Isolation and Confinement Issues in Long Duration Spaceflight

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Abstract—As humankind prepares for further exploration of our solar system it is crucial to consider the wide range of potential psychological and physiological effects brought about by long duration spaceflight.[1][2]

This paper reviews efforts to address these effects in three areas: human factors design, physiological health, and psychosocial issues. Human factors design considerations include increasing user-friendliness and earth-like familiarity of space vehicles. Physiological concerns involve physical conditioning and reducing individual stress levels. Psychosocial efforts have traditionally focused on crew selection in addition to coping with the stresses of isolation and confinement.

However as the duration of spaceflight missions increases, it is necessary to consider a fourth factor: interpersonal dynamics. Interpersonal dynamics will influence communications, crew compatibility, and coping. The role of group psychology will become especially salient during prolonged confinement during longer missions. This heightened potential for interpersonal problems demands attention, with important implications for crew training and mission design.

Furthermore, besides the stresses already faced by current spaceflight crews, crewmembers on longer duration missions will likely encounter reduced communication, increased stress – especially from homesickness – and difficulty maintaining motivation.

While some countermeasures have previously been suggested – increased crew autonomy, selection of compatible crews, and training flight crews together to increase cohesiveness – a better understanding of social psychological issues during extended spaceflight is necessary.

Thus as NASA and other space faring organizations prepare for longer duration missions, efforts undertaken now to develop preventative measures for mitigating psychosocial challenges are far more preferable to the potentially much greater demands of managing and treating psychological crises real-time during a spaceflight mission.

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1. INTRODUCTION

As humankind dreams and schemes to return to the moon and eventually continue on to Mars, many unanswered questions come to mind regarding the survivability of longer duration spaceflight missions to remote destinations. In preparing for such missions, NASA hopes to draw on the past four decades of mostly shorter duration spaceflight experience, while adding to our knowledge base of longer duration experience with on-going missions aboard the International Space Station [1]. However, compared to efforts directed at keeping crewmembers physically safe and physiologically fit, relatively little effort has been focused on the psychosocial issues and accommodations that must also be dealt with in order to accomplish these dreams. Furthermore, handling any kind of crisis at a remote location requiring extensive travel for either outside assistance or personnel evacuation greatly complicates and intensifies the situation, and increases the pressure on the crew to avoid such crises altogether. Ironically, this increased pressure to avoid crises could itself actually increase the likelihood of occurrence of a psychosocial crisis.

The traditional approach to preventing psychological problems in spaceflight crews has tended to emphasize three major tactics:

(1) implementation of human factors considerations in design features through user-friendliness, ergonomics, familiar earth-like orientation, etc. [2];

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(2) enhancing physiological health and fitness through diet, exercise [3], stress relief techniques [4, 5], etc; and

(3) addressing intrapersonal issues through personality screening [6, 7], and training to cope with confinement [3, 4, 8].

In addition to the three aforementioned tactics, the authors suggest a fourth which merits further examination: interpersonal group dynamics. Though perhaps considered an extravagant concern for short duration spaceflight missions, healthy group dynamics are absolutely essential for productive functioning of remote crews in long duration isolation and confinement.

2. DISCUSSION

Because of the unpredictable nature of psychological crises, any effort expended in advance on the prevention of psychological problems is far preferable to the great amount more that might otherwise be needed later for management or treatment, not to mention damage remediation. In this section we will discuss the four tactics of preventing psychological problems in spaceflight crews referred to in the introduction.

Human Factors Design Considerations

Crew safety must always be the uncompromised top priority in any human space mission. The crew is already operating under tenuous and stressful conditions, and should never intentionally be placed in harm's way. Secondary priorities are mission success, as well as the preservation of investments in hardware, software, and other less tangible commodities, such as the goodwill of mission supporters.

The list of recommendations below represents a variety of design measures that can be implemented to prevent psychological problems from occurring.

