The Psychological Dangers of Long-Duration Spaceflight

And the Importance of Crew Selection

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Life on Mars?: Final Paper

As a mission to Mars draws nearer and the duration of space missions in general increase, many concerns related to the prolonged duration of these missions arise. Questions facing the mission designers range from unique engineering challenges to concerns about the health of astronauts on such prolonged expeditions. Health related concerns include issues such as the level of radiation astronauts might be exposed to, particularly from solar particle events and galactic cosmic radiation, as well as the impact of calcium and bone loss in zero gravity environments. In this paper, however, I would like to concentrate on another aspect concerning the health of astronauts: the psychological dangers of long-duration space flights. Specifically, I would like to assess the major psychological problems that could arise on such a mission, discuss why crew screening and selection will be crucial in reducing the psychological risks of an extended mission to Mars, and suggest that more research into group dynamics is necessary.

According to Albert W. Holland, the chief psychologist for NASA, "the high costs and constraints involved in placing humans in space make people the most important 'subsystem' within a mission."[1] Past experience in space has shown that the health of a crew, particularly their mental health, can have a great effect on the success or failure of a mission. At least three Russian missions, Soyuz 21, Soyuz T-14, and Soyuz TM-2, all had to be prematurely ended due to psychological difficulties that developed among the cosmonauts. American missions have not been immune to these dangers either; in 1974 the crew of Skylab III refused to communicate with ground control due to extreme frustration with their workload and a strained relationship with ground control.[2] Although all of the aforementioned are rather extreme examples of how the psychological

status of the crew dramatically impacted the goals of the mission, other crews and missions have been affected to a lesser extent.[3]

Over the course of a mission, especially a long-duration mission, psychological issues tend to develop from two kinds of sources: latent and overt. Latent stressors, such as the tedium of life aboard a shuttle, are unavoidable realities of spaceflight. Furthermore, these issues develop very slowly over time and can be very difficult for observers on the ground to detect and remedy. Isolation is perhaps the most inescapable of all stressors in spaceflight. “A rise in social tension frequently occurs under conditions of isolation and confinement” and occasionally is manifested as “open antagonism...through ‘pinging’ or highly aggressive teasing.”[4] Upon returning to earth, Cosmonaut Valery Ryumin wrote, “All the necessary conditions to perpetrate a murder are met by locking two men in a cabin of 18 by 20 feet…for two months.”[5] While thankfully no mission to space has ever ended in murder, isolation can lead to numerous problems including sleep deprivation, depression, irritability, anxiety, impaired cognition, and hostility.[6] A great deal of research has been dedicated to studying the effects of extreme isolation on humans. Although some research has been conducted on astronauts and cosmonauts and their reactions to isolation in space, the small number of men and women who have actually participated in space programs and the difficulty and expenses related to conducting comprehensive psychological experiments in space, have compelled scientists to use analog environments in studying the effects of isolation on individuals and small groups. Typically these analogues for space have included isolation in Polar Regions and underwater laboratories. Below are descriptions of two such experiments that I believe are particularly interesting and elucidating.

The first experiment I would like to discuss is a Transantarctic Traverse that took place in 1990. The crew was composed of an international group of six men from six different countries - China, France, Great Britain, Japan, Russia, and the United States. During the expedition these members were expected to fill out questionnaires testing "mood, motivation, group cohesion, efficiency, leadership, and social functions," in addition to undergoing thorough interviews before and after the expedition.[7] During the course of their journey, the crew encountered numerous problems. Weather conditions were much more extreme than they had anticipated, and the weeks of snow, wind, and fog caused them to lose some of their food and supplies, as well as radio contact with their "mission control". Over the course of the mission numerous individuals in the group grew frustrated with the isolation and the command structure of the expedition. Most members had a tendency to use intellectualization and simple denial as defense mechanisms when problems arose. When questioned following the completion of the trip, most members felt that isolation was the root of most tensions within the group and that "confidence in their meticulous planning" was the key to their success.[8]

The second experiment, again involving six men from a variety of countries, was conducted by the Norwegian Underwater Technology Center as a space simulation for the European Space Agency. The crew, some of whom were candidates for astronaut selection, was isolated in an underwater chamber for a period of 28 days. Over the course of this period, the participants completed questionnaires about their own psychological states as well as their crewmates'. In addition to this self-evaluation they were also constantly monitored and their communication skills reviewed every third day. During Week 1 most of the participants scored themselves positively, though their work

output was rather low. Week 2 received the most negative scores on the mood questionnaires; most participants were more "distant, tired, tense, and quarrelsome" due to the isolation and dissatisfaction with the managerial arrangement.[9] In Weeks 3 and 4 the mood of the group gradually improved, though tension was still present. The researches attributed these problems primarily to the command structure of the crew. "In the rather loose framework of the experiment the commander, the only military man present, took more and more control. Emotions rose as the rest of the crew began to react against and then distance themselves from him."[10] This experiment provides an example of not only stress and tension developing in groups under isolation, but also of the dangers of an ill-defined command structure.

