Psychological, Psychiatric, and Interpersonal Aspects of Long-Duration Space Missions

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America's future in space calls for manned missions that are of long duration and increasing complexity. Under these conditions, psychological and interpersonal stressors will take on added importance in affecting the safety of the crew and the outcome of the mission. Through an analysis of reports from manned American and Soviet space missions and Earth-bound simulations, several psychological, psychiatric, and interpersonal issues can be identified that could affect the success of the space station and other long-duration space ventures. Psychological issues include sleep problems, alteration in time sense, demographic effects, career motivation, transcendent experiences, homesickness, and alteration in perceptual sensitivities. Psychiatric issues include anxiety, depression, and psychosis, psychosomatic symptoms, emotional problems related to the stage of the mission, and postflight personality changes. Interpersonal issues include interpersonal tension, decreased cohesiveness over time, need for privacy, and task vs emotional leadership. Steps can be taken to minimize the impact of these issues, both before and during the mission.

Introduction

IN the past few years, NASA has undertaken serious debate regarding America's future in space.[1] The most advanced planning has centered around the construction of a permanent space station. This would operate in low-Earth orbit and consist of several modules designed to accommodate a crew of eight to ten individuals remaining in space for up to 180 days.[2] Although the crew mix would vary based on the needs of specific missions, there would be three types of crew members: station operators who are career astronauts trained in the operation and maintenance of station systems; station scientists who are career astronauts supporting station operators and conducting scientific experiments; and payload scientists who are not career astronauts who would concentrate on experiments involving a particular scientific enterprise. Beyond such plans for a space station, two other manned missions have been considered: a permanent outpost on the moon involving up to 30 people living and working on the lunar surface for several months at a time, and a manned trip to Mars that would involve a crew of six or more astronauts on a flight taking at least one year.[1]

These three scenarios represent a significant change from previous American space missions. In all three cases, crew members would be expected to remain in space under conditions of confinement and microgravity for months to years. Furthermore, a relatively large number of individuals would interact around complicated tasks that may be divergent. For example, the primary task of a space station operator would be quite different from that of a payload scientist, and the ability of these two types of crew members to work together in space over long periods of time has not been studied adequately. Although Space Shuttle missions are composed of crews of four to eight members with different jobs and responsibilities, missions normally last for seven to ten days and are highly structured and defined. The longest American space mission (the third Skylab mission) lasted only 84 days and involved a crew of men who had similar goals and motivations.

In contrast, the Soviets have conducted longer missions aboard the Mir space station involving heterogeneous crews of different nationalities, with some crew members remaining in space for over one year. Although the Soviet experience is useful as a demonstration that individuals can interact in space for long periods of time, little has been done to test important psychological, psychiatric, and interpersonal parameters involving such interactions. In fact, problems have occurred during spaceflights and Earth-bound space simulators that require a more thorough understanding of these factors. Not only would this understanding improve the quality of life of the crew members, but it also would improve the odds of achieving a successful mission. In addition, a thorough knowledge of important psychological, psychiatric, and interpersonal factors would aid in the selection of compatible crews, enhance preflight training, contribute to inflight resolution of psychosocial difficulties, and facilitate postflight adjustment.

Stressors and Stress in Space

In discussing important psychosocial issues that might affect crews during long-duration space missions, it is useful to distinguish between stressors and stress. A stressor is a stimulus that affects an organism in an arousing manner, whereas stress pertains to the changes in an organism that are produced by a given stressor. In space environments, there are four types of stressors: physical, physiological, psychological, and interpersonal. Physical and physiological stressors include such factors as acceleration, vibration, temperature variation, radiation, magnetic fields, microgravity, ambient noise, lighting, instrument display, atmosphere, food, liquids, and waste-removal. These stressors relate to engineering and habitability issues and go beyond the scope of this paper.

Psychological and interpersonal stressors include such factors as confinement, separation from family and friends, periods of monotony alternating with extreme activity, career motivation differences, use of free time, individual predispositions and unconscious conflicts, danger and emergencies, interpersonal friction, cultural/gender factors, crew size, complexity of mission goals, heterogeneity of crew, and leadership. These factors impact on individual crew members and may severely affect their ability to interact over long periods of time. These stressors and the stress they produce will be the major topic areas of this paper.