- As stated above, the crew must be – and feel – safe:
  - Mission planners and designers should work together to protect the crew from all potential electrical, thermal, pyrotechnic, radioactive, chemical, mechanical, and pressure hazards.
  - All structural corners, edges, and protrusions must be rounded and de-burred; all snag hazards must be eliminated.
- Mission/work design: give crewmembers a sense of control over their own work, schedules, decisions, or at least some input into decisions affecting them; allow creative use of free time.
- Vehicle/habitat design strategies:
  - Although microgravity (or weightlessness) enables interior design without traditional floors or ceilings [3], layouts of crew living and working areas should be as earth-like as possible, establishing a local vertical to prevent disorientation and the associated stress.
  - Incorporate earth scenes captured in video and art.
  - Implement artificial gravity during orbital or interplanetary flight (perhaps via tethered counter-mass) if feasible.
  - Provide for personal privacy, personal touches and reminders of home. Some of the tension caused by a feeling of "crowding" and loss of privacy may be assuaged by providing a calming environment within the spacecraft, particularly in areas designated for rest and relaxation. This can be accomplished at least in part through the use of cool colors, such as blues and greens, along with soft lighting [5].
  - Address "sensory hunger" issues by creating interactive environments within the vehicle, allowing crewmembers to alter wall color (via lighting or wallpaper) and other elements of décor [5]. To provide stimulation for the entire duration of long-term missions, development of various additional countermeasures may be required.
  - Environmental stressors, such as excessive noise, light and crowding (of hardware and personnel), should be minimized to the extent possible through vehicle design [3].

Physiological Health and Fitness

Stress. There are numerous sources of stress present during spaceflight. Isolation, confinement and separation from Earth induce psychological stress. Noise and vibrations associated with normal vehicle systems operations, fear of equipment failure, and the rigors of adjusting to microgravity are also consistent sources of stress [4]. These stressors continue throughout the flight, and may be exacerbated by interpersonal stressors and homesickness [8].

High levels of sustained stress can produce various effects. During long duration spaceflight missions chronic stress may result in decreased energy, intellectual impairment, decreased productivity, increased hostility, anxiety, sleep disorders, miscommunication, and impulsive behavior [4]. To alleviate these symptoms stress must be reduced, either directly, by removing or diminishing the causes of stress, or indirectly, by introducing countermeasures to relieve stress.

Given that many environmental stressors, such as isolation and separation from Earth, are unavoidable in long duration spaceflight missions, it is important to train crewmembers in stress relief techniques to alleviate stress despite the on-going presence of its causes.

Stress Relief Techniques. Various methods have been suggested for alleviating the stress of spaceflight. The list below contains the most practical suggestions, based on ease of use and minimal equipment requirements.

- meditation, a process of relaxation through thought blocking
- progressive muscle relaxation, a systematic self-guided process of tensing an relaxing the voluntary muscles in the body from head to foot
- autosuggestion, especially autogenetic training, a trained technique utilizing muscle relaxation and mental imagery to regulate one's heart rate and breathing.

Biofeedback training, the use of electronic monitoring devices to aid subjects in altering various physiological conditions, may also be useful, especially in addressing space adaptation sickness. Biofeedback training has a higher equipment requirement, however, and can only address a limited number of biological stress responses at one time. In comparison, the other suggested techniques require only moderate training and a quiet, comfortable room. [3, 4].

Stress relief techniques such as these enable crewmembers to decrease stress, improve sleep, reduce anxiety, and improve focus and awareness. The use of meditation may be especially valuable, allowing rest and psychological privacy from the rest of the crew [5]. Since both the risk and the impact of prolonged stress increase with the duration of the mission, these opportunities for rest and relaxation are especially important during long duration spaceflight missions [4]. It would be beneficial to train crewmembers in one or more of these relaxation techniques and encourage their use during spaceflight missions to relieve stress.

Not all methods of stress relief rely upon crewmember training. It might also be possible for ground control personnel to monitor stress levels and prevent them from escalating to dangerous levels. By carefully observing crewmember behavior, it may be possible to detect and address the early warning signs of high stress levels before they have a negative impact on performance [9].

It is important to note that the goal of stress relief is not to completely eliminate all stress. The periodic stress experienced in addressing critical situations can be beneficial by keeping crewmembers sharp, alert and engaged. However chronic, prolonged stress is detrimental to performance and should be the target of stress relief efforts [4].

Physical Fitness Training. It has long been known that regular exercise sessions will be necessary during long duration spaceflight [3]. Exercise will be required to help counteract the risks of degraded perception and motor skills, muscle atrophy, cardiovascular deconditioning, and bone demineralization on long duration missions. Exercise may also be encouraged as a method of stress relief [4].

