation.

INTERPERSONAL RELATIONSHIPS IN SPACE SIMULATION : THE LONG-TERM BED REST IN HEAD-DOWN TILT POSITION

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The long-term bed-rest has been organised by ESA and CNES*, in order to simulate physiological effects of weightlessness: eight volunteers had to stay during 42 days in bed, in head down tilt position (- 6°). There were two subjects in a room, they could not be alone and it was difficult for them to have their own personal space and intimacy. Like in outer space, in that circumstances, interpersonal relationships were of prime importance, and we proposed to study what effects isolation and confinement stress had on social relationships.

This situation has allowed, from a systematic observation, the study of the evolution of the relational behaviour in dyads, and to quote some social indicators of adaptation. Results show an important withdrawal, and the time passed alone is marked by the emergence, during the experiment, of specific preferential activities. A behavioural contagion is observed in each dyad (people have the same activities at the same time), excepting the unique case of abandon. Moreover, the most important rates of inactivity and withdrawal were noted in this case of giving up. Verbal indicators were useful to comment these results and showed that, for all the dyads, one of the two subjects was always playing a regulating role by expressing a very positive perception of the situation.

With this set of results, we emphasize the importance of psychosociological factors in isolation and confinement. Thus, it appears that different modalities of interpersonal relationships, and not only verbal interactions, play a significant role in adaptation to stress situations.

* ESA : European Space Agency
CNES : Centre National d'Etudes Spatiales (France)

PSYCHOLOGICAL ADAPTATION IN GROUPS OF VARYING SIZES AND ENVIRONMENTS

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INTRODUCTION

Several incidents of friction among crewmembers, tensions between ground and space crews, and lapses in judgment have been reported in both the Russian and U.S. space programs (Collins, 1985; Cooper, 1976; Bluth, 1980, Newkirk, 1990). In some cases, these lapses were judged to be potentially dangerous. As other space agencies gain more experience in long-duration space flight on the International Space Station, they can expect similar incidents. A number of factors are presumed to account for behavioral problems that occur in space. Common factors on all space flights are isolation and confinement, and the accompanying psychological discomfort they can cause. Similar feelings of hostility and occurrences of interpersonal tensions have also been reported in other isolated and confined environments (Gunderson, 1963; Lugg, 1977; Weybrew, 1963). The overall goal of the present research is to identify changes in psychological variables and to track adaptation in persons living and working in extreme, isolated environments. Data from twelve groups in diverse analogue environments will be summarized and compared in this presentation.

METHODS

Computerized questionnaires were administered twice weekly to crewmembers throughout the duration of their exposure to the extreme environments in which they were living and working. Data were collected from two 100-day Antarctic science traverses, one 60-day Antarctic construction traverse with a multi-cultural crew, seven Antarctic winter stations (260+ days), and two (30- and 60-days) crews in the Early Human Testing Facility. Groups ranged in size from 4 to 20 members. The traverse teams were all male, while all other groups were of mixed gender.

RESULTS

Individual and group differences in interpersonal tensions, individual morale, perceptions of the social and work climates of the various groups were examined. Results of time series regressions suggest that personal factors of the individual crewmembers, and local events are the primary causes for the changes observed in these varied groups.

CONCLUSION

Data from these twelve groups demonstrate the need for additional research in selecting and composing teams for long-duration space missions. The approach demonstrated in the current research has the potential to identify the events and personal characteristics that affect individual psychological adaptation and group functioning, in order to answer some of these important questions.

REFERENCES

- Bluth, B.J. Social and psychological problems of extended space mission. American Institute of Aeronautics and Astronautics, International Meeting and Technical Display on Global Technology 2000; 1980 May 6-8; Baltimore MD 7p A80-32854.
- Collins, D.L. Psychological issues relevant to astronaut selection for long-duration space flight: a review of the literature. 1985. Technical report for the Air Force Institute of Technology, Human Resources Laboratory, Houston, TX; AFMRL-TP-84-41.
- Cooper, H.S.F. *A house in space*. New York: Bantam Books; 1976.
- Gunderson, E.D.; Nelson, P.D. Adaptation of small groups to extreme environments. *Aerospace Medicine*, 34: 1111-1115; 1963.
- Lugg, D.J. Physiological adaptation and health of an expedition in Antarctica, with comment on behavioral adaptation. ANARE scientific report. Series B (4) medical science. Publication No. 126. 1977; 188p. Canberra, Australia.
- Weybrew, B.B. psychological problems of prolonged submergence. In Burns, N.M.; Chambers, R.M.; Henchler, E (eds). *Unusual environments and human behavior – physiological and psychological problems of men in space*. New York: MacMillan Company; 1963

DEVIANCE AMONG EXPEDITIONERS: DEFINING THE OFF-NOMINAL ACT IN SPACE AND POLAR FIELD ANALOGS

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INTRODUCTION

A review of the record of those living and working in extreme environments like space, under the seas, and the polar regions demonstrates that deviant acts do occur and take a number of forms. These run the gamut from a crewmember's show of frustration in communication with ground control or base, to his/her not using a piece of equipment in the prescribed way by the manufacturer, to delaying to report a critical piece of information, to expressed hostilities among the crew, to the display of mental disorders. However, what behaviors are off-nominal in the extreme environment have never been defined with any precision.

