ALTERED STATES OF CONSCIOUSNESS AS A SAFETY FACTOR IN LONG-DURATION SPACEFLIGHT

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Abstract: *Introduction: Long-duration space missions expose crews to extreme isolation, confinement, monotony, and constant dependence on technological systems. Psychological safety in this context cannot be reduced to the absence of disorders; it must include the capacity to maintain inner stability, flexibility, and meaning under prolonged stress. This paper examines altered states of consciousness (ASC) as a potential safety factor in long-duration spaceflight, in connection with recent work on risk in the cyber environment. Materials and Methods: The analysis integrates previous descriptions of ASC as psychophysiological states differing from ordinary waking consciousness in attention, self-experience, time perception, and emotional regulation, with the concept of cyber risk as a complex bio-psycho-social risk with daily, massive exposure. A space habitat is treated as an extreme form of such a cyber environment, where physical, psychological, and informational risks merge. Results: Within this perspective, ASC can serve three safety-related functions. First, as a mechanism for regulating stress and emotions under chronic isolation and monotony. Second, as a resource for inner distance from the cyber environment: consciousness practices allow the person to temporarily "step out" of operational mode and experience themselves beyond the role of system operator. Third, as a basis for shared, ritualized experiences within the crew that strengthen trust and reduce the risk of conflicts and group dynamics that can lead to errors. Discussion: ASC are not proposed as a panacea but as one element of a broader psychological safety strategy, which must also include assessment of cyber risk and ethical constraints. Non-pharmacological, culturally adaptable techniques are emphasized, compatible with diverse crews and mission constraints. Conclusion: When carefully, evidence-based, and ethically integrated into training and in-flight routines, altered states of consciousness can contribute to a more resilient "ecology of consciousness" in space, supporting both crew health and mission success.*

ИЗМЕНЕНИ СЪСТОЯНИЯ НА СЪЗНАНИЕТО КАТО ФАКТОР ЗА БЕЗОПАСНОСТ ПРИ ПРОДЪЛЖИТЕЛНИ КОСМИЧЕСКИ ПОЛЕТИ

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Ключови думи: *изменени състояния на съзнанието, космическа психология, психологическа безопасност, киберриск, продължителен космически полет, екология на съзнанието*

Резюме: *Въведение: Продължителните космически мисии излагат екипажите на крайна изолация, затвореност, монотонност и постоянна зависимост от технологични системи. Психологическата безопасност в този контекст не може да се сведе само до отсъствие на разстройства; тя трябва да включва способността за поддържане на вътрешна стабилност, гъвкавост и смисъл при продължителен стрес. Настоящият доклад разглежда измененитe състояния на съзнанието (ИСС) като потенциален фактор за безопасност при продължителни космически полети, във връзка с неотдавнашна работа върху риска в киберсредата. Материали и методи: Анализът интегрира предишни описания на ИСС като психофизиологични състояния, различаващи се от обикновеното будно съзнание по отношение на вниманието, самовъзприятието, възприятието за време и емоционалната регулация, с концепцията за киберриск като комплексен био-психо-социален риск с ежедневна и масова експозиция. Космическият хабитат се разглежда като екстремна форма на такава киберсреда, в която физическите, психологическите и информационните рискове се сливат. Резултати: В рамките на тази перспектива ИСС могат да изпълняват три функции, свързани с*

безопасността. Първо, като механизъм за регулация на стреса и емоциите при хронична изолация и монотонност. Второ, като ресурс за вътрешна дистанция от киберсредата: практиките на съзнанието позволяват на човека временно да „излезе“ от оперативния режим и да преживее себе си отвъд ролята на системен оператор. Трето, като основа за споделени, ритуализирани преживявания в екипажа, които укрепват доверието и намаляват риска от конфликти и групова динамика, водещи до грешки. Дискусия: ИСС не се предлагат като панацея, а като един елемент от по-широка стратегия за психологическа безопасност, която трябва да включва и оценка на киберриска, както и етични ограничения. Акцентът е върху нефармакологични, културно адаптивни техники, съвместими с разнородни екипажи и ограниченията на мисията. Заключение: Когато бъдат внимателно, основано на доказателства и етично интегрирани в обучението и рутините по време на полет, измененитe състояния на съзнанието могат да допринесат за по-устойчива „екология на съзнанието“ в космоса, подкрепяйки както здравето на екипажа, така и успеха на мисията.

1. Introduction

Long-duration space missions place crews in conditions of extreme isolation, confinement, monotony, and constant dependence on technological systems. Psychological safety in this context cannot be reduced solely to the absence of mental disorders. It must include the capacity to maintain inner stability, flexibility, and meaning under prolonged stress [1, 2].