Physical exercise has not typically ranked as a favorite pastime of astronauts [3]. Therefore it will be necessary to find ways to encourage and motivate crewmembers to exercise regularly. It may be worthwhile to include exercise within a behavioral program for astronauts, offering a choice of exercise activities and providing some kind of reward system for completion of routine exercise [2].

Intrapersonal Issues

Selection. Crew selection on the basis of psychological criteria, while imperfect, is an absolute necessity [7]. The goal is to select individuals who are both professionally and psychologically qualified, and prepared to be productive while enduring the stresses of spaceflight [3]. One study, based on a space mission simulation conducted in Antarctica [6], concluded that subjects should be comprehensively assessed based on the following criteria:

- Cognitive style: perceptual flexibility may aid coping with new situations
- Attention: individuals with difficulty concentrating may adapt poorly to life in space
- Emotionality and anxiety: individuals likely to remain calm under pressure may be better suited to high stress situations during spaceflight
- Defense mechanisms: (refer to the discussion of coping below)
- Global behavior: traits that are crucial to coping with crowding should be evaluated, such as territoriality and sociability
- Psychobiological parameters: strong physiological immunity to stress is highly advantageous.

These criteria may be respectively assessed using: ambiguous figures tests, measures of short term memory, psychological anxiety scales, defense mechanism inventories, systematic interviews, and medical examinations [6].

Confinement and Isolation. Confinement within the spacecraft limits the sensory stimuli available to crewmembers. As a result, on long duration flights, the monotony of life within the vehicle may cause what crewmembers have described as "sensory hunger." The consequences of this lack of stimulation include intellectual impairment, decreased motivation, sleep disturbance, and somatic and affective complaints [4]. (Some possible solutions are addressed above under *Human Factors Design Considerations.*)

Crewmembers also face isolation from friends, family, and other social support. Though communication through ground control is helpful, crewmembers are still tangibly isolated from the support, affection, and reassurances of their friends and family. As a result, some crewmembers may exhibit a separation reaction to leaving Earth, experiencing feelings of loneliness, fear, and loss of spatial orientation [4]. Additionally, isolation is a particular concern for long duration missions because the psychological load of homesickness increases over the duration of the mission, even when the mission is as short as 40 days [8]. As missions lengthen an increased effort to provide continued social support to crewmembers will be necessary to help counter the psychological burden of homesickness. Development of techniques for routine communication with friends and family might prove to be particularly worthwhile. Communication will be discussed further later.

Paradoxically, confinement to the vehicle may also encroach on the individual's need for privacy, or personal isolation. The sense of crowding and loss of privacy can promote negative psychological outcomes and increase tension. This negative reaction is especially prevalent among Americans, who have higher expectations for space and privacy than individuals from other cultures [5]. Astronauts will often cope with the stress of confinement by withdrawing socially [3]. It is important to provide private space for crewmembers seeking to relax individually. In addition, it may be advisable to select individuals who generally demonstrate less need for privacy and personal isolation [5].

Maintaining Motivation. With on-going confinement and increasing time in space, motivation tends to drop after the initial high at the start of the mission. Individuals are motivated to do well during the initial days of work, but as the job becomes routine, motivation decreases [10]. Results are mixed with respect to the changes in mood and group climate over time. While a more recent study [11] found no evidence of a "3rd quarter phenomenon" for crew tension and behavior, other studies have found an increase in homesickness during the second half of the mission [8]. One recent proposal [2] outlined the development of a behavioral program, suggesting that motivation may be sustained by allowing crewmembers to choose amongst a number of work tasks and then rewarding each task with an allotment of time for leisure activities. Selecting crewmembers with high intrinsic motivation may also be advisable [10].

Mission Workload. Long duration spaceflight will require a reconsideration of mission design guidelines. It has been proposed [3] that while tasks are often overscheduled on short duration missions, longer missions may instead present the challenge of ensuring that crewmembers have adequate work for the entire duration of the flight. Monotony and boredom have the potential to generate as much stress as over-stimulation [4].

Changes to the way general work and specific tasks are designed or organized can also be a practical countermeasure to the stresses of spaceflight. Crewmembers should have at least some level of input into designing their schedules as well as choosing and prioritizing their tasks, rather than just being presented with a rigidly controlled schedule [2]. Simply giving crewmembers some sense of control over their own work can help to reduce stress and tension, while at the same time possibly even boosting their productivity [5]. In addition, care must be taken that time spent not working is sufficiently rewarding [3]. A proper schedule of work and rest relies upon not just having time off from work, but having the opportunity for meaningful recreation as well as relaxation.