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Usefulness of Analogs and Short-Term Space Missions

The Soviets have had extensive experience in space aboard their Salyut and Mir space capsules. They have seriously considered the psychological and interpersonal stressors of space and have provided psychological support to their cosmonauts. For example, an Earth-bound psychological support group monitors voice communications from space for signs of stress and provides cosmonauts with the opportunity to talk with family, friends, and celebrities on Earth using two-way TV communication.[3,4] However, despite this interest and commitment, psychosocial research has not been conducted in space to any great extent. In fact, most information from both American and Soviet space missions consists of anecdotal stories, press releases, publications of diaries and biographies, and a few self-reports of questionable validity and reliability.

In contrast, there is an extensive empirical literature involving psychosocial factors during short-term space missions and Earth-bound space mission analogs that has relevance to long-duration space missions. Reviews of these studies have been published.[5-15] Examples of such missions include Arctic and Antarctic expeditions; submarines and submersible simulators (e.g., Sealab, Ben Franklin, Tektite); land-based simulators [e.g., School of Aerospace Medicine (SAM), General Electric, Douglas, and McDonnell Douglas capsules, Project Argus, cockpit simulators]; hypodynamia (bedrest studies); and short-term space missions (e.g., Gemini, Apollo, Skylab, Space Shuttle, Spacelab, Soyuz, Salyut, Mir).

Several reasons exist to examine such studies and relate their findings to long-term spaceflight. Some of the studies were conducted under proper scientific conditions, thus allowing for important variables to be controlled and clear conclusions to be drawn from the results. Other studies involving Antarctic expeditions and submarine missions were more naturalistic, but they were still more carefully conducted scientifically than current space missions. Finally, there is great consistency of findings across these studies, thus supporting the reliability of their results.

However, the validity of the analog studies is open to question, since important variables in long-term space missions may be missing. For example, microgravity is not present in any land-based simulation, and the presence of true confinement is not a prominent feature of Antarctic expeditions. Obviously, more scientific research needs to be done during actual space missions in which variables can be controlled and reliable data obtained, but these studies have not been conducted for various practical, scientific, and political reasons.

Nevertheless, a careful review of studies involving Earth-bound analogs and reports from short-term space missions has isolated a number of psychological, psychiatric, and interpersonal issues relevant to future long-duration space missions. These factors serve to highlight potential problems and solutions.

Psychological Issues

Important psychological issues, along with space missions and the analogs in which they have been observed, are shown in Table 1. Sleep problems include insomnia, poor quality of sleep, and changes in sleep cycle as measured through EEG studies. Sleep problems have been related to interruption in circadian rythmicity, and as work/rest cycles and habitability factors have been studied and modified, the quantity and quality of sleep in space have improved. A typical pattern is for individuals to sleep poorly at the beginning of a mission or near the end when they are excited or anticipating return. However, sleep difficulties can occur at any time and may be an indication of underlying depression or other psychological problems. Thus, sleep difficulties may be seen as related to correctable physical or physiological stressors, such as cabin noise or changes in circadian rhythms; normal psychological processes, such as anticipation or excitement due to a mission's beginning or ending; or underlying psychiatric difficulties related to psychological and interpersonal stressors.

Table 1 Psychological issues

Issue	Observed in
Sleep problems	Gemini, Apollo, Space Shuttle, Soyuz 9, Salyut 7, Antarctic, submarines, SAM simulator, hypodynamia
Alteration in time sense	Skylab, Spacelab 1, Soviet space missions, submarines, hypodynamia
Demographic effects	Sealab, Tektite
Career motivation	Antarctic
Transcendent experiences	American and Soviet space missions, jet pilots
Homesickness	American and Soviet space missions, Antarctic, submarines, simulators
Alteration in perceptual sensitivities	Soviet space missions

An interesting psychological phenomenon that has been described during space and Earth-bound space analog missions is an alteration in time sense, whereby individuals complain of insufficient time to perform scheduled activities. For example, in one study of selected tasks during the three Skylab missions, more than half of the tasks required more time to complete when they were performed in space than during preflight simulations.[15,16] In another study onboard a 1985 Space Shuttle flight, there was a tendency for reaction time to be related to space motion sickness symptoms and for short-duration time perception to be progressively overestimated as the mission proceeded, as compared with pre- and postflight baselines.[17] These time sense distortions need to be studied further, because future space missions will depend on the precise scheduling of tasks and accurate, quick decision-making ability during times of emergencies.