The second type of stressor is overt. Overt stressors arise from specific events; critical failures of equipment and family issues back on earth are both examples of overt sources of tension. While the effects of this type of stressor are usually easier to detect because of their sudden onset, prevention is often impossible. It is difficult to predict how individual crew members will react to different overt stressor events, though the effects are often very similar to those produced by latent stressors and surely are equally dangerous to the health of a crew member and the success of the mission.

In past space missions and analog environments, severe psychological issues have arisen among crews due to both latent and overt stressors. These issues have affected individual performances as well as group cohesion and have on a few occasions even forced a mission to be curtailed. It is suspected that as mission length increases the dangers of "oral outbursts, friction between crews and people on the ground, depression

and demoralization, guilt, fear, burnout among ground teams, motivation drops, cardiovascular arrhythmia and other physical manifestations of stress, reduced short-term memory, and mission significant errors in completing tasks" will only increase.[11] When selecting a crewmember, therefore, one must consider the candidate's abilities to cope with both latent and overt stressors.

Despite the great number of psychological dangers and the very serious effects that they can have on a crew and a mission, many countermeasures can be taken. Like the types of stressors, the countermeasures fall into two general categories: preflight prevention, and in-flight solutions. Examples of preflight preventative measures include careful psychological screening for crew selection, psychological training for the crew, promotion of good crew-ground relations, meticulous mission planning, as well as numerous other measures related to the physical environment of the astronauts, work/rest characteristics, and the autonomy of the crew.[12] However, no matter how well a crew is selected and a mission is planned, it is inevitable that some psychological issues will arise during the trip. Therefore, in-flight monitoring and intervention by ground teams have often been very helpful in remedying stressful and tense situations among crewmembers. Of course, evacuation or abortion of a possible is also a possible though extremely undesirable solution if serious psychological disputes do arise.

While all of the factors mentioned are extremely helpful, I would like to argue that crew selection is the most logical and effective means of reducing the psychological dangers of a long duration spaceflight. Presently, the longest mission ever undertaken by an astronaut, or rather a cosmonaut, was 14 months. Current plans for a mission to Mars estimate that the mission will take approximately two and a half years; six months flight

time there and back, plus an additional year and a half on the planet. On such a long mission the effect of latent stressors will clearly be multiplied; additionally the chances of encountering serious overt stressors also greatly increases. Only individuals most capable of dealing with the inevitable psychological impact of such a mission should be chosen. Likewise, and perhaps most importantly, in-flight monitoring and counseling will be far more problematic when there is a communications delay. Thus more autonomy is necessary for all aspects of the mission, including the on-board management of psychological issues that arise. Careful crew screening and selection will also, dramatically reduce the amount of preflight psychological training required.[13] A mission to Mars will be much more technically complicated than any previous mission, that crew preflight time will already be filled with mission related tasks; any time devoted to psychological training that could safely be spared likely will be omitted. Finally, I believe that for a mission as prominent and publicized as one to Mars will be, the number of applicants and qualified candidates will be large. Thus intense crew screening on the basis of psychological concerns should be very possible. To put it simply, on a long-duration spaceflight, specifically one to Mars, "a gram of prevention is worth a kilogram of cure".[14]

Having examined the benefits of crew screening over other possible countermeasures, I would now like to discuss who should be selected and how this selection process should take place. "In general, any selection system must answer at least two questions: (1) Is there any evidence of clinical traits or psychiatric dysfunction that would impair the candidate's health or performance on the job and mission?…(2) To what extent does the applicant have the psychological capabilities or behavioral skills to

perform well on the job and mission?"[15] In, other words, it is critical to determine whether or not there are any preexisting psychological concerns that might prevent an applicant from performing properly, and secondly whether or not she has the psychological traits and skills that will be needed to complete the mission. The first question is a "select-out" question meaning that it is used to "weed out" inappropriate candidates, hopefully very early in the process. The second question relates to the suitability of a person for a given mission. This type of "select-in" procedure usually takes longer, relating the applicant not only to her specific job, but also to the other members of the crew. This "select-in" procedure is far more interesting to study for it illustrates what personality traits NASA is looking for, rather than what concerns prohibit a person from participating in a mission.

