

## FMARS 2007: STRESS AND COPING IN AN ARCTIC MARS SIMULATION

Sheryl L. Bishop  
University of Texas Medical Branch USA  
sbishop@utmb.edu

Ryan Kobrick  
University of Colorado USA  
Ryan.Kobrick@Colorado.EDU

Melissa Battler  
University of Western Ontario CANADA  
mbattle@uwo.ca

Kim Binsted  
University of Hawaii USA  
binsted@hawaii.edu

### Abstract

**Introduction:** In the summer of 2007, the Mars Society conducted a four-month simulated Mars exploration mission at the Flashline Mars Arctic Research Station (FMARS), in the Canadian High Arctic on Devon Island, Nunavut. In addition to an intense mission profile of research, the team also operated on the Martian 'sol', (39 minutes longer than the 24 hour Earth day), for over a month, to evaluate the effects on crew psychophysiology or mission operations. **Methods:** Team members completed the AstroPCI personality inventory as well as an online questionnaire battery dealing with stress, coping and group functioning on five occasions throughout the mission (pre and monthly). **Results:** Descriptive analyses indicated differences between individual coping styles across time as well as differences in how the genders coped. Overall, stress increased for males while decreasing for females. Males used consistently more Avoidant coping while females utilized Task coping and Social Emotional coping. **Conclusions:** Simulations situated in environments that are characterized by prolonged true isolation and real environmental challenges appear to provoke true demands for adaptation rather than temporary situational accommodation as has been evidenced by shorter simulations situated in laboratories or more benign environments. Both complimentary and compensatory coping patterns were in evidence.

### 1. Introduction

There have been a limited number of sites situated in real environments in which the impact of confinement and isolation on small groups has been systematically studied. Most often, investigations on the impact of extreme environments on small groups are conducted on teams convening for expeditions in which the research is of secondary priority. The Mars Society has operated two habitats for such studies for a number of years: the Mars Desert Research Station (MDRS) situated in a desert location in Utah, USA, and the second, the Flashline Mars Arctic Research Station (FMARS) located in the High Canadian Arctic on Devon Island, Nunavut, Canada. Historically simulations at

MDRS run for two weeks while simulations at FMARS usually run for four weeks. In the summer of 2007, the Mars Society conducted a four-month simulated Mars exploration mission at the FMARS with seven crew members, quadrupling the previous record for in-situ Mars mission simulations as well as maintaining exceptional levels of isolation. The Canadian-American crew were volunteers willing to dedicate four months of their life for an extraordinary experiment in which the minute details of their lives would be scrutinized and evaluated. The mission profile called for conducting a comprehensive program of geological and microbiological field exploration operating under similar constraints that human explorers would face on Mars as well as completing a number of

repeated psychological and group functioning assessments designed to investigate sources of interpersonal stress and strategies to cope. They were not given any special training in this regard and the crew was not screened or selected on any dimension of compatibility. The crew used a 20 minute time delay in all communications as part of their mission protocol to simulate the Earth-Mars time delay. In addition to an intense mission profile of research data collection, analyses and reporting, station maintenance and educational outreach, the team also operated on the Martian 'sol', (39 minutes longer than the 24 hour Earth day), for over a month, to evaluate the effects on crew psychophysiology or mission operations.

Of particular interest was the role of personality, stress and coping in environments characterized by extreme confinement and isolation. Stress is an inherent characteristic of environments characterized by danger, remoteness of assistance, isolation from others and confinement with its attendant reduction in social networks and diminished environmental stimuli. Projections for long duration space missions must also add the as yet unquantified impact of prolonged weightlessness, extraordinary loss of contact with humankind, a high radiation environment and unknown dangers. Therefore, accurate assessment of predictable stressors and identification of those that can be obviated by informed selection and appropriate training is paramount.

There is no right or wrong coping strategy. However, within small groups, differences in coping and resilience to stress can operate to mitigate or exacerbate dysfunction. Coping strategies are key to individual management of stressful life events [1]. Windle and Windle noted that different coping approaches can exert either positive or negative influences on adaptation [2]. In past studies, task coping (problem oriented) styles have been found to positively impact adaptation and health while emotional oriented coping negatively impacts adaptation and health [1]. The FMARS crew members were committed to the need for full disclosure and honesty regarding their sources of stress and interpersonal tension as part of the science of the mission. Their willingness to share their experiences during this challenging mission is a testament to their individual and collective contribution to humanity's preparation for exploration of the solar system.