Nonspecific demographic effects have been related to success in undersea submersible missions. For example, in the Sealab program, later-born divers performed better than first-born or only children, whereas during the Tektite mission, first-born aquanauts performed better overall.[18-20] These findings suggest that later-born individuals are more adaptable to physical stressors than first-borns, since the Sealab habitat was more cramped and located in deeper water than the Tektite submersible. However, many of the early astronauts were first-born children who performed superbly under the novel conditions of the early space missions. One other interesting demographic effect from Sealab and Tektite was that aquanauts who came from smaller towns adjusted better than those who came from larger cities. This finding raises interesting questions about the inclusion of individuals in future space missions who grew up in urban environments.

Space travelers in the future will be highly specialized and will vary considerably from one another in their training and career motivation. For example, plans for a space station call for career astronauts to work with payload scientists, whose main task will be to specialize in a particular scientific experiment. How such individuals with different educational backgrounds and motivations will interact remains to be seen. Gunderson[21] performed a study at five U.S. Antarctic stations and found a striking difference in reported symptoms between naval and civilian scientific personnel during the wintering-over periods from 1964 to 1966. In terms of percentages of change in symptomatology, the naval men experienced more insomnia, depression, and hostility, whereas the civilian scientists experienced more anxiety. Gunderson speculated that work role influenced these findings. For example, the civilian scientists were able to conduct experiments and write scientific reports during the winter months, whereas the naval men had little to do and may have reacted with boredom and interpersonal conflict. On the other hand, confinement and danger existed during these periods, possibly resulting in more anxiety among the less seasoned civilian scientists. Other factors may have contributed to these differences, such as age and maturity level, degree of education, and nonspecific demographic effects.

Several astronauts and cosmonauts have reported transcendent experiences during space missions.[15,22] Some have expressed humility at their relative insignificance as compared to the vastness of space. Others have experienced a new understanding of the Earth and the unity of mankind. Still others, having gained a new sense of the meaning of life and the nature of God, have experienced religious conversions. Some of these experiences have been related to a feeling of unreality and separation from Earth that has been likened to the "break-off" phenomenon reported by jet pilots flying under monotonous high-altitude conditions.[23] Although the break-off phenomenon has been related to preexisting emotional difficulties,[24] it is a relatively common experience and is probably more of a psychological phenomenon than a psychiatric problem. However, such experiences can endanger space missions. For example, preoccupation with the beauty of the cosmos caused one Salyut 6 cosmonaut to float out through an open air lock without attaching his safety line,[12] and a similar experience led to the perturbation of the gyroscopic system of Skylab when an astronaut left his work station to get a better view of the Earth.[25]

Homesickness and loneliness due to separation from family and friends have been experienced in space, as well as on many Earth-bound simulation missions. These feelings tend to be related to mission duration and amount of leisure time. On some Soviet space missions, the psychological support group has arranged for the cosmonauts to interact with family, friends, and celebrities on Earth through two-way TV communications.[3,4] This technique has proven to be quite useful. For example, Yuri Romanenko has stated that twice-a-week contact with his family by means of a special television hook-up helped to boost his spirits during the 326 days he spent in space. To fill his leisure time, he wrote 20 songs that further enhanced his morale.[26] The psychological support group also has allowed its cosmonauts to receive gifts and momentos from visitors who are sent up for brief periods of time. In addition, they have encouraged the transmission of musical broadcasts and sounds reminiscent of the Earth (e.g., rainfall, bird songs) as ways of boosting the morale of long-term space travelers.[4] These supportive efforts become particularly important during the middle phase of a space mission, when activities become routine and morale begins to drop. The types of activities individuals prefer during leisure moments relate to individual preferences and motivational factors. Reading or engaging in special projects may be welcomed by some, whereas talking with family and friends or listening to music may be preferred by others.