Two methods are involved in the "select-in" procedures. First, there are "objective" tests, "such as paper and pencil tests, computer or CD software, videos, and electronic or physiological equipment".[16] These methods are balanced with more "subjective" examinations, "such as structured interviews, veteran ratings, and expert ratings of performance in special situations or environmental conditions."[17] Both methods are intended to identify the presence of certain character traits and personalities, which are felt to be desirable for astronauts to possess. While these traits are of course numerous and to some extent determined on an individual basis, others are uniformly desirable, such as: high motivation, ability to work well within a team, adaptability, and the capability to calmly deal with latent and overt stressors.

Selection and screening of course do not end after these "front door" examinations. Rather, the assessments continue on into preflight training where the

psychologists and veteran astronauts observing the crew "can accurately understand their psychological capabilities and behavioral skills" in realistic work settings.[18] One of the methods of selection that I feel is particularly important is that of "self-selection". In examining whether or not an individual has the ability to work well in a group, the potential crewmembers themselves represent the most important source of information. "Individuals know best whom they prefer to work with and whom they do not, even if they have difficulty articulating the reasons."[19] For this reason, I would recommend that in choosing any crew for a mission to mars, the candidates should be isolated in an analog environment in order that they can view their potential crewmates in stressful situations and based on these experiences self-select their crew at least to some extent.

Beyond the specific procedures of crew screening and selection, I would also like to briefly examine two other issues related to this selection process: gender and nationality. Although these are both touchy subjects, a number of articles and experiments have raised issues that should be addressed. In 1991, a psychology team at the University of California-Davis examined mission destination, mission duration, and perceptions of space habitat acceptability as these issues specifically related to gender. That study employed a role-playing methodology in which college students were asked to evaluate certain hypothetical mission scenarios relating to environmental comfort, personal control, work schedule, inconveniences, emotional release, shared facilities, and makeshift services.[20] The researches found that "strong gender differences emerged: On most dimensions, women found conditions less tolerable than did men." Those researchers proposed that one possible explanation for the differences encountered might be "that compared to [the] male subjects, [the] female subjects are less suited for the

rigors of space." Nevertheless, there is another possible explanation; "that gender differences reflect sex-role prescriptions that men should be able to 'take it', while women should downplay their competency in such 'masculine' areas as space exploration." Evidence of this second possible explanation can be found in the fact that "the only area where women actually showed a higher level of tolerance was in the area of emotional release", which addressed "subjects' willingness to abstain from sexual contact, alcohol, tobacco, and other drugs"; "given cultural norms, women might be more reluctant to admit that they would find abstinence as difficult to tolerate as men, and men might be reluctant to admit that they would be willing to abstain from behaviors that support a macho self-image." In the end, the researchers concluded that the results of this study could well be related to cultural issues unrelated to adaptability in space and that more research is necessary.[21]

Recently, there have also been investigations into the group climates of all-female expeditions in comparison with all-male and mixed ones. One such study was performed on four American women on an expedition to the South Pole. The researches wanted to examine "group factors including leadership and decision-making processes, cooperation, and emotional sharing, and their relationship to task effectiveness."[22] They found that there was much more communication and emotional concern between group members. One of the group members in her journal wrote, "It felt like our commitment to making the whole mechanism work and communicate remained high… I don't experience that in the same way in a mixed group."[22] Furthermore, when compared to all-male groups, this all-female group responded to stressors much more favorably. "Problem solving and positive reappraisal were the primary coping methods reported in dealing with significant

stressors"; "investigations of all-male Antarctic expedition groups indicated that intellectualization, denial, and repression" are the most common methods of coping.[24] Nevertheless, this is just one experiment and more research is surely needed.

