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Behavior and Performance on Long-Duration Spaceflights: Evidence from Analogue Environments

RUNNING HEAD: Behavior and Performance during Spaceflight

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ABSTRACT

Background: Analyses of data collected in Antarctica since 1963 were conducted to identify features of behavior and performance likely to occur during long-duration missions in space.

Methods: The influence of mission duration and station latitude on POMS mood scores was examined in 450 American men and women who overwintered in Antarctica between 1991 and 1998. The influence of crewmember social characteristics, personality traits, interpersonal needs, and station environments on measures of behavior and performance at the end of the austral winter was examined in 657 American men who overwintered between 1963 and 1974. Both data sets were used to examine the influence of crew social structure on individual performance.

Results: Seasonal variations in mood appear to be associated with the altered diurnal cycle and psychological segmentation of the mission. Concurrent measures of personality, interpersonal needs, and coping styles are better predictors of depressed mood and peer-supervisor performance evaluations than baseline measures because of the unique features of the station social and physical environments and the absence of resources typically used to cope with stress elsewhere. Individuals in crews with a clique structure report significantly more depression, anxiety, anger, fatigue and confusion than individuals in crews with a core-periphery structure. Depressed mood is inversely associated with severity of station physical environment, supporting the existence of a positive or "salutogenic" effect for individuals seeking challenging experiences in extreme environments. **Conclusion:** Behavior and performance on long-duration space flights is likely to be seasonal or cyclical, situational, social, and salutogenic.

Keywords: Antarctica, behavior and performance, extreme environments, manned spaceflight

Biomedical investigations of human performance in space have traditionally focused on the effects of radiation and microgravity on physiological processes (29). However, there has been an increased awareness in recent years that psychosocial factors are equally, if not more, important to the success of long-duration missions in space. This recognition has occurred in response to anecdotal evidence of the individual and interpersonal problems that occurred during the Shuttle-Mir Space Program (SMSP) and other long-duration Russian/Soviet missions, and studies of personnel in other isolated and confined extreme (ICE) environments (5). Nevertheless, despite the growing awareness of the importance of psychosocial factors, there is insufficient information on the nature of these factors and their effects on behavior and performance on long-duration spaceflights.

In the absence of such information, analogue environments offer enormous potential in the development of empirically-based scientific principles that identify the environmental, individual, group and organizational requirements for the long-term occupancy of space by humans (5,29). One of the best analogues for long-duration spaceflight consists of polar expeditions and research stations located in high latitude environments, particularly the Antarctic (5,14,30). Admittedly, there are several features of long-duration missions in the Antarctic that may compromise it's fidelity as an analogue for long-duration missions in space, including larger crews, differences in social and demographic characteristics of individual crewmembers, and the absence of microgravity. Nevertheless, polar expeditioners and astronauts on long-duration missions both live under conditions of prolonged isolation and confinement. They are also similar with respect to procedures for screening and selection, the nature of work, crew composition, and organizational structure. There has been a human presence on the coldest, driest, highest, and windiest of the earth's continents for over 100 years. Extensive data on individual, social and environmental influences on behavior and performance have been

collected since the establishment of permanent research stations by several different nations during the International Geophysical Year (1957) (9). These data offer substantially larger sample sizes over longer periods of observation than the small, three-person crews of the long-duration missions aboard the Mir Space Station and the 3-7 person crews of the short-duration American and Soviet missions. The Antarctic also offers certain logistical advantages to conducting such research compared to studies conducted in-flight. These advantages include better communications with crewmembers during the mission and reduced costs in transporting research-related equipment and supplies.

The objective of this paper is to describe some of the lessons learned from a secondary analysis of existing data collected over the past 45 years in the Antarctic in an effort to identify certain general characteristics of behavior and performance in ICE environments likely to occur on long-duration spaceflights. These analyses were conducted under the auspices of the Antarctic – Space Analogue Program (ASAP), a NASA-funded project intended to address the following: 1) the social dynamics of small, isolated groups, and 2) the environmental, social, and psychological determinants of effective performance in isolated and confined environments.

Methods

For this study, the ASAP conducted secondary analyses of two major data sets and reviewed the results of studies based on three other data sets. Participants of all of these studies spent one or more austral winters in the Antarctic. All of these individuals were evaluated as medically and psychologically qualified for winter-over duty. The psychological evaluations were conducted by teams of United States Navy clinical psychologists and psychiatrists using a standardized protocol (9). In each instance, informed consent was obtained from each participant after the study objectives and data collection procedures had been fully explained. Procedures for the secondary analysis of data collected from these studies were reviewed and

approved by the Institutional Review Board at the University of California, San Diego.

Operation Deep Freeze Study

Subjects for this study were 657 men who spent the austral winter at one of eight stations operated by the United States Antarctic Research Program (USARP) between 1963 and 1974. Information was collected on the following: 1) social and demographic characteristics, 2) personality characteristics, 3) characteristics of interpersonal needs, 4) characteristics of the station environment, and 5) self-reported and peer and supervisor evaluations of individual performance. Information on the first three sets of characteristics were collected during the psychological screenings for each winter-over candidate. Measures of station environment and individual performance were assessed at the end of the austral winter.

Social/Demographic Characteristics collected in this study were obtained from responses to the Personal History Questionnaire (9) administered during the psychological screening of each candidate and included age, education, military/civilian status, marital status, and number of years in service (if military) or in current occupation (if civilian).

