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Isolated Groups on Earth and in the Sky: Outlines of Space Psychology

SPATIAL AND TEMPORAL ANCHORAGES OF SPACE PSYCHOLOGY

Mankind is only beginning the long process of conquering Deep Space. The full career arc of space conquest is still only in our imagination.

In this endless scope, four phases are usually distinguished. The first is the era of near-Earth or neighbourhood missions: the world of orbiting spacecraft and conquering the Moon. The second phase is the landing and settlement on Mars – the return journey is known to take about 500 days. The third stage would be to conquer the Solar System. The fourth stage, the age of interstellar travel, is known only from science fiction literature and films where we have seen and heard a lot about frozen, fertilised ovum colonies, astronauts travelling in suspended animation, or gigantic generational spaceships (Kanas 2011: 576–581).

Whatever era of space travel we are talking about, all of them feature small groups of people who live enclosed in capsules in an environment unsuitable for human survival. Crews who live in such capsules for a relatively long time are called Isolated, Confined and Extreme groups – in short, ICE groups. The main focus of space psychology is on how ICE groups in outer space feel, think

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and do; how they can maintain their physical and mental integrity; how they get along with each other; how they relate to the mission centre on Earth, and how they can perform and succeed in their mission. Terrestrial capsule environments – and ICE groups within them – have existed throughout history and continue to exist today and in the future (Suedfeld–Steel 2000: 228).

For many decades, we have had comprehensive knowledge of the psychodynamics of ICE groups winterovering in Antarctica and the Arctic. These accounts contain almost all the elements that are still studied by space psychologists today. Therefore, space psychology has incorporated polar psychology into the model, and that is why we can say that its roots go back at least a century or more. At present, studies are conducted in two main areas: in space, analogue sites and simulations, commonly referred to as ground-based analogues.

GROUND-BASED HABITATS AND SIMULATIONS

In the past decades, many simulation habitats have been built and operated to study the human factors expected on the Moon and on Mars (for a review see Heinicke–Arnhof 2021). We briefly mention two analogue sites and two simulations that included Hungarian research interests in the investigation of the psychodynamics of the crews.

Concordia Research Station

Opened in 2005, Concordia is a French–Italian permanent research facility, built at 3,233 m above sea level, located more than 1,000 km inland in Antarctica (IPEV 1992/2024). It hosts about 70 people in the Summer, and 12 to 15 winteroverers. Its primary goal is to conduct research in a variety of fields, such as astronomy, glaciology and atmospheric science. The station is a good terrestrial space analogue because it is one of the most isolated places in the world in an extremely hostile – cold, dry and dark for long months – environment.

Halley VI Research Station

Established in 1956 to study the Earth's atmosphere, the Halley Research Station is operated by the British Antarctic Survey (BAS). Operational since 2012, and comprised of eight interlinked pods, the present Halley VI is suitable to accommodate about 70 people (BAS 1962–2024).

It is the world's first relocatable research facility. Built on skis, the pods can be towed across the ice by specialist heavy vehicles. Being able to move the research station is vital: in 2017, the station was relocated because of a nearby large ice crack on the Brunt Ice Shelf.

Mars Desert Research Station (MDRS)

MDRS was created by the Mars Society, a U.S. organisation founded in 1998. The Society's mission is to raise worldwide scientific and public awareness of Mars research and to promote scientific research and space industry activities that support Mars exploration and settlement (Mars Society MDRS 2001–2024). The Station started its activities in 2001. The facility is constantly expanding and is located in a Martian landscape in Utah. It offers a habitat for seven people and has several complementary structures. The simulation is based on the idea that the crews, who have been going there for more than 20 years, mostly for two weeks, live as "Martian colonists". By now, more than 280 international crews have been turned up at this desert station. The Hungarian aspect of the story is that between 13 and 26 April 2008, the seventy-first crew was Hungarian. The Hungaromars 2008 project, funded by the Hungarian Space Office, involved a team of six scientists and media professionals, and was followed with great interest by the public (Hungarian Space Office 2008).