Altered states of consciousness (ASC): Psychophysiological states that differ from ordinary waking consciousness with respect to attention, self-experience, time perception, emotional regulation, and information processing. They may arise spontaneously or be induced through non-pharmacological practices (meditation, rituals, sensory modulation, etc.) and are regarded as a potential resource for inner distance, stress regulation, and the maintenance of meaning under extreme conditions.

Safety factor: An element or mechanism that increases the resilience of the system (in this case, the crew) to risks by reducing the probability of errors, conflicts, emotional breakdown, or loss of performance. In the context of space missions, ASC are considered one such factor within a broader strategy of psychological safety.

Long-duration / prolonged spaceflight: A space mission lasting from several months to years, characterized by prolonged isolation, confinement, microgravity, sensory monotony, limited communication with Earth, and constant dependence on life-support technological systems.

Human presence in space is often formulated as a matter of reaching, surviving, and accomplishing the mission. The present paper defends a more modest yet fundamental position: even with perfect technical safety, the human being can be existentially endangered if the lived experience of the body, time, and meaning is neglected. These dimensions are particularly relevant to the topic of psychological crisis during long-term residence in an artificial and confined environment. Isolation and confinement (Isolated and Confined Extreme – ICE environments) lead to measurable changes in mood, cognitive functions, interpersonal relations, and even brain plasticity [3, 4].

2. Materials and Methods

The analysis is conceptual and philosophical. It draws on phenomenological descriptions of bodily experience, temporality, and meaning, as well as on the existing literature in the fields of space medicine, psychology, and ethics. No new theoretical framework is proposed; the focus is on three concrete dimensions of human existence in space habitats and on their relation to altered states of consciousness as a possible resource for psychological safety. The space habitat is treated as an extreme form of a cyber environment in which physical, psychological, and informational risks merge [5].

3. Results

3.1. Transformation of bodily experience

The space environment radically alters the experience of the body. Under conditions of microgravity, isolation, and constant dependence on life-support systems, the body shifts from the mode of “I can” to the mode of “I am being maintained.” There is a risk that the astronaut may turn from a living subject into a functional component of the mission. This transformation is existential rather than merely physiological. Microgravity disrupts vestibular and proprioceptive signals, leading to changes in the sense of self-location, bodily coherence, and the boundaries of the self [6, 7]. Similar effects are observed in sensory deprivation and in certain mental states such as depersonalization and derealization.

3.2. Collapse of time

In confined habitats, time tends to collapse into operational time. Personal and biographical rhythm becomes subordinated to strict schedules and to delayed communication with Earth. Personal temporality narrows, intensifying the sense of monotony and potentially contributing to psychological crisis. The “third-quarter phenomenon” is well documented: after the midpoint of a mission a decline in mood, motivation, and performance is often observed [8, 9]. Experiments such as Mars-500 and HI-SEAS show that the perception of time becomes distorted, the future appears blurred, and memories of the past intensify nostalgia and a sense of loss [10].

3.3. Erosion of meaning

In a fully artificial environment in which every gesture is regulated, the questions “why am I here” and “what am I doing with this life” become simultaneously more urgent and more difficult to articulate. This leads to a quiet erosion of meaning – a process that may remain unnoticed until it has already affected motivation, group dynamics, and crew resilience. Existential anxiety and the feeling of detachment from Earth (the “Earth-out-of-view phenomenon”) can intensify loneliness and a sense of meaninglessness [11]. At the same time, some astronauts describe transformative experiences (overview effect, ultraview effect) that expand perspective and can strengthen the sense of connectedness [12].

3.4. Altered states of consciousness as a safety factor

Altered states of consciousness can fulfill three safety-related functions:

- a mechanism for regulating stress and emotions under chronic isolation and monotony;
- a resource for inner distance from the cyber environment – the practices allow temporary “stepping out” of operational mode and experiencing oneself beyond the role of system operator;
- a basis for shared, ritualized experiences within the crew that strengthen trust and reduce the risk of conflicts and errors arising from group dynamics.

