Psychosocial Effects of Adjustment in Antarctica: Lessons for Long-Duration Spaceflight

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This paper examines the utility of remote, isolated Antarctic research stations as analogs for long-duration spaceflights from the perspective of psychosocial processes of adaptation and adjustment. Certain features of the physical and man-made environments found in Antarctica are similar to those that will be encountered in outer space. In both settings, men and women are likely to experience a number of physiological and psychological changes in response to the extreme environmental conditions and the prolonged isolation and confinement. Biomedical research in Antarctica provides an opportunity to study the causes of these changes and to develop strategies for reducing the risks to health and well-being before they pose a serious threat to crew safety and mission success. A number of lessons for long-duration spaceflight are examined, including screening and selection of personnel; training programs designed to facilitate individual adjustment and group adaptation and minimize group conflict; identification of optimal leadership characteristics for small, isolated groups; an understanding of social dynamics and group "microcultures" necessary for the organization and management of small but heterogeneous groups; organization of work activities; facility design; and support infrastructure.

Introduction

UNTIL now, with the exception of the Apollo I and Challenger disasters, venturing into the unknown reaches of space has not seriously compromised the health and performance of American astronauts. As long as the U.S. space program involved missions of relatively short duration, it has been content to recruit and train individuals who were physically fit and possessed "the right stuff." However, as we begin to plan for missions of longer duration, information on the factors that may impede the health or performance of astronaut personnel becomes critical.

The experience of some astronauts with space adaptation syndrome (motion sickness), bone decalcification, cardiovascular deconditioning, depression, irritability, and cognitive impairment has made us aware of the potential hazards of prolonged exposure to an extreme environment.[1] As missions come to involve destinations further and further from Earth, the task of evacuating personnel for medical or psychological reasons will become more complex. Therefore, it is imperative that we act now to reduce the risks to health and well-being before they pose a serious threat to the safety of crew members and to the success of a mission.

The Soviets have had some success in collecting data on the psychological aspects of prolonged isolation in space.[2,3] In contrast, the U.S. space program has sought to acquire a similar perspective through the use of data collected in analog settings.[4] Examples of such analogs include nuclear submarines, undersea research laboratories, supertankers, and offshore oil platforms. The best analogs are the scientific research stations operating year-round in the Antarctic.

Antarctica as a Space Analog

Antarctica is a place of great beauty, but it is also a place of great extremes. As the coldest, highest, driest, and windiest of the Earth's continents, it is no wonder that there are no permanent inhabitants. Certain features of the Antarctic environment approximate the physical environments of other planets. The Dry Valleys, for instance, have been compared with the surface of Mars.[5] Because of this extreme environment, we have had to construct artificial environments to protect ourselves.

In some respects, these environments are very similar to those proposed for outer space. McMurdo, the largest American base in Antarctica, possesses certain characteristics that make it a suitable analogy in a social and behavioral sense to the proposed lunar base. Antarctic and space facilities are also similar with respect to the nature of their scientific and political objectives (e.g., maintaining an American presence in a region governed by international treaties).

While Antarctic research stations have been considered appropriate analogs of the proposed space station and proposed facilities on the moon and other planets, they also provide useful information on the social and psychological processes of human adjustment to prolonged isolation. A particular feature of Antarctic life with similarities to extended missions in space is the composition of the personnel manning these stations (Table 1). These similarities extend to the nature of the work (science, exploration, and support), the heterogeneous crews (military and civilian men and women), the high level of skills, organizational similarities (division of labor, chain of command), and the rotational structure of tours of duty.

In addition to the similarity in group composition and social characteristics, Antarctic research station personnel and crew members of extended spaceflights both are confronted with two opposing worlds: the natural and the sociocultural. Whether it is the wide expanse of space or the Antarctic continent, the natural world represents limitless opportunities for exploration and knowledge, but also danger to human life. The sociocultural world, on the other hand, which is much smaller and artifically constructed, gives a sense of order and meaning to the physical environment and security from the hazards of nature but also represents confinement and certain constraints on human behavior. Successful adjustment to both long-duration spaceflights and prolonged isolation in Antarctica demands some form of behavioral compromise to, or synthesis of, these two worlds.