Coping. In order to handle the stresses of spaceflight, each crewmember must use coping strategies that work for stressors that are inescapable and uncontrollable. Assessment of various coping strategies during 10- and 40-day submarine missions suggests that problem-focused coping, social sensitivity, and high levels of motivation correlated well with the most successful outcomes. In particular, those who utilized a strategy of active problem solving, calmly and purposefully approaching issues from all sides to find pragmatic solutions, coped better with increasing feelings of homesickness toward the end of the mission. Individuals reliant upon high social support experienced increased initial stress, but this could be alleviated by strong social relationships with other crewmembers [8]. If these results can be extrapolated through simulation or analogy to long duration missions, they may suggest that highly motivated, socially sensitive individuals who exhibit problem-focused coping might be best equipped to handle the stresses of long duration spaceflight.

Meditation has also been proposed as a potentially valuable tool in coping with stress during long duration space missions. Time spent meditating may provide relaxation by psychologically removing the individual from the stressful situation [4]. However, further understanding of the usefulness of such techniques in coping with on-going stress will be necessary to understand their effectiveness for long duration spaceflight.

Interpersonal Issues with Crewmembers

While identifying and developing countermeasures for intrapersonal issues such as isolation and confinement has perhaps been the highest priority in the field of space psychology, long duration spaceflight missions will require increased consideration of issues facing the crew as a unit, not just as a collection of individuals. The longer the duration of a mission, the more salient these psycho-social human factors become. For instance, a survey of astronauts and cosmonauts found evidence of diminishing support for their leaders over time, as well as displacement of tension and negative emotions to mission control personnel [11]. Some potential areas for exploring interpersonal issues are discussed below.

Crew Composition. Little has been written about the importance of selecting crewmembers that are compatible with one another. While it is crucial to select crewmembers that are professionally and psychologically qualified as individuals, these individuals must also fit in well with the other members of the crew. Characteristics such as complementary needs, similar values, and a noncompetitive work orientation are beneficial to interpersonal compatibility [3].

In designing the ideal crew, experts generally agree that it is important to have an effective crew leader. A broad literature review [12] suggests that effective leaders are optimistic, respected by the crew, sensitive to crewmember feelings, effective at making crewmembers feel personally valued, dedicated to mission objectives, and invite crew participation in decision making, yet are still able to take charge when necessary. Similarly, a study of pilots [10] found that crews led by individuals who rated high in "instrumentality" (goal-orientation and independence) and "expressivity" (interpersonal warmth and sensitivity) on the Extended Personal Attributes Questionnaire were most effective when compared to two other pilot personality subgroups. Among astronauts, "job competence" and "group living" were found to correlate positively with positive ratings from one's peers. It was found that "group living," a collection of factors related to teamwork and desirability as a colleague, could be largely explained by variance in "expressivity" [13]. In short, the best leaders are not only technically skilled individuals, but are skilled in handling interpersonal issues as well.

Some human spaceflight experts have suggested that it may be advisable to include a trained psychologist on the crew for long duration spaceflight missions. This proposal neglects the potentially adverse crew reaction to the presence of a psychologist. An on-board psychologist may cause crewmembers to feel as if their performance is constantly being assessed or questioned, or to worry about appearing to be weak in some way [14]. Crewmember fear of professional disqualification or judgment, or reactance against sensitive questions posed for psychological assessment could result in some degree of individual or even group backlash against the psychologist [3]. The psychologist may also become perceptually associated with ground control and be viewed as a representative of their interests, rather than as an advocate for the crew's interests. As a result, the psychologist could risk becoming excluded by the rest of the crew [15]. Furthermore, if the psychologist's relationship with the crew is initially negative it is not likely to improve [16]. Still, the inclusion of a psychologist as a member of the crew is not entirely implausible. In order for this idea to work it will be essential for the psychologist to build a respectful professional relationship with the crew, and for him or her to be treated in every way as a member of the crew, rather than as a liaison from mission control [14].

These issues are nevertheless focused on the selection of individuals, and do not address the broader issues involved in selecting a team. In planning for longer duration spaceflight missions, it will be advisable to consider the needs as well as the attributes of the crew as a community, rather than as a collection of individual crewmembers [17]. A more comprehensive appreciation for the desirable traits of the crew as a group, rather than merely the traits of the individual members, is necessary to guide the selection of a fully effective, compatible crew.