Personality Characteristics. The personality characteristics of winter-over crew members were measured by responses to the Deep Freeze Opinion Survey (DFOS) which was originally employed to screen prospective candidates for winter-over duty and to predict performance on the ice (9). The DFOS contains 133 items, which result in 20 different scales. Five of these scales assess attitudes towards the Antarctic assignment: motivation, job importance, boredom, confidence in organization, and confidence in medical care. Four scales represent personality self-descriptions based on clusters of intercorrelated traits: decisiveness (decisive, obedient, alert, handy, orderly, and self-improving), excitability (excitable, argumentative, hostile, suspicious, and impulsive), bluntness (blunt, stubborn, rough in manner, and hard), and absentmindedness

(absentminded, awkward, slow, forgetful). Four scales represent the personality characteristics of achievement, autonomy, nurturance and orderliness modeled after the Edwards Personal Preference Schedule (EPPS) (8). Seven scales were derived from an inventory consisting of 50 trait adjectives rated by subjects on 8 point scales in terms of how much the individual would like these characteristics in a close friend: efficiency, sympathy, conservatism, optimism, dignity, cynicism, and adventurousness.

Interpersonal Characteristics. Interpersonal needs were assessed using the FIRO-B (28), which identified six different forms of behavior expressed to and desired from others: Inclusion-Expressed (participating in group activities); Inclusion-Wanted (desiring to be included in group activities); Control-Expressed (controlling others, expressing dominance and leadership); Control-Wanted (wanting direction or regulation from others); Affection-Expressed (being affectionate with others); and Affection-Wanted (wanting affection from others).

Measures of Performance. Individual performance was assessed on the basis of peer and supervisor ratings of the emotional stability, task ability, and social compatibility of each station member (9). *Ability* was assessed by asking each subject to identify the five crew members considered to be the best at their assigned duties (hardest working, most efficient, etc.). *Stability* was assessed by asking each subject to identify the five crewmembers considered to be the most calm and even-tempered. *Compatibility* was assessed by asking each subject to identify the five crew members considered to be the easiest to get along with (friendly, helpful, supportive, etc.). Each crewmember was further evaluated by his peers in terms of leadership characteristics and overall performance. In all five instances, each subject was then scored on the number of times they were nominated by fellow crewmembers. Each crewmember was also evaluated by a supervisor at the beginning, middle and end of winter using an 11-item scale that assessed the same five dimensions of performance. In addition, a Winter-Over Syndrome Scale (WOSS) (16)

was derived from self-reports of mood obtained early and late in the winter season. The scale consisted of 10 items: feeling blue, feeling lonely, difficulty falling asleep or staying asleep, waking at night, feeling tired during the day, feeling easily annoyed or irritated, feeling critical of others, feeling nervous or tense, inability to concentrate, and feeling uneasy or worried.

Station Physical Environment. Finally, information on station latitude, altitude, and mean annual temperature was obtained to examine the influence of these characteristics on individual behavior and performance. The eight stations in this study ranged in latitude from $64^0$45'S (Palmer Station) to 90^0S (South Pole Station); in altitude from 5 meters (Hallett Station) to 3,350 meters (South Pole Station); and in mean annual temperature from -7^0C (Palmer Station) to -52^0C (Plateau Station).

South Pole Social Networks Study

Participants in this study were 63 men and 20 women who spent the austral winter at the Amundson Scott South Pole Station between 1991 and 1994. Each month, study participants were asked to complete the Profile of Mood States (POMS), a 65-item, self-report mood questionnaire that obtains data on six factors: Tension-Anxiety, Depression-Dejection, Anger-Hostility, Vigor-Activity, Fatigue-Inertia, and Confusion-Bewilderment (13). A Total Mood Distrubance (TMD) score is derived by summing the scores of five of the subscales (Tension-Anxiety, Depression-Dejection, Anger-Hostility, Fatigue-Inertia, and Confusion-Bewilderment) and subtracting from this sum the Vigor-Activity subscale score. Participants also completed a questionnaire that asked them to rate on a scale of 1 to 10 the extent to which they interacted socially and the extent to which they asked for advice for every other crewmember. At the end of the winter, participants were asked to complete pile sort tasks in which the names of all crewmembers were sorted into various groups on the basis of perceived quantity and quality of social interactions. Piles of crewmember names were then summed and subjected to multi-dimensional scaling procedures to

determine whether the crew was fairly cohesive and unified (a core-periphery structure) or divided into subgroups or factions (a clique structure).

Review of Other Antarctic Studies

The secondary analyses of these two data sets were complemented by a review of published studies based on three other major studies conducted in the Antarctic since 1988. These studies included: 1) a pre and post-winter assessment of depression and other health status indicators in a cohort of 100 men and 19 women who spent the 1989 austral winter at McMurdo and South Pole Station (18); 2) a study of mood and subsyndromal seasonal affective disorder in a cohort of 69 men and 20 women who spent the 1991 austral winter at Palmer, McMurdo, and South Pole Stations (19); and 3) a study of changes in thyroid function and their effects on mood in a cohort of 18 men and 4 women who spent the 1996-97 or 1997-98 seasons at McMurdo (21,22,24).

Results and Discussion

Our examination of these data sets revealed four principles of behavior and performance in isolated and confined environment likely to be characteristic of long-duration spaceflights. Under these conditions, behavior and performance is likely to be seasonal or cyclical, situational, social, and "salutogenic". Each of these principles is described in greater detail below.

Seasonal Characteristics

Longitudinal assessments of behavior and performance in the Antarctic reveal certain patterns that suggest an influence of various features of the physical and psychosocial environment. For instance, analyses of the Operation Deep Freeze data set revealed a significant increase in winter-over syndrome symptoms from early to late winter (mean = 7.2, s.d. = 4.2 versus mean = 9.1, s.d. = 4.6; $t = 8.86$, $p < 0.001$). A review of data collected from personnel

who spent the austral winter at Palmer, McMurdo and South Pole Stations in 1991 revealed a significant increase in the prevalence of subsyndromal seasonal affective disorder from late austral summer to mid-winter (19). A comparison of personnel at Palmer ($64^0$45'S) and South Pole (90^0S) Stations revealed significant differences in SAD-SIGH measures of seasonally-related depressive symptoms at mid-winter (July/August) and late winter (October) (19). Cold temperatures that confine personnel indoors and restrict outdoor activity may account for differences in symptoms between stations, but not for differences between summer and winter symptoms observed at all three stations since these stations vary with respect to the degree of confinement and temperature during the winter. When viewed collectively, therefore, these results suggest that behavior in Antarctica is influenced by patterns of exposure to daylight associated with time of year and latitude.

