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Mars: Anticipating the Next Great Exploration. Psychology, Culture and Camaraderie

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Abstract

The first part of this paper reviews the available sources of information relevant to predicting the psychological conditions of a voyage to Mars and back. These sources are simulations, environments created especially to resemble some aspects of the actual voyage, and analogues, environments that exist independently of the Mars mission but by their nature some of its characteristics. Individual or group isolation chambers are prototypical simulators; early terrestrial explorations, present-day Antarctic stations, and LEO space habitats typify analogues. The second part of the paper urges that the predominant focus on predicted problems and countermeasures be expanded to include the many positive aspects documented in the narratives of astronauts and other explorers: an appreciation of the beauty of the natural environment, camaraderie, changes in values and self-confidence, and other evidences of personal growth.

Key Words: Mars exploration, Human exploration, Aerospace Psychology, Isolated confined environments, Human Factors, Human Performance, Culture, Violence, Sex

1. Introduction

High on the list of human motives are the desires for novelty and excitement: the urge to explore. Stories of exploration, sagas of the quest, evoke fascination and awe. Having explored most of our planet, we are left with two great unknowns: the ocean depths and the limitless expanses of outer space. After our first successful steps into space, we are now getting ready to encounter Mars. The Red Planet has been an inviting destination at least since the "discovery" of its canals, once thought to indicate intelligent life. Human imagination has roamed freely around the planet since then (see, e.g., Bradbury, 1950); we are now approaching the time when imagination can be combined with first-hand knowledge.

2. Analogues and Simulations Show What We Can Anticipate

At this point, our ideas of what a trip to Mars would be like for the travelers come entirely from analogue and simulation studies. To clarify the terminology, we use "simulation" to refer to environments designed specifically to approximate some characteristics of the target environment, whereas "analogue" environments exist for other purposes but inherently share some of those characteristics.

The prototypical *simulator* for spaceflight is an enclosed chamber in which people are isolated from the outside world, in numbers and for periods approximating those of space missions and performing tasks, accessing food and sanitary facilities, and communicating as a space crew would. The most frequently studied *analogue* is a polar station where people live and work isolated by remoteness and climate, carrying out their duties in a physically and socially restricted indoor environment, with a technological life support system that keeps them safe within a dangerous outside environment that they cannot enter without elaborate safety gear and precautions. Orbiting space stations are also useful analogues for the Mars mission, and some of the data derived from them are summarized here.

Psychologically, the closest earthly analogues to the Mars expedition are the terrestrial and maritime explorations of Earth itself. These imposed conditions of discomfort, danger, isolation, and confinement, with stretches of monotony and tedium, for periods ranging up to several years. Other similarities include a long and hazardous voyage to the site to be explored, the perils, exertions, and uncertainties of the exploration itself, and another long and hazardous voyage home for the survivors. Examples of maladaptive reactions abound, as in the *Belgica* expedition, the first to winter over in Antarctica, with its episodes of psychosis, hallucinations, paranoia, and despair (Cook, 1980). There have been few psychological studies of expeditionary archives, but "historical space psychology" (Suedfeld, 2009) has already provided some findings of relevance to the potential Mars crew (Allner & Rygalov, 2008; Stuster, 1996; Johnson & Suedfeld, 1996). Among these have been the roles of mission phase, factors affecting the habitability of living and working spaces, and effective ways for leaders and crews to alleviate boredom and stress.

The first space simulators foreshadowed the first space capsules: a lone man in a small chamber or immersed in a tank of water, with restricted movement and greatly reduced visual and auditory stimulation (Lilly 1956, Zubek, 1969). Participants experienced simple to complex hallucinations, and although a rare few enjoyed the experience (Lilly 1956, 1977), many had bad psychological reactions. Initial results, therefore had raised concerns for the safety and mental health of the astronauts. However, neither the simulation subjects nor the astronauts whose environment they were simulating suffered serious impairments.

As crew sizes and mission durations grew, there was uncertainty about how isolated small groups would get along with each other. Admiral Byrd’s fear that murder might result from isolating two or three men in a small cabin through an Antarctic winter seemed realistic. Simulators were designed for two to four subjects confined in a small space for a week or more, during which they performed various individual and cooperative tasks (Altman & Haythorn, 1967). The results were generally encouraging; no major incidents of hostility or refusal to work together were reported.