Human Adaptation in Antarctica

Lantis[6] observed that the social environment of polar regions would comprise a more potent source of stress than the

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Table 1 Characteristics of crew members of Antarctic research stations and long-duration spaceflights

Factors	Antarctic research stations	Long-duration spaceflights
Selection of personnel	Volunteers Medical and psychological screening Occupational requirements and skills	Volunteers Medical and psychological screening Occupational requirements and skills
Nature of work	Science Exploration Support Administration Construction Maintenance Logistics Communication Medical	Science Exploration Support Administration Construction Maintenance Logistics Communication Medical
Crew composition	Men and women Military and civilian personnel Different nationalities	Men and women Military and civilian personnel Different nationalities
Crew size		
5–10	Field camps	Exploratory missions
11–20	Small stations	Initial planetary bases
21 and more	Large stations	Advanced planetary bases
Organizational structure		
Agency	NSF/U.S. Antarctic Program	NASA
Division of labor	Science and support	Science and support
Chain of command	Officer in charge Station manager Station science leader	Mission commander Science leader
Duty rotations	4–13 month tours	3–36 month tours

Table 2 Social stressors in Antarctica

External stressors
Inability to contact family and friends
Real or imagined unpleasant events at home
Feelings of rejection resulting from
Delays in arrival of relief parties
Shortages in supplies
Interference in station routines by outside authorities
Internal stressors
Lack of privacy in cramped quarters
Boredom due to
Lack of environmental stimulation
Interaction with the same group of individuals
Sexual deprivation
Emotional deprivation
Absence of statuses and roles defining social position in outside world

physical environment. Confinement to the Antarctic continent for certain periods of the year and isolation from the outside world produce both internal and external major sources of stress (Table 2). External sources of stress include the inability to contact family and friends, real or imagined unpleasant events at home,[7] and feelings of rejection resulting from delays in arrival of relief parties, shortages in supplies, and interference with station autonomy by outside authorities and parent agencies.[8] Internal sources of stress include the lack of privacy in cramped quarters, forced social interaction with no opportunity to escape unpleasant or undesirable individuals or situations, boredom due to the lack of social and environmental stimulation, sexual and emotional deprivation, and the absence of statuses and roles defining one's social position in the outside world.[9–11] Both types of stress are likely to exist during long-duration spaceflights as well.

Although the specific nature of these changes may not be identical, personnel in the Antarctic and in space must also confront a number of physiological changes. In the Antarctic, these changes include a complete absence of Stage IV sleep, as well as sizable reductions in the amount of Stage III and REM sleep, a disruption of circadian rhythms, dyspnea (shortness of breath), arterial hypoxia, headaches, hypocapnia (deficiency of carbon dioxide in the blood), hyperventilation, suppression of the immune system, and disruption of thyroid function.[12–16] These are attributed to extreme environmental conditions including high altitude, light-dark cycles, and the absence of viral and bacterial agents.

The physiological changes associated with the harsh environment also combine with the psychosocial stressors associated with prolonged isolation to produce a number of psychological changes among Antarctic personnel, resulting in symptoms such as insomnia, irritability, headache, nightmares, anxiety, depression, boredom, fatigue, a decline in personal hygiene, and reduced motivation combined with intellectual inertia, impaired memory, impaired concentration, decline in alertness, and a general apathetic state (Table 3).[9] Although isolation or climactic conditions during the summer are not as severe as during the winter, many individuals begin to experience at this time one or more of these symptoms due to the novelty and extreme nature of the environment.