## **2. Methods**

### **2.1 FMARS**

The habitat is a circular 24 foot diameter, two-deck structure mounted on landing struts with private sleeping accommodations for six crewmembers. The seventh crewmember was bunked in loft space also used for storage of food supplies. Along with the environmental challenges, crew members had to also contend with the possibility of polar bears which inhabit the region requiring armed escort by assigned crewmembers for each EVA conducted by the team. Simulation space suits were utilized by EVA teams upon all egresses necessitating considerable effort and preparation time. Due to safety requirements and to preserve confinement protocols for the majority of the crew, two team members were initially designated as the 'out of simulation' team and allowed to exit the habitat without suits to maintain the generators and equipment. For the armed escort, a third member was added to the rotation for EVA excursions to reduce the workload of the other two members. The in-simulation team routinely used an airlock depress/repress procedure upon each exit and entry to the habitat. There was no TV, no radio, or mobile phone. The habitat was equipped with a satellite phone for the use in emergencies and short wave radio for communication with team members while outside the habitat.

All routine communication with the outside world was conducted via computer text, audio and video messages including any initial medical emergencies. Medical assistance for the majority of the mission was only available via lifelight services several hours away.

### **2.2 Objectives**

The core psychological scientific objectives for the parent study included:

- Assessment of the contribution of personality factors to stress, coping and group dynamics
- Group functioning, group fission and fusion factors
- Triangulation of self report subjective stress assessments, mood reports, and coping styles
- Exploration of differences and similarities in coping and group interaction by gender

This presentation will deal primarily with our findings regarding comparisons between the genders on stress, mood and coping.

### 2.3 Instruments

Prior to deployment, all participants were asked to complete the Mars Habitat I, a web-base battery of psychological questionnaires that assess various dimensions of personality, baseline stress and coping strategies. During the mission, at the end of each month, participants were asked to complete a second questionnaire battery, Mars Habitat II, (web-based or hard copy) which included assessments of group dynamics, stress and coping. Sheldon's Perceived Stress inventory was a 10 item self-report measure of stress [3]. Self-report measures of this kind have been found to be valid measures of state anxiety [4]. Coping was assessed using a 28 item Brief Coping Questionnaire which measures 14 subscales related to coping strategies. Personality was assessed utilizing the Astro-PCI, a battery of pen and paper psychological questionnaires that assess various dimensions of personality [5]. The AstroPCI is a 73-item battery composed of three tests measuring interpersonal orientation, achievement motivation and Type A behavior. The 10 individual scales are as follows: Positive Instrumentality (task orientation), Positive Expressivity (interpersonal orientation), Negative Instrumentality (hostility), Negative Communion (self-subordination and submissiveness), Verbal Aggressiveness (verbal passive aggressiveness), Mastery (the desire to be challenged), Work (willingness to apply oneself diligently), Competitiveness (the desire to best others), Achievement Striving (motivation to succeed), and Impatience/Irritability. Internal consistencies of the various scales ranged from .56 to .76 [6].

In addition to the AstroPCI, the gold standard for global personality assessment for the last 20 years has been the NEO-Personality Inventory by Costa and McCrae [7]. This instrument assesses five global dimensions of personality: Neuroticism, Extraversion, Openness to Experience, Agreeableness and Conscientiousness. These dimensions have been found to be associated with the previous personality 'right stuff/wrong stuff/and no stuff' profiles identified by Helmreich et al in longitudinal studies of American Astronaut candidate performance [8-11].

Crews were given baseline measures on all assessments either prior to arrival (i.e., the personality battery) or on Day 1 for the stress, coping and group assessment evaluations. Repeated measures were then taken each month throughout the mission.

### 2.4 Data Analyses

Given that our sample size for this mission was small, our analyses are primarily descriptive. It should be kept firmly in mind that such small sample sizes do not generalize to other samples or represent evidence for the population in general. It is our hope that continued data collection over multiple missions will result in sufficient numbers to address issues that can be appropriately treated with parametric statistical approaches.

## 3. Results

Figure 1 displays the NEOPI-FFA profiles for all group members. For the FMARS team, the seven team members were very similar on Openness. Six of the seven were similar on Neuroticism and Extraversion. However, Member 6 persistently displayed a distinctly different personality profile (high on Neuroticism, low on Extraversion, Agreeableness and Conscientiousness) indicative of an easily upset, more introverted, self-oriented individual. Similarly, Members 1 and 3, also show either low Agreeableness or low Conscientiousness profiles which are not generally conducive to positive group interaction.