Crew Training. One factor that will clearly be instrumental in addressing interpersonal issues is the training of crewmembers. Perhaps most importantly, training the crew together as a group will produce better results than a crew of qualified individuals trained separately. Effective crews are knowledgeable about their overall mission as well as their individual tasks, their equipment and their team. Familiarity with fellow crewmembers facilitates communication, increasing efficiency and performance [18].

Specifically, educating the crew about interpersonal relationships will improve the crew's ability to handle interpersonal conflicts. If the crewmembers are trained to expect interpersonal issues, they will be better able to handle conflicts when they arise [4, 8]. This approach is clearly preferable to reliance on an emergency "sensitivity session" after a serious conflict has arisen between parties, such as occurred between the crew and ground control during the third Skylab mission, which led to the first American "strike in space" [14].

In addition to advance awareness of potential conflicts, training in other interpersonal skills may be advisable. For instance, training in conflict resolution and mediation may assist crewmembers in handling disputes. It may be beneficial to train crewmembers to support one another socially. Such training may help assuage the stress of separation from friends and family on Earth by allowing fellow crew members to provide the social support normally given by friends and family.

Training in social dynamics and fostering a team mentality may also help improve team cohesiveness. Crewmembers may also benefit by being instilled with realistic expectations and encouraged to conceptualize spaceflight as a lifestyle, not an endurance race to be survived.

Experimental application of these measures will be necessary before they can be fully assessed and closely tailored to the needs of the space program.

Crew Confinement. In addition to its impact on individual stress, confinement and isolation increase social stress. Confinement increases social tension, and may result in aggressive teasing and other antagonistic behaviors between crewmembers [3]. Perceptions of crowding and loss of privacy may also inflame existing interpersonal conflicts, especially among men [5]. Alternatively, crewmembers may react to circumstances by withdrawing from social interaction, isolating themselves from the rest of the crew [3]. Obviously neither reaction - increased antagonism nor withdrawal - contributes positively to overall crew performance.

As noted above in the section on *Human Factors Design Considerations*, some of the tension brought on by confinement may be assuaged by providing a calming environment within the spacecraft. However, such environmental countermeasures are not a comprehensive solution. Crewmembers on long duration missions must be able to function effectively as a productive and cohesive team. Therefore a more thorough understanding of how to promote sustained peak performance by an isolated and confined crew over the long haul is critical.

Communication within Crew. Communication amongst the members of the crew is a vital aspect of crew success. In fact, the effective performance level of groups can be inferred from their communication patterns [15]. In stressful situations maintaining the ability to communicate with humor is particularly valuable [3].

There are a multitude of elements that may hinder both verbal and nonverbal communication among the crewmembers during spaceflight. Conditions within the vehicle may interfere with verbal communication. One notorious cause of miscommunication is the high level of ambient noise associated with vehicle systems. Additionally, internal atmospheric conditions may interfere with verbal communication by altering voice characteristics or forcing astronauts to shout to overcome dissipated sound waves. Nonverbal communication may also be disrupted in space; weightlessness distorts facial expressions and limits control over otherwise normal body language cues [15].

Other socio-cultural factors may also influence communication between crewmembers. In a crew consisting of members from a variety of professional backgrounds discipline-specific jargon may hinder free communication within the crew [3]. Language differences and diverse cultural backgrounds may also increase the risk of miscommunication [15].

It is possible that crew communication during spaceflight may be enhanced by training. A recent study [18] found that teams in which the members were familiar with each other and had experience working together as a group were more effective and communicated more efficiently.

Interpersonal Issues with Ground Control

All interaction between ground control and the flight crew is influenced by the specific medium of communication used. Communication via media (e.g. video/screen, audio/phone, electronic mail, etc.) is inherently different from face-to-face communication. Limited electrical power, the limits of human perception, and the limitations of each form of media (e.g., distance delays for transmissions) restrict the amount and type of information that can be communicated between the crew and ground control. Thus in planning for long term spaceflight missions it is necessary to work within these constraints. Specifically, communications protocols must be effective and as efficient as possible even when the crew is at a distance where prompt two-way communication is not possible. [15].

