



Psychosocial Characteristics of Optimum Performance in Isolated and Confined Environments

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Acronyms

BHP	Behavioral Health and Performance
CBT	Cognitive Behavior Therapy
CCBT	Computer-based Cognitive Behavior Therapy
CCT	Cross-cultural Training
CER	Comparative Effectiveness Research
CES-D	Center for Epidemiologic Studies – Depression
DSM	Diagnostic and Statistical Manual of Mental Disorders
EPPS	Edwards Personal Preference Schedule
FIRO-B	Fundamental Interpersonal Relations Orientation-B
HRP	Human Research Program
ICE	Isolated, Confined Environment
IPT	Interpersonal Psychotherapy
IRP	Integrated Research Plan
MI	Motivational Interviewing
MMPI	Minnesota Multiphasic Personality Inventory
NEO	Neuroticism, Extroversion, and Openness to experience
NEO-FFI	NEO Five Factor Inventory
PANAS	Positive Affect Negative Affect Scale
PCI	Personality Characteristics Inventory
POMS	Profile of Mood States
PST	Problem Solving Therapy
RCT	Randomized Controlled Trial
SHC	Subjective Health Complaints
16PF	16 Personality Factor
SSQ	Social Support Questionnaire
SST	Social Skills Training
UCL	Utrecht Coping List
WHO	World Health Organization

Introduction

The Behavioral Health and Performance (BHP) element addresses human health risks in the NASA Human Research Program (HRP), including the risk of behavioral health and psychiatric conditions. BHP supports and conducts research to mitigate the behavioral medicine risk for exploration missions and, in some instances, current flight medical operations.

BHP has identified research gaps within the behavioral medicine risk. Gap BMed6: What psychosocial characteristics predict success in an isolated, confined environment (ICE), as defined in the BHP Integrated Research Plan (IRP), outlines a research strategy that primarily incorporates identifying the most malleable psychosocial characteristics in isolated, confined, and extreme environments to develop and/or strengthen these characteristics to serve as countermeasures of possible decrements in BHP success. The first step in addressing this gap is to conduct an extensive and exhaustive literature review to identify the most malleable psychosocial characteristics that predict success when considering the context of an ICE.

This report addresses two specific aims:

- Identify psychosocial characteristics that predict success in ICEs
- Identify those characteristics that are most malleable

Methods

The review of the literature on ICEs was modeled after the format used by the Cochrane collaborative in preparing systematic reviews of the literature (Higgins & Green, 2009). This format includes details on the search strategy, description of selection criteria for studies to review, and review methods.

Searches of published and unpublished studies were then conducted using the following sources of information: electronic databases, including the National Library of Medicine's PubMed Central, PsycINFO, Social Sciences Citation Index, and Sociological Abstracts; specialist bibliographies such as the Antarctic Bibliography; unpublished technical reports and manuscripts; and library catalogs for books on isolation and confinement in extreme environments. Search terms included isolation, confinement, extreme environments, human behavior, and performance. These materials were then reviewed to identify studies that described specific psychosocial characteristics as being associated with one or more

measures of behavior and performance. Studies that included outcome measures of behavior and performance in ICEs but did not include psychosocial characteristics as potential predictors of these outcomes (e.g., studies that examined whether duration of exposure to isolation and confinement or changes in circadian rhythms were associated with behavior and performance) were excluded from further review.

Studies were assigned values based on whether they were anecdotal or reviews (score = 0) or whether they reflected quasi-experimental (cross-sectional or longitudinal observational designs) (score = 1) or experimental (randomization of participants or conditions of isolation and confinement) designs (score = 2). Quasi-experimental and experimental designs were combined because there was no evident theoretical model or conceptual framework for hypothesizing the direction of causality from performance to psychosocial characteristics, in contrast to several theoretical models and conceptual frameworks that view performance as an outcome and psychosocial characteristics as predictors of performance (Shadish, Cook & Campbell, 2002).

Psychosocial characteristics identified in the studies reviewed included social-demographic characteristics, personality characteristics, clinical evaluations, coping skills, and other characteristics of individuals, as well as characteristics of groups and their leaders. Demographic characteristics included age, gender, education and socioeconomic status (measured by number of years of school, occupation, or family income), work experience, birth order, military or civilian status, place of residence (urban or rural), marital status (married or unmarried), record of truancy or delinquency, cultural background (nationality), and cultural orientation (individualistic vs. collective). Clinical evaluations included the results of a clinical assessment by a psychiatrist and/or clinical psychologist, and results from any standardized clinical assessment tools like the Minnesota Multiphasic Personality Inventory (MMPI: Tellegen et al., 2003) or screening instruments like the Center for Epidemiologic Studies – Depression Scale (CES-D; Radloff, 1977), Positive Affect Negative Affect Scale (PANAS; Watson et al., 1988), and Subjective Health Complaints (SHC) Inventory (Eriksen et al., 1999). Coping skills were assessed using standardized measures of coping such as the Social Support Questionnaire (SSQ: Sarason et al., 1983) and the Utrecht Coping List (UCL: Schreurs et al, 1993). Other characteristics of individuals included number of previous expeditions in ICEs, interests in hobbies or other leisure activities, religiosity (i.e., participation in religious activities), reaction to environment, and perceived work-related stress. Personality characteristics were based on use of standardized instruments such as the NEO Five Factor Inventory (NEO-FFI: Costa & McCrae, 1991), the 16 Personality Factor Questionnaire (16PF: Cattell,

1946), Personality Characteristics Inventory (PCI: Musson, Sandal & Helmreich, 2004), Edwards Personal Preference Schedule (EPPS: Edwards, 1959), Minnesota Multiphasic Personality Inventory (MMPI: Tellegen et al., 2003), and FIRO-B (Schutz, 1957), and were grouped into the following categories: global personality traits, motivational indicators, cognitive indicators, mood indicators, self-efficacy indicators, interpersonal indicators, and attitudes and perceptions. Group indicators included group size; homogeneity or heterogeneity with respect to demographic characteristics, culture, and personality; and crew cohesiveness with respect to status, roles, and leadership. Leadership indicators were grouped into categories of style and skills.

Due to the large number of characteristics identified in these studies, several were grouped together into clusters based on similarity of constructs or presence of common themes. These included demographic characteristics reflecting age, experience, and maturity (Demographic Cluster A) or cultural background (Demographic Cluster B); personality characteristics that reflected global traits (Personality Cluster A), motivation (Personality Cluster B), mood (Personality Cluster C), self-efficacy (Personality Cluster D), cognition (Personality Cluster E), interpersonal needs and skills (Personality Cluster F), and perceptions and attitudes (Personality Cluster G); group characteristics that reflect size of crew (Group Cluster A), homogeneity or heterogeneity (Group Cluster B), and crew cohesion (Group Cluster C); and leadership styles (Leadership Cluster A) or skills (Leadership Cluster B).

Measures of performance were grouped into five categories – task ability, emotional stability, social compatibility, leadership, and overall performance. Task ability or performance of assigned duties was generally evaluated on the basis of supervisor ratings or peer nominations (Gunderson, 1974). Emotional stability was measured using standardized psychometric instruments (e.g., Center for Epidemiologic Studies – Depression Scale, Profile of Mood States [POMS: McNair, Lorr & Droppleman, 1992]), clinical evaluations based on Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria, or supervisor ratings or peer nominations (Gunderson, 1974). Social compatibility was measured using standardized sociometric instruments (e.g., SYMLOG Adjective Rating Form, Bales & Cohen, 1979), or supervisor ratings or peer nominations (Gunderson, 1974). Behavior reflecting leadership was assessed on the basis of supervisor ratings or peer nominations (Nelson, 1963a). Overall performance was measured on the basis of supervisor ratings and peer nominations of single items (e.g., ideal winter-over, would winter-over again) (Gunderson, 1974).

The malleability of a psychosocial predictor was determined on the basis of whether the characteristic could somehow be changed, or whether it could be eliminated from consideration as a potential risk to

less than optimum performance if it could not be changed. For instance, demographic characteristics such as age and gender, for example, cannot be changed, but can be eliminated from consideration as a behavioral medicine risk through programs of screening and selection.

When available, data contained in the papers were used to identify correlation coefficients (Pearson's r or Spearman's r), odds ratios, and effect sizes (Cohen's d) for all associations reported to be statistically significant. Nevertheless, a previous review of this literature (Shea et al., 2009) noted substantial variation in measurement of both psychosocial characteristics and performance, making it impossible to conduct a traditional meta-analysis. To address this limitation, study associations reported to be statistically significant were rated as small, medium, or large effect based on a schema proposed by Hopkins (2002). Using criteria proposed by Cohen (1988), correlation coefficients between 0.1 and 0.3 reflect a small effect; correlations between 0.3 and 0.5 represent a medium effect; and correlations larger than 0.5 represent a large effect. Effect sizes between 0.2 and 0.6 represent small effects; effect sizes between 0.6 and 1.2 represent medium effects; and effect sizes larger than 1.2 represent large effects. Odds ratios between 1.5 and 3.5 represent small effects; odds ratios between 3.5 and 9.0 represent medium effects; and odds ratios larger than 9.0 represent large effects.

Further, a coding system was developed to prioritize variables based on the fidelity of the study design to long-duration missions in space. A fidelity score was calculated for each study by summing the scores of four variables. Each variable had a range from 1 to 3, resulting in a fidelity score that ranged from 4 to 12. The four variables were:

- A. Similarity to space flight
 - 1. Analogue setting (polar, undersea)
 - 2. Space simulation
 - 3. Space flight
- B. Similarity of study participants to long-duration expedition astronauts
 - 1. Possibly similar with respect to age, but not gender, education, or cultural diversity
 - 2. Similar with respect to age and education, but not gender or cultural diversity
 - 3. Similar with respect to age, gender, and education, and possibly cultural diversity
- C. Similarity with respect to duration of mission
 - 1. 30 days or less
 - 2. 31 to 364 days
 - 3. 365+ days

D. Similarity to crew size

1. Large (16+) crews
2. Moderately small (9 to 15) crews
3. Small (1 to 8) crews

Fidelity scores were calculated only for studies that used a quasi-experimental or experimental design; any study that relied on anecdotal evidence or was a review of the literature was eliminated from further analysis. Each psychosocial predictor identified in a particular study was assigned a fidelity score calculated for the study as a whole. For instance, a study that identified older age and introverted personality as being significantly associated with emotional stability might have a fidelity score of 8. Both of these psychosocial characteristics that were found in that study to be statistically significantly associated with one or more performance outcomes were then assigned a fidelity score of 8. An average fidelity score was calculated for each psychosocial predictor based on the total fidelity score of the reference or references that specified the psychosocial characteristic as a significant predictor of performance divided by the number of references (studies).

We should note that although current plans for extended missions call for crews of no greater than four individuals, only four of the 31 studies examined that used a quasi-experimental or experimental design were based on crews of two to four individuals (Kahn & Leon, 1994; Leon & Scheib, 2007; Atlis et al., 2004; Kanas et al., 1996). Hence, crews of eight or less were given the highest fidelity score in the crew size category.

Finally, psychosocial characteristics identified from studies with quasi-experimental or experimental designs were prioritized based on three variables: 1) the number of studies reporting a statistically significant association or associations between a particular characteristic or cluster of characteristics and one or more indicators of performance; 2) the average fidelity score of these studies; and 3) the magnitude of the statistical effect reported for these associations in these studies. Magnitude of statistical effects for a particular psychosocial characteristic was calculated by summing the number of studies that reported data that could be used to calculate a small (assigned a value of 1), medium (assigned a value of 2), or large (assigned a value of 3) statistical effect. Characteristics were then placed into three groups for each type of performance predicted: 1) the three most important predictors; 2) other important predictors that were based on three or more studies reporting statistically significant associations; and 3) less important predictors that were based on one or two studies reporting statistically significant associations.

Results

A summary of the information extracted from reviews of 120 articles that met our screening criteria is found in the Appendix. This table provides information on study citation, type of study, performance type, and psychosocial characteristics examined.

Characteristics associated with performance category

Predictors of Task Ability. Psychosocial characteristics within four of the seven categories were identified as being significantly associated with task ability. Demographic characteristics included older age (Sarris, 2006), male gender (Sarris, 2006), military (Palinkas et al., 2000b) or civilian (Doll & Gunderson, 1969) status, education/socioeconomic status (Sauer et al., 1999, Sarris, 2006), years of work experience (Palinkas, Gunderson, Johnson et al., 2000), no record of delinquency/truancy (Nelson & Gunderson, 1963a), and being unmarried (Owens, 1975).

Personality characteristics that predicted for high task ability included the following: low neuroticism (Owens, 1975); high (Sarris, 2006) or low (Rosnet et al., 2000) extroversion; high PCI measures of positive instrumentality/expressivity (McFadden et al., 1994) and low measures of negative instrumentality (Rose et al., 1994); high emotional (self) control (Gunderson & Kapfer, 1966); high need achievement (Gunderson, 1974); low motivation, a representation of a high ability to adapt motivation to circumstances (McFadden et al., 1994); low boredom (Palinkas, Gunderson, Johnson et al., 2000); low hypo- or hyperinvestment in work (Rivolier et al., 1999); low hostility against the self and ritualization of activities (Rivolier et al., 1999); high alertness (Gunderson & Kapfer, 1966) and few difficulties with concentration (Rivolier et al., 1999); high PCI measures of negative expressivity – community (supposedly reflecting willingness to assert oneself) (Rose et al., 1994) and low discordance between the real and ideal self (Rosnet et al., 2000); low FIRO-B measures of expressed inclusion (Gunderson, 1973, Nelson & Gunderson, 1963), expressed (Gunderson, 1973) and wanted affection (Palinkas, Gunderson, Johnson et al., 2000); high role clarity and low role conflict (Sarris, 2006); high perceived fit with station culture (Sarris, 2006); and low assertiveness (Rosnet et al., 2000).

Clinical characteristics included high positive affectivity (Kahn & Leon, 1994).

Other individual characteristics included a high degree of religiosity (Nelson & Orvick, 1964) and number of previous expeditions (Sarris, 2006).

Group characteristics included large group size (Doll & Gunderson, 1969); crew homogeneity related to urban-rural residence and number of hobbies, and some personality characteristics such as FIRO-B wanted control, and Edwards Personal Preference Schedule (EPPS) measures of autonomy, motivation, and describing friends as efficient (Gunderson & Ryman, 1967) or measures of dogmatism, achievement, affiliation, dominance) (Altman & Haythorn, 1967b); crew heterogeneity related to other personality characteristics (FIRO-B expressed inclusion and expressed control) (Gunderson & Ryman, 1967); and membership in crews with high cohesiveness as reflected in measures of group identity and affiliation (Altman & Haythorn, 1967b), compatibility of dyads (Haythorn & Altman, 1967), and team preference for its leader (Kanki & Gregorich, 1992).

Predictors of Emotional Stability. Psychosocial characteristics within all seven categories were identified as being significantly associated with high task ability. Demographic characteristics included older age (Gunderson & Arthur, 1966; Gunderson & Nelson, 1965a; Nelson & Gunderson, 1964; Nelson & Orvick, 1964; Ikegawa et al., 1998; Taylor, 1993; Palinkas et al., 1989; Taylor & McCormick, 1985), male gender (Palinkas, Glogower et al., 2004), work experience (Biersner & LaRocco, 1987), socioeconomic status and education (Gunderson & Arthur, 1966; Gunderson & Nelson, 1965a; Popkin et al., 1974; Weybrew & Noddin, 1979; Palinkas, Glogower et al., 2004; Biersner & LaRocco, 1987; Godwin, 1985), military (Gunderson & Nelson, 1965a) or civilian status (Doll & Gunderson, 1971b; Gunderson & Arthur, 1966; Gunderson, 1968; Palinkas, Glogower, Gunderson, Holland et al., 2000; Palinkas, Glogower et al., 2004; Palinkas et al., 1989), being unmarried (Palinkas et al., 1995; Godwin, 1985; Weybrew et al., 1961) first-born (Gunderson & Arthur, 1966), having no record of delinquency or truancy (Nelson & Gunderson, 1963a), urban residence (Nelson & Orvick, 1964), and cultural background (Palinkas, Johnson et al., 2004; Kanas, Salnitskiy, Gushin et al., 2001). It should be noticed that the association between civilian status and emotional stability reported in several studies may have been confounded by the fact that civilians were often scientists or skilled technicians and most of the military were enlisted personnel. One study of polar expeditioners (Gunderson & Nelson, 1965a) found the association between age, military rank, and years in the military and emotional stability to be linear at large stations but nonlinear at small stations.