Ground-based Experimental Complex (NEK) in Moscow

A whole different world of terrestrial space analogue simulation is revealed in the Ground-based Experimental Complex (Nazemnyy Eksperimental'nyy

Kompleks – NEK) at the Institute for Bio-Medical Problems (IBMP), Moscow, which also involves extensive international cooperation.

Experiments in the IBMP facility were started in the late 1960s (IBMP 1960–2024). The series of Mars 500 simulations began in 2007. Following a 14-day, then a 105-day isolation, the 520-day main project lasted from April 2010 to October 2011. It simulated a complete flight of an international crew to Mars and back, including communication delays with the Earth, limited consumable resources, etc. (IBMP 2007–2011). The same facility also hosts the Sirius space simulation, including a series of several model experiments lasting 17, 120, 240 and 365 days (IBMP 2017–2024).

PSYCHOLOGICAL ISSUES IN ICE GROUPS

Although in our days, the overwhelming majority of psychological information still comes from ground-based analogues, the investigation methods are changing and expanding very rapidly.

Sources of knowledge

In the early stage of polar expeditions, the life of ICE groups was not remotely visible. From the moment the ship vanished on the horizon, there was no way of knowing the fate of the crew until the explorers returned, and their reports became known to the public. These reports took the form of interviews, newspaper articles, diaries, memoirs and books written by the participants, mostly by leaders and doctors of the groups. These types of documents are called anecdotal reports. Even the earliest anecdotal sources contain abundant information about group events and problems and their solution in ICE settings.

In the heroic age of polar exploration, the members of the Belgica expedition to Antarctica in 1897–1899 suffered deep depression, which the expedition's doctor Frederick A. Cook tried to treat by sitting the crew in front of a large blazing fire – the modern-day equivalent of winter depression or seasonal affective disorder therapy (Palinkas–Suedfeld 2008: 153–154).

In his book, *Alone,* Admiral Byrd reports how being cramped into a small space can cause even the most carefully selected, disciplined people to freak out over the smallest things – like someone moving their belongings into their area or taking too long to chew a bite. "During my first winter at Little America, I walked for hours with a man who was on the verge of murder or suicide over imaginary persecutions by another man who had been his devoted friend. For there is no escape anywhere. You are hemmed in on every side by your own inadequacies and the crowding pressures of your associates. The ones who survive with a measure of happiness are those who can live profoundly off their intellectual resources, as hibernating animals live off their fat" (Byrd 1938: 19).

Anecdotal sources are considered to be of historical importance and are seen as good places to start in developing ideas and hypotheses for more formal studies (Kanas–Manzey 2008: 3). The rapid rise of text analytics technologies today has radically improved the processing of both old and new anecdotal sources by computer-aided qualitative research and content analysis.

Another source of knowledge about ICE groups is the psychological questionnaires and tests. Many versions of these are known and used today. The more familiar and widespread a test is, the better the opportunity for comparing different settings.

Psychophysiological symptoms and syndromes

Psychological problems may overlap with medical ones. This includes some well-known somatic symptoms, such as fatigue, weight gain, gastrointestinal problems, rheumatic aches and pains, and headaches. Another set of problems is related to disturbed sleep, e.g. circadian rhythm sleep disorder, including difficulty falling and staying asleep, and loss of slow-wave or REM sleep. These are sometimes referred to as the Big Eye Syndrome.

A cluster of issues is related to impaired cognition and performance, e.g. reduced accuracy and increased response time for cognitive tasks of memory, vigilance, attention, reasoning and intellectual inertia. (For more details of psychological effects, see Palinkas–Suedfeld 2008: 155–158).

Emotional and interpersonal issues

In the investigation of ICE groups, emotionality has always been treated as a multifaceted psychological construct, which includes mood and morale, anxiety, depression, aggression, hostility, life satisfaction, positive psychological outcomes, and so on. Settings, crew sizes and methodologies of emotionality assessment have also been varying broadly.