One partial remedy would be to reduce the need for communication with ground control by allocating more responsibility to the crew. In fact this countermeasure may be a practical necessity; as distance from Earth on long term missions increases, the increased delays in transmission of communications will increase the need for the crew to be able to function autonomously [15]. In addition, crews that have been trained as a group are also likely to exhibit more efficient communication, and thus need less back and forth communication [18]. Thus training the flight crew together with the ground control crew may also reduce the amount of communication required between the spacecraft and Earth.

One significant communication link that will be vital to maintain, however, is the opportunity for each crewmember to communicate privately with his or her personal network of friends and family [15]. The burden of homesickness only appears to intensify over time [8]. For long duration missions, the ability to maintain contact with friends and family will be an invaluable way to counter crewmember anxiety.

Ground control may also serve as an outlet for crewmember frustrations. As Connors [15] has noted regarding spaceflight, “when one group is also isolated and confined, thinly disguised or even open hostility toward the outside group can result”. Unrest within the crew is often displaced and directed toward ground control [11]. It is essential that ground control personnel maintain an amiable relationship with the crewmembers, and are responsive to crewmember needs.

Brewing hostilities toward ground control may also disrupt the relationships between crewmembers. When any two groups work together, liaisons must work to mediate the interests and concerns of each side. The liaisons from the crew face the risk of becoming perceived by the rest of the crew as a mouthpiece for ground control. Thus crew hostility directed at ground control may also disrupt relationships within the crew, with the crew liaisons to ground control being excluded by the rest of the group [15].

3. Summary and Conclusions

There are many factors (whether unplanned or intentional) that determine the success and well-being of crews in isolation and confinement for spaceflight missions. Mission planners, crew selection committees, and spacecraft designers have little control over the unplanned factors, so our attention is focused on the factors that can at least be partially controlled. Historically, the three most prominent areas that have been intentionally addressed through mission, crew, and spacecraft design include:

1. **human factors spaceflight design principles**, used to enhance crew safety, user-friendliness, and a sense of earth-like familiarity;

2. **physiological health and fitness**, including regular exercise and specific stress relief techniques;

3. **intrapersonal crew factors**, such as selection, response to the spaceflight environment, workload, motivation, and coping strategies.

In this paper, the authors submit a fourth area that we believe warrants intentional focus; that being:

4. **interpersonal crew factors**, such as crew composition and compatibility, training, group dynamics, and communications both within the crew as well as between the crew and outsiders.

Perhaps our most significant recommendations in this area would be the following:

- Select and train flight and ground crews together as a group to improve crew cohesiveness, communication, and efficiency, as well as provide better preparation if and when interpersonal conflict arises.

- Give the spaceflight crew greater autonomy in order to reduce reliance on time-delayed communications with ground control; this may also help alleviate the potential adversarial relationship between flight and ground personnel, as well as help to maintain flight crew motivation.

- Pursue further research on the development of socially stable flight crews and the amelioration of interpersonal stress during sustained isolation and confinement as a group.

In order to gain a better understanding of how interpersonal factors might be better controlled to promote long duration mission success, additional research will be necessary. Future research in this area might include real-time or retrospective studies of various aspects of interpersonal issues in analogous circumstances. Long duration naval submarine missions, scientific Antarctic winter-overs, or even humanitarian or faith-based assistance and relief provision missions to remote populations in geographically isolated locations might provide opportunities for such investigations. Data of interest to be collected and analyzed in such studies should seek to draw correlations between measures of mission success and the following factors: group selection, composition, training, structure and hierarchy of authority, group dynamics, social tensions, and communications issues.

In summary, each of the four factors listed above (human factors design principles, physiological health, intrapersonal crew factors, and interpersonal crew factors) which already impact the successfulness of space crews in near-space, short duration missions will be magnified in significance for the more distant and longer duration missions now being considered by NASA and the international space community.

Finally, it is important to realize that in complex, high stress situations such as spaceflight, challenges are bound to arise. We must resist the urge to consider every unexpected behavior as deviant. After all, despite the complications added by socio-cultural factors, a commendable job has been done in handling these challenges thus far [14]. The results of the space program have been highly beneficial to society at large through information and technology spin-offs in every conceivable field, as well as to the space- and ground-based participants themselves [19]. There is no single countermeasure – or even set of countermeasures – that can be expected to prevent all possible contingencies. Stress relief training, personality screening, and other methods designed to eliminate potential crewmember problems are each limited in the scope of their impact [10, 14, 15].