A second pattern that appears to be circannual in nature was observed in a cohort of 22 men and women participating in a study of cold-related changes in thyroid function and its effect on mood. POMS Total Mood Disturbance scores showed an effect of time over the 12 months of Antarctic residence with a sine distribution ($p < 0.001$) and two peak values above the mesor, one in November and one in July, as well as a trough below the mesor in March (22). This circannual pattern is almost identical to the seasonal variation in serum TSH levels in the placebo group of study participants during the 1996-97 season (24).

A third pattern that appears to be seasonal in nature is revealed in Figure 1 below. An analysis of deviations from the mean POMS Total Mood Disturbance scores at the South Pole during the austral winters of 1991 to 1994 based on a nonlinear iterative least squares model revealed a significant difference in the second half of the winter (July – October) compared to the first half (March – June) ($r^2=0.677$, $p < 0.001$) (Figure 1).

Figure 1 about here

The association between depressive symptoms and time of year and latitude are consistent with studies of individuals in the general population that suggest an increased risk of Seasonal Affective Disorder and subsyndromal seasonal affective disorder with increasing latitude and decreased exposure to bright light during the winter months (11,23,26). The circannual patterns of change in total mood disturbance and serum TSH levels support an association between cold-related changes in thyroid function in Antarctica, referred to as the Polar T_3 Syndrome, and the mood symptoms of the Winter-Over Syndrome (21,22). These patterns are not confined to the winter months but occur during an entire year of exposure to an ICE environment. The increase in total mood disturbance scores and symptoms of confusion-bewilderment after the mid-point of winter isolation found in the South Pole Social Networks data set suggest the existence of a "third quarter phenomenon" among personnel in isolated and confined environments (2). This phenomenon appears to be more psychosocial than environmental in nature and is independent of mission duration. It results from the realization that the mission is only half completed, and that a period of isolation and confinement equal in length to the first half remains. In this instance, the elevation in mood scores remains relatively constant throughout the second half (i.e., third and fourth quarters) of the austral winter.

Situational Characteristics

There is a long tradition of research on individual characteristics that predict for optimal performance and high adaptability to ICE environments (9,25,27). The object of these investigations has been to identify characteristics that might be used to "select-in" individuals most likely to adapt to such environments. However, our analyses of the human experience in Antarctica suggests that there are few, if any, traits that serve as useful predictors of performance during the austral winter. For instance, a previous study of 119 men and women who spent the

1989 austral winter in Antarctica found that while several features of personality characteristics, coping methods and resources, and social resources were associated with concurrent measures of depressive symptoms, the only baseline measures that were significantly associated with late winter depressive symptoms were pre-deployment depressive symptoms and satisfaction with social support (18). Furthermore, of these two predictors, only pre-deployment depressive symptoms was a significant independent predictor of late winter depressive symptoms. These results suggested that baseline measures of personality, stress and coping are weak prospective predictors of behavior and performance during the winter because such performance is influenced more by the conditions of isolation and confinement than by stable traits of individuals (3,10). These conditions include the stressors (e.g., isolation, confinement), and the limited availability of resources necessary to cope with these stressors. Likewise, methods and resources used to cope with stressful situations prior to deployment in Antarctica may not be effective in coping with isolation and confinement in Antarctica because they are situation-specific and not generalizable from one social environmental context to another, particularly when that context is an ICE environment.

A similar prospective study of the 657 men who overwintered at 8 different stations in Antarctica between 1963 and 1974 found that military crewmembers received significantly higher combined peer-supervisor evaluations of task ability, social compatibility, and overall performance than their civilian counterparts (Table I). Being married was a significant independent predictor of leadership. Many of the personality traits and interpersonal needs were significant predictors of predictors in the expected direction. For example, a high level of boredom expressed at screening was inversely associated with task ability, emotional stability, social compatibility, and overall performance. The desire for optimism in friends was a significant independent predictor of emotional stability and social compatibility. Peer-supervisor

assessments of crewmember leadership were positively associated with the need to control others and inversely associated with self-reports of absentmindedness. However, other traits and characteristics were also associated with these performance measures, but not in the expected direction. For instance, the need for order was inversely associated with emotional stability and leadership, while the need for achievement was inversely associated with social compatibility. A desire for efficiency in friends was inversely associated with emotional stability. High levels of motivation were inversely associated with evaluations of leadership, and a desire for affection from others was inversely associated with task ability, emotional stability, social compatibility, and overall performance.

Table I about here

The low need for achievement and orderliness, affection from others, and efficiency in friends may reflect characteristics uniquely suited to ICE environments. Under conditions of isolation and confinement, the ability to satisfy a need for achievement and order is often restricted by the environment itself. Individuals wishing to complete projects on schedule become frustrated at delays in communication with the outside, constant equipment failure, or absence of necessary supplies (17). Prior to the advent of computerized inventory control systems, it was often quite difficult to locate necessary equipment and supplies on station, even when such materiel was physically present. Crewmembers who adapt best to such situations are those who adjust their expectations to fit the reality of the situation (15). Adjustment of expectations to meet the reality of the situation may also account for the inverse association between a desire for efficiency in friends and emotional stability. Similarly, the ability to satisfy a desire for affection from others is limited by a perceived need among all crewmembers to create their own personal space in a confined setting. The willingness to display friendship and offer emotional support to other crewmembers is often counterbalanced by a perceived inability

to offer effective support and a fear of being burdened by the problems of others that are similar in nature to one's own problems (17).