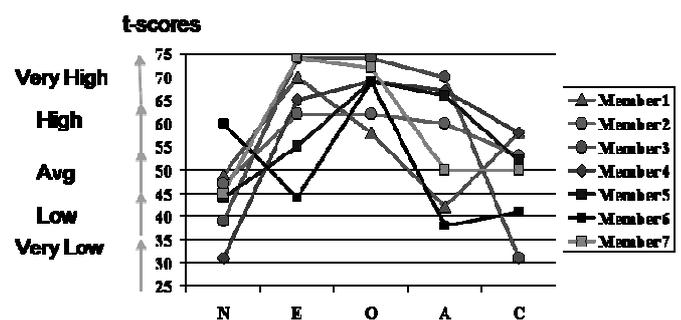
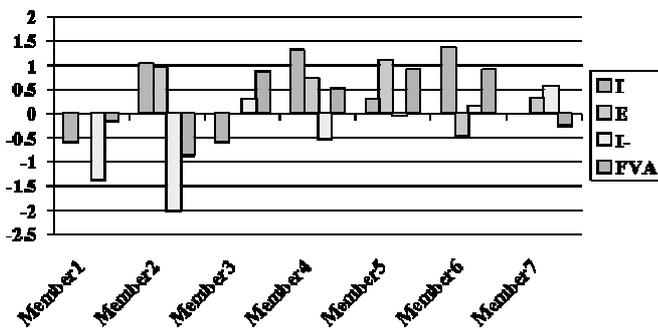


Figure 1 NEOPI-FFA Profiles

On interpersonal orientation characteristics, (Figure 2) levels of low hostility were characteristic of all members. However, general profiles were varied across members. Member 2 exemplified the prototypical 'right stuff' profile with positive levels of

task and interpersonal orientations combined with low levels of hostility and verbal aggressiveness.

**Standardized scores**



**I=Instrumentality (task); E=Expressiveness (interpersonal); -I=Neg. Instru.(Hostility); FVA=Verbal Aggressiveness**

Figure 2 Interpersonal Orientation Profiles

An examination of achievement motivation scores (Figure 3) indicates a noteworthy low degree of impatience and irritability across team members confirming the low hostility profile in the previous graph. The group as a whole demonstrated a surprising lack of significant levels of achievement striving given the expressed levels of mastery, the desire to engage in challenging tasks. Elevated levels of competitiveness, the desire to best others, were exemplified by several team members. High levels of this competitive urge to best others have been shown to be disruptive and interfere with performance in a number of previous studies.

**Standardized scores**

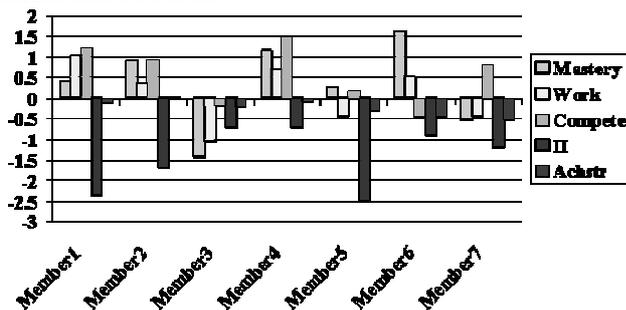


Figure 3 Achievement Motivation Profiles

3.1 Gender Comparisons

3.1.1 Personality

A comparison across genders on personality (Figure 4) indicates that the two groups are very similar on all dimensions except neuroticism with

the females being notably lower, contrary to stereotype. This may reflect a selection winnowing since highly neurotic females are unlikely to volunteer for such simulations.

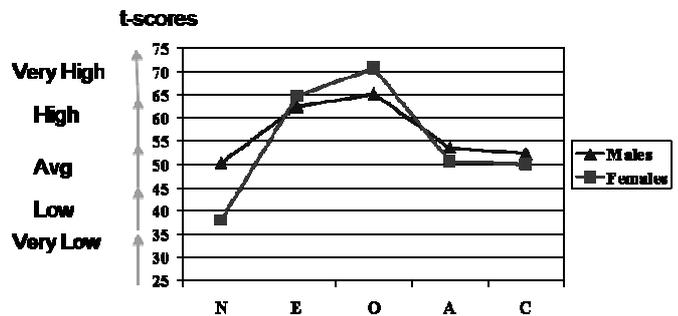
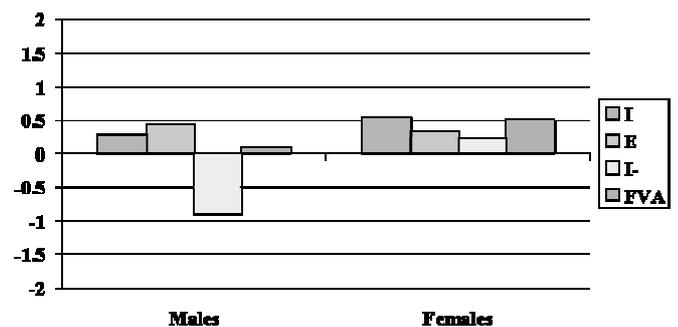


Figure 4 NEUPI-FFA Gender Comparisons

On interpersonal orientation (Figure 5), the two profiles are again very similar with the exception of a much lower hostility profile for the men compared to norms.