As the year progresses, most Antarctic winter-over personnel display a cluster of symptoms known as the "winter-over syndrome,"[7] characterized by varying degrees of depression, irritability and hostility, insomnia, and cognitive impairment. Cognitive changes include difficulty in concentration and

Table 3 Symptoms of stress in Antarctica

Insomnia ("big eye")	General apathetic state
Irritability	Decline in alertness
Headaches	Increased appetite, weight gains
Nightmares	Digestive ailments
Anxiety	Rheumatic aches and pains
Depression	Increased sensitivity to physical and social stimuli
Boredom	Increased alcohol consumption
Fatigue	Aggressive behavior
Decline in personal hygiene	
Reduced motivation	
Impaired memory and concentration	

memory, absentmindedness, and the occurrence of mild hypnotic states known as "long-eye." These symptoms have been observed to increase over time, peaking at midwinter, and then declining during the third quarter of winter-over duty, only to increase again at the end of the winter-over period.[17]

In some instances, alcohol abuse has been a problem on the ice, leading to disruption of social relations among station personnel, decreased work performance, and increased risk for accidental injury.[18,19] There have also been a few episodes of severe psychopathology, resulting in confinement of personnel or midwinter evacuation when feasible.[7] In one instance, a member of a Soviet station is said to have taken an axe and murdered a fellow crewman after losing to him in a game of chess.[20] Fortunately, such cases are extremely rare.

Long-Term Health Effects of Prolonged Isolation and Extreme Environmental Conditions

Despite the potential degradation to health and performance associated with more severe forms of the winter-over syndrome, prolonged isolation does not appear to have any adverse long-term effects. For the past four years, studies have been conducted at the Naval Health Research Center, San Diego, on the long-term effects of isolation on the health and performance of enlisted Navy men who participated in the Operation Deep Freeze Program between 1963 and 1974.[19,21-24] Information on the health status, screening results, personality profiles, social background, and service history of these individuals was obtained from a computerized database. The medical and service history records of the enlisted Navy personnel were used to examine their health and performance after they had returned from a year in the Antarctic. The subjects were divided into two groups: those who wintered over at one of six small stations during this period, and those who were screened and evaluated as eligible for winter-over assignments but who were assigned elsewhere during that period, largely because the pool of volunteers was much larger than the number of available billets. These men were then followed for an average of 6 years after returning from Antarctica, with some men being followed for as much as 15 years.[22]

These studies found that the winter-over group had over 20% fewer total first hospital admissions than the control group ($p < 0.05$). The winter-over group also displayed significantly fewer first admissions in selected diagnostic categories such as neoplasms (e.g., lung cancer, lipoma, leukemia) (73% fewer admissions); endocrine, nutritional, and metaboiic diseases (e.g., diabetes mellitus, obesity) (60% fewer admissions), and diseases of the musculoskeletal system (e.g., osteoarthritis, internal derangement of joint, displaced disc) (44% fewer admissions).[21] When hospital admission rates were examined in a longitudinal fashion by six-month intervals, an increase in admissions rates was observed among the winter-over personnel subsequent to returning from Antarctica, but these rates were no greater than those of the control group. Within a year of returning from Antarctica, however, the rates declined significantly.[23]

The obvious explanation for these findings is that the winter-over subjects were healthier than the controls before going to Antarctica. However, both experimental and control groups were matched on the basis of physical health and psychological suitability for wintering-over. Also, the potential confounding influence of self-selection in a group of volunteers was controlled for because all of the subjects volunteered to winter-over. Furthermore, rates were adjusted to control for differences in age and occupation. Therefore, the results cannot be attributed to the presence of confounding variables.

If wintering-over is both a physiologically and psychologically stressful experience, therefore, why are these individuals not at increased risk for subsequent illnesses? The solution remains a mystery, but the answer may be an obvious one. Either the experience is not as stressful as we imagine, as recent field investigations have suggested, or winter-over personnel learn to cope with the stress and these skills are later applied to dealing with other stressful situations.