Negative affect problems, such as depression, subsyndromal seasonal affective disorder, anger, irritability and anxiety are mostly within the normal range but may sometimes overlap with psychiatry. Chronic fatigue, nervous tension and the resulting conflicts may lead to lasting interpersonal hostility and clique formation within the group. In extreme cases, excommunication, or exclusion of an individual from the group may result in a spontaneous fugue state sometimes referred to as Antarctic stare or Long Eye Syndrome.

In addition, emotional problems, tensions and conflicts may lead to the deterioration of work performance, including task negligence and forgetfulness.

A unique problem: The Third-Quarter Phenomenon

In the realm of eternal frost, nothing is evergreen, except the debate on the third quarter of emotional dysphoria.

It has been mentioned long ago that sleep difficulties, bad mood and irritability are considerably higher during the mid-winter period in polar settings. In examining this question, researchers initially proposed a three-phase time model (for an overview see Palinkas 2003: 356). In an early empirical study on fourteen men in Antarctica, Palmai divided a one-year period into four segments, and, by different methods, he found that “the third quarter saw some further decline in morale, reflected also in irritability of the more responsible members” (Palmai 1963: 265).

Nearly 30 years later, Bechtel and Behring summarised the – mostly anecdotal – evidence for the fact that mood and morale "reach nadir somewhere between the one-half and two-thirds mark of the mission" and coined the term "Third-Quarter Phenomenon" (Bechtel–Berning 1991: 261). Empirical support of the model was e.g. Stuster et al. 2000; Sandal 2000; Décamps–Rosnet 2005; Ehmann et al. 2018. However, Steel and Suedfeld found no evidence of this emotionality drop pattern (Steel–Suedfeld 1991; Steel 2001).

Kanas and his colleagues most recently reviewed research on the third-quarter phenomenon in ground-based space simulations and in-orbit missions in space. They concluded that one reason for the conflicting results is that factors other than time may influence the well-being of crews in the third quarter. They also found that previous research has paid little attention to the effects of on-mission events. For the Mars mission, it is thought that, as the mission will consist of three main phases – outbound, Mars landing–exploration and return to Earth – each of these will have its unique temporal characteristics and stressors, and the effects of these will be explored in future research (Kanas et al. 2021).

SELECTION OF CREWS

The psychological issues of ICE groups can be studied from several points of view, such as whether psychological problems and their countermeasures concern the individual, the human relations within the group, the group as a whole, or the crew's relation to the Mission Control – but at the start of it all, the most important factor is crew selection.

Space psychology literature agrees that the selection process consists of two main parts: the Selecting Out (Screening) and the Selecting In (Choosing) phases (Suedfeld–Steel 2000: 239–240).

Societal background and support to astronauts

For “Phase Zero” of the selection process to begin, there must be a pool from which applicants are drawn. Early polar explorers did not start their crew recruitment by Selecting Out but right by Selecting In – candidates were chosen from the contacts and personal recommendations of expedition organisers and leaders; they usually sought experienced professionals in specific fields – seamen, doctors, scientists, etc.

An exception to this was Admiral Byrd. An honorary Chief Scout himself, he had the idea of taking a boy scout with him on his new Antarctic expedition. In 1928, he called on the National Council of the Boy Scouts of America to nominate one of its 826,000 members for the trip. He sent a radio message to the American scouting community with the strict conditions of the application. Following the call, 28,400 scout troops were mobilised and, according to the book, “thousands upon thousands” of eager boy scouts submitted their applications. After a “thorough sifting” of thousands of applications, there remained 88 candidates, then 17, then 6, and finally 1 – Paul Siple, who later wrote a book about his adventure. The foreword by James E. West, the then U.S. Chief Scout not only gives a detailed history of the selection process (which is an early forerunner of today’s astronaut selections) but also reflects the enormous social popularity that the call brought to the cause of polar exploration (Siple 1931: 5–18).

Today, both large and emerging space nations are paying increasing attention to educating the public, including young people, about space activities.

The fascination with astronautics often starts from a childhood dream. According to a Harris Poll survey conducted in the U.S., U.K. and China as NASA celebrated 50 years of Moon landing, “86% of children aged 8 to 12 said they are interested in space exploration, and 90% of them wanted to learn more. Interestingly, 83% of parents (averaged across the three countries) who participated in the survey believe their children are interested in space. Yet, only 53% of kids say their interest in space is fueled by their parents, they are citing teachers (79%) and the internet (71%) as primary learning sources” (The Harris Poll 2019).