**I=Instrumentality (task); E=Expressiveness (interpersonal); -I=Neg. Instru.(Hostility); FVA=Verbal Aggressiveness**

Figure 5 Interpersonal Orientation Gender Comparisons

Achievement motivation profiles (Figure 6) do reflect some differences in competitiveness (men are higher) and work (women are below norms). Both men and women were near or exceeded one standard deviation below norms on impatience and irritability as well as achievement striving. The low achievement profiles were surprising in this sample where one would expect individuals drawn to testing themselves in an extreme environment to be significantly higher than norms on these dimensions.

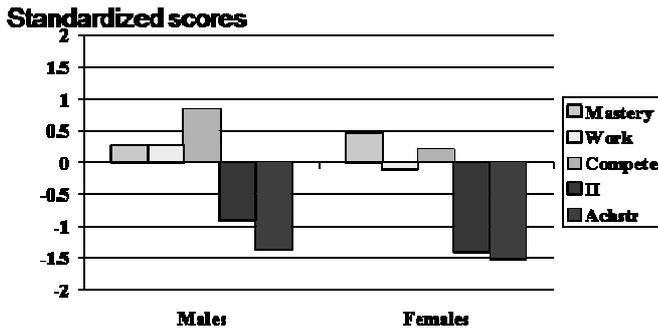


Figure 6 Achievement Motivation Gender Comparisons

### 3.1.2 Stress and Coping

The pattern of stress (Figure 7) was dramatically different between males and females at mission beginning. However, males displayed a significant increase between baseline and the end of the first month and stayed elevated above females until mission end. Females displayed a reduction of similar magnitude by the end of Month 1 with small steady reductions until mission end.

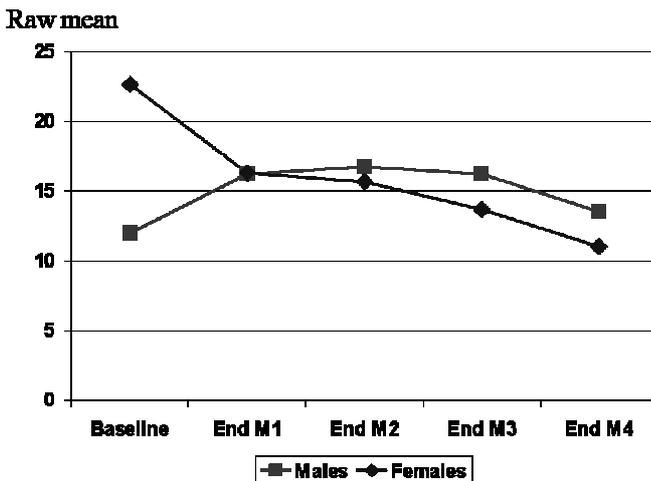


Figure 7 Stress Comparisons Between Genders

Comparisons of global coping styles across mission duration (Figure 8 and 9) indicated that males persistently relied upon avoidance approaches with social emotional coping generally second in usage. Female used avoidance coping the least across all time points with a predominant preference for task coping with social emotional coping a close second. Reported stress levels were very low for males at mission beginning compared to later reports and to females. Males stress levels were consistently elevated from the second month through mission end as was avoidance coping. Females stress levels were consistently lower.

The combination of avoidance coping with social emotional coping for males would indicate coping responses that would be oriented towards emotional arousal but reluctance to confront or address issues. Female predominance in task and social emotional coping reflects a style focused on 'fixing' problems by doing something rather than avoiding the issues and emotional arousal when efforts to resolve problems were thwarted. Although small sample size prevents any conclusions based on this data, the efficacy of task coping and inefficacy of avoidance coping has been supported consistently in previous studies.