The answer lies in studying the patterns of adjustment to the isolation and to the environment of Antarctica to see how those patterns might reduce the risk of illness and performance degradation in space. For instance, coping with the stress of isolation may lead to the development and utilization of networks of social support and psychological resources such as autonomy, self-sufficiency, and flexibility that have been identified in other studies as moderators of the stress-illness relationship.[24] These patterns of adjustment may be viewed as occurring in three phases of adjustment: summer, winter, and reentry to the outside worid. If we can understand how individuals and groups cope with the isolation of wintering-over and how they adjust to an extreme environment, we can then identify ways of reducing the potentially harmful psychological and health effects of prolonged isolation in space.

Lessons to Be Learned from the Human Experience in Antarctica

In the short term, this research could contribute to NASA's efforts in a number of ways, including screening and selection of personnel, training, organization of crews, organization of work activities, selection and training of crew leaders, design of facilities, and development of a support infrastructure. Each of these areas is examined in turn.

Screening and Selection

Because of the difficulty in evacuating personnel for medical or psychiatric reasons, and in an effort to reduce the impact of these physiological and psychological changes on health and performance on the ice, all U.S. personnel have been routinely screened by teams of Navy psychiatrists and psychologists since the late 1950s. The importance of this screening effort is reflected in the fact that during the first two years of Antarctic screening, the recommendations of the screening teams were entirely disregarded. Half of the members of one station were disqualified by the screening team but sent to the Antarctic anyway. This group was characterized as having more difficulty and conflict among members than any other winter-over group.[25]

There are four primary areas in determining the psychiatric suitability of candidates for a winter-over assignment: motivation, history of past job-related effectiveness, present ego strength and adequacy of defense mechanisms, and adequacy of interpersonal relationships.[26] Overall, the screening program has been successful in identifying and eliminating individuals who might be totally ineffective under the stress of Antarctic isolation, or who might require hospitalization for a psychiatric disorder. However, although the program has generally been successful in screening out individuals unqualified for winter-over duty, it has been less successful in identifying or "screening in" individuals who are best qualified for such an assignment. Clinical evaluations have not been powerful predictors of Antarctic adjustment.[27]

Some characteristics have been found to predict successful adaptation. For instance, individuals who score low on measures of depression and divergent thinking and high on measures for cheerful, trusting, and cautious personalities, seem to adjust well to the Antarctic environment.[28] Being interested in many hobbies and activities consistently predicts poor performance in Antarctica.[29] Extroverts are less successful at adapting to this environment than more inner-directed, quiet, retiring types.[30] Characterized as self-sufficient, intelligent, calm, and independent, these "educated isolates" score higher on performance evaluations and report for sick call significantly less often than more group-centered personnel.[31]

However, other characteristics, such as age, occupational experience, marital status, and family history, have not been found to be consistently related to adjustment in the Antarctic. Furthermore, biographical attributes and personality measures such as achievement need and job motivation that predict social adjustment for one subgroup of personnel do not predict emotional adjustment for the same subgroup or social adjustment for another subgroup.[27] The association between personality characteristics such as a need for autonomy or achievement and measures of emotional composure, social compatability, and task performance appears to depend on the individual's status as a civilian or member of the military, the individual's occupation, and station size.

Given the variation in those affected by the winter-over syndrome, research is required to determine who will be least affected by the stressors associated with prolonged isolation in an extreme environment. At the same time, Antarctica can provide a laboratory for developing techniques that will help identify personnel who can best perform under similar circumstances in space with the least risk to their health and well-being.