Finally, there is some indication that perceptual sensitivities may be altered in space over time. For example, Grigoriev et al.[3] have noted that after three to five months, some cosmonauts experienced increased sensitivity to loud sounds or the manner in which information was presented to them from Earth. They concluded that ground support personnel need to monitor the mental state of the cosmonauts and be sensitive to their needs at all times. Several Soviet researchers have reported success in using the analysis of cosmonaut speech through recordings of space transmissions as an indication of stress and emotional state.[27-29] In contrast, a similar analysis of the formal aspects of speech (e.g., fundamental and formant frequencies) by American researchers has resulted in the conclusion that this technology was insufficiently predictive of crew member psychological state to warrant further use in space.[30,31] Despite this difference of opinion over the usefulness of voice analysis as a method of monitoring stress, careful attention to changing crew member state is an important consideration in future long-term space missions.

What are the implications of the foregoing psychological issues? First, it is important that crews be briefed preflight about the importance of these factors. With information comes mastery, and strategies for dealing with psychological stressors can be discussed. Second, it is important to monitor the psychological state of crew members inflight and provide ways of boosting morale and filling leisure time. The Soviets have found that a ground-based psychological support group is useful in helping cosmonauts deal with these issues. However, individuals differ in terms of personal reactions, and these differences may change as the mission progresses. Finally, many of the factors considered in this section are adaptational responses to the stressors brought about by the unusual environment of space. As such, they are normal reactions to abnormal conditions. However, other reactions may result in more serious distress and overt symptomatology, and it is to these that we now turn.

Table 2 Psychiatric issues

Issue	Observed in
Anxiety, depression, psychosis	Arctic, Antarctic, submarines, hypodynamia
Psychosomatic symptoms	Salyut 6, Antarctic, submarines, SAM simulator, hypodynamia
Rohrer stages: anxiety, depression, anticipation	Salyut 7 and other Soviet space missions, Antarctic, submarines, Ben Franklin, Tektite, Lockheed simulator, Soviet simulators
Postflight personality changes	Apollo 11 and other astronauts, McDonnell Douglas simulator, submariners' wives syndrome

Psychiatric Issues

Important psychiatric issues are listed in Table 2. Severe anxiety, depressive, and psychotic reactions have not been reported in space, although they have been described in Earth-bound analogs. For example, Gunderson[21] found that naval personnel stationed in the Antarctic were more likely to experience psychiatric problems (3%) than similar personnel stationed elsewhere (1%). Rasmussen and Haythorn[32] studied the wintering-over periods of men stationed at five U.S. Antarctic stations. During this time, no one was hospitalized for psychiatric reasons, but behavioral problems were noted that were related to the duration of stay. For example, at one station the number of anxiety episodes increased from 3 during the first four months to 8 during the next four months and 19 during the last four months. The corresponding figures for suspicious episodes were 0, 7, and 16, and for periods of uncooperativeness 1, 2, and 13. In a report from two cruises of the Polaris submarine, the incidence of anxiety, depressive, and psychotic reactions was judged to be 5%.[33] In a review of nuclear submarine missions serving as potential space station analogs,[34] 1.2% of the men were at high risk for disqualification from further duty on the basis of psychiatric problems. Sixty percent of these individuals were assigned to submarines that stayed submerged for the entire patrol, whereas the remaining 40% were from submarines that frequently reached the surface and put into port. In terms of the total percentage of major symptoms, 50% were related to anxiety, 39% to interpersonal problems, 29% to depression, and 25% to sleep problems. Other reviews of submarine missions cited in this source[34] estimated the incidence of psychological problems as reaching 5%, but not all of these difficulties resulted in disqualification. Although infrequent, psychotic reactions also have been documented in which the individual lost touch with reality and put the mission at risk.

Psychosomatic symptoms have been reported during space missions. These symptoms have included headaches, gastrointestinal problems, and fears of developing various physical illnesses during the mission. For example, one Salyut 6 cosmonaut described in his diary fears of having an appendicitis attack, and he also experienced tooth pain following a dream of a toothache.[35] Psychosomatic symptoms also have been reported during Earth-bound missions. For example, one submarine report stated that on an average day, a quarter of the men experienced a headache.[36] Whereas physical and physiological stressors (e.g., vibration, temperature, cabin noise, atmospheric contamination) could have contributed to some of these problems, it is likely that psychological and interpersonal stressors (e.g., confinement, loneliness, vulnerability to danger, interpersonal tension) also played a role.