Social Characteristics

Our analysis of the role of interpersonal needs and social support in the behavior and performance of Antarctic winter-over crewmembers revealed a paradox. On the one hand, social support is important to these men and women. This was reflected in the significant inverse associations between satisfaction with support and concurrent and prospective measures of depressive symptoms (18). However, these measures include satisfaction with support received from individuals who are not fellow crewmembers, i.e., family and friends back home. With respect to other crewmembers, an repeated measures analysis of variance of personnel who spent the austral winter at the South Pole between 1992 and 1994 revealed a significant decline in the extent to which individuals asked others for advice ($F = 9.56$, $p < 0.001$) or provided advice ($F = 29.51$, $p < 0.0001$) to others (Figure 2). Although this decline appears to be associated with a corresponding increase in mean POMS Total Mood Disturbance scores, this association is not significant.

Figure 2 about here

However, this is not to say that social interaction is relatively unimportant in the Antarctic. Use of multidimensional scaling of data collected from pile sorts of crewmember categorization of the structure of the winter-over crews at the South Pole during the same three-year period revealed three distinct patterns. The first pattern is a clique structure in which crew members identified three distinct subgroups, based on areas of the station each subgroup usually spent most of their leisure time: 1) the "Biomed" group; 2) the "Library" group; and 3) the "Bar" group. Each group had a membership of five individuals. There were an additional six individuals who were not a part of any group. The second pattern is a core-periphery structure.

In this structure, most (n=16) crewmembers strongly identified themselves as members of the same group (the core), followed by five additional members who maintained close ties with the core but were somewhat more independent (semiperiphery); and six individuals who were more independent in their social interactions (periphery). The third, pattern is a clique-core/periphery hybrid in which a relatively unified group contains identifiable subgroups.

A comparison of mood scores over the course of the austral winter by means of a repeated measures analysis of variance (MANOVA) revealed a significant difference among the three crew structures with respect to tension-anxiety ($F=4.76$, $p < 0.012$) (Figure 3A), depression ($F=3.22$, $p = 0.046$) (Figure 3B), and anger-hostility ($F=3.05$, $p = 0.053$) (Figure 3C). The crew characterized by a clique structure exhibited significantly higher levels of tension-anxiety, depression and anger than the crew characterized by the core-periphery structure throughout the entire winter. The POMS scores of the crew characterized by the hybrid structure fell somewhat in between those of the other two crews. The three crews also differed significantly with respect to the amount of support given to fellow crewmembers over the course of the winter (data not shown, $F = 3.83$, p , 0.001).

Figures 3A 3B and 3C about here

These results suggest that individual behavior and performance is indeed influenced by crew dynamics and patterns of interaction, but not by the degree of support obtained from fellow crewmembers. A previous study of the 1989 winter-over crew of McMurdo (20) revealed that station members who scored low on measures of emotional stabilty and supervisor/clinician evaluations of individual performance were not socially isolated. This finding was in contrast to the numerous studies that have documented an association between depression and a decrease in size of social networks and amount of received social support (4,12). The lack of an association may be interpreted as evidence of the tolerance of depressive symptoms on the one hand (6), and

the limited use of other crewmembers to cope with stress on the other hand, largely because these crewmembers are facing the same stressors (17). Hence, an important distinction must be made between social dynamics as a stressor and social support as a mediator of the stress-performance relationship. Behavior and performance in ICE environments is social from the standpoint that impaired social interaction may be responsible for decrements, but that individuals adapt to such environments by refraining from a reliance upon their fellow crewmembers for support.

Salutogenic Characteristics

The fourth characteristic of behavior and performance in ICE environments is that it is "salutogenic." A term coined by Aaron Antonovsky (1), salutogenic was intended to convey the idea that under certain conditions, stress could actually be beneficial and health-promoting, and not simply "pathogenic" or destructive to health and well-being. These conditions have been identified as "flow experiences" by Czikszentmihalyi (7) in which individuals seek out challenges and obtain increased self-esteem and self-efficacy by successfully meeting these challenges.

The human experience in the Antarctic provides numerous instances of individuals who have had such flow experiences with salutogenic results. Our analysis of the data collected since 1963 uncovered two particular sources of evidence suggesting that some individuals, at least, exhibit improvements in performance and well-being during extended periods of isolation and confinement in extreme environments. The first source of evidence was obtained from an examination of mood disturbances during early and late winter among the 657 men who overwintered between 1963 and 1974. Symptoms of the winter-over syndrome (depression, irritability, insomnia, cognitive impairment) were inversely associated with the altitude, latitude, and mean annual temperature of the stations where individuals spent the austral winter (Table II).

However, when these symptoms were separated into sleep related and non-sleep related categories, an interesting pattern emerged. Complaints of disturbed sleep (difficulty falling asleep or staying asleep, waking up at night, feeling tired during the day) were positively associated with the severity of the station physical environment in early winter, but not in late winter. In other words, the winter-over personnel in this cohort had somehow managed to adapt to the characteristics of the physical environment, thereby minimizing the impact of this environment on their sleep patterns. On the other hand, other symptoms (feeling blue, lonely, annoyed or irritated, critical of others, uneasy or worried, nervous or tense, and unable to concentrate) were *inversely* associated with severity of the station physical environment at both early and late winter. In other words, the more severe the physical environment, the fewer mood disturbances that were not sleep-related.