In Hungary, the media, the government (Department for Space Activities of the Hungarian Ministry of Foreign Affairs and Trade 2024), and the various space portals (e.g. Space News 2024) provide up-to-date and historical information for those interested in space activities. The Hungarian Astronautical Society (MANT) organises student competitions, high school team competitions, student clubs, space camps and educational publications, and also publishes presentations on YouTube (MANT 1956–2024). All this allows not only space organisations to search for astronaut candidates, but also for the candidates to find their way to both Hungarian and international organisations.

Selecting out and selecting in

The selecting out and selecting in phases are designed to gradually select the final crew from a large pool. The first stage is essentially a psychiatric screening.

The process is usually one-way, but not always. The scope of possible candidates becomes ever broader with advancing time. In 1928, in Admiral Byrd's polar expedition, anybody who was not American, not a scout and not a boy had no chance even to apply. In 1963, two years after Gagarin, the first female cosmonaut, Valentina Tereshkova, appeared in the history of space travel. In 1998, the age limit for spaceflight was also significantly extended when the first American astronaut, John Glenn, returned to space at the age of 77.

In our days, all space agencies combine select-out and select-in methods: candidates who are healthy in every respect are subject to personality questionnaires, performance tests, life interviews and group exercises.

According to Santy and Jones, the psychological screening phase is no longer aimed at identifying negative traits but is used as a basis for identifying the characteristics desirable for various activities: the aim is to select the most suitable persons for the job in question. Astronauts working on space stations perform a wide variety of jobs, and it is therefore very difficult to define in general terms what the desirable personality traits of astronauts are. The authors stress that these aspects should in no way be used as a starting point but require continuous assessment, i.e. it should be established whether they are indeed valid predictors of the desired behaviour and performance (Santy–Jones 1994: 901).

Over time, it has also become clear that short- and long-term missions do not have quite the same order of importance of psychological strengths. In their data collection on Russian, European and American astronauts, Galarza and Holland compared ten sets of characteristics. The two most important are 1. Mental and Emotional Stability; and 2. Good Performance under Stressful Conditions. Of these two sets of traits, the former is more important for long-term missions, the latter for short-term missions. 3. Group living skills (including multicultural adaptation) are the third most important aspect for long-duration space missions but are relegated to seventh place in the short term. 4. Teamwork skills (including conflict resolution and cooperation; the ability to put the team's interests ahead of personal goals; and the ability to follow and carry out instructions) is ranked fourth in both types of mission. 5. The ability to cope with isolation from family and friends is of roughly equal importance, ranking sixth in the short term and fifth in the long term. 6. Achievement motivation (commitment and perseverance at work, determination) is ranked eighth in the short term and sixth in the long term. 7. Decision-making ability (including situational awareness and alertness) is the third most important aspect for short-term missions, but only seventh for long-term ones. 8. Conscientiousness (responsibility and attention to detail) is ranked fifth in the short term and eighth in the long term. 9. Communication; and 10. Leadership skills are ranked ninth to tenth in both mission types (Galarza–Holland 1999: 4).

Currently, all space agencies involved with ISS operations recruit their astronauts using psychiatric and psychological selection strategies that combine select-out and select-in approaches that usually occur at the time that individuals are screened in their application to become astronaut candidates (Kanas–Manzey 2008: 169).

Hungary is planning to send a second Hungarian astronaut to orbit. The history of the selection and training of the first Hungarian astronaut and his space journey is inextricably linked with the history of Hungarian aerospace medicine (Remes et al. 2013; Remes 2020). The phases of the selection and preparation of the Hungarian astronaut can be followed continuously in the media and on various internet platforms.

The next question is how the selected excellent people will get along with each other during long-duration spaceflights.

THE RIGHT STUFF

The ideally assorted crew would be the "right stuff". The term was first coined in NASA jargon. Its origin is a play on words like staff and stuff ('personnel' versus 'what-d-ya-call-it') and comes from Tom Wolfe's novel of the same title (Wolfe 1979).