Next, missions on orbiting space stations -- Spacelab, *Salyut, Mir,* the International Space Station -- stretched to weeks and months, with larger and more diverse crews, intense work schedules, and disrupted circadian rhythms. Simulations changed accordingly, although they still could not duplicate such factors as the physiological changes due to microgravity and radiation, or the psychological impact of being off Earth and knowing that in serious emergencies rescue was impossible. Canadian, European, and Russian projects studied the effects of up to eight months of capsule isolation and confinement on experimental subjects. Head-down bedrest studies combined confinement, stimulus monotony, and restricted movement with a change in blood distribution that approximates the effects of microgravity.

At the time of this writing, six men are about half-way through the planned 520-day confinement of the Russian-European Mars500 study, which includes simulated Mars surface operations. An international group of scientists is pursuing a program of physiological and psychological studies.

The Mars voyage has also inspired simulations in natural environments. Nongovernmental organizations, some with funding and cooperation from space agencies, have for years used stations in the Utah desert and the Canadian High Arctic (Zubrin, 2003). Participants conduct research wearing simulated spacesuits whenever they leave their shelter and communicate by radio, with the same 44-minute two-way time lag as an Earth–Mars conversation would take (as in the Mars500 simulator). These deployments last only a few weeks, and do not attempt to replicate the three-phase nature of a Mars mission.

In recent times, analogue environments have better approximated the conditions of prolonged space missions. The Canadian Analogue Research Network runs stations in the north of the country, concentrating on earth science, biology, engineering, and testing equipment. Again, the tour durations and conditions are quite different from those expected for Mars. Other analogues are undersea habitats, constructed to study marine biology, the physiology of saturation diving, and so on. NASA Extreme Environment Mission Operations (NEEMO) crews, including many astronauts, have lived for up to three weeks in a marine biology research habitat in Florida, 20 meters below the sea surface. Like astronauts, "aquanauts" depend on high-tech life support both inside and outside the capsule. Their activities and living conditions also quite closely approximate life and work in space; for example, they have undertaken construction work outside the capsule, just as did the astronauts who built the International Space Station (NASA, 2006).

2a. The relevance of analogues and simulations Submarines and small isolated outposts such as weather stations and early warning radar sites have been studied to see how their crews perform real, not just experimental, tasks during months or years of social and physical monotony, remoteness from and limited contact with the outside world, crowding and lack of privacy, and a harsh and potentially lethal environment outside the habitat. Speculative extrapolations from such studies to space capsules have been common, although their validity has been actively debated (e.g., Harrison, Clearwater, & McKay, 1990).

The most frequently cited terrestrial analogues are Antarctic stations. Winter-over crews, with half a dozen to almost a hundred members, generally face nine months of total, and three of partial, isolation and confinement, with physical and social monotony and a very challenging external environment that requires bulky clothing and poses intermittent danger. In some programs, crews spend two years on site.

There have been dramatic incidents: a reported murder over a chess game in a Russian station, an Argentine physician setting fire to his own station, violent fights in a variety of stations, and so on (Griffiths, 2007). On a less lurid, but nevertheless worrisome level, winter-over personnel have exhibited a range of psychiatric symptoms. Although severe mental symptoms are rare, a subclinical "winter-over syndrome" comprises cognitive impairment, sleep disturbances (especially insomnia, the so-called "Big Eye"), interpersonal conflict, negative affect, depression, anxiety, and low energy. Fugue states (the "twenty-foot stare in the ten-foot room," or "Long Eye") also occur (Shea, Leveton, & Palinkas, undated). All of these conditions are temporary, usually disappearing before or soon after returning home.

The results of analogue and simulation studies have been reasonably accurate predictors of long-duration space missions. Although levels of stress have generally not surpassed the coping abilities of space crews, there have been psychological problems: among them, the components of the winter-over syndrome, which of course was first identified in an analogue.

Leadership and group dynamics pose both difficulties of adjustment and opportunities to reduce such difficulties, depending on how they are handled. The hierarchical pyramid common to military and bureaucratic tradition is flattened when the crew is just as highly educated and trained, and as rigorously selected, as the commander, and when the normal markers and powers of rank are much diminished. For a crew experiencing a multi-year, multi-stage voyage to and from a strange planetary surface, good leadership focusing on cohesion and morale will become as crucial as it was for the polar expeditioners of Nansen, Amundsen, and Shackleton.