Global personality characteristics that predicted for high emotional stability included the following: low NEO scores and other measures of neuroticism (Palinkas, Gunderson, Holland et al., 2000) and extroversion (Strange & Youngman, 1979; Biersner & LaRocco, 1987) and high measures of conscientiousness (Eilbert & Glaser, 1959); high PCI scores for positive instrumentality/expressivity

(Sandal et al., 1996) and low equivalents of negative instrumentality/expressivity (Gunderson & Arthur, 1966); and high 16PF scores and other measures of emotional (self) control (Gunderson & Kapfer, 1966; Leon et al., 1989). Predictive motivational indicators included high achievement motivation (Pope & Rodgers, 1968; Leon et al., 1989) and low boredom (Palinkas, Gunderson, Johnson et al., 2000; Rivolier et al., 1999). Mood indicators associated with emotional stability included low hostility against self (Gunderson & Kapfer, 1966; Rivolier et al., 1999), low EPPS scores on aggression (Wright et al., 1963), low sexual preoccupation (Rivolier et al., 1999), low pessimism (Rivolier et al., 1999), and low susceptibility to anxiety (Leon et al., 2002; Mocellin et al., 1991; Rivolier et al., 1999). Predictive indicators of cognitive function included high alertness (Gunderson & Kapfer, 1966). Predictive indicators of self-efficacy included high self concept (Pope & Rodgers, 1968) and ability to make one's self concept more like the concepts of other crew members (Gushin et al., 1998) and high (Wright et al., 1963) and low (Palinkas, Gunderson, Johnson et al., 2000) EPPS scores on need for orderliness. Predictive indicators of interpersonal needs include low EPPS scores on autonomy and nurturance (Palinkas et al., 1989); low FIRO-B scores on wanted control (i.e., wanting to be controlled by others) (Gunderson, 1973), expressed control (i.e., wanting to control others) (Palinkas, Gunderson, Holland et al., 2000), wanted affection (i.e., wanting affection from others) (Palinkas, Gunderson, Johnson et al., 2000), expressed affection (i.e., expressing affection to others) (Gunderson, 1973), and want inclusion (i.e., wanting to be included by others) (Palinkas, Gunderson, Holland et al., 2000); high EPPS scores on deference (Wright et al., 1963); high interpersonal sensitivity and socialization (Biersner & LaRocco, 1987); a low need for efficiency but a high need for optimism in friends (Palinkas, Gunderson, Johnson et al., 2000); a low preference for friends who are sympathetic, sentimental, confiding, praising, and warm (Gunderson & Arthur, 1966); and good role specificity or ability to program self into role (Pope & Rodgers, 1968).

Clinical characteristics that predicted for high emotional stability included predeployment clinical evaluations (Doll et al., 1969); low MMPI scores on hypochondriasis, psychopathic deviate, psychoasthenia, schizophrenia, and hypomania (Wright et al., 1963); and low baseline depressive symptoms (Palinkas & Browner, 1995; Palinkas et al., 1995).

Coping resources and strategies that predicted for high emotional stability included high satisfaction with social support (Palinkas & Browner, 1995) and a low UCL score on acceptance (Barbarito & Peri, 1999).

Other individual characteristics that predicted for high emotional stability included number of previous expeditions (Taylor & McCormick, 1985), and high (Evans et al., 1987) or low (Doll et al., 1969; Slater, 1969) interest in hobbies/activities (Doll et al., 1969; Slater, 1969), a low level of religiosity (Gunderson & Nelson, 1965a), and enjoyment and awe of environment (Atlis et al., 2004).

Group characteristics that predicted for high emotional stability included large group size (Gunderson, 1968; Smith, 1969), small group size (Palinkas, 1991; Palinkas et al., 1989), crew homogeneity related to demographic characteristics (Altman & Haythorn, 1967a) and personality (low dominance and need for achievement [Haythorn et al., 1966]), and compatibility and cohesiveness (Altman & Haythorn, 1967a; Palinkas, Gunderson, Johnson et al., 2000; Johnson et al., 2003; Haythorn & Altman, 1967).

Characteristics of team leaders that predicted for high crew member emotional stability included older age (Smith & Haythorn, 1972) and high levels of support to subordinates (Kanas et al., 1996).

Predictors of Social Compatibility: Psychosocial characteristics within all seven categories were identified as being significantly associated with high social compatibility. Demographic characteristics included older age (Gunderson & Nelson, 1965a; McGuire & Tolchin, 1961; Gushin et al., 1996), male gender (Schmidt et al., 2005), socioeconomic status and education (Gunderson & Nelson, 1965a; Natani, 1971), military service (Palinkas, Gunderson, Johnson et al., 2000), first born individuals (Radloff & Helmreich, 1968), being unmarried (Weybrew et al., 1961), rural residence (Nelson & Orvick, 1964), cultural background (Leon et al., 1994; Palinkas, Johnson et al., 2004), and collective cultural orientation (Palinkas, Johnson et al., 2004). One study of polar expeditioners (Gunderson & Nelson, 1965a) found the association between age, military rank, and years in the military and social compatibility to be linear at large stations but nonlinear at small stations. Another study reported differences by occupation in preference for privacy/interaction (Weiss et al., 2007).

Global personality characteristics that predicted for high social compatibility included the following: low NEO scores and other measures of openness to experience and high measures of agreeableness (Rose et al., 1994); high PCI scores for positive instrumentality/expressivity (McFadden et al., 1994; Sandal et al., 1998) and low scores for negative instrumentality/expressivity and impatience/irritability (Rose et al., 1994); and high 16PF scores and other measures of emotional (self) control (Gunderson & Kapfer, 1966). Predictive motivational indicators included high achievement motivation (Sandal et al., 1999; Sandal et al., 1995), ability to adapt motivation or need for achievement to circumstances (Sandal et al., 1998; Palinkas, Gunderson, Johnson et al., 2000), low boredom (Palinkas, Gunderson, Johnson et al., 2000),

and a balance of motivational factors (World Health Organization [WHO], 1985). Predictive mood indicators included low hostility against the self (Gunderson & Kapfer, 1966), low aggressiveness (Rivolier et al., 1999), and low withdrawal to oneself (Rivolier et al., 1999). Predictive indicators of cognitive function included high alertness (Gunderson & Kapfer, 1966). Predictive indicators of self-efficacy included high assertiveness (Sandal et al., 1995), tolerance (WHO, 1985), flexibility (WHO, 1985); sense of humor (WHO, 1985), and ability to make one's self-concept more like the concepts of other crew members (Gushin et al., 1998); and low self-centeredness (Rivolier et al., 1999). Predictive indicators of interpersonal needs includes low FIRO-B scores on expressed (Gunderson, 1973) and wanted (Palinkas, Gunderson, Johnson et al., 2000) affection; high wanting optimism in friends (Palinkas, Gunderson, Johnson et al., 2000); mutual respect, emotional support, ability to confide in partner, and motivation to maintain positive and supportive relationships (Leon & Sandal, 2003); high interpersonal sensitivity (Sandal et al., 1999), a low need for dominance (Sandal et al., 1995), low levels of criticism of others (Rivolier et al., 1999), and low levels of distrust of others (Rivolier et al., 1999).

Clinical characteristics that predicted for high social compatibility included predeployment evaluations by psychiatrist and psychologist (which were found to vary by occupation) (Doll et al., 1969), and high positive affectivity (Kanas, Salnitskiy, Weiss et al., 2001).

Coping resources and strategies that predicted for high social compatibility included high satisfaction with social support (Sandal et al., 1998), and high problem-solving strategies (Sandal et al., 1999).

Other characteristics of individuals that predicted for high social compatibility included a low interest in hobbies/activities at small stations (Gunderson & Nelson, 1965a); high levels of religiosity (Nelson & Orvick, 1964); the shared experience, excitement of space flight, close quarters, and isolation from Earth (Kelly & Kanas, 1992; Kelly & Kanas, 1993); a lack of recent life event changes (WHO, 1985); and low perceived work-related stress (Kanas, Salnitskiy, Gushin et al., 2001).

Characteristics of groups that predicted high social compatibility included large group size (Doll & Gunderson, 1971a; Harrison, 1980; Kanas & Feddersen, 1971; Smith, 1969) and crew homogeneity related to culture (Kanas, 1998; Oberg, 1981; Chaikin, 1985; Bluth, 1981; Bluth, 1984), demographic characteristics (Nelson, 1964b; McGuire & Tolchin, 1961; Gunderson, 1966; Law, 1960; Kanas, 1998), personality (Gunderson & Ryman, 1967; Leon & Scheib, 2007; Altman & Haythorn, 1967a), interest in hobbies/activities (Gunderson & Ryman, 1967), expedition goals (Leon & Scheib, 2007), work experience (Kanas, 1998), and preference for type of leadership (Kanas, 1998). Crew homogeneity related to culture

included similar personal hygiene standards and grooming habits, verbal and nonverbal patterns of communication, gender roles, norms and stereotypes, professional background, and decision making processes (Sandal, 2004; Lozano & Wong, 1993); similar attitudes toward the experiment, privacy, emotional expressiveness, appropriate gender behavior, and coping in relation to conflict and housekeeping (Sandal, 2004); language and dialect (Sandal, 2004; Kanas, 1998; Oberg, 1981; Chaikin, 1985; Bluth, 1981; Bluth, 1984); and values or beliefs (Sandal, 2004; Chaikin, 1985; Bluth, 1981; Bluth, 1984; Gushin et al., 1997). Crew homogeneity related to demographic characteristics included age (Nelson, 1964b), socioeconomic status and education (McGuire & Tolchin, 1961; Gunderson, 1966; Law, 1960; Natani et al., 1974), and urban-rural residence (Gunderson & Ryman, 1967). One study (Kanas, 1998) found that homogeneity related to gender was associated with high social compatibility, while another study found heterogeneity with respect to gender to be associated with high social compatibility (Rosnet et al., 2004). Problems in sample size and strict comparison between same gender versus mixed gender crews, however, preclude meaningful interpretation of the results of either study. Crew homogeneity related to personality included describing friends as efficient (Gunderson & Ryman, 1967), EPPS measures of need for affiliation and achievement (Altman & Haythorn, 1967a), and autonomy, motivation, and nurturance (Gunderson & Ryman, 1967). However, another study (Altman & Haythorn, 1967a) reported that crew heterogeneity related to an EPPS measure of the need for dominance and the Rokeach scale measure of dogmatism predicted for high social compatibility. Specific characteristics of crews, including team preference for its leader (Kanki & Gregorich, 1992), perceptions of similarity and equality (Atlis et al., 2004; Gushin et al., 1996), and high role complementarity, consensus, redundancy, latency, and isomorphism (Johnson et al., 2003) also were associated with high social compatibility.

Characteristics of team leaders that predicted high social compatibility included older age (Smith & Haythorn, 1972), a participative/supportive style of leadership (Blair, 1992; Weybrew, 1991), and ability to adapt leadership style to context (Blair, 1992).

Predictors of Leadership. Predictors of high leadership performance included both demographic and personality characteristics, but also characteristics of style and skills associated with leadership. Demographic characteristics associated with high leadership performance included older age (Smith & Haythorn, 1972), work experience (Smith & Haythorn, 1972), high education/socioeconomic status (Miller et al., 1971), and being married (Palinkas, Gunderson, Johnson et al., 2000).

Personality characteristics associated with high leadership performance included being emotionally controlled, stable, adaptable, accepting of authority, and motivation to be efficient and part of a group (Nelson, 1963a); high levels of self-confidence, alertness, and motivation (Nelson, 1964a); a low PCI score on negative instrumentality-communion (Rose et al., 1994), low EPPS scores on motivation and orderliness (Palinkas, Gunderson, Johnson et al., 2000), and low FIRO-B measure of expressed control (Palinkas, Gunderson, Johnson et al., 2000).

Style characteristics associated with high leadership performance included soliciting advice of subordinates (Gunderson & Nelson, 1965a; Nelson, 1962; Nicholas et al., 1988), relating to men as individuals and not as subordinates (Nelson, 1962), giving personal praise to members and rewarding them whenever opportunities arise (Sells, 1965; Nelson, 1962), ruling by consensus (Taylor, 1993), not being soft or easy going but emphasizing discipline and adherence to regulations (Sells, 1965), keeping informed about station activities at all times (Nelson, 1962), maintain daily contact with subordinates (Nelson, 1962), sticking by decisions once they are made (Nelson, 1962), and being highly task-oriented to the goals of the group, delegating and seeking advice of members, being highly people oriented, and showing concern about team members (Nicholas et al., 1988).

Skills associated with high leadership performance included the ability to exercise a participative/supportive style in routine situations and authoritarian style in emergencies (Nelson, 1962; Weybrew, 1991), ability to exercise versatility regarding responsibilities, readiness to discuss issues, desire and skills in resolving issues (WHO, 1985), ability to maintain group harmony (Nelson, 1963a; Nicholas & Penwell, 1995; Nelson, 1962), watching for clique rivalries and not aligning with any one subgroup (Law, 1960), ability to delegate authority and maintain positive contacts with other officers and men (Campbell, 1953), and ability to set work face and establish expectations for performance (Nelson, 1962).

Predictors of Overall Performance. Psychosocial characteristics within six of the seven categories were identified as being significantly associated with overall performance. Demographic characteristics associated with high overall performance included older age (McGuire & Tolchin, 1961; Draggan, 1987; Gunderson et al., 1964), female gender (Grant et al., 2007), high socioeconomic status, and education (Gunderson & Nelson, 1965a; Nelson & Gunderson, 1963a; Miller et al., 1971; Crocq et al., 1974; Gunderson et al., 1964), military service (Palinkas, Gunderson, Johnson et al., 2000; Palinkas, Gunderson, Holland et al, 2000), civilian status (Natani, 1971), rural residence (Radloff & Helmreich, 1968), no history of truancy or delinquency (Gunderson et al., 1964), and being unmarried (Owens,

1975) or married (Gunderson et al., 1964). One study of polar expeditioners (Gunderson & Nelson, 1965a) found the association between age, military rank, and years in the military and overall performance to be linear at large stations but nonlinear at small stations.