The psychological aspects of long-duration spaceflight have raised the issue of crew matching as a priority. Suedfeld identified four historical phases in the development of this area.

The first phase was the "right stuff mentality". This essentially meant that crews that were properly matched were seen as invulnerable.

During the second phase of this approach, already in the 1970s, researchers realised that the invulnerability of optimally assembled crews was a myth, and a shift in focus towards resilience (i.e. full recovery from negative effects) was initiated.

In the third phase, in addition to the pathogenetic approach, salutogenetic or positive psychological thinking gained ground, where the positive after-effects of missions were also involved.

In the fourth phase, the author outlines "an integrated, complex Gestalt" in which, in addition to the selection and compatibility issues, attention must also be paid to the life course of the men and women who complete their careers in space (Suedfeld 2005).

The Right Stuff for long-duration exploratory missions

Space psychology is getting ever closer to creating the picture of an ideal crew for long-duration exploratory missions, i.e. for the settlements on the Moon and Mars.

In their overview, Landon and her colleagues discuss two such NASA models in detail. One is the Spence-Helmreich model, the other is the more traditional Five-Factor Model (FFM) (Landon et al. 2017). Both models have been investigated for decades in a wide variety of empirical research.

The Spence-Helmreich model of personality

The Spence-Helmreich model of personality consists of two elements: Instrumentality and Expressivity. Both attributes have positive and negative aspects and are assessed by the Personality Characteristics Inventory (PCI) (Chidester et al. 1991). Instrumentality is an indication of achievement and goal orientation and reflects three main needs: Mastery, Work and Competitiveness. Expressivity is an indicator of interpersonal attitudes and behaviours, with four categories of attributes: Expressivity, Verbal Aggression, Negative Communion and Impatience–Irritability. As the names suggest, there are positive and negative aspects to both personality traits. On this basis, three clusters are currently distinguished. The Right Stuff or Positive Instrumental–Expressive Group, the Wrong Stuff or Negative Instrumental Group, and the No Stuff or Low Motivation Group (Landon et al. 2017: 39). This model is a complement of the Five-Factor Model.

The Right Stuff Profile according to the Five-Factor Model

The Five-Factor Model (FFM) has a long conceptual history and has been used in a comprehensive variety of fields in personal, clinical and organisational psychology. Its present assessment tool, the Neuroticism Extraversion Openness Personality Inventory, or NEO-PI, and its more recent variants are connected to the lifework of Costa and McCrae (for history and description see e.g. McCrae–John 1992; Costa–McCrae 2000). The Model consists of five personality trait factors: Neuroticism, Extraversion, Openness, Agreeableness and Conscientiousness. These factors are continuous dimensions.

As mentioned above, the Galarza–Holland model for crew selection was also partly built on the five-factor approach (Galarza–Holland 1999). The Five-Factor Model describes the personality traits of an imaginary optimal crew as well.

So, what are the optimal personality traits of an imaginary crew in a Lunar or Martian colony?

Multiple studies have confirmed that the most important personality trait is Emotional Stability (Ursin et al. 1992; Palinkas et al. 2000). It is the other end of the Neuroticism spectrum. Along the subscales of this factor, the ideal Right Stuff member is not anxious, not hostile, not depressed, not self-conscious, not impulsive and not vulnerable.

As to the Extroversion–Introversion spectrum, authors agree that a range of low to moderately high is acceptable, i.e. the optimal crewmember is a sociable introverted person.

As to Openness to Experience (with subscales including Aesthetics, Feelings, Actions, Ideas, Values and Fantasy), a moderate range is acceptable – adaptability and cross-cultural competence are important.

The Agreeableness factor indicates the quality of interpersonal orientation with facets of Trust, Straightforwardness, Altruism, Compliance, Modesty and tender-mindedness. The moderately high to high level of this trait is optimal.