In discussing psychiatric issues, one must be cognizant of mission duration, since symptoms of anxiety and depression may be related to time spent under isolated conditions. On the basis of an extensive review of Antarctic and submarine missions, Rohrer[37] described three stages of reaction to conditions of isolation and confinement. The first stage took place during the early part of the mission and was characterized by heightened anxiety. This anxiety was related to perceived danger and the novelty of the situation. Rohrer believed that psychotic episodes were most likely to occur during this phase. The second stage was a period of depression and boredom; it occurred during the middle of the mission and occupied the greatest length of time. During this stage, the crew settled down to routine tasks, and homesickness and problems in coping with increased leisure time were most likely to be present. The final stage occurred near the end of the mission and consisted of anticipation and jitteriness. During this phase, increased aggressiveness and hostility were likely to occur, along with immature, adolescentlike behavior.

In their work with cosmonauts, Grigoriev et al.[4] have described two stages. The first covers the initial two to six weeks of flight when the crew is adapting to the new environment. During this stage, the psychological support group gives high priority to helping the cosmonauts to alleviate the shock of their novel environment and to learn ways of properly scheduling their activities. The second stage includes the remaining time in flight and is characterized by what Gregoriev et al. call "deprivation effects." These are described as changes resulting from isolation, monotony, and deficient stimulation (e.g., lack of social contacts, uninteresting work). During the second stage, the psychological support group's basic goal is to control the monotony and potential for homesickness via audiovisual communication with family and friends on Earth and through personal gifts brought to the crew by visiting cosmonauts. Although Gregoriev et al. did not address the third stage of isolation as described by Rohrer, this has been described by a Salyut 7 cosmonaut who wrote in his diary that he felt a sense of anxiety and unease about returning to Earth and having to face the real world again.[35] Thus, the Soviet experience has supported the presence of the Rohrer stages in space.

Personality changes have been noted in several astronauts and cosmonauts after their return to Earth. Although many of these changes have consisted of a difference in outlook or increased sensitivity to human needs, some have assumed pathological proportions, leading to depression and marital problems. One Apollo 11 astronaut has described serious difficulties readjusting postflight, which resulted in a need for psychiatric intervention.[38] Psychological changes also have occurred after space simulations, such as the increased anxiety and suspiciousness noted in one crew member following a 90-day McDonnell Douglas simulator study.[39] Postflight adjustment problems may affect other people as well. For example, many military marriages adjust to the fact that one spouse will spend long periods of time away from home, and difficulties arise after that spouse returns. Isay[40] has coined the term "submariners' wives syndrome" as a result of his study of 432 wives on a submarine base, where he found that 61% became depressed shortly after the return of their husbands from sea patrol. Similarly, Pearlman[41] found that most of the 485 women he studied on a submarine base had feelings of anger and despair caused by long separations, but seemed to tolerate this well. However, serious marital problems often occurred following the return of their husbands. Thus, the aftermath of long-term space missions needs to be evaluated, not only in terms of its influence on future space travelers but also its effects on spouses and other family members who remain at home.

What are some of the implications of the foregoing psychiatric issues? First, effective means of assessing psychopathology on the basis of preflight interviews and psychological testing need to be developed so that individuals vulnerable to psychiatric problems in space can be screened out. The ability to make accurate predictions on the basis of rapid screening techniques is still in its infancy, but investigators have been able to predict later performance in some simulation studies.[42-44] Second, it is important to monitor crew members inflight for signs of psychiatric difficulties and to provide a way for them to discuss problems as they develop. For example, having a private space-to-ground audiovisual link between a crew member experiencing psychiatric difficulties and a therapist on Earth would be valuable. Although this type of support should prove adequate in the majority of cases, there will be occasions when more aggressive intervention will be needed, particularly when it is unlikely that an impaired crew member can be returned to Earth in a reasonably short time. Crew members need to be trained in techniques of brief psychotherapy, the administration of tranquilizing medications, and crisis intervention.[5,45] Means of restraining a psychotic crew member also should be present. These precautions would be worthwhile, since a psychotic reaction during a long-term space mission would jeopardize the mission and threaten the lives of all of the crew members.