Global personality characteristics that predicted for high overall performance included the following: high NEO and other measures of agreeableness (Rose et al., 1994) and low measures of neuroticism (Owens, 1975), extroversion (Palmai, 1963; Draggan, 1987; Palinkas, Gunderson, Holland et al., 2000; de Monchaux et al., 1979), openness to experience (Rose et al., 1994) and conscientiousness (Palinkas, Gunderson, Holland et al., 2000; Rose et al., 1994); low emotional expressivity and self-reflection (Biersner & Hogan, 1984); high 16PF measures of toughness/poised (Taylor, 1974) and emotional stability (Draggan, 1987; de Monchaux et al., 1964; Nelson & Gunderson, 1962; Nelson & Gunderson, 1963; Sandal et al., 1998; Taylor, 1974) and low measures of imaginative and careless (Taylor, 1974). Predictive motivational indicators included high motivation and need for achievement (Biersner & Hogan, 1984; Kahn & Leon, 1993; Taylor, 1987; Gunderson & Nelson, 1965b; Nelson & Gunderson, 1962; Nelson & Gunderson, 1963b) and ability to adapt motivation to circumstances (Barbarito & Peri, 1999; Weybrew et al, 1961; Nelson & Gunderson, 1962), high industriousness and job satisfaction (Nelson & Gunderson, 1962; Nelson & Gunderson, 1963b), and low boredom (Gunderson & Nelson, 1965a; Gunderson & Nelson, 1965b; Nardini et al., 1962; Palinkas, Gunderson, Johnson et al., 2000). Predictive mood and neurotic traits included low bodily concerns (Kahn & Leon, 1993); a low score on 16PF measure of anxiety (Taylor, 1987); high MMPI score on responsibility and low scores on repression-sensitization, control, and heterosexual aggression (Taylor et al., 1969); and low ratings of tension (Gunderson & Kapfer, 1966). Predictive indicators of cognitive function included high alertness (Nelson & Gunderson, 1963b), low divergent thinking (Biersner & Hogan, 1984), and exercising reasonable goal formation and implementation strategies (Draggan, 1987). Predictive indicators of self-efficacy included high self confidence (Kahn & Leon, 1993; Nelson & Gunderson, 1963b), low EEPs score or need for orderliness (Palinkas, Gunderson, Johnson et al, 2000), and high ratings of self reliance and adaptability (Gunderson & Kapfer, 1966). Predictive indicators of interpersonal needs included low FIRO-B measures of wanted control (Gunderson, 1973), expressed inclusion (Gunderson, 1973), and wanted affection (Palinkas, Gunderson, Johnson et al., 2000); low 16PF measures of group dependent (Taylor, 1974; de Monchaux et al., 1979); low competitiveness (Kahn & Leon, 1993); high interpersonal sensitivity (Nardini et al., 1962); high ratings of being friendly (Gunderson & Nelson, 1965b); motivation to be part of the group (Nelson & Gunderson, 1962; Nelson & Gunderson, 1963), willingness to accept authority (Nelson & Gunderson, 1963), and low ratings of mistrust of others (de Montchaux et al., 1979). Predictive

indicators of attitudes and perceptions include high perceptions of the job as important and providing personal gain from participation, and of the group as well organized, having definite goals and scheduled activities (Gunderson & Nelson, 1965b).

Clinical characteristics that predicted for high overall performance include predeployment evaluation by a psychiatrist and psychologist (Nelson, 1963b), high levels of positive affectivity (Kahn & Leon, 1993), and few subjective health complaints (Grant et al., 2007)

Coping resources and strategies that predicted for high overall performance included high satisfaction with social support (Sandal et al., 1998), low demands for social support (Nardini et al., 1962), and high emotion-focused coping (Grant et al., 2007).

Other individual characteristics that predicted for high overall performance included high religiosity (Gunderson et al., 1964) and an interest in hobbies or leisure activities that was high at large stations (Gunderson & Nelson, 1965a; Gunderson et al., 1964) and low at small stations (Gunderson & Nelson, 1965b; Draggan, 1987).

Characteristics of team leaders that predicted for high overall performance included being positive about the job and having pride in organizations and personnel (Sells, 1965), adapting style of leadership to context (Nicholas & Penwell, 1995), using delegation effectively (Sells, 1965; Kinsey, 1959), using recognition and reward, giving frequent complements to individuals, and accepting each individual crew member's personal problems (Sells, 1965), and the ability to set work pace and establish a social atmosphere (Sells, 1965).

Prioritization of psychosocial characteristics

Characteristics of the quality and fidelity of reported associations from the study references are described in Tables 1 and 2 below. Table 1 indicates which of the 120 studies utilized a quasi-experimental or experimental design and which contained data that could be used to calculate a statistical effect (a correlation coefficient, effect size, or odds ratio). Table 2 contains information on the four criteria of study fidelity to long-duration missions and the fidelity score of each reference.

The psychosocial characteristics for each of the five measures of performance identified from studies with an experimental or quasi-experimental design is presented in Tables 3-9. For each characteristic, the number of studies reporting a statistically significant association, followed by the average fidelity score of these studies and the summed statistical effect measure is presented.

The most important predictor of task performance in isolated and confined extreme environments appears to be the cluster of global personality traits that include low levels of neuroticism, extraversion, and openness to experience and high levels of agreeableness as measured by the NEO-FFI; high positive instrumentality and low negative instrumentality as measured by the PCI; and high self control. This cluster accounted for nine studies with statistically significant associations, an average fidelity score of 9.1, and a statistical effect score of 11. The second most important predictor is crew homogeneity related to demographic characteristics, interest, and hobbies, and crew homogeneity related to some personality characteristics and heterogeneity related to other characteristics. This cluster accounted for five studies with statistically significant associations, an average fidelity score of 7.8, and a statistical effect score of 11. The third most important predictor was the cluster of personality characteristics relating to interpersonal needs and skills. These characteristics included low levels of wanted and expressed affection as measured by the FIRO-B, high role clarity and low role conflict, low assertiveness, and a high perceived fit with the organizational culture of the crew or station. This cluster accounted for five studies with statistically significant associations, an average fidelity score of 7.6, and a statistical effect score of 9.

Other predictors of importance included the cluster of demographic characteristics reflecting maturity, experience, and skills including older age, occupation, work experience (four significant associations, fidelity score = 7.3, effect score = 5), and the cluster of group characteristics reflecting cohesion (three significant associations, fidelity score = 7.3, effect score = 0).

Less important predictors included the clusters of personality characteristics reflecting high self-efficacy and high motivation, high alertness, low hostility against the self, large groups, high positive affectivity, number of previous expeditions, high levels of religiosity, being unmarried, male gender, military service, civilian status, and urban residence.

The most important predictor of emotional stability identified in the studies reviewed was the cluster of demographic characteristics that included older age, work experience, occupation, first born, and no record of truancy or delinquency. This cluster accounted for 20 studies with statistically significant associations, an average fidelity score of 7.4, and a statistical effect score of 11. The second most important predictor of emotional stability was the personality cluster reflecting interpersonal needs and skills that included low needs for autonomy and nurturance and a high level of deference to others as measured by the EPPS; low levels of wanted and expressed affection, wanted control and wanted inclusion as measured by the FIRO-B; high interpersonal sensitivity; a high need for optimism and low

need for efficiency in friends; a low need for interpersonal sensitivity from others, and high role specificity or ability to program oneself into a social role. This cluster accounted for 12 studies with statistically significant associations, an average fidelity score of 7.6, and a statistical effect score of 8. The third most important predictor of emotional stability was the cluster of personality characteristics reflecting global personality traits that included low levels of neuroticism and extraversion as measured by the NEO-FFI; low levels of repression and high levels of responsibility as measured by the MMPI; high positive instrumentality as measured by the PCI; low emotional expressivity; and high self control. This cluster accounted for eight studies with statistically significant associations, an average fidelity score of 6.9, and a statistical effect score of 5.

Other important predictors of emotional stability included civilian status (five associations, fidelity score = 8.0, effect score = 4); clinical characteristics (four associations, fidelity score = 8.8, impact score = 5); the cluster of psychological characteristics reflecting mood (four associations, fidelity score = 8.8, effect score = 3); the cluster of personality characteristics reflecting motivation (four associations, fidelity score 8.3, effect score = 1); the cluster of group characteristics reflecting cohesion that included high crew identity/affiliation, compatibility of social dyads, and high role complementarity, consensus, redundancy, latency, and isomorphism (four associations, fidelity score = 7.5, effect score = 0); being unmarried (three associations, fidelity score = 7.3/ effect score = 2); and the cluster of personality characteristics reflecting self-efficacy (three associations, fidelity score = 8.0, effect score = 1), and cultural background (two associations, fidelity score = 9.5, effect score = 5). Civilian status, however, is confounded by higher levels of education and occupational status in civilians compared to enlisted military personnel who participated in most of the studies of polar expeditions.

Less important predictors included the cluster of group characteristics related to homogeneity or heterogeneity, male gender, military service, urban residence, high alertness, a high need for orderliness as measured by the EPPS, high level of conscientiousness as measured by the NEO-FFI, high satisfaction with social support, low use of acceptance as a coping strategy, number of previous expeditions, enjoyment and sense of awe from the environment, high and low interest in hobbies and leisure activities, low levels of religiosity, large and small crew sizes, and a participative/supportive style of leadership.

The most important predictors of social compatibility were crew homogeneity related to demographic characteristics, culture, and personality. This cluster of characteristics accounted for 14 statistically significant associations with a mean fidelity score of 7.9 and an effect score of 11. The second most

important predictor of social compatibility was the cluster of personality characteristics reflecting global traits. This cluster of characteristics accounted for 18 statistically significant associations with a mean fidelity score of 9.3 and an effect score of 10. The third most important predictor was the cluster of personality characteristics reflecting interpersonal needs and skills. This cluster of characteristics accounted for seven statistically significant associations with a mean fidelity score of 8.1 and an effect score of 15.

Other important predictors of social compatibility included the cluster of demographic characteristics reflecting age, maturity, experience, and skills (seven associations, fidelity score = 9.0, effect score = 0); the cluster of group characteristics reflecting cohesion (six associations, fidelity score = 8.0, effect score = 0); the cluster of personality characteristics reflecting motivation (five associations, fidelity score = 8.0, effect score = 3); and the cluster of associations reflecting cultural background (three associations; fidelity score = 8.0, effect score = 5).

Less important predictors of social compatibility included the cluster of clinical characteristics, the cluster of coping characteristics, enjoyment and awe of the environment, low interest in hobbies and leisure activities, high levels of religiosity, low work-related stress, less hostility against the self, high alertness, large crews, high positive affectivity, rural residence, military service, male gender, being unmarried, a participative/supportive style of leadership, and a leader's ability to adapt style to context.

The most important predictor of leadership was the cluster of characteristics related to leadership style. These characteristics included a participative/supportive style, emphasis on discipline and adherence to regulations, use of recognition and reward, keeping informed of activities engaged by subordinates, maintaining daily contact with subordinates, and sticking by decisions once they are made. This cluster of characteristics accounted for nine studies reporting statistically significant associations with an average fidelity score of 7.8 and an effect score of 18. The second most important predictor of leadership was the cluster of personality characteristics reflecting global traits. This cluster accounted for six studies reporting statistically significant associations with an average fidelity score of 10 and an effect score of 11. The third most important predictor of leadership was the cluster of personality characteristics reflecting motivation. This cluster accounted for five studies reporting statistically significant associations with an average fidelity score of 7.8 and an effect score of 9.

Other important predictors of leadership included the cluster of characteristics reflecting leadership skills (five significant associations, fidelity score = 7.6, effect score = 9), the cluster of personality

characteristics reflecting interpersonal needs or skills (four significant associations, fidelity score = 8.0, effect score = 10), the cluster of personality characteristics reflecting self-efficacy (four significant associations, fidelity score = 8.5, effect score = 7), and the cluster of demographic characteristics reflecting age, maturity, and experience (three significant associations, fidelity score = 7.7, effect score = 0).

Less important predictors included high alertness, a high level of expressed control over others, and being married.

The most important predictor of overall performance was the cluster of personality characteristics that reflect motivation, including high motivation and need achievement, high industriousness, high job satisfaction, high adaptability, and low boredom. This cluster accounted for 19 studies reporting statistically significant associations with an average fidelity score of 9.5 and an effect score of 39. The second most important predictor was the cluster of personality characteristics that reflected global personality traits, including low NEO-FFI measures of neuroticism, extraversion, openness to experience and conscientiousness, and high measures of agreeableness; low MMPI measures of control and repression and high measures of responsibility; low emotional expressivity; and high self control. This cluster accounted for 17 studies reporting statistically significant findings with an average fidelity score of 8.1 and an effect score of 17. The third most important predictor was the cluster of personality characteristics reflecting interpersonal needs and skills, including low levels of wanted affection, wanted control and expressed inclusion as measured by the FIRO-B; high interpersonal sensitivity, low competitiveness, low level of dependence on groups as measured by the 15PF; motivation to maintain social relations and be a part of the group; friendliness; and a low mistrust of others. This cluster accounted for 12 studies reporting statistically significant findings with an average fidelity score of 7.6 and an effect score of 17.

Other important predictors of overall performance included the cluster of demographic characteristics reflecting age, maturity, experience and skills (eight significant associations, fidelity score = 7.8, effect score = 6); the cluster of personality characteristics that reflect self-efficacy (five significant associations, fidelity score = 7.8, effect score = 3); clinical characteristics (four significant associations, fidelity score = 8.0, effect score = 7); the cluster of personality characteristics that reflect mood (four significant associations, fidelity score = 8.5, effect score = 4); the cluster of characteristics reflecting leadership skills (four significant associations, fidelity score = 7.3, effect score = 0), and coping resources and strategies (three significant associations, fidelity score = 7.7, effect score = 1).

Less important characteristics associated with overall performance included the cluster of personality characteristics reflecting cognition, high or low interest in hobbies or leisure activities, military service or civilian status, female gender, a low family socioeconomic status, being married or unmarried, rural place of residence, a high openness to experience, high levels of religiosity, and use of recognition and reward by leaders.

Prioritization of psychosocial characteristics by category

To assess the importance of a set of characteristics for each performance measure, we compared the number of studies reporting statistically significant associations, mean fidelity scores of these studies, and statistical effect scores for each performance category or cluster (Table 10). The clusters or categories of variables that predicted all five categories of performance included Demographic Cluster A (age, maturity, experience, and skills) and Personality Clusters A (global traits), B (motivation), D (cognition), E (self-efficacy), and F (interpersonal needs and skills). Global personality traits accounted for the most statistically significant associations with performance ($n = 44$), followed by demographic characteristics reflecting age, maturity, experience, and skills ($n = 43$), and personality characteristics reflecting interpersonal needs and skills ($n = 41$). Studies documenting associations between global personality traits reported the highest average fidelity score (9.04), followed by cultural background (8.75) and personality characteristics reflecting mood (8.50). Personality characteristics reflecting global traits, motivation, and interpersonal needs and skills represented the highest statistical effect scores (53, 46, and 44).

Evaluation of potential countermeasures

Three different types of countermeasures have frequently been recommended for use in optimizing astronaut performance during extended duration missions and minimizing the risk of performance decrements: screening, selection, and training (National Research Council, 1998; Institute of Medicine, OM, 2001). Each of these will be examined in turn with regard to the ICE literature on psychosocial characteristics that predict optimal performance.

Screening. Unlike other countermeasures, the screening of individuals for desirable psychosocial characteristics that predict optimal performance does not result in a change in these characteristics. Rather, psychological screening is focused on psychosocial characteristics that are either not malleable or that would require a greater cost investment to implement countermeasures that change malleable characteristics. Nevertheless, psychological screening is an important component to both selection and

to training because it provides information that can be used to identify individuals who should be selected for long-duration missions and because it can be used to target specific forms of training countermeasures to be implemented with specific individuals who are selected for such missions. When used, psychological screening is believed to improve the effectiveness of both selection and training as potential countermeasures for enhancing individual and group performance in extreme and isolated environments.

The technique of select-in screening (Palinkas, 1990; Institute of Medicine, 2006) is intended to identify those characteristics that predict for optimal performance under a specific set of conditions; in this case, living and working in extreme ICEs. The record of success of such efforts, however, is somewhat mixed. Studies of Operation Deep Freeze candidates by Gunderson and colleagues (Gunderson, 1974) found that screening predicts performance, but the same psychosocial characteristic does not predict all forms of performance (ability, stability, compatibility) for a specific individual, and the same psychosocial characteristic does not predict the same type of performance for different groups of individuals (enlisted, vs officers vs civilians). Studies of astronaut personnel by Helmreich and colleagues (Rose et al., 1994; McFadden et al., 1994) found certain psychological characteristics (high positive instrumentality and expressiveness and low negative instrumentality, expressiveness, and communion) to predict astronaut assessments of fellow astronaut task effectiveness and social compatibility); similar findings have been observed with submarine personnel and polar expeditioners (Sandal et al., 1996). A more recent study by Grant and colleagues (2007) found no significant agreements between the psychological screening measures and those actually selected by the British Antarctic survey. Participants characterized as exceptionally well adapted by the station commanders had higher scores on Openness on the NEO-FFI (the “Big Five” personality inventory) and higher levels of emotion-focused coping and fewer subjective health complaints. However, other studies (Rose et al., 1994) have found lower scores on the Openness measure to be associated with performance. Participants rated by station commanders as “poor” had higher levels of defensive hostility, and lower levels of emotion focused coping.