One possibility might be to develop techniques that screen individuals at the group level rather than at the level of individual personalities. Proposed crews may be observed prior to wintering-over to determine patterns of social interaction and the extent to which the group works together to accomplish assigned tasks and reduce the potential for conflict. Another possibility is to select personnel on the basis of personality characteristics and anticipated social status within the group. For instance, recent studies of Antarctic personnel have suggested that individuals who perceive themselves to be powerless because they cannot exercise autonomy in either a social or psychological sense have the greatest difficulty in adjusting to the demands imposed by the Antarctic environment because they are unable to negotiate the conflicting demands of the self and social group.[19] Thus, individuals who have a low social status (i.e., junior-enlisted Navy seabees), a low need for autonomy, and a high need to be controlled by others appear to adapt well to the prolonged isolation of the Antarctic winter, whereas personnel with a similar status but a high need for autonomy and control over others adapt poorly.[32] Candidates for long-duration spaceflights, therefore, might be selected on the basis of personality and occupational (i.e., mission assignment) characteristics associated with emotional composure, social compatability, and task performance under conditions of prolonged isolation.

Training and Group Dynamics

The human experience in Antarctica also teaches us that screening alone is insufficient for minimizing the risk for illness and stress. Screening must be supplemented with programs that train personnel to cope with the stress associated with prolonged isolation. Antarctica provides a unique opportunity to train astronaut personnel to cope with the stress of prolonged isolation using techniques such as biofeedback, meditation, and stress inoculation training. It also provides opportunities to develop and test methods and techniques that foster group cohesiveness and task performance, while minimizing the potential for social conflict.

Among the major effects of individual and group processes of adaptation and adjustment to winter-over duty in Antarctica have been the parallel processes of group fusion and fission. Fusion of the social group at Antarctic stations has been found to occur in three stages; in the first stage, the group is open to interaction among all members. Some pairs form as two persons find common interests and backgrounds. The second stage is marked by the formation of cliques, based on age and authority, occupational status and station responsibilities, religious beliefs, tastes in music, and extent of substance use. The third stage is one of coalescence in which the entire group organizes around a social core.[9,19]

Group fusion is marked at particular times during winter-over duty, such as during fires or other station emergencies when crew members are forced to work together for their mutual survival.[9] It is most noticeable at the end of the winter-over period when replacements arrive. There is an almost universal sense of resentment at the outsiders who invade the station and disrupt or criticize established routines. These outsiders also provide a focus for displaced anxieties over having to once again become part of the larger society.[19] Events such as parties may also bring individuals and cliques together in an expression of group solidarity. Finally, resentment toward outside authorities also serves to unify group members, especially since anything that can be interpreted as a sign of rejection by outside superiors emphasizes the group's dependent status. Perceived rejection by outside superiors and parent agencies may seriously threaten feelings of personal autonomy and competence, as well as raise the men's re-entry anxiety levels and unduly undermine their psychological well-being.[9]

While helping to promote group cohesion, training programs may also enable individuals to handle interpersonal conflict and group fission more effectively. Conflict is inevitable at all stages of group formation in an isolated setting. In the first stage, difficulties may arise between individuals or pairs. The second stage, as noted earlier, is marked by conflict between cliques, but even in the third stage, the social core is frequently in conflict with the isolates or peripheral cliques.[30]

Conflicts such as these are the result of differences in the sociocultural background and occupational roles of station personnel. Historically, one particular source of social conflict has been the military vs civilian status of station members. U.S. stations have been staffed with a split command and two organizational subgroups, one scientific and civilian and the other logistic and military, each with different organizational, occupational, and career orientations. A major source of conflict at these stations has been the inherent difference between the disciplined, regulated, conservative activities of the Navy personnel on the one hand and the relatively unstructured, disorderly, independent lifestyles of the scientists on the other.[9,33]

Other sociocultural and occupational sources of conflict in Antarctic research stations have been the status of station members as superiors or subordinates (such as officers vs enlisted Navy personnel) and differences in levels of education. Different occupational subgroups, both military and civilian, are characterized by different motivation and personal values and personality traits.[29,34]

The failure of one or more members to adopt group norms also contributes to social fission and group conflict within a station. Personnel who are alcoholics, for instance, or personnel who refuse to participate in housekeeping chores, are held in contempt by the rest of the station members and frequently are ostrasized or excluded from social activities.[35]

Although group conflict rarely manifests itself in the form of physical violence, it is often reflected in arguments over individual responsibilities and station routines, as well as in more abstract discussions relating to politics and social issues.[36] Recent fieldwork in Antarctica also suggests that group conflict can lead to significant reductions in the quality and quantity of work performed.