## MALES

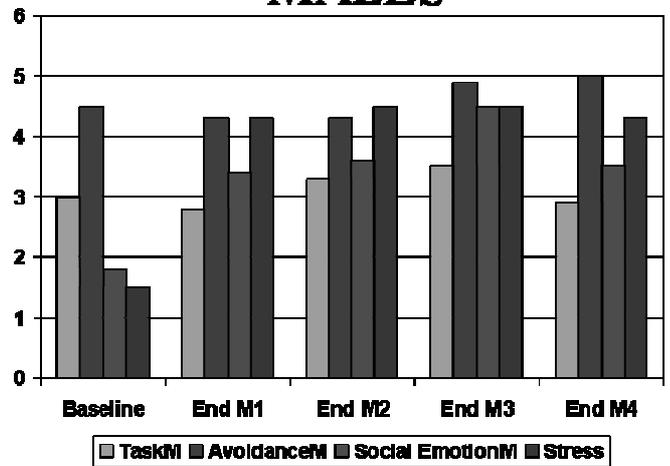


Figure 8 Male Global Coping Styles Across Time

## FEMALES

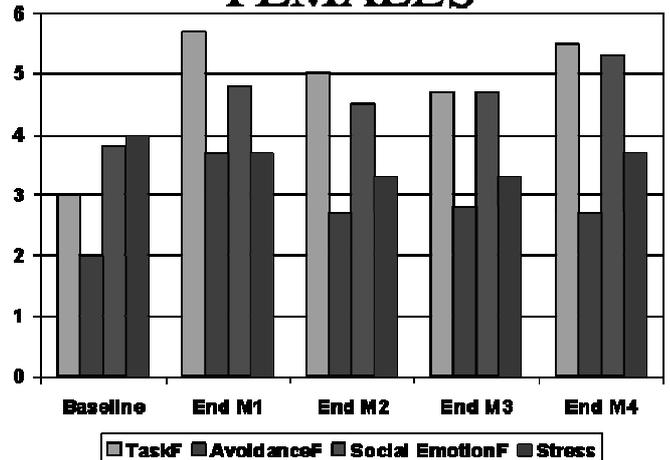


Figure 9 Female Global Coping Styles Across Time

Coupled with emotional coping (generally not conducive to effective adaptation), the predominant usage of avoidance coping may actually delay effective adaptation and contribute to individual and

group stress. These two styles would be equally stressful for each of the other to deal with over long periods of time.

The contrast between genders in global coping styles when averaging coping across time is graphically illustrated in the opposite preferences displayed in Figure 10. The predominance of male avoidance coping contrasted to female's reliance on task and social emotional coping is dramatically demonstrated.

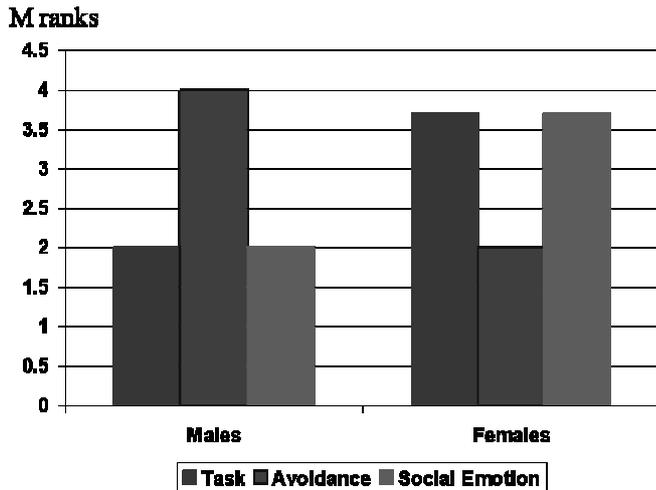


Figure 10 Comparison of Global Coping Styles Across Genders Averaged Over Time

Mood profiles were distinctly different between the genders as well. Males reported generally higher levels of positive affect at baseline which increased slightly and remained stable (Figure 11).

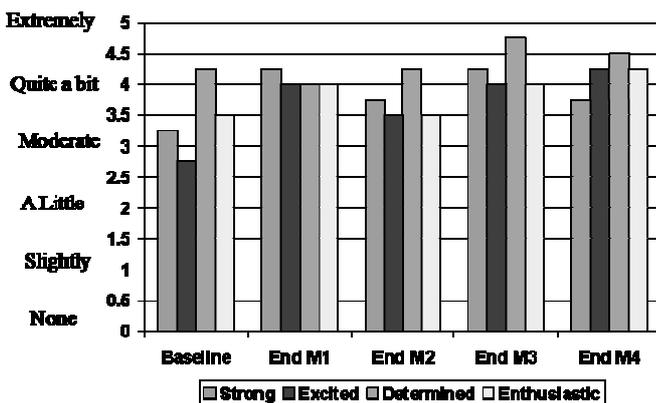


Figure 11 Male Positive Affect Across Time

Females were surprisingly low on reported positive affect initially especially excitement which remained noticeably less than the males across the mission (Figure 12). Interestingly, assessments of 'feeling

strong' and determined increased dramatically for women as the mission progressed.

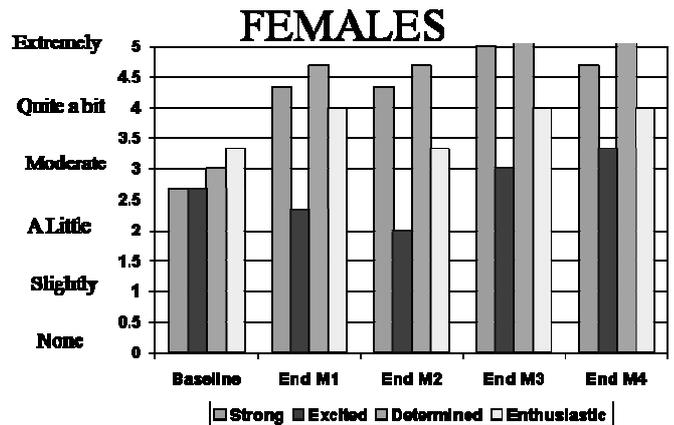


Figure 12 Female Positive Affect Across Time

Negative mood profiles were also distinctly different between the genders (Figure 13 and 14). Males consistently reported greater feelings of tiredness across the mission and greater loneliness and frustration.