Routine psychological screening has been proposed for prevention of the adverse behavioral effects of certain psychosocial characteristics such as neuroticism (Lahey, 2009). Behavioral interventions designed to reduce levels of neuroticism in individuals seem feasible; however, to date, no such interventions have been identified. In the absence of such countermeasures, routine screening could be used to identify individuals in need of further individual evaluations and possibly training countermeasures like the cognitive behavioral therapy interventions discussed below (Lahey, 2009).

Target characteristics for psychological screening would include the following:

- Global personality traits
- Mood
- Interpersonal needs and skills
- Self efficacy
- Leadership style and skills
- Coping skills and strategies

Selection. Selection of crew members for long-duration missions can occur in two different forms: selection based on individual characteristics and selection based on the characteristics of the entire group. Selection based on individual characteristics includes elements of social and demographic background, personality, clinical profile, coping skills and strategies, other characteristics, and leadership styles and skills. Target characteristics for individual selection identified from the ICE literature that would be relevant to extended-duration space missions include older age, high levels of education or socioeconomic status, years of experience in a profession, number of previous missions or expeditions, being unmarried, and possession of a sense of enjoyment and awe of the environment. They would also include global personality traits, motivational indicators, mood, cognition, self efficacy, and interpersonal needs and skills. They would include results from predeployment clinical evaluations, low levels of predeployment depressive symptoms and high levels of positive affectivity, and possession and use of specific coping resources and strategies. Finally, they would include possession and use of specific leadership skills and styles.

However, all of the characteristics found to predict performance in other isolated and confined environments may not be suitable for selection of personnel for long-duration space missions. For instance, it is likely that most if not all candidates for extended-duration missions will possess similar levels of education/socioeconomic status and sense of enjoyment and awe as such individuals are both self selected and selected by organizations like NASA because of their scientific and technical skills. Selection could also focus on individual personality, leadership, and other traits. Other characteristics identified as being significantly associated with performance may not be suitable for selection as the findings regarding these characteristics are somewhat mixed. For instance, some studies found male gender to be associated with task ability, emotional stability, and social compatibility, while other studies found female gender to be associated with overall performance. Similarly inconsistencies in

associations exist with respect to military and civilian status, urban and rural place of residence, high and low levels of religiosity, high and low interest in hobbies and leisure activities, and formation of larger or smaller size crews. Being married was associated with leadership performance, but being unmarried was associated with task ability, emotional stability, and social compatibility. Other predictors like low family socioeconomic status might be eliminated from consideration because of the overwhelming evidence in the opposite direction. Still others like predeployment depressive symptoms and subjective health complaints may be eliminated from consideration due to the low probability of obtaining valid and reliable information from astronauts who are reluctant to provide such information if it minimizes their chances of being selected (National Research Council, 1998).

Selection based on group characteristics includes elements of social and demographic characteristics, personality, and cultural background that reflect homogeneity of individual members of the group or, in the case of certain specific psychological traits such as dominance, heterogeneity of individual members. However, as with the selection of individuals, there exist numerous constraints on the utilization of selection as a countermeasure that should be taken into consideration. For instance, while crew members may exhibit significant differences in emotional stability or social compatibility based on cultural background or orientation, decisions as to whom to assign to a mission from what country or organization must also take into consideration the political and financial realities (i.e., what country or organization is providing financial support for the mission), as well as the objectives of the mission and the technical needs required to support those objectives (i.e., exploration, base construction, science, logistical support). Consequentially, the desire to enhance individual or group performance may be one goal of selection procedures, but it must compete with other goals, some of which are likely to be viewed as more important or critical to mission success.

Target characteristics to be considered for selection include the following:

- Demographic characteristics reflecting age, maturity, experience, and skills
 - Older age
 - Occupation
 - Years of work experience
- Personality characteristics
 - Global personality traits
 - Motivation

- Mood
- Interpersonal needs and skills
- Self efficacy
- Group characteristics
 - Homogeneity of demographic and personality characteristics
 - Heterogeneity of selected personality characteristics
 - Group cohesion
- Clinical characteristics
 - Predeployment clinical evaluations
 - High positive affectivity
- Leadership style and skills
- Coping skills and strategies
- Number of previous missions/expeditions

Training. Training-based countermeasures are designed to change behavior. Most of the current evidence-based practices that focus on behavior change are designed to change behaviors that are dysfunctional or maladaptive. These include alcohol, drug abuse, and other addictive behaviors, antisocial behavior; and mood disorders such as depression and anxiety. While the effectiveness of these techniques in reducing negative behaviors have been well documented, their effectiveness in preventing the occurrence of these negative behaviors or in promoting positive behaviors is less clear.

Social Skills Training (SST) is one type of countermeasure that has the potential for reinforcing psychosocial characteristics that predict for optimal performance or preventing the occurrence of decrements in social compatibility. SST interventions employ behavioral and social learning principles to teach skills involving medication management, early detection and self-management of symptoms, coping with life stress, grooming and hygiene, interpersonal problem solving, and conversation skills (Wallace et al., 1992). The goals of treatment are explicit, sessions are clearly planned, agendas are provided in manuals and workbooks, and homework assignments (in vivo practice) are given. Prepackaged SST modules are available that include manuals for therapist training, patient workbooks, and demonstration videos (Psychological Rehabilitation). The aim of SST is to improve the patient's social interaction through modeling, rehearsal, feedback, and role-play.

Target characteristics for the use of SST to enhance performance during long-duration space missions would include the following:

- Interpersonal needs and skills
- Cultural background
- Crew homogeneity related to demographic characteristics, culture, and personality
- Group cohesion
- Coping resources and strategies
 - Use of and satisfaction with social support
- Leadership style and skills
 - Participative/supportive leadership style
 - Ability to maintain group harmony and resolve conflicts
- Global personality traits
 - Extraversion

Training based on the principles of Cognitive Behavioral Therapy (CBT) is another potential countermeasure for promoting psychosocial characteristics associated with optimal performance and preventing the risk of performance decrements. CBT was originally developed as an intervention for depressive disorders (Beck et al., 1979) but was modified to address the needs of patients experiencing a variety of other mental illnesses, including anxiety disorders (Barlow, 1988), substance dependence (Monti et al., 1989), and personality disorders (Linehan, 1993). CBT trains patients to identify problematic thoughts and behaviors and to engage in exercises (both cognitive and behavioral) that help dispute irrational or unhelpful beliefs.

One widely used CBT-based intervention with potential for use with astronaut personnel assigned to extended-duration missions is Problem Solving Therapy (PST). PST uses the behavioral activation (Jacobson et al., 2001) components of CBT, but with less emphasis on changing cognition and greater emphasis on individual assessment of personal contextual problems and skill building to enhance self-management skills (Nezu et al., 1989). In randomized studies, PST has been found to reduce depressive symptoms among primary care patients with major depression or dysthymia (Barrett et al., 2001; Catalan et al., 1991; Dowrick et al., 2000; Mynors-Wallis, 1996; Mynors-Wallis et al., 1997, 2000). PST is available in published treatment manuals for depression (Nezu et al., 1989). PST is based on a theoretical framework that incorporates negative life events, current daily problems, immediate and

long-term emotional reactions, problem solving coping, and their relationship to depression (Nezu et al., 1989). According to this framework, experiencing negative life events can lead to the occurrence of a wide range of daily problems, which are believed to function as sources of stress. If these stressors are coped with effectively (i.e., the problems are resolved), people are likely to experience only mild or no depressive symptoms. However, if individuals are ineffective in their problem-solving attempts, the probability of moderate-to-severe depression increases.

A second intervention of potential use for extended-duration missions is Computer-based Cognitive Behavioral Therapy (CCBT). This has been introduced in recent years without the need for a trained therapist, or with their minimal involvement. Various versions of this shift toward technology mediated self-help exist, and range from completely computerized versions such as *Beating the Blues* to facilitated self help by a practitioner and a model with minimal intervention from a non- or minimally trained professional. CCBT is seen as an effective first line tool within a stepped care framework for the management of common mental health problems based on self-reported improvements in anxiety and depression (Cavanagh et al., 2006).

A third CBT-based intervention that was deliberately designed to prevent the occurrence of performance decrements in small, isolated groups is a program known as Business in Mind (Martin et al., 2009). This is a DVD program (60 minutes in length) involving skills development of managers operating in remote areas to improve mental health of managers and their employees. The program contains four distinct modules. Module 1 aims to develop participants' understanding of stress and coping processes, introducing relationships among thoughts, feelings, and behaviors. Module 2 is designed to enhance participants' level of psychological capital (self efficacy, hope resilience, optimism). Module 3 is focused on overcoming barriers to living a healthy lifestyle (diet, exercise). Module 4 focuses on assisting crew leaders in creating a positive work environment and overcoming interpersonal stressors by developing their emotional intelligence and communication skills. However, despite the program's face validity for use with astronaut crews, its effectiveness has yet to be evaluated.

Interpersonal Psychotherapy (IPT) is another therapeutic technique with potential for promoting positive behaviors and preventing risks to optimal performance. IPT was developed in the 1970s by Klerman et al. (1984) as a time-limited, weekly outpatient treatment for major depressive disorder. It has been applied and extended to a variety of other psychiatric diagnoses (dysthymic disorder, bulimia nervosa, recurrent depression, bipolar disorder, substance abuse, social phobia, panic disorder, body dysmorphic disorder, chronic somatization, and borderline personality disorder) (Klerman et al., 1984;

Weissman et al., 2000). Current evidence suggests that IPT is an efficacious therapy for depressive spectrum disorders and may be superior to other manualized psychotherapies, including CBT (Feijo de Mello et al., 2005). IPT deals with current, rather than previous interpersonal relationships, focusing on the patient's immediate social context. Moreover, it intervenes in symptom formation and the social dysfunction associated with depression, rather than addressing the enduring aspects of personality (Weissman & Markowitz, 1998). Therapy occurs in three distinct phases. The first phase usually comprises one to three sessions and includes a psychiatric diagnostic assessment. The patient's current social functioning and close relationships, including the habitual patterns and expectations characterizing those relationships and how they influence the patient's mood, are reviewed. This review provides a framework for understanding the social and interpersonal context present at the onset of the depressive symptoms and defines the focus of treatment (Weissman & Markowitz, 1998). Symptoms are then linked to the patient's situation in a formulation (Markowitz, 1998) that comprises one (or more) of the following problem areas in the patient's life: a) grief; b) interpersonal role disputes; c) role transitions; or d) interpersonal deficits (Weissman & Markowitz, 1998). The second phase of treatment entails the development of specific strategies for the chosen interpersonal problem area. The last phase of IPT takes place during the concluding 12 to 16 weeks of treatment and it is aimed at giving support to the patient's renewed sense of independence and competence by recognizing and consolidating therapeutic gains.

Motivational Interviewing (MI) is another evidence-based practice that has been demonstrated to be effective in changing behavior. MI is a direct, client-centered counseling style for eliciting behavior change by helping clients explore and resolve ambivalence (Rollnick & Miller, 1995). It is guided by a number of general principles, including: expressing empathy, by use of reflective listening; developing discrepancy between client goals and current problem behavior by use of reflective listening and objective feedback; avoiding argumentation by assuming that the client is responsible for the decision to change; rolling with resistance, rather than confronting or opposing it; and supporting self-efficacy and optimism for change (Miller & Rollnick, 1991). The technical aspects of MI include three elements: client-centered counseling skills, based on Rogerian counseling; reflective listening statements, directive questions; and strategies for eliciting internal motivation from the client, operationalized in the form of self-motivating statements from the client, also known as "change talk." More than 200 clinical trials of MI have been published, and efficacy reviews and meta-analyses have documented its effectiveness for cardiovascular rehabilitation, diabetes management, hypertension, illicit drug use, disease, infection risk reduction, management of chronic mental disorders, problem drinking, smoking, and concomitant

mental and substance use disorders. It has been found to be effective both in reducing maladaptive behaviors (e.g., problem drinking, gambling, HIV risk behaviors) and in promoting adaptive health behavior change (exercise, diet, medication adherence). The clinical style and moreover the apparent mechanisms of change in MI thus seem to be related to generalizable processes of human behavior and not limited to specific target problems (Miller & Rose, 2009).

Target behaviors for the use of these psychotherapeutic interventions to enhance performance during long-duration space missions would include the following:

- Motivation
- Mood
 - Anxiety
 - Anger, irritability
 - Depressive symptoms
 - Positive affectivity
- Global personality traits
- Interpersonal needs and skills
- Group cohesion
- Coping resources and strategies

Leadership Training. High performance leadership is defined as leading and managing people and organizational systems to achieve and sustain high levels of effectiveness by optimizing goals, design, and management at the individual, process, and organizational levels (Holton & Naquin, 2000, p. 1). This leadership can be transactional or transformational. Transactional leadership seeks an exchange between leader and follower in which both achieve some benefit. Transformational leadership seeks to develop the potential of the follower or organization to fulfill higher level needs. According to Bass (1998), the transactional leader works within the organizational culture as it exists; the transformational leader changes the organizational culture. Leadership development is defined as “every form of growth or stage of development in the life cycle that promotes, encourages, and assists the expansion of knowledge and expertise required to optimize one’s leadership potential and performance” (Brungardt, 1996, p. 83). Numerous programs exist for training in leadership styles and skills, too numerous to adequately review in this report. These programs focus on enhancing knowledge, expertise or behavior, and systems or organizational productivity (Avolio, 1999; Bass, 1990; Conger & Benjamin, 1999). Meta-

analyses of different leadership development training programs have found significant effects in subjective and objective learning, subjective behavior, and objective results (Burke & Day, 1986). However, most leadership training programs target the interpersonal skills and work performance of individual managers (Moxnes & Eilertsen, 1991); in contrast, relatively few programs target organizational performance (Fiedler, 1996). A meta-analysis performed by Collins and Holton (2004) found the effect size for knowledge outcomes of a range of leadership training programs ranged from .96 to 1.37; expertise outcomes from .35 to 1.01; and system outcomes averaged .39.

Leadership during long-duration missions is expected to be primarily transactional, but may also involve elements of transformational leadership. To our knowledge, no studies of existing training programs to promote or enhance either form of leadership have been conducted in extreme and isolated environments. Consequently, research using randomized controlled designs is required to determine whether existing programs or adaptations of existing programs could lead to increased leadership knowledge, behavior, or organizational outcomes. Target characteristics for the use of such programs to enhance performance during long-duration space missions would include the following:

- Leadership styles and skills
- Group cohesion
- Crew homogeneity related to demographic characteristics, culture, and personality

Cross-cultural training. Cross-cultural training (CCT) has long been advocated as a means of facilitating effective cross-cultural interactions (Brislin, 1981; Landis & Brislin, 1983; Harris & Moran, 1979). As with leadership training, numerous programs exist that are designed to facilitate the integration of individuals representing different cultural backgrounds into the same group, organization, or system. These programs are designed to develop three types of skills: self maintenance (mental health, psychological well being, stress reduction, feelings of self confidence); interpersonal; and cognitive/perceptual (Mendenhall & Oddou, 1985). These skills allow individuals to more rapidly adjust to a new cultural environment through development of familiarity, comfort, and proficiency regarding expected behavior and values and assumptions inherent in the new culture, all of which may be different from one's own culture (Black & Mendenhall, 1990). They also presumably lead to increased levels of individual and organizational performance (Black & Mendenhall, 1990).