Programs designed to promote group cooperation and reduce interpersonal conflict are likely to play an important role in the training regimens of crew members of long-duration spaceflights. Crew coordination training programs such as the one proposed by Nicholas et al.[37] might be implemented in Antarctic research stations to determine their effectiveness in building and maintaining teams of individuals in isolated and confined environments.

Leadership

An understanding of characteristics of effective leadership in small isolated social groups is another contribution that human experience in the Antarctic may make to the space program. Ever since the days of Amundson and Scott, leadership styles and the personality traits of individual leaders have been seen as accounting for much of the success or failure of an expedition to the Antarctic. Those features that promote high levels of performance and minimize social and intrapersonal conflicts in the Antarctic may also have value in accomplishing similar results on long-duration missions in space.

Previous research in Antarctica has indicated that the most important qualities of the leader of a small, isolated group are the ability to tolerate intimacy and leveling of status without losing authority and the respect of the group, and self-reliance in the lonely responsibility of command.[30] The importance of leadership in mitigating group conflict and maintaining a high level of morale and performance is reflected in a study of two small stations by Biersner and Hogan.[28] The station where the leader received high ratings from other station members had a highly successful winter-over period. Maintenance and technical tasks were performed at consistently high levels, and social compatibility remained high during the nine months of confinement. However, at the second station, the leader received poor marks from fellow winter-over personnel, station equipment was in poor repair, technical performance met only minimum standards, and conflicts among members of the group were frequent and severe. Poor leaders may also become scapegoats for the failure of an entire crew to successfully adjust to prolonged isolation.

Because civilian leaders of Antarctic stations have only limited means with which to enforce their decisions during the winter-over period, their influence over the behavior of station crew members is usually based on inspiration, example, and respect. However, for these leadership tools to be effective, the personality characteristics of the leader and group members must be compatible or subject to compromise. Similarly, compatibility or compromise between leaders and crew members will be required for effective leadership during long-term missions in space.

Antarctica provides an opportunity to conduct research on individual, social, and environmental factors that distinguish between poor and effective leadership behavior in small, isolated groups. Different leadership strategies and patterns of interaction between leaders and followers may be examined to identify those strategies and resources that will enhance group performance, promote social compatability, and ensure the success of long-duration missions in space.

Crew Composition and Social Organization

As noted earlier, the social composition and organization of small, isolated social groups are influenced by the interaction of the social and cultural background of crew members with the fundamental processes of group fission and fusion. As Antarctic research stations become demographically more heterogeneous, they provide opportunities for understanding the problems and prospects of organizing and integrating a diverse collection of individuals into an effective crew for a long-duration mission in space. Social and behavioral science research at Antarctic stations could help to identify the best mix of work skills, social skills, personality characteristics, and coping resources in an isolated crew. The division of labor and interactions between subgroups such as the military support personnel and civilian scientists may also be examined at stations such as McMurdo.

Issues regarding the presence of men and women under conditions of prolonged isolation may also be examined in studies of Antarctic research stations. Although the anecdotal evidence on male-female relationships in Antarctica has been inconclusive,[10] this issue has not been the subject of previous research because women have only been a part of American winter-over crews since 1979, and many nations still refuse to allow women to winter-over. Recent fieldwork in Antarctica indicated that women exerted a positive influence on the psychosocial processes of adjustment to the prolonged isolation. Several male informants indicated that the presence of women helped to "normalize" the social environment and discouraged certain forms of behavior such as drinking and fighting that could lead to accidental injury or group conflict. Nevertheless, research on male-female relations at American stations would enable us to determine the optimum ratio of men to women and whether or not the development of intimate relationships between certain crew members would be socially disruptive.