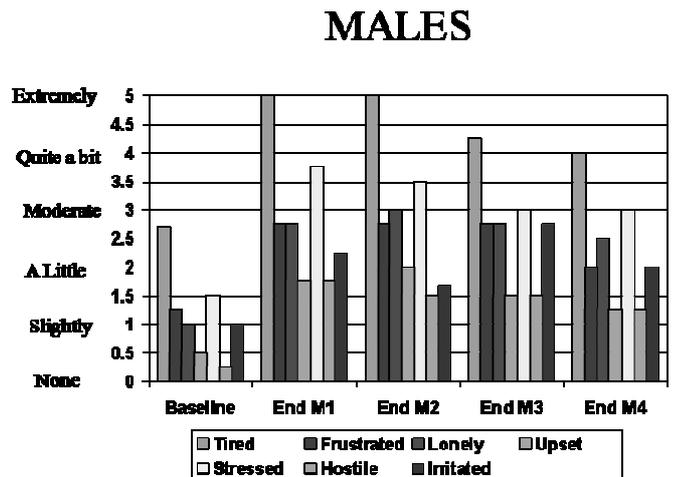


Figure 13 Male Negative Affect Across Time

Both groups reported moderate to moderately high levels of stress and tiredness. The highest levels of irritation for both groups was reported at the end of Month 3 which may be indicative of the 'third quarter' effect reported by some studies of Antarctic teams during which the greatest levels of emotional distress are experienced. It also coincided with the period of maintaining the Martian 'sol' schedule. To what extent the additional negative affect was reflective of the local strain of the slightly longer Martian schedule or its asynchronous drift with the external world (e.g., mission control, family and friends) cannot be ascertained.

## FEMALES

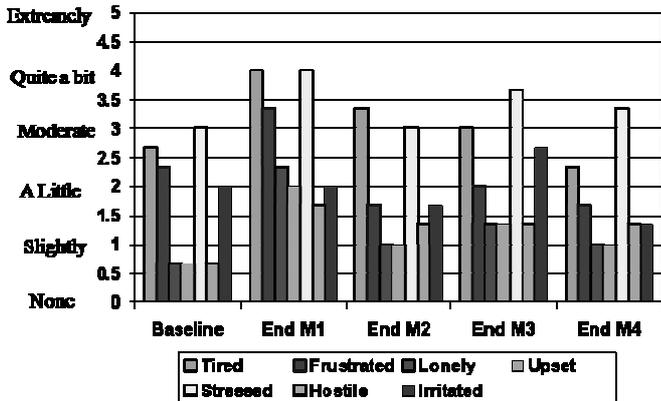


Figure 14 Female Negative Affect Across Time

### 3.1.3 Mood and Affect

Mood scores averaged across the four months show the major differences between males and females seem to lie in the degree of tiredness, excitement felt, and loneliness with males being clearly higher than females on these dimensions (Figure 15). Of the negative moods, low to moderate levels of irritation, frustration and subsequent stress were expressed. Both groups displayed high levels of determination, enthusiasm and strength.

Thus the pattern of positive and negative affect suggests that males were feeling more isolated and frustrated which may have contributed to feelings of fatigue or, conversely, been exacerbated by extreme physical tiredness. Combined with an avoidance coping style, resolution of interpersonal conflict would have been slow to be resolved.

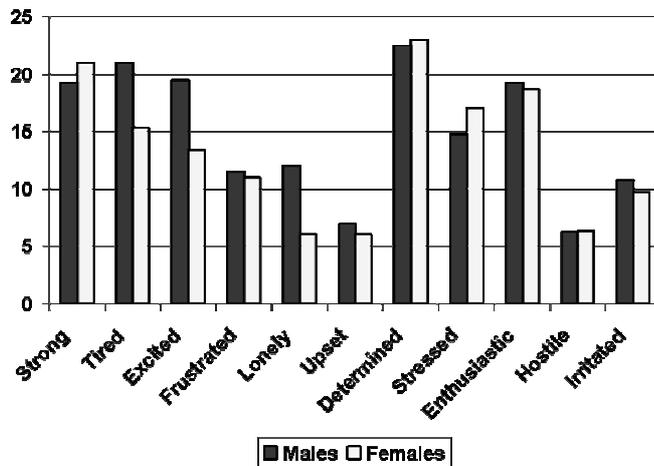


Figure 15 Comparison of Averaged Affect Across Genders

## 4. Summary

Male feelings of isolation, frustration and loneliness, their use of avoidance coping, elevated feelings of arousal and excitement were mirrored in incidences of individual conflict and tension between group members. Post mission debrief interviews indicated a number of occurrences involving interpersonal conflicts over disagreements in group choices of entertainment, communication problems embedded in language differences, unreciprocated attraction, personality differences, challenges to authority and schedule compliance that were centered on male crewmembers. Most of these issues were addressed by the team in such a way as to keep tensions at manageable levels; however, multiple crewmembers acknowledged the high likelihood that these same issues on a longer duration mission would have produced significant problems for the crew.