Still, efforts to implement the principles of psychology within spaceflight missions have proven successful, particularly in the area of relieving stress [19]. The next step, made particularly cogent by the ambition to send humans to distant destinations, is to incorporate social psychology in investigating and resolving the inevitable interpersonal challenges associated with such long duration missions [11].

References

[1] H. H. Emurian and J. V. Brady, "Behavioral Health Management of Space Dwelling Groups: Safe Passage Beyond Earth Orbit," *Behavior Analyst Today*, vol. 8, p. 113, 2007.

[2] *NASA-STD-3000 Man-Systems Integration Standards (MSIS)*. NASA, 1995.

[3] M. M. Connors, A. A. Harrison, and F. R. Akins, "Psychology and the resurgent space program," *American Psychologist,* vol. 41, pp. 906-913, Aug 1986.

[4] A. S. Levine, "Psychological Effects of Long-Duration Space Missions and Stress Amelioration Techniques," in *From Antarctica to Outer Space: Life in Isolation and Confinement*, A. A. Harrison, Y. A. Clearwater, and C. P. McKay, Eds. New York: Springer-Verlag, 1991, pp. 305-315.

[5] D. Raybeck, "Proxemics and Privacy: Managing the Problems of Life in Confined Environments," in *From Antarctica to Outer Space: Life in Isolation and Confinement*, A. A. Harrison, Y. A. Clearwater, and C. P. McKay, Eds. New York: Springer-Verlag, 1991, pp. 317-330.

[6] J. Rivolier, C. Bachelard, and G. Cazes, "Crew Selection for an Antarctic-Based Space Simulator," in *From Antarctica to Outer Space: Life in Isolation and Confinement*, A. A. Harrison, Y. A. Clearwater, and C. P. McKay, Eds. New York: Springer-Verlag, 1991, pp. 291-296.

[7] J. Rivolier, G. Cazes, and I. McCormick, "The International Biomedical Expedition to the Antarctic: Psychological Evaluations of the Field Party," in *From Antarctic to Outer Space: Life in Isolation and Confinement*, A. A. Harrison, Y. A. Clearwater, and C. P. McKay, Eds. New York: Springer-Verlag, 1991, pp. 281-290.

[8] G. M. Sandal, I. M. Endresen, R. Vaernes, and H. Ursin, "Personality and coping strategies during submarine missions," *Military Psychology,* vol. 11, pp. 381-404, 1999 1999.

[9] T. H. Kelly, R. D. Hienz, T. J. Zarcone, R. M. Wurster, and J. V. Brady, "Crewmember performance before, during, and after spaceflight," *Journal of the Experimental Analysis of Behavior,* vol. 84, pp. 227-241, Sep 2005.

[10] T. R. Chidester, R. L. Helmreich, S. E. Gregorich, and C. E. Geis, "Pilot personality and crew coordination: Implications for training and selection," *International Journal of Aviation Psychology,* vol. 1, pp. 25-44, 1991 1991.

[11] N. Kanas, "Interpersonal Issues in Space: Shuttle/Mir and Beyond," *Aviation, Space, and Environmental Medicine,* vol. 76, pp. B126-B134, Jun 2005.

[12] J. M. Nicholas and L. W. Penwell, "A proposed profile of the effective leader in human spaceflight based on findings from analog environments," *Aviation, Space, and Environmental Medicine,* vol. 66, pp. 63-72, Jan 1995.

[13] T. J. McFadden, R. L. Helmreich, R. M. Rose, and L. F. Fogg, "Predicting astronaut effectiveness: A multivariate approach," *Aviation, Space, and Environmental Medicine,* vol. 65, pp. 904-909, Oct 1994.

[14] W. K. Douglas, "Psychological and Sociological Aspects of Manned Spaceflight," in *From Antarctica to Outer Space: Life in Isolation and Confinement*, A. A. Harrison, Y. A. Clearwater, and C. P. McKay, Eds. New York: Springer-Verlag, 1991, pp. 81-87.

[15] M. M. Connors, "Communication Issues of Spaceflight," in *From Antarctica to Outer Space: Life in Isolation and Confinement*, A. A. Harrison, Y. A. Clearwater, and C. P. McKay, Eds. New York: Springer-Verlag, 1991, pp. 267-279.