Subscales of Conscientiousness are competence, order, dutifulness, achievement striving, self-discipline and deliberation. In general, this trait is very important in long-term exploratory missions, because it is a strong predictor of team performance. However, e.g. Palinkas and colleagues argue that high scorers in this trait may easily become frustrated by deficiencies, inadequacies, delays, or similar difficulties, and this may be a source of stress in the group, whereas less conscientious individuals may better manage these problems and express a more flexible and adaptable attitude toward them (Palinkas et al. 2000: 623).

In sum, the Five-Factor Personality Trait Model appears to be a fairly strong predictor of individual and team performance, but further research is needed in the field to solve the remaining debates (Landon et al. 2017).

Beyond the issue of individual personality traits, Right Stuff has several aspects that affect the group as a whole. The most important of these are crew autonomy and cultural differences.

Crew autonomy

Concerning individual autonomy, Suedfeld and Steel (2000) call attention to a personality paradox "that cries out for research" (Suedfeld–Steel 2000: 242). The paradox is between adventure and boredom. On the one hand, people who join ICE groups, whether it is for Antarctic winterovering or space travel, are looking for excitement, adventure and challenge, and very quickly find themselves in a monotonous and boring environment from which they are unlikely to escape for a long time. On the other hand, such adventurous people have a high need for autonomy and sometimes find it difficult to tolerate being controlled by others or by the organisation.

Concerning group autonomy, expeditionary ICE groups are usually set up, funded and launched by an organisation that defines the purpose of the mission. Accordingly, the concept of crew autonomy makes sense in the context of the relationship between the crew and Mission Control and accompanies the whole history of ICE groups. In case of ships, direct contact with the sending organisation was lost as soon as the ship ran out to the open sea. In polar expeditions, the winteroverers had practically no connection with their homeland – but today, in the age of the Internet, the situation is different. There is relatively little experience with this issue in space, but the aim is to achieve an optimal level of crew autonomy. Space psychologists agree that crew autonomy is medium in Antarctic winterovering, low-to-high in orbital ISS missions; it will be high in Lunar missions and extremely high in Mars missions (Kanas–Manzey 2008: 217). The issue has been investigated, for example, in the Mars 500 ground-based space simulation in Moscow (Gushin et al. 2012; Gushin et al. 2016; Supolkina et al. 2021).

Space psychologists started to investigate a phenomenon that may occur in extremely high autonomy settings. This is Groupthink, a concept taken by Irving Janis from Orwell's book, *1984* (Janis 1982). Occurring in highly cohesive groups under stressful conditions, groupthink is an illusion of invulnerability and unanimity. Further features of groupthink are ignoring warnings, unquestionable belief in the inherent morality of the group, direct pressure on any individual who expresses doubts about any of the group-shared illusions, and self-censorship of group members, i.e. avoiding deviation from group consensus. This dangerous condition may deteriorate group performance and decision-making capacity, thereby representing a serious hazard for the performance of crews acting in a high-risk environment (Kanas–Manzey 2008: 224–225).

Cultural differences

In the present and future eras of heterogeneous crews, the key question is how psychosocial adaptation by crews from different cultures can be studied. Research on cultural differences in polar and space psychology is largely based on Hofstede's wide-ranging work (Hofstede 1980; 2011).

Helmreich and Merritt found that three of Hofstede's dimensions were relevant for pilots and, consequently, for spaceflight: Individualism–Collectivism, Power Distance and Uncertainty Avoidance (Helmreich–Merritt 1998). Partly based on this model, Helmreich identified three determinants relevant to space psychology: national, organisational and professional cultures (Helmreich 2000).

Besides the three main types of cultural differences, an evolving field in the study of crew heterogeneity is the investigation of gender issues. Studies range from mixed-gender through gender-balanced to all-female studies in many settings (Bishop et al. 2010; Binsted et al. 2010; Blackadder-Weinstein et al. 2019; Supolkina et al. 2020; Tafforin 2020).

A 21-membered international team of eminent scholars of the field conceptualised a review and still valid recommendations for the future, involving the host–guest problem and the minority issue, as well (Kanas et al. 2009). A recent review refers to cultural differences in the framework of cross-cultural competency as a selection factor for long-duration exploration missions (Landon et al. 2017).