The difference in the patterns of positive and negative affect reported by team members strongly suggests that there was a difference in expectations and framing of the expedition that generally but not uniformly aligned along gender lines. The higher levels of reported excitement and enthusiasm by male participants coincides with repeated incidences where individuals deferred duties in favor of pursuing prolonged exploration while on EVAs indicating a greater willingness to supplant mission schedules with personal preferences. The lower levels of excitement and enthusiasm evidenced by the women reflected a more pragmatic framing of the mission as a challenge to successfully complete. These differences may have contributed to perceptions of the women by the men as less flexible, compliant and more rule-bound with reciprocal perceptions on the part of the women of the men as less mission focused. These generalizations have been noted in other studies of men and women's teams. However, it should be emphasized that there were individuals of both genders who were more similar to their cross gender counterparts than to their same gender cohorts.

## 5. Discussion

One goal of small group studies is to identify group fission and group fusion factors. Group fission

factors are those that contributed to discord while group fusion factors contribute to group cohesion. In the FMARS team, stress was clearly evident across the mission for both groups and all individuals. It is impossible to parse the impact of the environment from the contribution of interpersonal frustration, loneliness, and intergroup conflict which were all evident during the four months. A certain amount of intergroup conflict is inevitable for all groups and, overall, the FMARS team members remained focused on the overall mission goals. Some sources of conflict can be avoided by better selection and training. Some can be mitigated by avoiding structures that lend themselves to high likelihood of conflict or role stress. Both of these sources were evident for this team, e.g., the inclusion of a single member whose mother tongue was not English or the relegation of some team members to purely support roles. The lack of meaningful contribution to the discovery part of expeditions has persistently been found to contribute to lack of ownership of mission goals by team members. It is not enough to just support the team. One must feel a part of the excitement and contribution to generation of new knowledge.

There were notable problems as well when a member tasked with an authoritarian role became compromised as a key player in persistent reoccurrences of unreciprocated sexual interest. The conflict undermined trust in the motivation behind unpopular maintenance of protocols and safety procedures.

There were also numerous incidences where the in-simulation and out of simulation groups found themselves at odds. Out of simulation members took advantage of various activities to relieve the stress of confinement being experienced by the in-simulation group which served to heighten feelings of disparate contribution to the verisimilitude of the mission. Maintaining a joint crew with non-equivalent mission roles will always be challenge. For the most part, the team effectively dealt with this issue by bridging the groups with a floating member who could advocate for both subgroups.

One persistent problem that was not effectively resolved during the mission was the issue of majority versus minority decisions taken by the group. When resources for leisure and pleasure are minimal, equitable use becomes of paramount importance to group functioning. In the case of the 2007 FMARS team, the desire to follow a popular

TV show, *Lost*, by a majority of the team overshadowed prior commitments by the group to equitably choose leisure activities desired by the minority. The fact that some of these alternative activities involved viewing media that required English subtitles further heightened the cultural differences and difficulties of mixed nationality crews. The situation was further exacerbated by the lack of familiarity of the out-group members with the storyline of *Lost* which made participation that much more difficult. The prevailing group rationalized their decision to satisfy their desire to watch the next installment of the program by taking the unwillingness of those dissenting to confront the group and demand equitable access as acquiescence even though most admitted during debrief that they were acutely aware of the distress this caused.

Poor matches between personality and mission parameters of isolation, confinement and roles were evident for several individuals. Research from Antarctica clearly indicates that not all personalities are good fits for confined and isolated environments. My own research has persistently found a very different personality profile for trekking expeditions compared to that needed for habitat missions [12]. However, several individuals were uniformly lauded by group members as being key sources of leadership and support. The emergence of these boundary role persons has been repeatedly shown to be critical to effective team functioning. They serve to bridge the various interests of subgroups and individuals and provide the social ties that hold groups together.

Finally, the team reported stress from pressures to be inclusive of all members in all activities. Taking private time away from the group was difficult to accomplish and often frustrated by the lack of auditory privacy. While visual privacy could be accomplished by retreating to one's room, all conversations were discernable from almost any part of the habitat with few exceptions. The out of simulation members often resorted to shirt-sleeve private conversations in the generator hut but this was not available for in-simulation members who had to don suits to leave the habitat.