The human experience in the Antarctic has demonstrated the existence of rules and traditions of adaptation to prolonged isolation that comprise a cultural system. When station personnel first arrive in the Antarctic, they represent a collection of culturally heterogeneous individuals with different social backgrounds, occupational assignments, attitudes, and values. However, each station gradually develops a cultural system of its own. These "microcultures" change from year to year as personnel rotate in and out of stations. Nevertheless, the cultural systems of certain stations retain a certain amount of continuity from one year to the next.

These cultural systems are a product of several different features of the human experience on the ice. One such feature is the history of that experience with its record of successes and failures. The legacies of Scott and Amundson and of Byrd and Siple, remain as part of the cultural heritage of Antarctic scientific and support personnel.

Processes contributing to group cohesion and the adoption of certain norms of behavior that foster individual adjustment and group adaptation also underlie the development of station microcultures. For instance, areas such as lounges, galleys, and exercise rooms, where differing groups interact, are typically subject to rules that prevent friction between groups. Expressions of this norm include the "no dirty dishes" rules in mess halls or "no outside shoes" rules that prevent visitors from adding to the residents' housework by tracking in dirt and mud.

The behaviors of station members are also governed by and evaluated in terms of other norms including cooperation, hard work, and a disdain for rash or foolhardy behavior or the excessive consumption of alcohol. Within each station from one year to the next, a high value is typically placed on certain qualities such as self-sufficiency, decisiveness, intelligence, ability to work alone, good communication skills, assertiveness, and independence.[19,36]

The social identity of station members is another feature of station microcultures. In visiting Antarctic stations, one can observe many cultural features that over the years have differentiated winter-over crews.[38] Examples are the signs pointing to members' hometowns; sporting events such as the annual Scott's Hut race at McMurdo and the "Penguin Bowl" football game held at Williams Field; or the initiation rituals associated with a certain station such as the Three Hundred Club at South Pole Station.

Finally, station microcultures are a product of a fundamental relationship between man and nature and the need of humans to impose a sense of order and meaning on an otherwise chaotic and unfamiliar environment.[35] Whether in the Antarctic or in space, these cultural systems are based on the experiences of groups of individuals with a defined range of social, cultural, and psychological characteristics (i.e., scien-

tists and support personnel in Antarctica and astronauts in space) in unusual and unfamiliar environments. One would expect, therefore, that the perspective shared by these groups of their respective environments would differ from the perspectives of other men and women not familiar with these environments.

These microcultures are a fundamental part of the processes of individual adjustment and group adaptation to prolonged isolation in an extreme environment. An understanding of the nature of these cultural systems and the role they play in these processes could lead to policies and programs that contribute to the development of healthy microcultures in space. The significance of such cultural systems for psychosocial adaptation during prolonged missions in space has already been identified elsewhere.[39]

Organization of Work

Along with social compatibility and emotional control, task performance has long been used as one of the criteria for successful adjustment to the Antarctic winter-over experience.[27] However, as with the issue of male-female relationships, the importance of work schedules in the processes of psychosocial adjustment in Antarctica is frequently mentioned but has not been subjected to systematic research. Based on their analysis of the work patterns at French research stations in Antarctica, Rivolier and Bachelard[10] have argued that some compromise must be struck between underemployment and overemployment of personnel. The former condition leads to boredom, whereas the latter condition, a subject of concern on previous short-duration spaceflights,[1] contributes to exhaustion and fatigue. Either condition appears to increase the risk of experiencing the psychophysiological symptoms that form the winter-over syndrome and can lead to significant degradations in performance.