Table 3 Interpersonal issues

Issue	Observed in
Interpersonal tension due to crew heterogeneity, size, personality conflicts, and displacement of anger to outside personnel	Gemini 7, Apollo 9, Skylab 4, Spacelab 1, Salyut 7 and other Soviet space missions, Antarctic, submarines, Sealab, Ben Franklin, SAM simlator, Douglas and McDonnell Douglas simulators, Projet Argus, hypodynamia
Decreased cohesiveness over time: task vs emotional interactions, subgroups, scapegoats	Salyut 7, Antarctic, submarines, Ben Franklin, Tektite, SAM simulator, General Electric and McDonnell Douglas simulators, Project Argus
Need for privacy	Skylab 4, other American and Soviet space missions, submarines, Project Argus
Task vs emotional leadership	Salyut 6, other American and Soviet space missions, submarines, Antarctic, Sealab, cockpit simulators

Interpersonal Issues

Important interpersonal issues affecting long-term manned space missions are shown in Table 3. Interpersonal tensions have been documented in Earth-bound simulations and space missions.[5-15] Several factors play a role. First, the more heterogeneous the crew is in terms of race, background, career motivation, and sex, the more likely it is that tensions will occur. Conflicts have been recorded between non-Soviet and Soviet cosmonauts,[12] and issues involving differing career goals have been described previously. Although Space Shuttle missions have illustrated that men and women can interact during short-term space missions, there has been evidence of sexual stereotyping on the part of male cosmonauts toward female cosmonauts.[12,35] One of the Tektite submersible missions was composed of a crew of five women, and their performance was judged to be equivalent to or better than that of the all-male crews.[19] In a review of women serving as naval officers and enlisted personnel at sea,[34] it was concluded that they performed successfully, but that problems still existed in terms of gender conflicts and sexual stereotyping.

A second issue related to interpersonal tension concerns crew size. Bales and Borgotta performed a classic study of the relationship between group size and social interaction by observing groups of two to seven male college students and examining individual interactions using the Bales interaction process analysis.[46] Through an analysis of this work and its application to manned spaceflight, Kanas and Feddersen[8] determined several trends relevant to long-duration space missions. First, the larger the group, the greater the tendency for efficient organization and communication to occur, at least within the bounds of the seven-man upper limit studied by Bales and Borgotta. Second, even-numbered groups tended to form equal-numbered subgroups that would deadlock and show an inability to resolve issues. Finally, the larger the group, the greater the tendency for leader-follower relationships to emerge, particularly in odd-numbered groups. Thus, given a space station crew size of 8 to 12 individuals, this work suggests that the ideal number would be 11. This analysis is based on studies with college students and ignores important issues such as gender, role differentiation, etc. Nevertheless, it indicates that crew size by itself might play a role in contributing to interpersonal problems in space.

A third parameter related to interpersonal tension has to do with personality conflicts. Which individuals get along with each other and which don't? For example, during Project Argus, pairs of men were studied under both isolated (e.g., confined to their cabins) and unisolated conditions. It was found that individuals who were both high in a need for dominance on the Edwards personal preference scale withdrew from each other in the isolated condition.[43] Similar problems were observed between immature, aggressive men who were confined in the four-man simulator at the School of Aerospace Medicine.[47] Obvious personality conflicts can be observed and dealt with when astronauts train together preflight. However, this might not be the situation in a future space station, where a payload scientist might be sent to join crew members already onboard. Effective means of assessing how these people are likely to interact should be developed to prevent incompatibility.

A final factor contributing to interpersonal tension is a tendency for confined individuals to get angry with the outside personnel monitoring their activities.[6-8,35,42,48-52] In simulators, anger directed at the outside has occurred when overt anger was not observed between the confined subjects, and vice-versa.[42,51,52] This supports the hypothesis that what is happening is a displacement of interpersonal tension to safer, more remote individuals outside. The Soviet psychological support group has been sensitive to crew member-ground control interactions as an indicator of inflight stress,[3] and in-group/out-group problems have been noted in other situations involving audio-only teleconferencing.[53] This phenomenon needs to be studied during space missions in order to minimize the potential for space crew-ground control conflicts.