Table II about here

Further analysis of these individuals revealed three patterns of mood disturbance: 1) an increase in symptom scores from early to late winter (63.0%); 2) no change in symptom scores (8.5%); and 3) a decrease in symptom scores (28.4%). When compared with individuals who exhibited an increase in symptom scores, the only personality traits or interpersonal needs associated with a decline in symptom scores were a low need to include others (FIRO-B IE; $F=6.49$, $p = 0.01$), a low need to be included by others (FIRO-B IW; $F = 5.40$, $p = 0.02$), and a low need to express affection to others (FIRO-B AE; $F = 5.13$; $p = 0.02$).

A second piece of evidence suggesting some form of positive adaptation to the characteristics of the physical environment is derived from a comparison of the seasonally-related depressive symptoms experienced among personnel who overwintered at McMurdo and South Pole Stations in 1991. Although we noted earlier that S-SAD is positively associated with station latitude, mean Hamilton Depression Rating Scale (HDRS) scores and seasonally-related

depressive symptom (SAD-SIGH) scores of personnel at McMurdo in 1991 were significantly higher than the respective scores of personnel at South Pole the same year (19).

Taken together, these results suggest that extreme environments generate positive forms of adaptation in certain individuals, particularly those with a low need for social interaction. While not all individuals obtain such an experience, these results suggest prolonged exposure to an ICE environment does not necessarily produce pathogenic consequences. On the contrary, certain individuals are likely to acquire significant psychological benefits or flow experiences from such environments.

Conclusion

The secondary analyses of two major data sets and review of studies conducted from three other data sets both suggest that behavior and performance in ICE environments is seasonal or cyclical, situational, social, and salutogenic. Planning for a long-term human presence in space must take into consideration the possibility that these four characteristics of behavior and performance will manifest themselves in space; that countermeasures based on the principles underlying these characteristics should be developed to enhance performance and prevent performance decrements; and that future research on behavior and performance in space should be conducted to validate the existence of these characteristics and their underlying causes.

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Table I. Stepwise regression of performance measures on social/demographic, personality, interpersonal, and environmental characteristics

Characteristics	Task ability	Emotional stability	Social compatibility	Leadership	Overall performance
Military/civilian	-.13*		-.13*		-.16*
Marital status				.16**	.02
Years of duty	.19**				
Need - orderliness		-.14**		-.12*	-.11*
Need - achievement			-.15**		
Attitude - boredom	-.10*	-.10*	-.10*		-.10*
Attitude - motivation				-.12*	
Friend – optimism		.18***	.14**		
Friend – efficiency		-.12*			
Control – expressed				.10*	
Affection wanted	-.12*	-.17***	-.11*		-.13**
R^2	.06***	.10***	.09***	.12***	.07***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table II. Mood disturbances by characteristics of station physical environments, 1963-1974

Mood disturbance	Early Winter			Late Winter		
	Altitude	Latitude	Temperature	Altitude	Latitude	Temperature
Sleep-related symptoms	.15**	.10*	.14**	.05	.02	.03
Other symptoms[1]	-.10*	-.15***	-.10*	-.14**	-.16***	-.15***
Total symptoms	<.01	-.06	<.01	-.08	-.10*	-.09*

[1] Depression, anxiety, irritability, unable to concentrate.

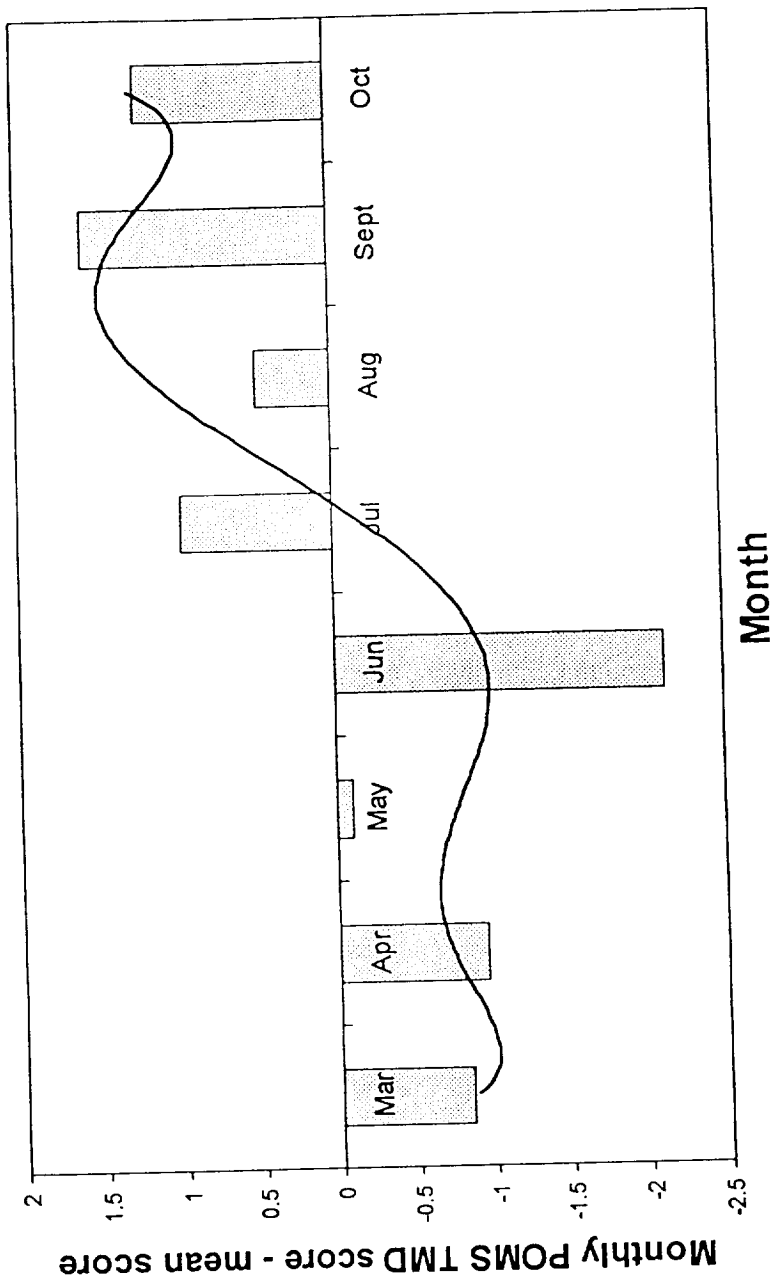
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