2b. Sex, Culture and Communication In-group cohesion in analogues varies, depending on personality, cultural background, mission duration, group size, leadership, etc. Cohesion within simulation capsules has been acceptable although occasional friction occurred, and has often been accompanied by distancing from, and occasional hostility toward, staff outside the capsule who supervise and direct crew activities (e.g., Le Scanff et al., 2009). This reaction is common in space, especially when ground control leaves insufficient latitude and control for the astronauts over their own tasks and schedules (Kanas & Manzey, 2003). The issue of crew autonomy will loom large in the Mars mission, and has recently been emphasized in NASA’s research foci (Kanas et al., 2010).

When simulation crews include members with different national and linguistic backgrounds, misunderstandings and communication difficulties may plague both the crew and their outside colleagues. Increased crew heterogeneity -- in cultural background, profession, language, and gender -- is a potent source of problems.

Several of these issues were dramatically illustrated during the "Sphinx" (Simulation of Flight of International Crew on Space Station, SFINCSS)-99 simulation. About two months into the experiment, two Russian crewmembers engaged in a bloody fight. Shortly thereafter, a Canadian female volunteer, Dr. Judith Lapierre, was twice forcibly kissed by the Russian commander who pulled her outside the range of cameras and stuck his tongue in her mouth despite her vigorous protests.

Russian administrators considered this normal behavior during a New Year’s Eve party; non-Russian participants strongly disagreed. The administrators’ solution was to lock off access by the four Russians to the chamber inhabited by the three-person multinational group which included the five foot tall, 32-year old Dr. Lapierre. These responses were deemed inadequate and defensive by the non-Russians and led to their increased alienation. One quit the experiment, ostensibly because of the stress of these events but possibly also because, as a non-scientist, he had no work of his "own" to conduct. There were also complaints about the food, the level of sanitation, and the low level of English ability in the Russian mission control (Oberg, 2000).

According to the "Bioastronautics Roadmap" (Longnecker & Molins, 2006) a report commission by the National Research Council, if kept in a cramped space ship for years, surrounded only by stars and the blackness of space, astronauts are likely to think about sex and romance, and in a coed crew, this may result in sexual activity, and even pregnancy in space.

However, there are no authenticated stories of sex in space, and cross-cultural relations in actual space stations have not been this abrasive. Nevertheless, it is frequently true that members of a foreign minority flying on either Russian or American spacecraft are psychologically less comfortable than the majority. Although this does not detract from their trust in their crewmates, their attitudes toward the space agency in charge deteriorate -- just as in the simulation (Suedfeld, Wilk, & Cassell, 2010).

3. A Positive Look at the Next Great Exploration

3A. Widening the focus. Why, if exploration is so stressful, have there always been eager participants? Why are there thousands of applicants every time a space agency announces openings for astronaut candidates? The perhaps apocryphal story of hundreds of men applying to join "a mission from which safe return is unlikely" is quite credible.

Space agencies have understandably emphasized the need to protect astronauts from psychological problems, a pathogenic (illness-oriented; Antonovsky, 1987) approach. The alternative, salutogenic (health-generating) "positive psychology," needs to be imported into the study of spaceflight and other challenging enterprises (Suedfeld, 2002). Positive psychology combines an emphasis on human strengths -- love, courage, creativity, altruism, rationality -- with an appreciation of how these strengths shape our reactions to different experiences (Snyder & Lopez, 2002; Suedfeld, 1997).

Old archives and recent research show how, in our concerns about problems and countermeasures, we have largely ignored a major portion of the truth: explorers of all types have experienced and demonstrated high levels of resilience, positive emotions, and personal benefits as a result of their adventures. Ships' logs and trekkers' memoirs tell a better story than the descriptions of winter-over syndrome and its cousins. Even in the years when polar exploration was at its least comfortable and most hazardous, expeditioners exulted in the beauty and awesomeness of the scenery, the joys of camaraderie, and the feeling of strength in having overcome adversity (Mocellin & Suedfeld, 1991). Even the most troubled expeditioners described music, dancing, and funny stories, the ingenuity of crewmembers, the "restfulness and contentment of this life within its lonely world of ice" (Cook, 1980, p. 201) and the beautiful colors of the sky, ice, and water. Astronaut memoirs and interviews show similar positive notes.