Currently NASA treats male and female applicants in an identical manner. Furthermore, according to Dr. Albert Holland, from what he has seen in spaceflight missions as well as analog environments, mixed gender crews tend to be more stable than all male or all female crews.[25] Other studies have also found that the presence of women on mixed-gender expedition teams changes the dynamics of the group process." Moreover, "having one woman as a team member" has made the men on the mission "feel less competitive with each other."[26] It is my personal belief that while more research is warranted, especially in isolated analog environments, men and women would probably be equally adaptable to the rigors of space. Nevertheless, the emotional stability that women tend to bring to a crew might make an all-female crew, or at least a mixed gender crew, more desirable than an all-male one.

A second issue related to crew selection is the nationality of crewmembers and the internationality of crews. The European Space Agency, along with French and German scientists, conducted a psychological test in a second language on 93 engineers and scientists. They found that when the battery examination was administered in English, "the Spanish and Italian group scored higher on the impatience scale". "Spanish and Italian [scientists] also scored higher on the question 'how easily they got irritated,'…and also scored higher than other groups on self-reported bad-temper."[27] Whether or not these results represent true cultural differences in unclear; nevertheless,

because of the high likelihood of international space missions in the future, more testing, especially on the impact of second languages, seems warranted.

In addition to these analog tests carried out by the ESA, the American and Russian cooperative experiences on board MIR and the International Space Station have also raised questions relating to multinational crew composition. Many of the early astronauts, John Blaha in particular, found their experiences aboard MIR very frustrating. The reasons behind this frustration are complex, however are in part due to his difficulty learning the Russian language. Questions of command and the amount of autonomy that Blaha should have been given also upset him greatly at times.[28] Although the experiences of astronauts and cosmonauts working together have improved greatly, there are still psychological concerns relating to language and cultural differences. Furthermore, if future space missions are to be truly international expeditions, the command structure must be made very clear for if not explicitly stated tension could arise during the mission as it has in past analog.

There are many dangers inherent in any long duration spaceflight, such as a mission to Mars. These concern all aspects of the mission, though one item that deserves more attention than it has received in the past is the crew's psychological health. On any mission, and especially on long duration missions, both latent and overt stressors will inevitably arise; a crew's ability to effectively deal with these stressors is of central importance to both the health of the crew and the success of the mission. While there are many preflight and in-flight methods for preventing and dealing with psychological issues, on a mission to Mars in which the physical and mental challenges will be

particularly demanding, communications difficult, and the applicant pool large, extensive applicant and crew screening represent the primary method for reducing the risk of these psychological dangers. Nevertheless, much more research on group dynamics specifically related to gender, nationality and internationality, before any real comprehensive selection scheme can be formed.

End Notes

1. Albert Holland's *Psychology of Spaceflight*, pg. 155.
2. Ibid, pg. 155.
3. Mary M. Connors' *Psychology and the Resurgent Space Program*, pg. 909.
4. *Psychology of Spaceflight*, pg. 156.
5. Ian Mundell's *Stop the rocket, I want to get off*, pg. 34.
6. Jack Stuster's *Bold Endeavors: Lessons from Polar and Space Exploration*, pg. 124.
7. H. Ursin's *Psychobiological Studies of Individuals in Small, Isolated Groups in the Antarctic and in Space Analogues*, pg. 771.
8. Ibid, pg. 772.
9. Ibid, pg. 777.
10. *Stop the rocket, I want to get off*, pg. 36.
11. *Psychobiological Studies of Individuals in Small, Isolated Groups in the Antarctic and in Space Analogues*, pg. 779.
12. *Psychology of Spaceflight*, pg. 165.
13. Interview with Dr. Albert Holland, 5/16/02.
14. *Psychology of Spaceflight*, pg. 171.
15. Ibid, pg. 177.
16. Ibid, pg. 177.
17. Ibid, pg. 177.
18. Ibid, pg. 178.
19. Ibid, pg. 181.
20. Albert A. Harrison's *Mission Destination, Mission Duration, Gender, and Student Perceptions of Space Habitat Acceptability*, pg. 225.
21. Ibid, pg. 228-231.
22. Gloria R. Leon's *Group Climate and Individual Functioning in an All-Women Antarctic Expedition Team*, pg. 672.
23. Ibid, pg. 689.
24. Ibid, pg. 671.
25. Interview with Dr. Albert Holland.
26. *Group Climate and Individual Functioning in an All-Women Antarctic Expedition Team*, pg. 672.
27. *Psychobiological Studies of Individuals in Small, Isolated Groups in the Antarctic and in Space Analogues*, pg. 778.
28. Bryan Burrough's *Dragonfly*, pg. 98.