



## The evolution of methodological approaches to the psychological analysis of the crew communications with Mission Control Center



Vadim I. Gushin, Anna K. Yusupova, Dmitry M. Shved\*, Lilia V. Shueva, Alla G. Vinokhodova, Yuri A. Bubeev

State Research Center of Russian Federation – Institute for Biomedical Problems of Russian Academy of Sciences, Khoroshevskoye shosse, 76A, Moscow, Russia

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### ABSTRACT

The study of the crew communications with Mission Control Center (MCC) is a standard procedure of remote medical and psychological monitoring of space crews in Federal Space Agency of Russia. The main purpose of this analysis can be considered as obtaining of diagnostic data on the psycho-neurological status affected by space flight factors. The article presents an overview of the results of 20 years investigations of the crew communications with MCC in the series of ground experiments with isolation and confinement, and in the pilot study aboard the International State Station (ISS), as well. The special attention was paid to the evolution of methodological approaches to the study of speech. The main results of the crew communications studies under the effects of space flight factors are presented, the basic phenomena of its dynamics under the conditions of long-term isolation, sensory deprivation, monotony, autonomy and communication delay are considered. The prospects of studying the space crew communications within the frame of onboard experiment “Content” are discussed.

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\* Corresponding author.

E-mail address: [d.shved84@gmail.com](mailto:d.shved84@gmail.com) (D.M. Shved).

## 1. Introduction

The information exchange between the space crew and different ground services (launch, technical and landing facilities, Mission Control Center (MCC), etc.) and other space sites included in the automated control system, is an essential part of cosmonaut's professional activity. This interaction includes, first of all, aural communication between the crew and MCC, which is carried out through the communication channel, opened for the whole MCC personnel (unlike private communication channels that are used for specific purposes, including medical and psychological support of space flight). In the course of this communication the cosmonauts regularly inform MCC about performed technological operations, the spaceship systems status, and emerging problems, as well. In reply, the MCC group involved in communication gives the advice and guidance to the crew, directing and controlling their work. Such interaction, from psychological point of view, provides the crew with information relevant both professionally and personally, allows them to analyze better the current situation, to make well-timed and reasonable decisions for the spaceship control, as well as its' technical systems maintenance, to keep the track of events on Earth, etc. [1].

Thus, the voice information exchange can be regarded as a very important part of professional activity of the cosmonauts, as well as MCC, and the information exchange efficiency directly determines the correct decision making on control of the flight progress. Good personal and intergroup interaction, understanding each other and cooperation during decision making provides the flight program implementation and satisfaction of the crew need for obtaining of new informational stimuli under sensory deprivation. The informative, opened and sincere communications between ground and space professional groups, on the one hand, determine the emotional and working status of the cosmonauts, and, on the other hand, prevent the development of so-called deprivation effects caused by extended space flight.

## 2. The standard procedure of the inflight psycho-neurological monitoring

Combination of information about cosmonauts' professional activity, engineering and technological aspects, as well as medical and psychological tasks, makes the communication of the space crew with Mission Control Center an important source of objective and operative data for crew behavior monitoring. Therefore, registration and subsequent in-depth analysis of the crew communications is an essential part of Russian spaceflight medical support system since the 70-ies of last century. The main objective of analysis is to obtain operative diagnostic data on psycho-neurological status of the crewmembers under the effects of space flight factors [1]. Conducted by experts on Earth, remote monitoring of psycho-neurological status of the cosmonauts directly in the course of their real professional activity (the key element of which is communication with MCC) without the use of additional equipment and time-consuming operations of the crew can be regarded as a basic advantage of the methodology [2].

Wish to participation in the talks, frequency of involvement into conversation and duration of this participation (time parameter) were identified as the most important elements for structural analysis of speech in the frame of communicative approach to monitoring. Another key indicator for standard psycho-neurological control is thematic content of the talk, which is defined by an expert during the analysis. More precisely, this is the ratio between working and non-working topics, measured by duration of corresponding communications. Application of this methodology in the experiments with isolation in hermetic chambers led to its

development. The target of this development was the desire for making diagnostic process more objective, as well as application of the new psychosemantic methods of analysis of speech, in particular, of content-analysis. In this review we intend not only describe the main results of analysis of communications of the crews with MCC in ground simulations and space flights, but also will follow the evolution of this approach over the last 30 years.

## 3. The evolution of the methodology for analysis of the crew communications with MCC in the experiments simulating space missions

The experiments in hermetic chambers have been used by Russian physicians and psychologists over more than 50 years to study in-depth unfavorable medical and psychological phenomena identified in space flights. Besides, the new methodological approaches as well as the new logistics to study these phenomena are being tested in such experiments. For more detailed and comprehensive study of communication between small isolated groups and Mission Control Center the Department of Psychology of IBMP conducted the series of investigations in the experiments with long-term isolation HUBES-94, ECOPSY-95, SFINCSS-99, Mars-105 and Mars-520 [3–9].

### 3.1. HUBES-94 and ECOPSY-95 experiments

The aim of experiment HUBES-94 was to simulate a set of main conditions of the long-term space flight on Russian space station "Mir", as well as to work out the scientific medical and psychological Protocol for future 135-day flight of European astronaut aboard (EUROMIR-95 Program). It was conducted in the experimental facility of 100 cubic meters volume (size of the base "Mir" station unit), where the most important conditions of living and professional activity of Russian cosmonauts during long-term space flights were simulated (gas composition of atmosphere, temperature, humidity, work/rest schedule, water consumption, hygienic procedures, operators' activity, countermeasures, training, etc.). The crew consisted of 3 men, aged at 32–37 years; two of them were the members of Russian cosmonauts' corp.

The experiment with 90-day isolation ECOPSY-95 was organized next year with main conditions similar to HUBES-94 (same chamber, crew size, living conditions, activities to perform, system of communications with MCC, work/rest schedule, countermeasures, etc.). The specific objective of ECOPSY-95 was to study the effects of plants on psychological status of the crew in the hermetic chamber, as well as the influence of gas environment pollutants on plant growth, for which a greenhouse was placed in the facility. Moreover, in the frame of ECOPSY-95 the experimental approbation of cosmonauts' selection and training requirements to overcome difficult living conditions, related to sleep deprivation and professional work at night was executed. For this purpose, the subjects were twice – at 21st and 59th day of experiment – deprived of sleep for 60 h, during which they continuously performed the operator's tasks.

Both experiments were similar not only from the point of their scientific Protocols and simulated conditions, but also (and it is crucial) from the point of the system of the crew communications with MCC. The main component of this system were the aural communication between the crew and MCC, which was carried out according to the schedule established during this period on board of orbital station "Mir". That means that the maximum duration of audio communication session was 30 min, while the crew and MCC could get in touch every 90 min. Besides, every evening upon request of the psychologists Crew Commander sent to MCC a structured report, containing the information about the Protocol

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