In addition to the amount of work, the schedule of work activities also appears to have a significant impact on processes of psychosocial adjustment. At the Amundson-Scott South Pole Station, for instance, support personnel are often required to adhere to standardized work schedules each day whereas scientists are allowed greater flexibility in setting their own schedules in keeping with the nature of their projects. Consequently, the station forms into two groups on the basis of the time during the day that each group devotes to work and recreational activities. Moreover, the support personnel must adapt their sleep-wake cycles to a pattern similar to that in the United States, even though their circadian rhythms may be affected by the extremes of day and night at high latitudes.[9] Scientists, on the other hand, are allowed to "free-cycle," altering their sleep patterns to conform to work schedules and environmental constraints. Research is required to determine the benefits, if any, of free-cycling and whether individually tailored work schedules are feasible or desirable in long-duration missions in space.

Facility Design

Although the design of Antarctic research stations bears greater similarity to the proposed designs for bases and off-world colonies on the moon and other planets, it also provides some valuable lessons for the design of spacecraft for long-duration flights. For instance, one recent study at Palmer Station on the Antarctic Peninsula found that station members spend up to 60% of their waking hours alone. Bedrooms were used extensively as a place to obtain privacy.[40] Crew quarters in spacecraft should be designed to allow for privacy and isolation from other crew members if desired.

Similarly, crew members should be allowed to change certain features of their living and work environments if so desired. The Palmer Station study also found that the ability to move furniture in common areas and decorate rooms and work areas had an important adaptive function for winter-over crew members.[40] The decoration of living quarters and work spaces also provides a certain measure of perceived control over the environment, an important element in the process of adjusting to prolonged isolation in an extreme environment.[19]

Support Infrastructure

Finally, relations between the spacecraft and ground control or NASA in general could benefit from the experience of winter-over crews in dealing with institutional authorities such as the National Science Foundation, the U.S. Navy, or the civilian contractor responsible for support services. There have been several instances in which astronauts have expressed resentment at the hectic schedules imposed on them by a disembodied mission control during manned flights in space. This includes the highly publicized but overrated "revolt" of the crew of Skylab IV who found mission control's schedule of activities to be too demanding and exhausting.[1] As noted earlier, similar conflicts have emerged between the isolated stations and institutional authorities back home because of resentment over delays in delivery of supplies or orders that conflict with the wishes or desires of crew members.

A major contributor to the conflict between crew members of an Antarctic research station or astronauts in a spacecraft and institutional authorities "back home" has been the intermittent nature of communications with the outside world. The absence of face-to-face contact, garbled messages, or the inability to send or receive messages during certain times of the year often leads to misunderstandings and exaggerated concern over seemingly insignificant issues.[10] Technology and procedures that facilitate communication between the station and the outside world would be extremely useful for long-duration missions in space.

Procedures for communication with family and friends back home must also be established prior to the departure of long-duration space missions. In previous long-duration missions, Soviet cosmonauts have been able to establish visual and verbal contact with family members on a daily basis.[41] In the Antarctic, some investigators have reported that frequent communication with family and friends impedes the process of adjustment because it serves as a constant reminder of the stress associated with prolonged isolation.[10] There has also been some debate as to whether institutional authorities or station supervisors should withhold certain types of information, such as the death of a loved one or an impending divorce action, from those station members who are believed to be incapable of successfully coping with the assumed emotional reaction. However, no evidence exists to suggest that such an action should become an adopted policy, either in Antarctica or on a long-duration spaceflight. Moreover, failure to inform the isolated crew member could also have a negative impact on psychosocial adjustment, resulting in uncertainty, anxiety, resentment over the control exerted by institutional authorities, and performance degradation.

Conclusion

Despite the differences in environment, the nature of the mission, the characteristics of the crew, and the technology necessary for survival, Antarctica serves as a useful analog for the planning and operation of manned missions in space. In addition to the wealth of information already acquired through decades of social and behavioral research on health and performance in the Antarctic, this analog also provides the potential for additional research which will lead to programs that effectively screen and prepare individuals for extended periods in space. The use of Antarctica as an analog of space, therefore, must be evaluated not only in terms of the history of human experience on the ice, but also in terms of its potential as both a locale and tool in preparing for the human experience in space.

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