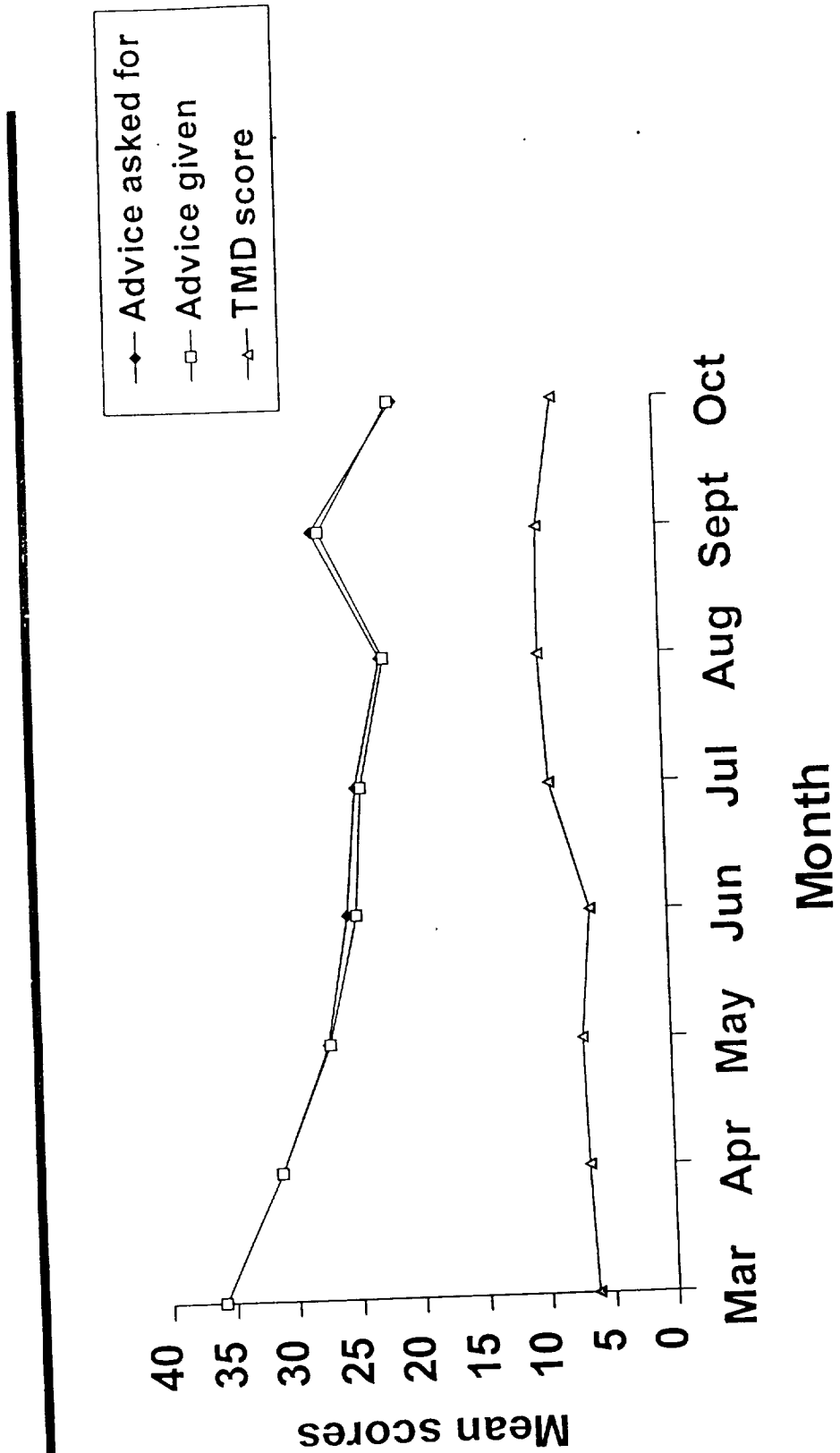
List of figures

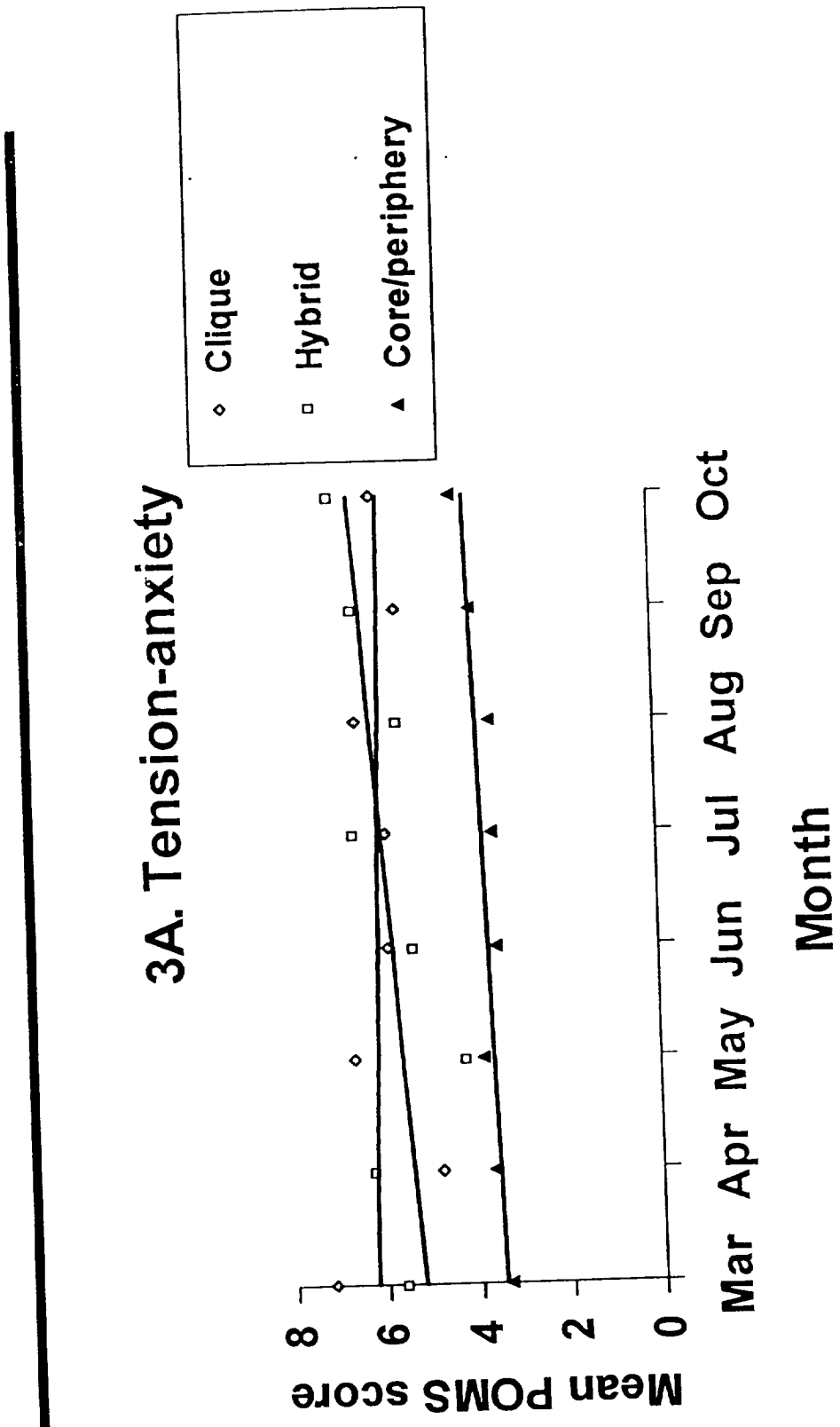
1. Deviation from mean POMS total mood disturbance score by month, South