Such an understanding is imperative now that humans verge on permanent societies in space. This paper reports the results of a reliability pre-test administered to both academic sociologists with only a general interest in deviance and to social and behavioral scientists working with deviance in extreme environments. The purpose of the pre-test was to lead to a standard definition of off-nominal behavior in isolated and confined environments (ICE). A sociological examination of deviance in the extreme environment is key to understanding the psychosocial human factors of space and space-like environments. Deviance relates to several questions about human behavior in space and space analog environments which have emerged in the past two decades.

Extracting off-nominal acts in their order of occurrence from diaries, logs, participant accounts, reports, and personal interviews can facilitate answering the following research questions: 1) What is the relationship between the number of off-nominal acts occurring during missions and crew size? 2) What is the relationship between the number of off-nominal acts occurring during missions and crew heterogeneity? 3) What is the relationship between the number of off-nominal acts occurring during missions and mission duration? 4) Is there really a "third-quarter phenomenon", where the number of off-nominal acts increases dramatically after the half-way point of the mission is reached? 5) If there are relationships among off-nominality and crew size, heterogeneity, and mission duration, are the relationships similar for space and polar field environments?

METHODS

The pre-test was provided to 6 participants, 3 social and behavioral scientists who have published extensively on human behavior in extreme environments, and 3 sociologists who were not familiar with the topic. It consisted of a number of passages of narrative drawn from four isolated and confined settings: 1) a Russian space station, 2) an American space flight, 3) an Arctic venture of the 1920s, and 4) a modern Antarctic field expedition. Passages were selected to depict a wide variety of behaviors. The purpose of the pre-test was stated in the instructions, that its aim was to arrive at a standard definition of the off-nominal act in the extreme environment. No presumed definition of what comprised an off-nominal act was advanced to the participants, except to suggest that it was an interaction among crew which prevented optimal functioning and ran the gamut from a minor incident to one of larger proportion. Participants were instructed to name any off-nominal acts they could discern in the passages and to number them. No participant was told the name of any other participant and they were all asked not to discuss the test with others interested in deviance in extreme environments.

RESULTS

Respondents fell into two discrete clusters: 1) those who extracted every item of deviant behavior possible from the passages, from trivial to life-threatening, and 2) those who discounted possible off-nominal acts owing to the extremity of circumstances, physical illness, or the cultural background of the actors. However, there was uniformity of agreement in labeling off-nominal those behaviors which involved mental disorder, poor hygiene, or were enacted by a distant base or ground control without due consideration for the position of the crew in the field.

CONCLUSION

Although the response to the pre-test did not issue a unanimous statement about off-nominality in extreme environments, it provided insight into elements that must be included in a standard definition and lent direction to a follow-up stage of testing to accomplish that goal. This phase of testing, in progress, is described, as is further research designed to use the operationalized definition of off-nominal acts in extreme environments.

GETTING EFFECTIVE SLEEP IN THE SPACE-STATION ENVIRONMENT

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INTRODUCTION

Getting enough sleep is important for all human beings who must function in the world. Sleep has particular significance, where a person's level of performance is critical to system safety. Therefore, establishing an effective system for ensuring sleep while aboard space-stations is surely a goal worth pursuing. In light of the 12-hour shifts and demanding tasks faced by space-station crew, sleep will be a very necessary element, not only for the safe operation of the space-station, but also for the health and well-being of the crew. The nature of sleep within the space-station environment, and the strategies which could be considered to counter-act the problems of sleeping in a space-station, are discussed.

FOCUS OF THE PRESENTATION

This is a discussion paper which reviews research on sleep, as applied within the aviation, transportation, processing industries, and in extreme environments. Information on sleep problems encountered, work arrangements that are effective, scheduling, core human factors concerns, personal coping strategies and interventions which can help alleviate problems, will all be addressed.

RESEARCH TO DATE

Research on shiftwork, hours of work, sleep patterns and functioning, sleep hygiene, and various strategies and countermeasures against fatigue (napping, drug therapy, light, lifestyle counselling) all point toward the need for a systematic approach to managing sleep. Sleepiness and fatigue have been compared with drunkenness, the resultant impact on performance showing that severe impairment indeed happens much too often, as reflected in North American accident statistics. An individual's ability to cope with fatigue and working shifts appears to decline with advancing age. The quality and quantity of sleep have been shown to correlate significantly with performance on standard cognitive tests. Various accounts from astronauts indicate that long work hours and reduced sleep periods, as well as decreased quality of sleep, all affect work performance. The sleep environment is clearly an important factor in promoting sleep and maintaining it. Preparation for sleep, a dark, quiet room, absence of stimulants and increased levels of melatonin in the body, and a comfortable sleeping position, all are necessary to allow a person to achieve sleep quickly and throughout the specified sleep period. Finally, the day-night cycle is an important factor in regulating sleep. Circadian effects will impact the success in getting to sleep and maintaining it.