3B. The positive effects of spaceflight. Friendship and cohesiveness among the crew, satisfaction in jobs well done, pride in having been chosen to fly in space, and appreciation of the beauty of the outside world, are frequently mentioned. Astronauts use humor and other techniques of early sailors to reduce stress (Johnson, 2010). Looking out the window, especially at the Earth, is a favorite spare-time activity, with crewmembers striving to identify places that are meaningful to them.

Positive psychology in space is increasingly being documented. Quantitative content analyses of oral and written histories (Suedfeld, 2007) have shown personal attributes more subtle than the obvious "Right Stuff" characteristics of bravery, adventurousness, intelligence, and resilience. Memoirs refer to positive emotions three times as often as to negative ones. They show an unbroken string of successful coping with the series of psychosocial crises experienced throughout life. The astronauts evidence trust in others, autonomy, initiative, industry, strong personal identity, intimacy, a concern with future generations, and a conviction that their life makes sense and is worthwhile. These last two characteristics increase significantly after spaceflight.

Although astronauts in this study scored predictably high in achievement motivation, their strongest motivation (although with a dip during the flight itself) was affiliation: warm and friendly relations with others. Russian cosmonauts were especially high on this measure. Problems were solved through mutual cooperation and information exchange, perseverance, and rational planning. The astronauts were confident about their emotional stability and coping abilities, and viewed themselves as active agents in dealing with trouble; in fact, upon their return they were even more certain of these abilities than prior to their mission.

Among values, the goals that guide people's lives (Schwartz, 1992), achievement, by far the most frequently mentioned overall, became far less dominant when the astronaut was recalling the flight itself. Instead, there were large increases in references to enjoyment, universalism (particularly a world at peace), and spirituality (especially unity with nature and belief in God). Both universalism and spirituality continued to increase into the post-flight period, and universalism finally became the second strongest value (after achievement). It was especially high among Russian cosmonauts, and among spacefarers who had been on long-duration missions. Comments about how beautiful the Earth looks from space, and how wrong it is for people to squabble over it instead of protecting it, were common (Suedfeld, Legkaia, & Brcic, 2010). The value of power also rose after spaceflight, perhaps reflecting the astronauts' desire to influence others in service to their other strengthened values. Generally, values serving collective interests rose, while individualistic values remained stable.

Such changes are similar to those found in post-traumatic growth (PTG), the salutogenic concept that traumatic experiences can lead to a more positive self-concept and to a better way of life (Tedeschi, Park, & Calhoun, 1998). Most space missions, of course, have not been traumatic experiences; but Ihle, Ritsher and Kanas (2006) devised a space-relevant version of the PTG Scale. Administered to 39 astronauts, it showed that some became more sensitive and responsive to their environment, showing increases in appreciating the Earth and space itself (e.g., a heightened sense of wonder about the universe), while others focused more on their inner life, such as changed priorities and appreciating each day. Although the difference is interesting, the salient finding is that both groups showed important positive changes as a result of their space experience.

In a recent study (Suedfeld, unpublished data), retired cosmonauts were asked how often they had experienced each of 22 negative feelings during missions. Almost all ratings were between "Almost never" and "Sometimes"; within that range, the highest was "too many things to do." The only feelings reported "Often" or "Usually" were positive ones: rested, calm, full of energy, safe and protected, enjoy myself, doing things I really like, and light-hearted.

Answering a post-mission growth scale, these respondents reported "Moderate" to "Great" increases in: knowing I can handle difficulties, new opportunities that wouldn’t have been available otherwise, and establishing a new path in life.

The data converge on some inescapable conclusions, further supported by ample anecdotal evidence. In general, astronaut selection effectively identifies resilient people who are good at both solving problems and getting along with others; for most participants, spaceflight is a peak experience; and among post-flight changes, astronauts consider themselves to be changed for the better in many ways. These findings in no way detract from the importance of anticipating problems and preparing countermeasures for the unique challenges of the Mars mission -- but equally, they point out the importance of also considering the possibly unique benefits of this great adventure, to the astronauts themselves and to humankind.

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