Pole, March through October, 1991-1994

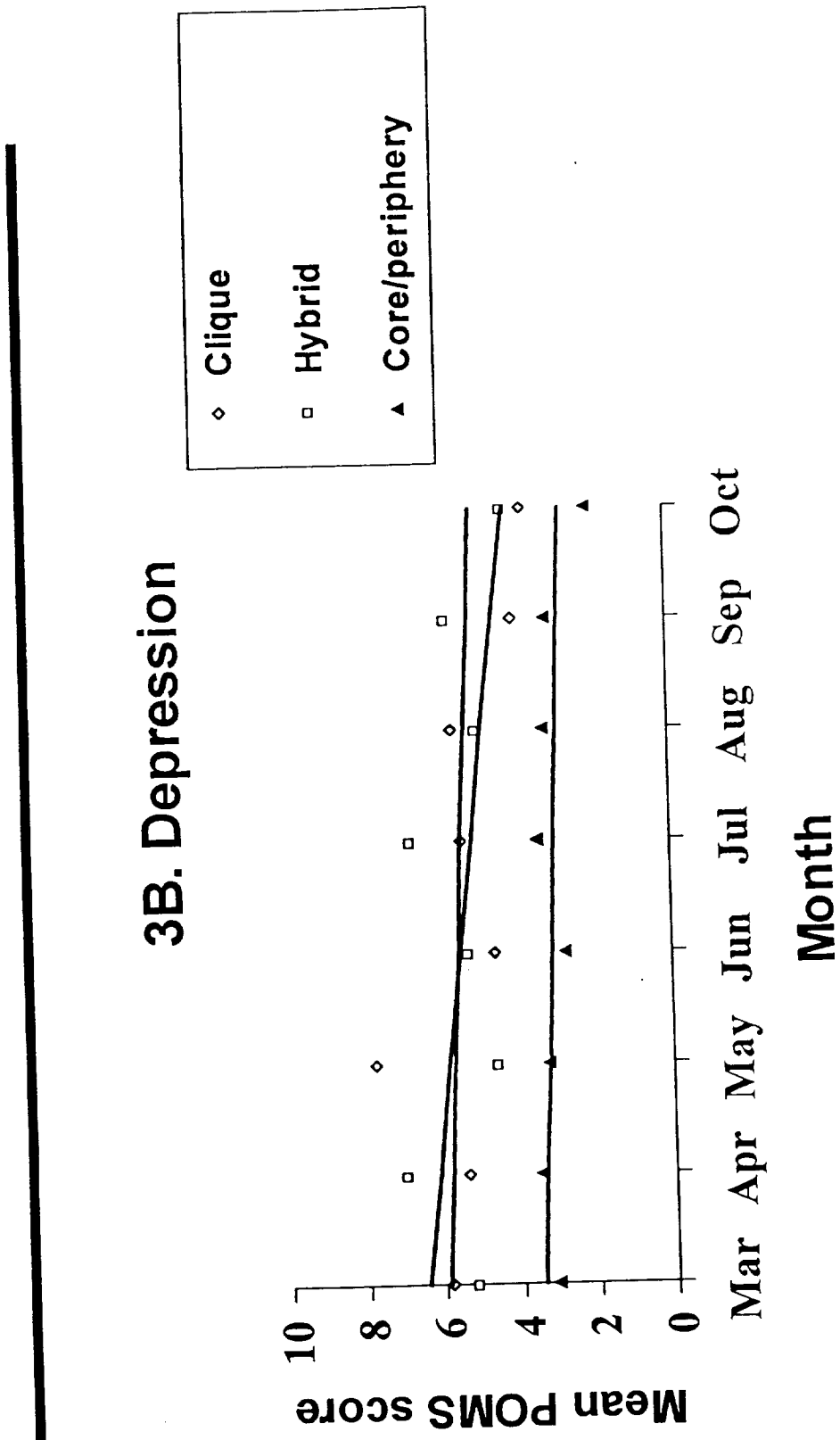
2. Advice asked for and given and POMS total mood disturbance score by month, South Pole, 1992-1994