RECOMMENDATIONS FOR SLEEPING IN THE SPACE-STATION

Recommendations for sleeping in a space-station environment include:

- ▶ astronaut training requiring knowledge about sleep hygiene, working shifts, relaxation techniques, dietary effects etc.
- ▶ provision of comfortable and effective sleeping quarters.
- ▶ application of strategic napping, task rotation, and other strategies for alleviating boredom and fatigue
- ▶ staffing on space-station that allows off-duty personnel freedom from responsibility, except in extreme cases.
- ▶ scheduling of shifts which is consistent with the circadian rhythm.
- ▶ introduction of artificial day/night cycles which are strong enough to set the circadian rhythm.

HUMAN SLEEP AND CIRCADIAN RHYTHMS ARE ALTERED DURING SPACEFLIGHT

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INTRODUCTION

Numerous anecdotes in the past suggest the concept that sleep disturbances in astronauts occur more frequently during spaceflight than on ground. Such disturbances may be caused in part by exogenous factors, but also an altered physiological state under microgravity may add to reducing sleep quality in a spacecraft. The presented investigations aimed at a better understanding of possible sleep disturbances under microgravity. For the first time, experiments were conducted in which sleep and circadian regulation could be assessed simultaneously in space.

METHODS

Four astronauts took part in this study aboard the Russian MIR station. Sleep was recorded polygraphically on tape together with body temperature. For a comparison, the same parameters were measured during baseline periods preceding the flights.

RESULTS

The circadian phase of body temperature was found to be delayed by about two hours in space compared to baseline data. A free-run was not observed during the first 30 days in space. Sleep was shorter and more disturbed than on earth. In addition, the structure of sleep was significantly altered. In space, the latency to the first REM episode was shorter, and slow-wave sleep was redistributed from the first to the second sleep cycle.

CONCLUSIONS

Several mechanisms may be responsible for these alterations in sleep regulation and circadian phase. Most likely, altered circadian zeitgebers on MIR and a deficiency in the process S of Borbély's sleep model cause the observed findings. The change in process S may be related to changes in physical activity due to weightlessness.

METHODOLOGICAL APPROACH TO STUDY OF COSMONAUTS ERRORS AND ITS INSTRUMENTAL SUPPORT

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INTRODUCTION

The methodological basis of the proposed approach is the idea of system essence of human-operator's error. In accordance with this principle an error is result of many causes associated with both operator and conditions, process and tools of performance. In our study¹ an error is considered in psychophysiological aspect. In the framework of Human-Operator Reliability Problem such approach is topical since psychophysiological state is integral characteristic reflecting the result of interaction between external (environmental) factors and internal (mental, physiological, physic features and qualities of human) factors.

METHODS

The method includes procedures of the collection, identification and analysis of information gained in the course of medical and psychological support of space flights. Indirect character of inflight data received mainly through radio and TV channels causes the necessity of application of expert evaluations method for their identification. This procedure is carried out by experts with using the following parameters:

- **CREW ERRORS:** causes and consequences;
- **PSYCHOPHYSIOLOGICAL STATE:** behavior, motor activity, speech and sleep disturbances, mood, emotional reactions, psychosensory disturbances, will-power, dominant interests, deprivation phenomena, suggestions/complaints, general condition;
- **PECULIARITIES OF WORK-REST SCHEDULE:** sleep-wake rhythm disturbances, crew workload, symptoms of the psychosomatic discomfort;
- **GROUP PHENOMENA:** group cohesion, intragroup guidance, group interaction.

The parameters of psychophysiological state, work-rest schedule and group behavior are evaluated with the scales reflecting power of negative symptoms. According to these scales the symptoms with the highest psychophysiological "cost" have the highest evaluations. The integral parameters of psychophysiological state and work-rest schedule tensity are calculated by adding up all separate evaluations. The method of correlation analysis is used for evaluation of interrelation between crew errors and other parameters. Accumulation, systematization and processing of inflight information are supported by data base which is instrumental component of the present method. Its operation does not require special preparation of users due to usage of friendly interface and dialogue mode of work.

RESULTS

The results of the analysis of interrelation among crew errors, cosmonauts psychophysiological state, work-rest schedule tensity and group characteristics in several flights on "Mir" Station are presented in the paper.

CONCLUSION

We consider that the results obtained using the present approach will allow to expand our knowledge about a nature of cosmonauts errors and may be utilized in the practice of the space flights support, cosmonauts training and manned spacecrafts design.

¹ This work is supported in part by contract NAS-15-10110