A systematic review of the literature performed by Black and Mendenhall (1990) found evidence to suggest that cross-cultural training leads to positive outcomes with respect to skills development,

adaptation, and individual and organizational performance. However, as with leadership training, there have been no studies of existing cross-cultural training programs to promote or enhance either adaptation or performance in extreme and isolated environments. Consequently, research using randomized controlled designs is required to determine whether existing programs or adaptations of existing programs could lead to increased cross-cultural skills, adaptation, or performance. Target characteristics for the use of such programs to enhance performance during long-duration missions would include the following:

- Cross-cultural differences in emotional stability and social compatibility
- Crew homogeneity related to culture

Discussion

Most of the 330 associations between individual psychosocial characteristics and one or more measures of performance identified in our review of studies using a quasi-experimental or experimental design were based on the findings of only one or two studies. Of the 120 studies examined, slightly more than one-third possessed data that could be used to identify a statistical effect. The number of associations supported by more than two studies was 15 (4.5% of all associations). One conclusion that may be drawn from this is that despite the wealth of research on psychosocial characteristics in isolated and confined extreme environments, the evidence supporting any one particular characteristic as a predictor of performance is quite limited. The most robust associations, based solely on statistical effects and/or fidelity scores, were between emotional stability and age, education/socioeconomic and civilian status, being unmarried, and compatibility of social dyads; between social compatibility and age, enjoyment and awe of the environment, and crew homogeneity related to demographic characteristics, culture, and personality; and between overall performance and education/socioeconomic status, an introverted personality, and high need for achievement and high motivation. The association between older age and emotional stability was found among polar expeditions and crew members of polar research stations, while the association between education/socioeconomic status and emotional stability was found in studies of both undersea (i.e., divers, submariners) and polar expeditioners. The associations between crew homogeneity and social compatibility were observed in space and all types of analogue settings.

A second major observation to be drawn from this analysis is the distinction between characteristics that represent fixed traits and characteristics that are potentially malleable through psychosocial

countermeasures. Malleable state characteristics such as depressive symptoms and certain traits such as susceptibility to anxiety and perhaps even introverted personalities may be addressed through cognitive behavioral therapy, interpersonal therapy, and other techniques that are evidence-based. Fixed traits such as age, education/socioeconomic status, and marital status are potentially enhanced in crews through programs of screening and selection. However, programmatic constraints such as the demands of participating nations to include one or more crew members from their respective nations and the unlikelihood of selecting single gender crews suggests that other countermeasures will be required to enable individuals with different backgrounds in heterogeneous crews to live and work together for prolonged periods of time.

For the most part, the studies reviewed pointed to an association between certain psychosocial characteristics and performance indicators under any environmental or occupational setting. Individuals who are older and have more experience, emotionally mature, highly motivated, socially adept, skillful in exercising leadership, satisfied with their jobs, highly productive, and who exhibit few symptoms of depression and anxiety and rely on social support networks to cope with stress in general are more likely to perform well under any conditions. Crews whose members express a strong group identity and affiliation and whose members share similarities with respect to social and personality characteristics and cultural background perform better than crews that do not share these traits. However, our review also identified certain characteristics that seem to run counter to our understanding of factors associated with successful performance. These include being unmarried, having an introverted personality (or low levels of extraversion), not being particularly conscientious or open to experience, not expressing one's emotion or possessing a capacity for self-reflection, having little interest in leisure activities, and needing little sympathy from others. Although perhaps considered to be maladaptive in normal living conditions, such characteristics may be uniquely suited to living in isolated and confined environments (Palinkas, Gunderson, Holland et al., 2000). Furthermore, the ability to adjust one's level of motivation and need for achievement to avoid frustration when environmental constraints like the lack of replacement parts or competing demands place inherent limitations on motivation and achievement points to the importance of flexibility and adaptability in isolated and confined environments. Individuals exhibiting such flexibility are most likely to exhibit optimal performance in such environments (Palinkas & Suedfeld, 2008).

In evaluating the results of this systematic review, certain limitations must be kept in mind. First, our prioritization of associations between individual psychosocial characteristics and measures of

performance were based primarily on the quality of the research design and the fidelity score assigned to that design. The more traditional approach of evaluating associations based on effect sizes using meta-analytic procedures were not adopted in this review due to the relatively small number of studies providing data reflecting statistical effects. Differences in measurement of both psychosocial characteristics and performance indicators also limit the generalizability of effect sizes. Second, although we had access to several unpublished studies or studies published only as technical reports, unpublished studies tend to have more negative results (Higgins & Green, 2009). Furthermore, our search criteria included only significant associations. Hence our review strategy did not include null findings that would normally also be included in a traditional meta-analysis. This decision was made because of the exploratory nature of this systematic review. Third, our objective was to identify psychosocial characteristics that predicted for optimum performance. In many instances, optimum performance was defined in these studies as the absence of a negative outcome or on a scale where a high score reflected a negative outcome (e.g., a high score on a depressive symptom scale) and a low score indicated a positive outcome. However, this definition of optimum performance did not always translate or convert well, particularly in studies where the objective was to identify characteristics associated with the risk of poor performance in contrast to characteristics associated with optimum performance. The absence of risk does not necessarily imply the existence of optimum performance. Finally, although we could identify specific countermeasures with potential for enhancing performance, we were limited in our ability to prioritize or recommend specific countermeasures based on evidence of their effectiveness with individuals living and working in ICEs. To our knowledge, there have been no studies of the effectiveness of training countermeasures on individuals in such environments and the evidence supporting the use of psychological screening and selection is somewhat mixed. Moreover, despite their potential for enhancing performance, most of the research on the effectiveness of psychotherapy-based countermeasures has been focused on the treatment or reduction of problems that constitute negative indicators of performance (e.g., depression, anxiety, substance use, group conflict) rather than the enhancement of positive performance outcomes. Positive performance is not merely the absence of negative performance indicators. Consequently, further research is recommended to adapt existing countermeasures or to develop, implement, and evaluate new countermeasures with the goal of promoting or enhancing positive performance.

Policy and Program Implications

The results of this systematic review suggest that NASA should place greater emphasis on performance enhancement. Current policies and procedures emphasize prevention of performance decrements. This policy is manifested in screening and selection procedures that are designed to “screen out” individuals likely to perform poorly in space and countermeasures designed to prevent the occurrences of poor performance due to prolonged separation from family members, interpersonal strain, and tension among fellow crew members or between crew and ground-based support personnel, fatigue, or the environmental conditions unique to long-duration space flight. However, the results of this study suggest that large improvements in task ability, emotional stability, and social compatibility may result from the application of screening, selection, and training countermeasures addressing specific psychosocial characteristics.

The results also offer programmatic guidance on the prioritization of efforts and resources targeting the application of specific countermeasures to address specific characteristics. Although the studies reviewed here identified several different characteristics, many of which were malleable through the use of training countermeasures and many which are not malleable but may be addressed through specific techniques for screening and selection, both characteristics and the countermeasures designed to address them may be rank ordered on the basis of the quality of the evidence, including the magnitude of effect (small, medium, and large) and fidelity of the analogue (crew size, characteristics of crew, mission duration, and characteristics of environment). Based on the results of this review, the characteristics that should be assigned the greatest priority include global personality traits like self-efficacy and emotional maturity, introversion, and agreeableness; high motivation; interpersonal needs and skills; crew heterogeneity with respect to certain characteristics and homogeneity with respect to other characteristics; and demographic characteristics like age, education, and years of work experience that reflect maturity and experience. The latter characteristics are best addressed through selection procedures, while crew heterogeneity/homogeneity is best addressed by screening and selection and the remaining characteristics may be addressed by training countermeasures as well as screening and selection.

Nevertheless, the decision to address specific psychosocial characteristics with specific countermeasures cannot be made on the basis of effect sizes and fidelity of analogue studies alone. For instance, addressing the relevance of the influence of cultural heterogeneity on crew performance must take into consideration the reality that the political importance of having a multinational crew representing the international partners of a long-duration mission will mitigate against the use of selection procedures to

ensure cultural homogeneity and favor the use of cross-cultural training programs to enhance awareness and adaptability to cultural differences within a crew.

One important criterion for the prioritization of addressing psychosocial characteristics for performance enhancement is whether the procedures are cost effective. At the broadest level, the determination must be made as to whether performance enhancement is ultimately more cost effective than prevention of performance decrements. Previous research in analogue settings does not permit such a determination. Further, the comparative effectiveness of applying different countermeasures to address the same psychosocial characteristic (for instance, use of psychological screening protocols like the NEO-FFI, selection procedures, or training programs based on principles of cognitive-behavioral theory) must be evaluated through established procedures of Comparative Effectiveness Research (CER) in which the benefits of improved outcomes (in this instance, enhanced task ability, emotional stability, social compatibility, leadership, and overall performance) associated with one or more countermeasures (screening, selection, training) relative to the costs associated with countermeasure implementation are compared between the countermeasure and current procedures or between competing countermeasures within the context of a randomized controlled trial (RCT).

Even under normal conditions, RCTs are expensive to conduct and require sufficiently large samples of participants to ensure the likelihood of finding statistically significant results. The small crews aboard the International Space Station and the logistical challenges of implementing an RCT in flight limit the feasibility of this approach to investigate cost effective outcomes during a rotation on the ISS. They are potentially more feasible in analogue settings with easier access for investigators and larger pools of potential study participants. To our knowledge, there have been no RCTs of potential countermeasures designed to enhance performance in isolated and confined environments. However, the results of our systematic review indicate that all analogues are not equally relevant or faithful to the conditions of long-duration space missions and all studies in the same analogue setting are not likely to produce the same or similar results. Assessment of the fidelity of the environment to long-duration missions is especially important in this regard. Such assessment should be based on agreed-upon assumptions, including similarity of degree of isolation and confinement; similarity of crew members with respect to age, gender, and education, and possibly cultural diversity; similarity of mission duration (1 year or longer), and crew size (four to six). Development of standards for assessment of the fidelity of analogue settings is critical as NASA begins to transition from research on psychosocial characteristics as predictors of performance to cost-effective practice.

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Table 1. Study Reference Design Criteria

Ref No	Authors	Experimental of Quasi-experimental	Effect Statistics
1	Doll & Gunderson, 1971a	1	1
2	Doll et al., 1969	1	0
3	Doll & Gunderson, 1969	1	1
4	Doll & Gunderson, 1971b	1	0
5	Gunderson & Arthur, 1966	1	1
6	Gunderson, 1968	1	1
7	Gunderson, 1973	1	1
8	Gunderson & Nelson, 1965a	1	0
9	Gunderson & Ryman, 1967	1	1
10	Nelson, 1963a	1	1
11	Nelson, 1964a	1	1
12	Nelson, 1964b	1	1
13	Nelson & Gunderson, 1963a	1	1
14	Nelson & Orvick, 1964	1	1
15	Leon & Sandal, 2003	1	0
16	Biersner & Hogan, 1984	1	1
17	Blair, 1992	1	0
18	Ikegawa et al, 1998	1	0
19	Kahn & Leon, 1993	1	1
20	Palmai, 1963	1	0
21	McGuire & Tolchin, 1961	1	0
22	Nardini et al, 1962	1	1
23	Gunderson, 1966	0	1
24	Law, 1960	1	0
25	Pope & Rogers, 1968	1	0
26	Popkin et al, 1974	1	0
27	Rosnet et al, 2004	1	0
28	Sandal et al, 1996	1	0
29	Sauer et al, 1999	1	1
30	Weiss et al, 2007	1	0
31	Sarris, 2006	1	1
32	Sandal, 2004	1	0
33	Rosnet et al, 2000	1	1
34	Leon & Scheib, 2007	1	0
35	Atlis et al, 2004	1	0
36	Kanas, 1998	0	0
37	Kanas et al, 1996	1	1
38	Kanas, Salnitskiy, Weiss et al, 2001	1	0

39	Oberg, 1981	0	0
40	Chaikin, 1985	0	0
41	Bluth, 1981	0	0
42	Bluth, 1984	0	0
43	Radloff & Helmreich, 1968	1	0
44	Kelly & Kanas, 1992	1	1
45	Kelly & Kanas, 1993	1	1
46	Gushin et al, 1998	1	0
47	Weybrew & Noddin, 1979	1	0
48	Rose et al, 1994	1	1
49	McFadden et al, 1994	1	0
50	Sandal et al, 1999	1	1
51	Sandal, 2001	1	0
52	Sandal et al, 1995	1	0
53	Sandal et al, 1998	0	0
54	Taylor, 1987	0	1
55	Gunderson, 1974	0	0
56	Leon et al, 2002	1	0
57	Mocellin et al, 1991	1	0
58	Palinkas & Browner, 1995	1	1
59	Smith & Haythorn, 1972	1	0
60	Altman & Haythorn, 1965	1	0
61	Altman & Haythorn, 1967a	1	0
62	Altman & Haythorn, 1967b	1	0
63	Sells, 1965	1	0
64	Kinsey, 1959	1	0
65	Nicholas & Penwell, 1995	0	0
66	Nelson, 1962	1	1
67	Campbell, 1953	1	0
68	Weybrew, 1991	0	0
69	Miller et al, 1971	1	0
70	Kanki & Gregorich, 1992	1	0
71	Nicholas et al, 1988	0	0
72	Palinkas, Gunderson, Johnson et al, 2000	1	1
73	Johnson et al, 2003	1	0
74	Gunderson & Kapfer, 1966	1	1
75	Gunderson & Nelson, 1965b	1	1
76	Leon et al, 1989	1	0
77	Stange & Youngman, 1979	0	0
78	Palinkas, Gunderson, Holland et al, 2000	1	1
79	Leon et al, 1994	1	0
80	Schmidt et al, 2004	1	0
81	Schmidt et al, 2005	1	0

82	Palinkas, Glogower et al, 2004	1	1
83	Palinkas, Johnson et al, 2004	1	1
84	Grant et al, 2007	1	1
85	Haythorn & Altman, 1967	1	0
86	Taylor et al, 1969	1	0
87	Haythorn et al, 1966	1	0
88	Palinkas et al., 1995	1	1
89	Biersner & LaRocco, 1987	1	0
90	Palinkas, 1991	1	1
91	Taylor 1993	0	0
92	Palinkas et al., 1989	1	1
93	Gushin et al, 1996	1	0
94	Gushin et al, 1997	1	0
95	WHO	0	0
96	Rivolier et al, 1999	0	0
97	Barbarito & Peri, 1999	1	1
98	Crocq et al, 1974	1	0
99	Natani et al, 1974	1	0
100	Taylor, 1974	1	1
101	Godwin, 1985	1	0
102	Nelson 1963b	1	0
103	Natani, 1971	1	0
104	Harrison, 1980	0	0
105	Kanas & Fedderson, 1971	0	0
106	Smith, 1969	0	0
107	Lozano & Wong, 1993	1	0
108	Evans et al, 1987	1	0
109	Draggan, 1987	0	0
110	Slater, 1969	0	0
111	Eilbert & Glaser, 1959	1	0
112	Wright et al.,	1	0
113	Weybrew et al., 1961	1	0
114	Owens, 1975	1	0
115	Taylor & McCormick, 1985	1	0
116	de Montchaux et al, 1979	1	0
117	Gunderson et al, 1964	1	1
118	Nelson & Gunderson, 1962	1	1
119	Nelson & Gunderson, 1963	1	1
120	Kanas, Salnitskiy, Gushin et al 2001	1	1