From the perspective of predictive processing, microgravity and prolonged isolation can relax the brain’s high-level priors (including the deeply entrenched gravitational prior). This temporary loosening of hierarchical constraints facilitates states of increased global integration and altered self-experience that share certain computational features with non-ordinary states of consciousness. Non-pharmacological practices that induce ASC may therefore act as controlled ways of exploiting this neurocognitive plasticity, supporting emotional regulation and the restoration of meaning under extreme conditions [6, 13]. ASC are not proposed as a panacea but as one element of a broader psychological safety strategy that must also include assessment of cyber risk as well as ethical constraints. Emphasis is placed on non-pharmacological, culturally adaptable techniques compatible with diverse crews and mission constraints. Russian space psychology has long paid attention to the “soft” altered states of consciousness that arise naturally under orbital conditions [14].

4. Discussion

The three dimensions – body, time, and meaning – show that existential risk accompanies technical risk. An astronaut may be physically safe yet existentially insecure if embodiment, temporality, and the sense of purpose are systematically undermined by the design of the mission and the habitat.

In the context of psychological crisis during long-duration flights, this means that the crisis does not necessarily arise only in response to acute incidents. Often it results from the gradual accumulation of transformations in bodily experience, the narrowing of time, and the erosion of meaning. Studies of Antarctic expeditions, submarines, and Mars-mission simulations (Mars-500, HI-SEAS, SIRIUS) confirm that prolonged isolation leads to increased irritability, social withdrawal, cognitive changes, and interpersonal tension [3, 9, 15].

In the analysis of the characteristics and modes of use of the International Space Station (ISS) it is emphasized that the station functions as a complex, fully closed, and technologically mediated environment in which every element of crew daily life – from motor activity and nutrition to communication, rest, and scientific work – is strictly regulated and dependent on life-support systems and ground control. This specific architecture and operational regime create conditions in which bodily experience is transformed, time shrinks to an operational rhythm, and questions about the meaning of presence acquire particular acuity. Precisely these features of the ISS as a real habitat show that existential and psychological challenges are not a side effect but an inseparable part of the very use of the station, making the integration of approaches to psychological safety – including altered states

of consciousness – necessary for the sustainable functioning of the human being on long-duration missions [18].

In the study “Risk in Cyber Environment” [19] it is argued that the cyber environment constitutes a new type of interaction medium that modifies existing risks and generates qualitatively new ones requiring a special evaluation instrument. The authors emphasize that the risk is not limited to the informational sphere but is a complex, personal, bio-psycho-social risk with daily and mass exposure and diverse consequences, whose assessment is currently inadequate and leads to underestimation. This understanding is especially relevant to the space habitat, which can be regarded as an extreme form of a cyber environment in which physical, psychological, and informational risks merge and mutually reinforce one another, making the integration of strategies for psychological safety and an ecology of consciousness necessary.

In August 2018 a slight pressure drop was recorded aboard the International Space Station (ISS). Official investigations by Roscosmos (with the participation of NASA) established that the hole resulted from human intervention with a drill, yet the final public conclusions concerning the exact place and cause (manufacturing defect on Earth, accidental error, or deliberate action) have not been disclosed in detail. An agreement exists between the two agencies not to publish the full results. Early statements by Roscosmos leadership admitted both a manufacturing error (subsequently sealed) and other versions, but later media speculation and individual comments pointing to sabotage by astronaut Serena Auñón-Chancellor, medical problems as a pretext, a damaged toilet, interpersonal conflicts, and deliberate sabotage or psychological breakdown have not been confirmed by official sources [17]. The classification of the data from this incident suggests significant difficulties in establishing the truth.

An important practical parallel is also offered by the experience of China. At a conference on aerospace medical engineering in Tianjin, experts emphasized that traditional Chinese medicine (TCM) plays a significant role in supporting crewed space missions. The holistic approach of TCM proves particularly suitable for the conditions of microgravity, where astronauts encounter changes in respiration, digestion, and mobility. During the Shenzhou-21 mission (nearly seven months in orbit) the crew used TCM apparatus for stimulating nerves and muscles in the middle and late stages of the flight in order to counteract muscle atrophy. The Chinese space station Tiangong is supplied with TCM medicines and functional drinks that help protect against radiation and support the immune system [16].

The integration of carefully selected, evidence-based, and ethically justified practices of altered states of consciousness can contribute to a more resilient “ecology of consciousness” in space – an ecology that supports both crew health and mission success. This includes both individual practices (meditation, mindfulness, rituals) and group practices that strengthen trust and shared identity.

5. Conclusion

The ethical question of human presence in space should begin from concrete experiences rather than from abstract principles. Attention to the living body, personal time, and meaning does not guarantee mission success, yet neglecting them renders any “safe” mission existentially risky for the human being who inhabits it. When altered states of consciousness are carefully, evidence-based, and ethically integrated into training and in-flight routines, they can become part of the strategy for psychological safety on long-duration space missions.

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