The use of email contact with family provided substantial resources for venting and emotional relief for all team members. The attempt to use email conversation as a private mode of in-group communication was differentially perceived by some

as insulting, impersonal and reflecting a lack of dealing with issues face to face while others found it a useful and effective mechanism for within group private conversation. This differential perception of the appropriateness of using email for within group conversation was not recognized until late in the mission.

While there were numerous challenges and sources of fission factors for the team to overcome, there were also numerous sources of fusion factors to strengthen their skills in dealing with the negatives. During the mission, emergent co-leadership roles evolved that incorporated a number of strengths of the group. With members of both genders and subgroups represented, this structure was able to bridge many of the instances of communication breakdowns that are inherent in any group. All members adamantly felt that prior experience had been highly beneficial in preparing them for many of the challenges of the prolonged confinement and isolation. It was uniformly agreed that those that did not participate extensively in prior training were at a disadvantage and were less integrated into the group.

It was also apparent that a meaningful role in the generation of knowledge and accomplishment of scientific goals was critical to the development of a shared mission identity. The lack of such personal scientific projects left some members without meaningful roles in group identity activities which contributed to subgroup formation and social isolation for those members. For those with projects, feelings of camaraderie and collegiate cooperation were in evidence and promoted high motivation, dedication and determination to accomplish mission goals.

Contact with family and friends were deemed of critical importance by all team members. Such contact was credited with successful personal management of intergroup conflicts and stress as well as mitigating individual feelings of isolation and loneliness. Although the crew observed a 20 minute communication delay protocol with external contacts, this was periodically violated for media interviews, educational outreach exchanges, personal contacts with bankers/travel agents, group counseling sessions with one of the principle investigators and, occasionally, even personal phone calls to family. The sheer ability to make these real-time contacts as well as the knowledge that civilization and home was a supply flight away

in Resolute, Nunavut, and beyond certainly played a part in mitigating the sense of isolation. This is of key importance since such immediate relief generated by real-time contact with family and friends will not be possible for long duration missions to Mars. Within group modalities will need to be far more effective than a reliance on external email and store and forward communications with family for such missions to manage stress and conflict.

## 6. Conclusion

There are numerous substantial questions about stress and coping that still need to be addressed. The experiences of the FMARS team was consistent with previous studies wherein males were more likely to utilize an avoidance pattern of dealing with interpersonal conflict and personal stress and females are more prone to an action oriented approach. This may be highly culturally influenced. The use of avoidance coping delays problem resolution and intervention. Avoidance patterns tend to frustrate task focused individuals which contributes to greater stress. In turn, demands by task focused individuals to actively address problems is perceived as pressure by avoidance copers. And so it goes...

Despite the persistent issue of unreciprocated attraction by one crew member for another, the crew strongly endorsed the inclusion of both males and females on the team. Research in mixed gendered teams strongly suggests that the presence of females normalizes social functioning in groups, allowing males to disclose more easily. This would be a beneficial counter to avoidance coping styles which appear frequently in males. It remains to be seen whether more effective coping approaches can be inculcated in team members through training.

Post mission debriefs at one year clearly indicated that all crewmembers had accurately identified critical events and issues as well as constructive reflection on better ways these could have been handled. Thus, each of these individuals are better prepared and likely to be more effective in future groups as well as better able to evaluate the fit between their own personality strengths and weaknesses and mission characteristics. This post mission learning supports an iterative approach whereby potential teams should be given opportunities to complete mini-missions as part of

their training. There is no substitution for experience. The 'best fit' individuals will be those that become most proficient at rapidly translating lessons learned into actual practice. The benefits to incorporating such empirical training in the selection and preparation of long duration crews could not be made more eloquently than by the experiences of the FMARS crew.

In closing, this was an extraordinary group of individuals who were willing to put themselves under substantial duress and challenge. They were successful in meeting all the scientific goals outlined by the mission objectives. The kinds of intergroup conflicts and challenges they grappled with are indicative of those that future crews will face. It is not the presence of conflict that is critical but the manner in which the group manages conflict that determines successful group functioning or not. The FMARS team members met some of those challenges successfully while others eluded effective resolution. As a group of volunteers who were not screened or matched on their personality or skills before the mission, one must count their overall success in maintaining a functioning group as laudable. Their contribution to future studies cannot be understated.

## 7. Acknowledgements

The continued contribution by the Mars Society to the field of small group research is without par. The continuous operation of FMARS and its sister station MDRS over the last 8 years has contributed untold man-hours of data to our understanding of group functioning in extreme environments. Similarly, this mission could not have been what it was without the FMARS 2007 crew. Each of these individuals has made a significant contribution to our ability to select, train and support the best fit team for a future Mars mission.

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