Table 2. Fidelity Scores of Study References

Ref No	Authors	Setting	Similarity	Duration	Crew size	Score
1	Doll & Gunderson, 1971a	1	2	3	2	8
2	Doll et al., 1969	1	2	3	2	8
3	Doll & Gunderson, 1969	1	2	3	2	8
4	Doll & Gunderson, 1971b	1	2	3	2	8
5	Gunderson & Arthur, 1966	1	2	3	2	8
6	Gunderson, 1968	1	2	3	2	8
7	Gunderson, 1973	1	2	3	2	8
8	Gunderson & Nelson, 1965a	1	2	3	2	8
9	Gunderson & Ryman, 1967	1	2	3	2	8
10	Nelson, 1963a	1	2	3	2	8
11	Nelson, 1964a	1	2	3	2	8
12	Nelson, 1964b	1	2	3	2	8
13	Nelson & Gunderson, 1963	1	1	3	2	7
14	Nelson & Orvick, 1964	1	2	3	2	8
15	Leon & Sandal, 2003	1	3	2	3	9
16	Biersner & Hogan, 1984	1	3	3	2	9
17	Blair, 1992	1	3	3	1	8
18	Ikegawa et al, 1998	1	2	3	3	9
19	Kahn & Leon, 1993	1	2	3	3	9
20	Palmai, 1963	1	2	3	2	8
21	McGuire & Tolchin, 1961	1	2	3	1	7
22	Nardini et al, 1962	1	2	3	1	7
23	Gunderson, 1966	1	2	3	2	8
24	Law, 1960	1	2	3	2	8
25	Pope & Rogers, 1968	1	2	3	2	8
26	Popkin et al, 1974	1	2	3	1	7
27	Rosnet et al, 2004	1	3	3	1	8
28	Sandal et al, 1996	1	2	2	1	6
29	Sauer et al, 1999	1	2	2	1	6
30	Weiss et al, 2007	1	2	3	1	7
31	Sarris, 2006	1	3	3	1	8
32	Sandal, 2004	2	3	2	3	10
33	Rosnet et al, 2000	1	2	3	1	7
34	Leon & Scheib, 2007	1	2	1	3	7
35	Atlis et al, 2004	1	2	2	3	8
36	Kanas, 1998	3	3	2	3	11
37	Kanas et al, 1996	2	2	2	3	9
38	Kanas et al, 2001a	3	3	2	3	11
39	Oberg, 1981	3	3	2	3	11

40	Chaikin, 1985	3	2	2	3	10
41	Bluth, 1981	3	2	2	3	10
42	Bluth, 1984	3	2	2	3	10
43	Radloff & Helmreich, 1968	2	3	2	3	10
44	Kelly & Kanas, 1992	3	3	1	3	10
45	Kelly & Kanas, 1993	3	3	1	3	10
46	Gushin et al, 1998	2	2	2	3	9
47	Weybrew & Noddin, 1979	1	2	2	1	6
48	Rose et al, 1994	3	3	2	3	11
49	McFadden et al, 1994	3	3	1	3	10
50	Sandal et al, 1999	1	2	1	1	5
51	Sandal, 2001	2	2	2	3	9
52	Sandal et al, 1995	2	3	2	3	10
53	Sandal et al, 1998	1	2	2	2	7
54	Taylor, 1987	1	2	3	2	8
55	Gunderson, 1974	1	2	3	2	8
56	Leon et al, 2002	1	3	3	3	10
57	Mocellin et al, 1991	1	3	1	3	8
58	Palinkas & Browner, 1995	1	3	3	1	8
59	Smith & Haythorn, 1972	2	1	1	3	7
60	Altman & Haythorn, 1965	2	1	1	3	7
61	Altman & Haythorn, 1967a	2	1	1	3	7
62	Altman & Haythorn, 1967b	2	1	1	3	7
63	Sells, 1965	1	2	3	1	7
64	Kinsey, 1959	1	2	2	1	6
65	Nicholas & Penwell, 1995	1	2	2	2	7
66	Nelson, 1962	1	2	3	2	8
67	Campbell, 1953	1	2	2	1	6
68	Weybrew, 1991	1	2	2	1	6
69	Miller et al, 1971	2	3	1	3	9
70	Kanki & Gregorich, 1992	1	3	1	3	8
71	Nicholas et al, 1988	1	1	1	1	4
72	Palinkas, Gunderson, Johnson et al, 2000	1	2	3	1	7
73	Johnson et al, 2003	1	3	3	1	8
74	Gunderson & Kapfer, 1966	1	2	3	2	8
75	Gunderson & Nelson, 1965b	1	2	3	1	7
76	Leon et al, 1989	1	3	2	3	9
77	Stange & Youngman, 1979	1	2	3	2	8
78	Palinkas, Gunderson, Holland et al, 2000	1	2	3	2	8
79	Leon et al, 1994	1	3	2	2	8
80	Schmidt et al, 2004	1	3	3	1	8
81	Schmidt et al, 2005	1	3	3	1	8
82	Palinkas, Glogower et al, 2004	1	3	3	1	8

83	Palinkas, Johnson et al, 2004	1	3	3	1	8
84	Grant et al, 2007	1	3	3	1	8
85	Haythorn & Altman, 1967	2	1	1	3	7
86	Taylor et al, 1969	1	1	1	3	6
87	Haythorn et al, 1966	2	1	1	3	7
88	Palinkas et al., 1995	1	3	3	1	8
89	Biersner & LaRocco, 1987	2	1	1	1	5
90	Palinkas, 1991	1	2	3	2	8
91	Taylor 1993	1	2	3	2	8
92	Palinkas et al., 1989	1	2	3	2	8
93	Gushin et al, 1996	2	3	2	3	10
94	Gushin et al, 1997	2	2	2	3	9
95	WHO	1	1	1	1	4
96	Rivolier et al, 1999	1	2	3	1	7
97	Barbarito & Peri, 1999	1	2	3	1	7
98	Crocq et al, 1974	1	2	3	1	7
99	Natani et al, 1974	1	2	3	1	7
100	Taylor, 1974	1	2	3	1	7
101	Godwin, 1985	1	2	3	1	7
102	Nelson 1963b	1	2	3	2	8
103	Natani, 1971	1	2	3	1	7
104	Harrison, 1980	1	2	1	3	7
105	Kanas & Fedderson, 1971	3	2	1	3	9
106	Smith, 1969	1	1	1	1	4
107	Lozano & Wong, 1993	3	3	1	1	8
108	Evans et al, 1987	1	3	3	2	6
109	Draggan, 1987	1	3	3	1	8
110	Slater, 1969	1	2	2	1	6
111	Eilbert & Glaser, 1959	1	1	3	1	6
112	Wright et al., 1963	1	2	3	3	9
113	Weybrew et al., 1961	2	2	2	1	7
114	Owens, 1975	1	2	3	1	7
115	Taylor & McCormick, 1985	1	2	2	2	7
116	de Montchaux et al, 1979	1	2	3	1	7
117	Gunderson et al, 1964	1	2	3	2	8
118	Nelson & Gunderson, 1962	1	2	3	2	8
119	Nelson & Gunderson, 1963b	1	2	3	2	8
120	Kanas, salnitskiy, Gushin et al, 2001	3	3	2	3	11

Table 3. Demographic Characteristic Number of Associations, Fidelity Scores and Effect Statistics by Performance Measure

Malleable Demographic Characteristics	Countermeasure	Task Ability	Emotional Stability	Social Compatibility	Leadership	Overall
Cluster A: Maturity, experience, skills						
Older Age	Selection	1/8/M	8/7.9/S-M	3/7.3/na	1/7/na	3/7.7/S
Work experience (years)	Selection	1/7/S	1/5/na	1/8/na		1/8/S
Education/socioeconomic status	Selection	2/7/M	9/7.2/S-M	2/7.5/na	2/8/na	3/7.7/S
First-born	Selection		2/8/S	1/10/na		
No record of truancy or delinquency	Selection		1/7/S			1/8/S
Cluster B: Cultural background						
Cultural background	Selection Training		2/9.5/S-L	2/8/S-L		
Collective cultural orientation	Selection Training			1/8/M		
Cluster C: Characteristics specific to isolation and confinement						
Unmarried	Selection	1/7/na	3/7.3M	1/7/na		1/7/na
Other characteristics						
Male gender	Selection	1/8/S	1/8/S	1/8/na		
Female gender	Selection					1/8/S
Low family SES	Selection					1/7/S
Military service	Selection	1/7/S	1/8/na	1/7/S		2/7.5/S
Civilian status	Selection	1/8/S	5/8/S-M			1/7/na
Married	Selection				1/7/S	1/8/S
Rural residence	Selection			1/8/M		1/10/na
Urban residence	Selection	1/7/S	1/8/M			

Number of studies reporting a significant association/average fidelity score of study/magnitude of effect statistics (S = small, M = moderate, L = large)

Table 4. Personality Characteristic Fidelity Scores and Impact by Performance Measure

Malleable Personality Characteristics	Countermeasure	Task Ability	Emotional Stability	Social Compatibility	Leadership	Overall
Cluster A: Global personality traits						
Low NEO Neuroticism	Screening Psychotherapy	1/7/na	1/8/S			1/7/na
Low MMPI control	Screening Psychotherapy					1/6/na
Low MMPI repression-sensitization	Screening Psychotherapy		1/5/na			1/6/na
High MMPI responsibility	Screening Training Psychotherapy		1/6/na			1/6/na
Low NEO Extroversion	Screening Social Skills Training Psychotherapy	1/7/L	1/5/na			3/7.7/S
Low NEO Openness to experience	Screening Training	1/11/M		1/11/S	1/11/M	2/10/S-L
Low NEO Conscientiousness	Screening Training					2/9.5/S
High NEO Agreeableness	Screening Psychotherapy	1/11/S		1/11/M	1/11/M	1/11/S
High PCI Positive Instrumentality/expressiveness	Screening Psychotherapy	1/10/na	1/6/na	3/7.3/M		
Low PCI Negative instrumentality	Screening Psychotherapy	1/11/M		1/11/S	1/11/S	
Low PCI Impatience and irritability	Screening Psychotherapy			1/11/M	1/11/S	
Low emotional expressivity and self-reflection	Screening Psychotherapy		1/8/S			1/9/H
High emotional stability and (self) control	Screening Psychotherapy	1/8/M	2/8.5/L	1/8/M	2/8/M-L	4/7.8/S-L

Cluster B: Motivational indicators						
High motivation and need achievement	Screening Training Psychotherapy		3/8.5/na	2/7.5/S	1/8/M	10/8.1/M-L
High industriousness	Screening Training				1/8/M	2/8/L
High job satisfaction	Screening Training				1/8/M	2/8/M-L
Low motivation/high adaptability	Screening Training	1/10/na		2/7/S	2/7.5/S-M	2/7.5/M
Low boredom	Screening Training	1/7/S	1/7/S	1/7/S		3/7/S-M
Cluster C: Mood indicators						
Low hostility against self	Screening Psychotherapy	1/8/M	1/8/L	1/8/M		
Low aggressiveness	Screening Psychotherapy		1/9/na			
Low anxiety	Screening Psychotherapy		2/9/na			4/8.5/S-M
Cluster D: Cognitive indicators						
High alertness (Cognitive)	Screening Training	1/8/M	1/8/L	1/8/M	1/8/M	1/8/M
Low divergent thinking	Screening Psychotherapy					1/9/M
Cluster E: Self-efficacy indicators						
High self confidence	Screening Training Psychotherapy				1/8/M	2/8.6/S
High self concept	Screening Training Psychotherapy		1/8/na			
High self-reliant	Screening Psychotherapy Training					2/7.5/S

Ability to make self concept more like concept of others	Psychotherapy		1/9/na	1/9/na		
High assertiveness (aggressive, dominant)	Training Psychotherapy			1/10/na	1/8/M	
High PCI Negative expressivity - communion	Screening Psychotherapy	1/11/M			1/11/M	
Concordance between real and ideal self	Psychotherapy	1/7/L				
Low EPPS Need for orderliness	Screening Training Psychotherapy		1/7/S		1/7/S	1/7/S
Cluster F: Interpersonal indicators						
Low EPPS Need for autonomy (from others)	Screening Psychotherapy		1/8/S			
Low EPPS Need for nurturance (from others)	Screening Psychotherapy		1/8/S			
High EPPS Deference (to others)	Screening Selection		1/9/na			
Low FIRO-B wanted affection	Screening Psychotherapy	1/7/S	1/7/S	1/7/S		1/7/S
Low FIRO-B expressed affection	Screening Psychotherapy	1/8/S	1/8/S	1/8/S		
Low FIRO-B wanted control	Screening Psychotherapy		1/8/S	1/8/M		1/8/S
Low FIRO-B expressed inclusion	Screening Psychotherapy					1/8/S
Low FIRO-B wanted inclusion	Screening Psychotherapy		1/8/S			
High interpersonal sensitivity/socialization	Screening Social skills training Psychotherapy		1/5/na			2/7.5/M
High role clarity and low role conflict	Training	1/8/M				
Low assertiveness	Training Psychotherapy	1/7/L				

Low competitiveness	Training					2/8/L
High accepting of authority	Screening Training				2/8/M	
High need for optimism in friends	Training Psychotherapy		1/7/S	1/7/S		
Low need for efficiency in friends	Training		1/7/S			
Low need for sympathy, sentiment, confiding, praise, and warmth in friends (need for interpersonal sensitivity from others)	Screening Training Psychotherapy		1/8/na			
Low 16PF Group dependent	Screening Psychotherapy					1/7/M
High role specificity/ability to program self into role	Training		1/8/na			
Ability to confide in partner	Social skills training Psychotherapy			1/9/na		
Ability to provide emotional support to others	Social skills training			1/9/na		
Motivation to maintain social relationships and be part of a group	Social skills training Psychotherapy			1/9/na	2/8/M-L	2/8/M-L
Friendly	Screening Selection					1/8/M
Low mistrust of others	Social skills training Psychotherapy					1/7/na
High perceived fit with station culture	Social skills training	1/8/M				
Other characteristics						
High EPPs Need for orderliness	Screening Training? Psychotherapy		1/9/na			
High NEO Extroversion	Screening Social skills	1/8/S				

	training					
High NEO Openness to experience	Screening Training					1/8/M
High NEO Conscientiousness	Screening Training Psychotherapy		1/6/na			
High FIRO-B expressed control	Screening Psychotherapy				1/7/S	

Number of studies reporting a significant association/average fidelity score of study/magnitude of effect statistics (S = small, M = moderate, L = large)

Table 5. Clinical Characteristic Fidelity Scores and Impact by Performance Measure

Malleable Clinical Characteristics	Countermeasure	Task Ability	Emotional Stability	Social Compatibility	Leadership	Overall
Predeployment clinical evaluations	Screening		1/8/na	1/8/na		2/7.5/M-L
Low MMPI measures of psychopathology	Screening Psychotherapy		1/9/na			
Low baseline depressive symptoms	Screening Psychotherapy		2/8/M-L			
High positive affectivity	Screening Psychotherapy	1/9/S		1/11/na		1/9/M
Low subjective health complaints	Screening Psychotherapy					1/8/M

Number of studies reporting a significant association/average fidelity score of study/magnitude of effect statistics (S = small, M = moderate, L = large)

Table 6. Coping Resource and Strategy Fidelity Scores and Impact by Performance Measure

Malleable Coping Characteristics	Countermeasure	Task Ability	Emotional Stability	Social Compatibility	Leadership	Overall
High satisfaction with social support	Social Skills Training/ Psychotherapy		1/8/S	1/7/na		1/8/na
Low demands for social support	Social Skills Training/ Psychotherapy					1/7/na
Low UCL score on acceptance	Psychotherapy		1/7/L			
High UCL score on emotion focused coping	Psychotherapy					1/8/S
High UCL score on problem solving strategies	Social skills training Psychotherapy			1/5/S		

Number of studies reporting a significant association/average fidelity score of study/magnitude of effect statistics (S = small, M = moderate, L = large)

Table 7. Other Individual Characteristic Fidelity Scores and Impact by Performance Measure

Malleable Other Characteristics	Countermeasure	Task Ability	Emotional Stability	Social Compatibility	Leadership	Overall
Cluster A: Experiential						
Number of expeditions	Selection	1/8/S	1/7/na			
Enjoyment & awe of environment	Selection		1/8/na	2/10/L		
Other characteristics						
High interest in hobbies/activities	Selection		1/6/na			2/8/M
Low interest in hobbies/activities	Selection Training		1/8/na	1/8/na		1/8/na
High levels of religiosity	Selection	1/8/M		1/8/M		1/8/S
Low levels of religiosity	Selection		1/8/na			
Low work-related stress	Psychotherapy			1/11/na		