COMPARABILITY AND INTEGRABILITY OF RESEARCH

The psychodynamics of groups in isolated, confined and extreme (ICE) environments show many similarities in different settings and environments, such as Arctic and Antarctic expeditions, mountain climbing expeditions, submarines, sea-based oil drilling platforms, and underwater and land-based simulations. Sandal, however, warns of the need for caution and care in considering these similarities when extrapolating psychological findings across settings (Sandal 2000).

Suedfeld thought carefully about the concept of analogy and argued that Antarctica is not a simulacrum (an insubstantial form or semblance) of outer space. Thus, polar psychology is an autonomous and independently important component of psychology, especially ICE psychology. He suggests that analogies should be based not necessarily on environmental characteristics, but on similarities in experience (Suedfeld 2018).

The most notable distinction between space and all Earth-based analogues and simulations lies in the absence of weightlessness in the latter. Microgravity, through many brain physiological mechanisms, can impact cognition and consequently social interactions. An illustrative example underscoring the significance of weightlessness comes from an experiment conducted aboard the International Space Station (ISS), where Takács and colleagues observed reduced performance over a 6-month mission (Takács et al. 2021).

Interestingly, no such decline was noted when the same task was performed in an Antarctic environment (Barkaszi et al. 2016). While some physiological effects of microgravity can be simulated on Earth through head-down tilt bedrest, a recent review of the cognitive domain by Barkaszi and her colleagues revealed more disparities than similarities between findings in space and bedrest studies (Barkaszi et al. 2022).

An often underestimated distinction between space and simulations is the degree of confinement. Participants in Antarctic stations and simulations like the Mars 500 facility enjoy private bedrooms and relatively spacious living areas. Conversely, the ISS cannot afford any private space, and the confinement would be even more severe in vehicles planned for the initial Moon and Mars expeditions. Ethical considerations likely deter Earth-based studies from attempting to simulate long-term confinement to a similar extent.

In terms of extreme environments, polar stations present themselves as a highly promising analogue for space. Stations like Concordia become technically inaccessible during winter, mirroring the situation on the ISS. From a societal standpoint, this implies that crews must independently address any emergencies that may arise. Additionally, given Concordia's effective altitude of more than 3,000 m, it could serve as a testbed for examining the impact of ICE conditions combined with hypoxia. Even mild hypoxia is known to impair cognition (e.g. Reményi et al. 2018) and could be a relevant factor in future long-duration space missions where the decreased cabin pressure is being considered for technical reasons.

Reviewing more than a hundred studies in terrestrial space analogue environments, Kanas and Manzey concluded that no single site or simulation can fully reproduce the space environment (Kanas–Manzey 2008). While this assertion holds merit, it is essential to recognise that the International Space Station also cannot replicate all the conditions of interplanetary missions.

SUMMARY AND OUTLOOK

The review studies on the subject of "future perspectives of space psychology" mainly summarise the issues and their countermeasures arisen so far, and word cautiously about issues to emerge in the still unknown future (De La Torre et al. 2012; Gushin et al. 2021). Nevertheless, some developments are seen to unfold.

First, space psychology is likely to develop in close cooperation with space technology and the space industry, with a multitude of new interactions and new professions. Some of the well-known psychological problems traditionally encountered in ICE groups are likely to persist in the future. Examples include sensory and social deprivation, monotony, homesickness, loneliness and even the need for good food. For these problems, new and rapidly evolving methods will offer solutions, such as virtual reality technologies, social robotics, space food technologies, space greenhouses, and so on.

Second, the emphasis seems to shift from a focus on the recognition and description of problems to a focus on countermeasures and solutions, and this is well reflected in the changing terminology. 'Cultural differences' are recently referred to as 'Intercultural Competence', the 'Right Stuff' as 'Behavioural Health and Performance', and the 'Earth-out-of-View' as the 'Disappearing Earth Phenomenon' (or the 'Break-Off').

Finally, the experience and results gained in ground-based and orbital sites will not fade into oblivion but will be integrated into the research carried out during long-duration space missions and on lunar and Mars colonies in the future.

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