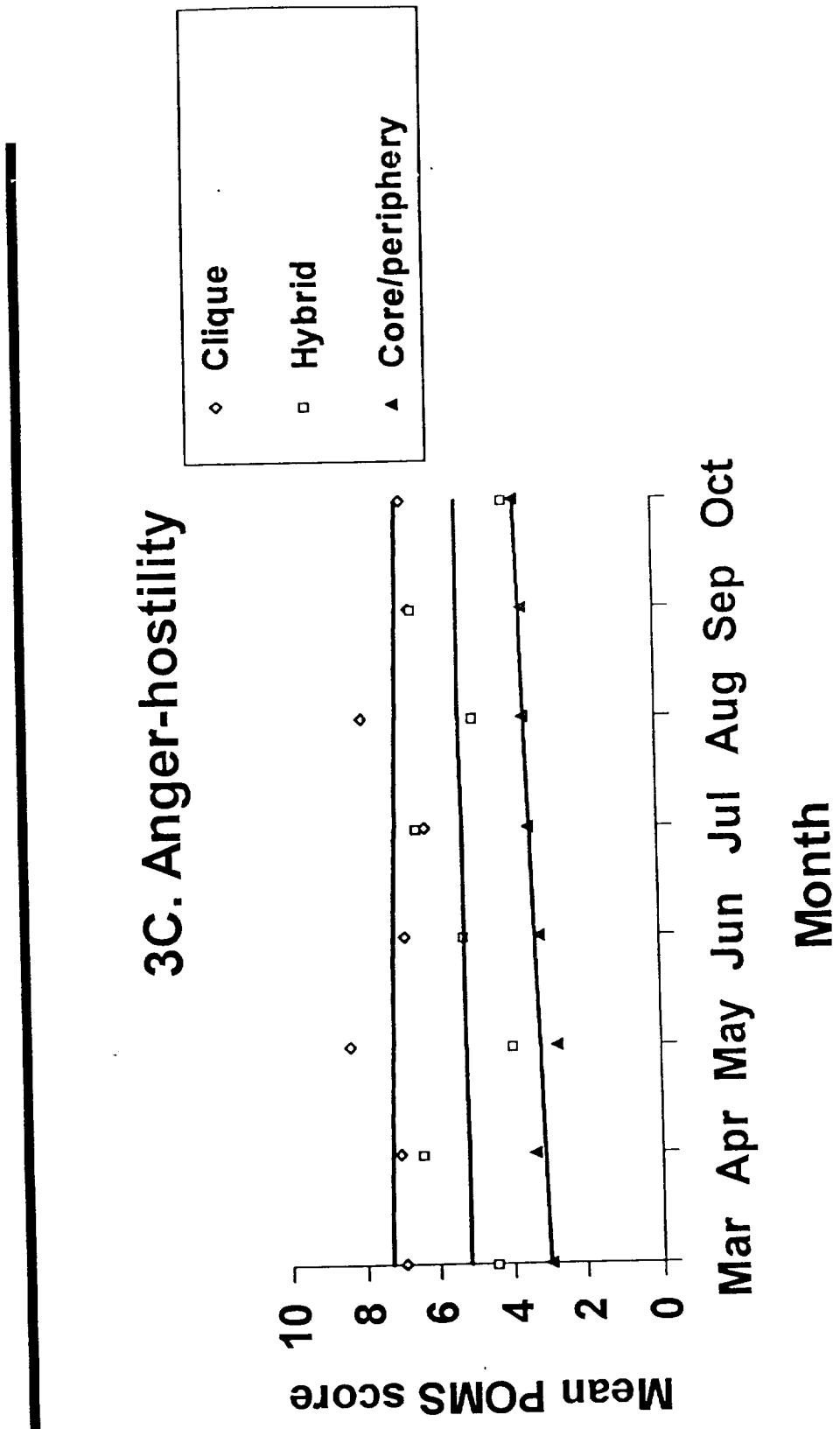
3. POMS depressive symptom scores by month and crew structure, South Pole, 1992-1994
   A. Tension-anxiety
   B. Depression
   C. Anger-hostility


Monthly POMS TMD score - mean score
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Month


Advice asked for
Advice given
TMD score
Mean scores
40
35
30
25
20
15
10
5
0
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Month


3A. Tension-anxiety
Clique
Hybrid
Core/periphery
Mean POMS score
8
6
4
2
0
Mar Apr May Jun Jul Aug Sep Oct
Month


3B. Depression
Clique
Hybrid
Core/periphery
Mean POMS score
10
8
6
4
2
0
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Month


3C. Anger-hostility
Clique
Hybrid
Core/periphery
Mean POMS score
10
8
6
4
2
0
Mar Apr May Jun Jul Aug Sep Oct
Month