Number of studies reporting a significant association/average fidelity score of study/magnitude of effect statistics (S = small, M = moderate, L = large)

Table 8. Group Characteristic Fidelity Scores and Impact by Performance Measure

Malleable Group Characteristics	Countermeasure	Task Ability	Emotional Stability	Social Compatibility	Leadership	Overall
Cluster A: Group Size						
Large groups	Selection	1/8/S	1/8/S	1/8/S		
Small groups	Selection		2/8/S-M			
Cluster B: Group homogeneity/heterogeneity						
Crew homogeneity related to demographic characteristics	Selection Training	1/8/H	1/7/na	4/7.5/S-L		
Crew homogeneity related to culture	Training			4/8.8/M		
Crew homogeneity related to personality	Selection Psychotherapy	2/7.5/M-L	1/7/na	2/7.5/M		
Crew homogeneity related to interest in hobbies/activities	Selection Training	1/8/L		1/8/L		
Crew homogeneity related to expedition goals	Selection Training			1/7/na		
Crew heterogeneity related to gender	Selection			1/8/na		
Crew heterogeneity related to personality	Screening Selection	1/8/M		1/7/na		
Cluster C: Group cohesion						
High crew identity/affiliation	Training	1/7/na	2/7.5/na			
High compatibility of social dyads	Selection Training	1/7/na	1/7/na	2/7/na		
High role complementarity, consensus, redundancy, latency, and isomorphism	Selection Training		1/8/na	1/8/na		
High perceived closeness/similarity/equality	Training			2/9/na		
High crew loyalty to leader	Selection Training	1/8/na		1/8/na		

Number of studies reporting a significant association/average fidelity score of study/magnitude of effect statistics (S = small, M = moderate, L = large)

Table 9. Leadership Style and Skill Fidelity Scores and Impact by Performance Measure (1)

Malleable Leadership Characteristics	Countermeasure	Task Ability	Emotional Stability	Social Compatibility	Leadership	Overall
Cluster A: Leadership Style						
Participative/supportive style	Selection Training		1/9/L	1/6/na	2/8/L	
Emphasize discipline and adherence to regulations	Training				2/7.5/L	
Use of recognition and reward	Training				2/7.5/L	1/7/na
Willingness to deal with subordinate's personal problems	Training					
Keep informed	Training				1/8/L	
Maintain daily contact with crew	Training				1/8/L	
Stick by decisions once made	Training				1/8/L	
Cluster B: Leadership skills						
Able to adapt style to context	Selection Training			1/8/na		1/8/na
Able to maintain group harmony and resolve conflicts	Selection Training				2/8/L	1/7/na
Able to delegate authority	Training				1/6/na	1/7/na
Able to set work pace, standards	Training				1/6/na	1/7/na
Abel to respond to emergencies	Training				1/8/L	

(1) Note: Predictors of emotional stability, social compatibility, and overall performance relate to characteristics of the team leader.

Predictors of leadership relate to characteristics of individual crew members.

(2) Number of studies reporting a significant association/average fidelity score of study/magnitude of effect statistics (S = small, M = moderate, L = large)

Table 10. Prioritization of Predictors by Performance Category

Prioritization	Performance Measure				
Level	Task ability	Emotional stability	Social compatibility	Leadership	Overall
I. Top 3	Global personality traits Crew homogeneity/ heterogeneity Interpersonal needs and skills	Age, maturity, experience and skills Interpersonal needs and skills Global personality traits	Crew homogeneity/ heterogeneity Global personality traits Interpersonal needs and skills	Leadership style Global personality traits High motivation	High motivation Global personality traits Interpersonal needs and skills
II. Other Important	Age, maturity, experience and skills Group cohesion	Civilian status Clinical characteristics Mood High motivation Group cohesion High self-efficacy Cultural background	Age, maturity, experience and skills Group cohesion High motivation Cultural background	Leadership skills Interpersonal needs and skills High self-efficacy Age, maturity, experience and skills	Age, maturity, experience and skills High self-efficacy Clinical characteristics Mood Leadership skills Coping characteristics
III. Less Important	High self-efficacy High motivation High alertness Low hostility against the self Large groups High positive affectivity Number of previous expeditions High religiosity Unmarried Male gender Military/civilian status Urban residence.	Crew homogeneity/ heterogeneity Male gender Military service Urban residence High alertness High need for orderliness High conscientiousness High satisfaction with social support Low use of acceptance as a coping strategy Number of previous expeditions Enjoyment and sense of awe of the environment High/low interest in hobbies and leisure activities Low religiosity Large/small crew sizes Participative/supportive leadership style	Clinical characteristics Coping characteristics Enjoyment and awe of the environment Low interest in hobbies and leisure activities High religiosity Low work-related stress Low hostility against the self High alertness Large crews High positive affectivity Rural residence Military service Male gender Unmarried Participative/supportive leadership style Leader's ability to adapt style to context	High alertness High expressed control Married.	Cognition High/low interest in hobbies and leisure activities Military/civilian status Female gender Low family socioeconomic status Married/ unmarried Rural residence High openness to experience High religiosity Leaders' use of recognition and reward

Table 11. Prioritization of Psychosocial Characteristics Based on Quantity, Quality, and Fidelity of Research Findings

Psychosocial Characteristic Category	Performance categories	Statistically significant associations	Mean fidelity score	Small effect X 1	Medium effect X 2	Large effect X 3	Overall effect score
Demographic cluster A (maturity, experience, skills)	5	43	7.53	12	4	0	20
Demographic cluster B (unmarried)	4	6	7.17	0	1	0	2
Demographic cluster C (cultural background)	2	4	8.75	2	1	1	7
Personality cluster A (global traits)	5	44	9.04	13	11	6	53
Personality cluster B (motivation)	5	35	7.83	7	9	7	46
Personality cluster C (mood)	4	10	8.50	2	3	1	11
Personality cluster D (cognition)	5	6	8.17	0	5	1	13
Personality cluster E (self-efficacy)	5	16	8.38	5	4	1	14
Personality cluster F (interpersonal)	5	41	7.56	16	8	4	44
Clinical characteristics	4	11	8.45	1	3	2	13
Coping resources and strategies	3	7	7.14	3	0	1	6
Other characteristics	4	16	8.14	2	3	2	14
Group cluster A (homogeneity/heterogeneity)	3	21	7.10	1	3	5	22
Group cluster B (cohesion)	3	13	7.69	0	0	0	0
Leadership cluster A (style)	4	12	7.00	0	0	7	21
Leadership cluster B (skills)	3	10	7.30	0	0	2	6

Appendix: Review Study Characteristics and Variables

Ref	Citation	Setting	Study type	N	Dependent Variable	Independent Variables
2	Doll, Gunderson & Ryman, 1969	Polar	Longitudinal	240	Emotional	Other: Low number of hobbies
2	Doll, Gunderson & Ryman, 1969	Polar	Longitudinal	240	Emotional	Clinical: Clinical evaluations
4	Doll & Gunderson, 1971b	Polar	Longitudinal	245	Emotional	Demographic: Civilians
5	Gunderson & Arthur, 1966	Polar	Cross-sectional	n/a	Emotional	Demographic: Civilians
5	Gunderson & Arthur, 1966	Polar	Cross-sectional	n/a	Emotional	Demographic: Older age
5	Gunderson & Arthur, 1966	Polar	Cross-sectional	n/a	Emotional	Demographic: Education
5	Gunderson & Arthur, 1966	Polar	Cross-sectional	n/a	Emotional	Demographic: First-born ($r = .24 - .30$)
5	Gunderson & Arthur, 1966	Polar	Cross-sectional	n/a	Emotional	Personality: Hard, stubborn, blunt, or rough in manner; Low preference for friends who were sympathetic, sentimental, confiding, praising, and warm
6	Gunderson, 1968	Polar	Longitudinal	338	Emotional	Group: Large group size ($OR = 1.06 - 1.26$)
6	Gunderson, 1968	Polar	Longitudinal	338	Emotional	Demographic: Civilians ($OR = 1.43$)
7	Gunderson, 1973	Polar	Cross-sectional	139	Emotional	Personality: Low FIRO-B wanted control ($r = .25$)
7	Gunderson, 1973	Polar	Cross-sectional	139	Emotional	Personality: Low FIRO-B expressed affection ($r = .20$)
8	Gunderson & Nelson, 1965a	Polar	Longitudinal	142	Emotional	Demographic: Age by group size (linear at large stations, nonlinear at small stations)
8	Gunderson & Nelson, 1965a	Polar	Longitudinal	142	Emotional	Demographic: Rank by group size (linear at large stations, nonlinear at small stations)
8	Gunderson & Nelson, 1965a	Polar	Longitudinal	142	Emotional	Demographic: Military (work) experience by group size (linear at large stations, nonlinear at small stations)
8	Gunderson & Nelson, 1965a	Polar	Longitudinal	142	Emotional	Other: Low religiosity
13	Nelson & Gunderson,	Polar	Longitudinal	64	Emotional	Demographic: Older age ($OR = 2.16$)

	1963a					
13	Nelson & Gunderson, 1963a	Polar	Longitudinal	64	Emotional	Demographic: No record of delinquency/truancy (OR = 2.61)
14	Nelson & Orvick, 1964	Polar	Longitudinal	48	Emotional	Demographic: Older age (r = .40), education (r = .42), urban residence (large hometowns) (r = .40)
18	Ikegawa et al., 1998	Polar	Cross-sectional	5	Emotional	Demographic: Older age
25	Pope & Rogers, 1968	Polar	Longitudinal	13	Emotional	Personality: Self concept (physical fitness, stamina, professional capability)
25	Pope & Rogers, 1968	Polar	Longitudinal	13	Emotional	Personality: Motivation, good role specificity, ability to program self into role
26	Popkin et al., 1974	Polar	Cross-sectional	22	Emotional	Demographic: Education
28	Sandal et al., 1996	Mixed	Cross-sectional	68	Emotional	Personality: High PCI score on positive instrumental/expressive personality
35	Atlis et al., 2004	Polar	Longitudinal	2	Emotional	Other: Enjoyment and awe of environment
37	Kanas et al., 1996	Simulation	Longitudinal	3	Emotional	Leadership characteristics: Supervisor support (r = .71)
46	Gushin et al., 1998	Simulation	Longitudinal	6	Emotional	Personality: Ability to make personal self-concept more like concepts of other crew members
47	Weybrew & Noddin, 1979	Undersea	Cross-sectional	261	Emotional	Demographic: High SES (Occupation)
56	Leon et al., 2002	Polar	Longitudinal	6	Emotional	Personality: Low susceptibility to anxiety
57	Mocellin et al., 1991	Polar	Longitudinal	13	Emotional	Personality: Low susceptibility to anxiety
58	Palinkas & Browner, 1995	Polar	Longitudinal	119	Emotional	Clinical: Low baseline depressive symptoms (r = .31)
58	Palinkas & Browner, 1995	Polar	Longitudinal	119	Emotional	Coping: High satisfaction with social support (r = 0.20)
59	Smith & Haythorn, 1972	Simulation	Experimental	56	Emotional	Leadership characteristics: older age
61	Altman & Haythorn, 1967a	Simulation	Experimental	36	Emotional	Group: Crew homogeneity
72	Palinkas, Gunderson, Johnson et al., 2000	Polar	Longitudinal	657	Emotional	Personality: Low need for order (r = .14), boredom (r = .10), wanting efficiency in friends (r = .12), and FIRO-B score on affection - wanted (r = .17)
72	Palinkas, Gunderson, Johnson et al., 2000	Polar	Longitudinal	657	Emotional	Personality: Wanting optimism in friends (r = .18)

72	Palinkas, Gunderson, Johnson et al., 2000	Polar	Longitudinal	64	Emotional	Group: Crew cohesion
73	Johnson et al., 2003	Polar	Longitudinal	64	Emotional	Group: Crew cohesion
73	Johnson, et al., 2003	Polar	Longitudinal	64	Emotional	Group: High role complementarity, consensus, redundancy, latency, and isomorphism
74	Gunderson & Kapfer, 1966	Polar	Longitudinal	62	Emotional	Personality: High emotional control, low hostility against self, and high alert (r = .53)
76	Leon et al., 1989	Polar	Longitudinal	8	Emotional	Personality: High achievement motivation, self-control
77	Stange & Youngman, 1979	Polar	Review	n/a	Emotional	Personality: Introversion
78	Palinkas, Gunderson, Holland et al., 2000	Polar	Longitudinal	657	Emotional	Demographic: Civilians (r = .14)
78	Palinkas, Gunderson, Holland et al., 2000	Polar	Longitudinal	657	Emotional	Personality: Low levels of NEO scores on Neuroticism (r = .15), and FIRO-B score on Inclusion - wanted (r = .13)
82	Palinkas, Glogower et al., 2004	Polar	Longitudinal	313	Emotional	Demographic: Male gender (OR = 0.68)
82	Palinkas, Glogower et al., 2004	Polar	Longitudinal	313	Emotional	Demographic: Civilians (OR = 0.30)
82	Palinkas, Glogower et al., 2004	Polar	Longitudinal	313	Emotional	Demographic: Education (OR = 0.80)
83	Palinkas, Johnson et al., 2004	Polar	Longitudinal	217	Emotional	Demographic: Cultural background (Russians report more anxiety (ES = 0.28) but less depression (ES = -0.14), fatigue (ES = -0.81) and vigor (ES = -0.44) than Americans)
83	Palinkas, Johnson et al., 2004	Polar	Longitudinal	217	Emotional	Demographic: Cultural background (Poles report more anger (ES = 0.20) but less fatigue (ES = -0.37) and vigor (ES = -0.29) than Americans)
83	Palinkas, Johnson et al., 2004	Polar	Longitudinal	217	Emotional	Demographic: Cultural background (Chinese report more depression (ES = 0.30) and confusion (ES = 0.43) but less fatigue (ES = -0.50) and vigor (ES = -0.27) than Americans)
83	Palinkas, Johnson et al., 2004	Polar	Longitudinal	217	Emotional	Demographic: Cultural background (Indians report more depression (ES = 0.44), anger (ES = 0.25), and vigor (ES = 0.80) but less fatigue (ES = -0.50) than Americans)
85	Haythorn & Altman, 1967	Simulation	Experimental	36	Emotional	Group: Compatible isolated dyads

87	Haythorn et al., 1966	Simulation	Experimental	36	Emotional	Group: Dyads homogeneous in personality (low on dominance)
87	Haythorn et al., 1966	Simulation	Experimental	36	Emotional	Group: Dyads homogeneous in achievement
88	Palinkas et al., 1995	Polar	Longitudinal	119	Emotional	Demographic: Not married ($r = .35$)
88	Palinkas et al., 1995	Polar	Longitudinal	119	Emotional	Clinical: Low baseline depression ($r = .51$)
89	Biersner & LaRocco, 1987	Simulation	Experimental	30	Emotional	Demographic: Education and work experience
89	Biersner & LaRocco, 1987	Simulation	Experimental	30	Emotional	Personality: High internality-externality (low extraversion), disinhibition (low repression), and socialization
90	Palinkas, 1991	Polar	Cross-sectional	513	Emotional	Group: Small group size ($ES = -0.37$)
91	Taylor, 1993	Polar	Review	n/a	Emotional	Demographic: Older age
92	Palinkas et al., 1989	Polar	Cross-sectional	513	Emotional	Demographic: Older age ($r = .12$), civilians ($r = .16$)
92	Palinkas et al., 1989	Polar	Cross-sectional	513	Emotional	Personality: Low need for nurturance ($r = .12$) and autonomy ($r = .24$)
92	Palinkas et al., 1989	Polar	Cross-sectional	513	Emotional	Group: Small group size ($r = .10$)
96	Rivolier et al, 1999	Polar	Longitudinal	27	Emotional	Personality: Low sexual preoccupation, boredom, obsessive thoughts, pessimism; high emotional control
97	Barbarito & Peri, 1999	Polar	Longitudinal	8	Emotional	Coping: Low acceptance ($r = .70$)
101	Godwin, 1985	Polar	Cross-sectional	268	Emotional	Demographic: Unmarried, high SES (occupation)
106	Smith, 1969	Mixed	Review	n/a	Emotional	Group: size
108	Evans et al, 1987	Polar	Longitudinal	9	Emotional	Other: Hobbies, activities
110	Slater, 1969	Polar	Review	n/a	Emotional	Other: Low interest in hobbies and activities
111	Eilbert & Glaser, 1959	Polar	Cross-sectional		Emotional	Personality: High conscientiousness, responsible
112	Wright et al., 1963	Polar	Cross-sectional	197	Emotional	Personality: High EPPS scores on deference and orderliness, low scores on aggression
112	Wright et al., 1963	Polar	Cross-sectional	197	Emotional	Clinical: Low MMPI scores on hypochondriasis, psychopathic deviate, psychasthenia, schizophrenia, and hypomania
113	Weybrew et al., 1961	Undersea	Longitudinal	n/a	Emotional	Demographic: unmarried
115	Taylor & McCormick, 1985	Polar	Longitudinal	12	Emotional	Demographic: older age
115	Taylor & McCormick, 1985	Polar	Longitudinal	12	Emotional	Other: Number of expeditions