[16] G. M. Sandal, R. Vaernes, and H. Ursin, "Interpersonal relations during simulated space missions," *Aviation, Space, and Environmental Medicine,* vol. 66, pp. 617-624, Jul 1995.

[17] D. M. Scott, "Keeping the Peace in Space: A Neighborhood Model for a Community-Based, Conflict-Resolution-Oriented Justice System," in *From Antarctica to Outer Space: Life in Isolation and Confinement*, A. A. Harrison, Y. A. Clearwater, and C. P. McKay, Eds. New York: Springer-Verlag, 1991, pp. 363-371.

[18] R. Espevik, B. H. Johnsen, J. Eid, and J. F. Thayer, "Shared mental models and operational effectiveness: Effects on performance and team processes in submarine attack teams," *Military Psychology,* vol. 18, pp. S23-S36, 2006 2006.

[19] E. C. Ihle, J. B. Ritsher, and N. Kanas, "Positive Psychological Outcomes of Spaceflight: An Empirical Study," *Aviation, Space, and Environmental Medicine,* vol. 77, pp. 93-101, Feb 2006.

[20] P. Suedfeld, "Invulnerability, Coping, Salutogenesis, Integration: Four Phases of Space Psychology," *Aviation, Space, and Environmental Medicine,* vol. 76, pp. B61-B66, Jun 2005.

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Leslie Wickman, Ph.D., *is currently director of the Center for Research in Science at Azusa Pacific University. She is an internationally respected research scientist and engineering consultant.*

For more than a decade, Wickman was an engineer for Lockheed Martin Missiles & Space in Sunnyvale, Calif., where she worked on NASA's Hubble Space Telescope and International Space Station Programs, receiving commendations from NASA for her contributions and being designated as Lockheed's Corporate Astronaut. For the last six years, she has worked as a research scientist with the RAND Corporation in Santa Monica on the technical and political aspects of various national defense issues. She also serves as a consulting scientist on fighter pilot training issues, future space launch vehicles, human factors problems for extreme environments, and runs a water reclamation research project.

As director of the Center for Research in Science at Azusa Pacific University, Wickman's responsibilities include addressing the relationship between science and theology. She has lectured extensively around the world on satellite servicing, astronaut operations, mission planning, and space physiology issues. She is also a dedicated athlete who plays competitive beach volleyball and women's professional tackle football.

Wickman holds a master's degree in aeronautical and astronautical engineering and a doctoral degree in human factors and biomechanics, both from Stanford University. She also graduated magna cum laude from Willamette University with a bachelor's degree in political science.

Annie Y. Tsai, Ph.D., *received her MA in Social Psychology in 2003 and doctorate Social and Cultural Psychology in 2005 from Stanford University. She joined the Psychology Department at Azusa Pacific University in the Fall of 2006 following her Fulbright tenure at National Taiwan University where she was visiting scholar. She has conducted cross-cultural studies in Korea, Japan, Taiwan, Hong Kong, and US. She has given numerous invited addresses at universities, presented posters and talks at international and American conferences, chaired different panels, mentored students to present at conferences, and written for publication. She is right now writing a book on Culture and Hierarchy to be published December of 2008.*

At Azusa Pacific University, she currently serves as faculty advisor for the Psychology Association and the Chinese Fellowship. She helping the Office of Diversity put together the first Faith and Diversity in the Academy Conference for the Council of Christian Colleges & Universities. She started the Applied Social Research Lab where she has been doing research on Applied Social Psychology. She has multiple projects on Group Dynamics issues. Dr. Tsai has also been active on different service oriented teams to Mexico, France, Taiwan, Hong Kong, and China. She has been an invited guest speaker at different churches, retreats, and community centers.

Raymond Walters *is currently an undergraduate student at Azusa Pacific University. Working as a research assistant with Dr. Annie Tsai, he is a newcomer to the field of space psychology.*

In his time at Azusa Pacific University Walters has been an active member of the Honors Program. He is currently serving as president of the Student Honors Council, working alongside faculty to shape educational policy and expand honors curriculum. He is also a motivated musician who has performed internationally with the Azusa Pacific Handbell Choir.

Walters is in his senior year, finishing a bachelor's degree in Psychological Sciences, with a double minor in Religion and Culture, and Philosophy. He is also a member of the Pew College Society and the Alpha Chi Honors Society. After graduation he plans to pursue a graduate degree in Psychometrics or Cognitive Psychology.