The second major interpersonal issue shown in Table 3 relates to crew member cohesiveness. Reports from space missions and Earth-bound simulators have described decreased cohesiveness among crew members over time.[6-8,12,35] For example, one Salyut 7 cosmonaut wrote in his diary that keeping good relations with ground control and fellow crew members was difficult, particularly as the mission progressed and fatigue increased. He described the presence of interpersonal tension that had to be controlled to prevent disruption in relationships.[35] In a School of Aerospace Medicine simulator study, there was a higher proportion of interactions involving the giving and receiving of information and a lower proportion of emotional interactions than was found in a composite of 21 other studies evaluating small group behavior.[54] These tendencies also have been described in short-term space missions. However, during long-duration space missions, in which unstructured activities and leisure time will be present, crew members will sometimes relate to each other around personal, emotionally-laden issues. This development could be healthy, but it also could result in disagreements and conflicts that would negatively affect cohesiveness.

Group cohesiveness also may be affected by subgrouping and scapegoating.[6-8] Subgroups have been observed during Antarctic and submarine missions, especially along work-related lines. This has importance for a space station because cohesiveness could suffer if, for example, career astronauts and payload specialists did not relate during moments of free time. Scapegoating also has occurred in Earth-bound settings, and excluded individuals may experience a behavioral syndrome that Rohrer[55] has called the "long eye" phenomenon. This is characterized by insomnia, despondency, restlessness, staring into space, and even hallucinations and paranoia. Obviously, the long eye phenomenon could be quite detrimental to crew performance in space.

The need for privacy during space missions has been clearly identified, and this need appears to be a natural reaction of individuals confined together. For example, during Project Argus, it was found that isolated people withdrew from each another and showed signs of territorial behavior.[43] During Skylab 4, one astronaut wrote that a lack of privacy seemed to increase interpersonal tension.[56] Much attention was given on Skylab to establishing separate compartments with fabric doors that each astronaut could call his own for purposes of sleeping, reading, or introspecting. People need people, but they also need their privacy, and this issue needs to be taken into account in designing a space habitat for a long-duration space mission.

On short-term spaceflights and submarine missions, the leadership structure is clear. The identified leader is the person responsible for piloting the spacecraft or captaining the submarine, and lines of authority are established in terms of task responsibility. If the leader is perceived too autocratically, then other crew members will be unwilling to challenge his or her authority. This reluctance to question authority has led to catastrophes in air crew performance when the captain becomes psychologically incapacitated.[57] In contrast, status leveling has been observed during Antarctic missions, and the most valued leaders have been described as those showing emotional concern for their men and operating in a more democratic mode.[58,59] On a Salyut 6 mission, the commander was less experienced than his partner, who was an older veteran possessing specific skills necessary to repair the space station. To deal with this awkward, potentially competitive situation, the two men decided to share decision making through mutual discussion, resulting in successful completion of the mission.[12] Both task and emotional leadership skills are necessary, with the former being needed during short-term, highly structured activities, and the latter becoming valuable during unstructured times. The ideal leader should possess both qualities: the ability to direct and carry out a task, and the sensitivity to understand the emotional needs of fellow crew members.

There are several implications of these interpersonal issues. First, it is important to establish valid and reliable testing methods for assessing the compatibility of crew members preflight, particularly when crew heterogeneity and potential personality conflicts are factors. Interviewing and testing procedures have correctly predicted crew incompatibilities during the Ben Franklin submersible mission,[44] and interpersonally oriented psychological tests have shown promise in crew selection in a number of simulators.[42-44] Second, preflight briefings on team building and conflict resolution should be incorporated into the training of space crews.[60-62] Evidence exists that premission sensitivity training has been useful in helping individuals interact better during Earth-bound confinement experiments.[42,51,52] Tensions that do occur can be ameliorated through "bull sessions," both in simulation[52] and during space missions.[48] Finally, it is important for crew members to work and train together so that their interactions can be observed. This will be difficult as noncareer astronauts become increasingly involved in space missions, but attempts should be made to monitor their interactions inflight with career astronauts to look for potential problems. Crews preparing for extremely long-term space missions, such as a flight to Mars, might be expected to spend time together confined in an Earth-bound simulator so that potential interpersonal conflicts can be observed and dealt with prior to the actual mission.

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