120	Kanas et al., 2001	Space	Cross-sectional	14	Emotional	Demographic: Cultural background (ES = 1.85)
8	Gunderson & Nelson, 1965a	Polar	Longitudinal	142	Leadership	Leadership characteristics: Solicit advice of subordinates
10	Nelson, 1963a	Polar	Cross-sectional	67	Leadership	Leadership characteristics: Emotionally controlled, stable, adaptable, accepting of authority, and motivated to be part of a group (ES = 0.86)
10	Nelson, 1963a	Polar	Cross-sectional	67	Leadership	Leadership characteristics: Maintaining group harmony (ES = 1.47)
11	Nelson, 1964a	Polar	Longitudinal	72	Leadership	Leadership characteristics: Self-confident (ES = 0.92), alert (ES = 1.05), job motivated (ES = 0.85), and aggressive (ES = 0.96)
11	Nelson, 1964a	Polar	Longitudinal	72	Leadership	Leadership characteristics: Job satisfaction (ES = 0.71), industrious (ES = 1.50), emotionally controlled (ES = 1.33), accepting of authority (ES = 1.27), and motivated to be part of a group (ES = 1.33)
24	Law, 1960	Polar	Longitudinal		Leadership	Leadership characteristics: Watch for clique rivalries and do not align themselves with any one subgroup
48	Rose et al., 1994	Space	Cross-sectional	65	Leadership	Leadership characteristics: Low PCI score on Negative instrumentality ($r = .25$) and Impatience/irritability ($r = .24$), high PCI score on Negative Expressivity – Negative Communion ($r = .38$); Low NEO score on Openness ($r = .33$), high NEO score on Agreeableness ($r = .33$)
63	Sells, 1965	Polar	Longitudinal	n/a	Leadership	Leadership characteristics: Give personal praise to members and reward them whenever opportunities arise
63	Sells, 1965	Polar	Longitudinal	n/a	Leadership	Leadership characteristics: Not soft or easy going but emphasized discipline and adherence to regulations
65	Nicholas & Penwell, 1995	Mixed	Review	n/a	Leadership	Leadership characteristics: Personal traits, task management style, interpersonal style, and group maintenance style
66	Nelson, 1962	Polar	Longitudinal	48	Leadership	Leadership characteristics: Related to men as individuals rather than subordinates ($r = .85$), praised men for job well done ($r = .85$), kept informed about station activities at all times ($r = .79$), maintained daily contact with men ($r = .76$), ability to plan station activities ($r = .85$), ability to make

						emergency decisions ($r = .85$), participate in group activities ($r = .69$), solicited advice from subordinates ($r = .60$), set an example ($r = .67$), able to maintain discipline ($r = .69$), stuck by decisions once made ($r = .46$), demanded good work ($r = .46$)
67	Campbell, 1953	Undersea	Cross-sectional	n/a	Leadership	Leadership characteristics: Ability to delegate authority and number of positive contacts with other officers and men
68	Weybrew, 1991	Undersea	Review	n/a	Leadership	Leadership characteristics: Participative/supportive style in routine situations and authoritarian style in emergencies
71	Nicholas et al., 1988	Mixed	Review	n/a	Leadership	Leadership characteristics: Highly task-oriented to the goals of the group and delegate and seek advice of members, highly people-oriented, and show concern about team members
72	Palinkas, Gunderson, Johnson et al., 2000	Polar	Longitudinal	657	Leadership	Leadership characteristics: Married ($r = .16$), low motivation/high adaptability ($r = .12$), low need for orderliness ($r = .12$), high expressed control ($r = .10$)
91	Taylor, 1993	Polar	Review	n/a	Leadership	Leadership characteristics: ruling by consensus
95	WHO, 1985	Polar	Review	n/a	Leadership	Leadership characteristics: versatility regarding responsibilities, readiness to discuss issues, desire and skills in resolving issues
7	Gunderson, 1973	Polar	Cross-sectional	139	Overall	Personality: Low FIRO-B score on Control - wanted ($r = .20$) and Inclusion – expressed ($r = .20$)
8	Gunderson & Nelson, 1965a	Polar	Longitudinal	142	Overall	Demographic: age by group size (linear at large stations, nonlinear at small stations)
8	Gunderson & Nelson, 1965a	Polar	Longitudinal	142	Overall	Demographic: rank by group size (linear at large stations, nonlinear at small stations)
8	Gunderson & Nelson, 1965a	Polar	Longitudinal	142	Overall	Demographic: military experience by group size (linear at large stations, nonlinear at small stations)
8	Gunderson & Nelson, 1965a	Polar	Longitudinal	142	Overall	Other: Low interest in hobbies
8	Gunderson & Nelson, 1965a	Polar	Longitudinal	142	Overall	Other: Participation in clubs, sports, hobbies by group size: high at large stations, low at small stations)
13	Nelson & Gunderson,	Polar	Longitudinal	64	Overall	Demographic: Low family socioeconomic status (OR = 2.37)

	1963a					
16	Biersner & Hogan, 1984	Polar	Cross-sectional	25	Overall	Personality: Low scores for emotional expressiveness (r = .61), self-reflection (r = .51), Openness to experience seeking (r = .56), divergent thinking (r = .39), and challenge (r = .44); high scores for status seeking (need achievement)(r = .36)
19	Kahn & Leon, 1993	Polar	Longitudinal	4	Overall	Clinical: High positive affectivity (r = .46)
19	Kahn & Leon, 1993	Polar	Longitudinal	4	Overall	Personality: High achievement motivation and self-confidence; low bodily concern and competitiveness
20	Palmai, 1963	Polar	Longitudinal	14	Overall	Personality: High introversion
21	McGuire & Tolchin, 1961	Polar	Longitudinal	17	Overall	Demographic: Older age
22	Nardini et al, 1962	Polar	Longitudinal	579	Overall	Personality: Sensitive to needs of others, low boredom
22	Nardini et al, 1962	Polar	Longitudinal	579	Overall	Coping: Low demands for social support
22	Nardini et al, 1962	Polar	Longitudinal	579	Overall	Clinical: Predeployment evaluations (r = .41 - .66)
23	Gunderson, 1966	Polar	Longitudinal		Overall	Personality: Low motivation
43	Radloff & Helmreich, 1968	Undersea	Cross-sectional	n/a	Overall	Demographic: Rural residence
48	Rose et al, 1994	Space	Cross-sectional	65	Overall	Personality: High NEO scores for agreeableness (r = .29); low openness (r = .28) and conscientiousness (r = .17)
54	Taylor, 1987	Polar	Review	n/a	Overall	Personality: High motivation to achieve, satisfaction with social support
54	Taylor, 1987	Polar	Longitudinal	204	Overall	Personality: High 16PF emotionally stable (ES = 0.40), low 16PF anxiety (ES = 0.41)
63	Sells, 1965	Polar	Longitudinal	n/a	Overall	Leadership characteristics: ability to set work pace and establish a social atmosphere
63	Sells, 1965	Polar	Longitudinal	n/a	Overall	Leadership characteristics: positive about their jobs, used delegation effectively, had pride in organizations and personnel, used recognition and reward, gave frequent complements to individuals, and accepted each individual's personal problems
64	Kinsey, 1959	Undersea	Longitudinal	n/a	Overall	Leadership characteristics: Quality of leadership
66	Nelson, 1962	Polar	Cross-sectional		Overall	Leadership characteristics: Decision-making methods used by leader by context (technical = participatory, emergency

						= authoritarian)
69	Miller et al., 1971	Undersea	Longitudinal	n/a	Overall	Leadership characteristics: High SES (occupation)
72	Palinkas, Gunderson, Johnson et al., 2000	Polar	Longitudinal	657	Overall	Demographic: Military service (r = .16)
72	Palinkas, Gunderson, Johnson et al., 2000	Polar	Longitudinal	657	Overall	Personality: Low boredom (r = .10), need for orderliness (r = .11), and FIRO-B score on wanted affection (r = .13)
74	Gunderson & Kapfer, 1966	Polar	Longitudinal	158	Overall	Personality: Low ratings of self reliant-dependent (r = .19), and adaptable-rigid (r = .31); high ratings of tense-relaxed (r = .22) and friendly (r = .39)
75	Gunderson & Nelson, 1965b	Polar	Longitudinal	158	Overall	Personality: High social compatibility (ES = 1.10), motivation (ES = 1.59), usefulness (ES = 1.57), teamwork (ES = 1.34, achievement (ES = 1.44), and efficiency (ES = 1.19), low boredom (ES = 1.14)
78	Palinkas, Gunderson, Holland et al., 2000	Polar	Longitudinal	657	Overall	Demographic: military service (r = .11)
78	Palinkas, Gunderson, Holland et al., 2000	Polar	Longitudinal	657	Overall	Personality: Low NEO scores on extraversion (r = .14) and conscientiousness (r = .14)
84	Grant et al., 2007	Polar	Longitudinal	348	Overall	Personality: High NEO scores on openness (OR = 5.2)
84	Grant et al., 2007	Polar	Longitudinal	348	Overall	Coping: higher levels of Emotion-focused coping (OR = 2.7)
84	Grant et al., 2007	Polar	Longitudinal	348	Overall	Clinical: lower subjective health complaints (OR = 0.3)
84	Grant et al., 2007	Polar	Longitudinal	348	Overall	Demographic: female gender (OR = 1.6)
86	Taylor et al., 1969	Simulation	Experimental	168	Overall	Personality: Low MMPI scores of repression-sensitization, control, and heterosexual aggression; high score on responsibility
98	Crocq et al., 1974	Polar	Longitudinal	120	Overall	Personality: Low motivation
98	Crocq et al., 1974	Polar	Longitudinal	120	Overall	Demographic: Occupation (scientists adjusted better than technicians, cooks, radio operators)
100	Taylor, 1974	Polar	Longitudinal	93	Overall	Personality: less group dependent (16PF Factor Q2) (ES = .62)
102	Nelson, 1963b	Polar	Longitudinal		Overall	Clinical Evaluations: Summary assessment
103	Natani, 1971	Polar	Longitudinal	21	Overall	Demographic: Civilians
109	Draggan, 1987	Polar	Review	n/a	Overall	Personality: emotional maturity, reasonable goal formation and implementation strategies, introverted
109	Draggan, 1987	Polar	Review	n/a	Overall	Demographic: Older age

109	Draggan, 1987	Polar	Review	n/a	Overall	Other: Few or unspecific hobbies or activities
114	Owens, 1975	Polar	Longitudinal	n/a	Overall	Demographic: Unmarried
114	Owens, 1975	Polar	Longitudinal	n/a	Overall	Personality: Low neuroticism
116	De Monchaux et al., 1979	Polar	Longitudinal	77	Overall	Personality: Introverted, trusting of others, self-reliant, emotionally stable
117	Gunderson et al 1964	Polar	Longitudinal	184	Overall	Demographic: Older age (r = .21), years of service (r = .20), rank (r = .28), education (r = .21), married (r = .21), and no history of delinquency/truancy (r = .27)
117	Gunderson et al 1964	Polar	Longitudinal	184	Overall	Other: High religiosity (r = .23), high hobbies/activities (r = .38)
118	Nelson & Gunderson, 1962	Polar	Longitudinal	18	Overall	Personality: adaptability (r = .50), emotionally controlled (r = .50), job motivation (r = .59), industriousness (r = .66), happiness (r = .52), job satisfaction (r = .61), motivation to be part of group (r = .50).
119	Nelson & Gunderson, 1963	Polar	Longitudinal	139	Overall	Personality: emotionally controlled (r = .68), job motivation (r = .48), industriousness (r = .56), happiness (r = .48), job satisfaction (r = .35), motivation to be part of group (r = .53), accept authority (r = .56), achievement motivation (r = .53), attitude towards project (r = .48), alertness (r = .43), self-confidence (r = .29).
1	Doll & Gunderson, 1971a	Polar	Cross-sectional	245	Social	Group: Station size (ES = 0.52)
2	Doll et al., 1969	Polar	Longitudinal	240	Social	Clinical: Predeployment evaluations by occupation
7	Gunderson, 1973	Polar	Cross-sectional	139	Social	Personality: Low FIRO-B score on expressed affection (r = .20)
8	Gunderson & Nelson, 1965a	Polar	Longitudinal	142	Social	Demographic: Age by group size: linear in large stations, nonlinear in small stations
8	Gunderson & Nelson, 1965a	Polar	Longitudinal	142	Social	Other: Low participation in clubs, sports, hobbies (at small stations)
8	Gunderson & Nelson, 1965a	Polar	Longitudinal	142	Social	Demographic: Rank by group size: linear in large stations, nonlinear in small stations
8	Gunderson & Nelson, 1965a	Polar	Longitudinal	142	Social	Demographic: Military (work) experience by group size: linear in large stations, nonlinear in small stations
9	Gunderson & Ryman,	Polar	Longitudinal	270	Social	Group: Crew homogeneity related to urban-rural residence

	1967					(r = .67)
9	Gunderson & Ryman, 1967	Polar	Longitudinal	270	Social	Group: Crew homogeneity related to hobbies (r = .85)
9	Gunderson & Ryman, 1967	Polar	Longitudinal	270	Social	Group: Crew homogeneity related to personality (need for achievement (r = .40), autonomy (r = .49), nurturance (r = .36), motivation (r = .44), and describing friends as efficient (r = .33))
9	Gunderson & Ryman, 1967	Polar	Longitudinal	270	Social	Personality: Low FIRO-B Control – wanted (r = .49)
12	Nelson, 1964b	Polar	Longitudinal	59	Social	Group: Crew homogeneity related to age
14	Nelson & Orvick, 1964	Polar	Longitudinal	48	Social	Demographic: Rural residence (Small hometown) (r = .49)
14	Nelson & Orvick, 1964	Polar	Longitudinal	48	Social	Other: High religiosity (r = .45)
15	Leon & Sandal, 2003	Polar	Longitudinal	12	Social	Personality: Mutual respect, emotional support, ability to confide in partner, and motivation to maintain positive and supportive relationships
17	Blair, 1992	Polar	Longitudinal	20	Social	Leadership characteristics: Ability to adapt leadership style to context
21	McGuire & Tolchin, 1961	Polar	Longitudinal	17	Social	Demographic: Older age
21	McGuire & Tolchin, 1961	Polar	Longitudinal	17	Social	Group: Crew homogeneity related to income/socioeconomic status
23	Gunderson, 1966	Polar	Review	n/a	Social	Group: Crew homogeneity related to occupation
24	Law, 1960	Polar	Longitudinal		Social	Group: Crew homogeneity related to culture
27	Rosnet et al., 2004	Polar	Longitudinal	52	Social	Group: Crew heterogeneity related to gender
30	Weiss et a., 2007	Polar	Cross-sectional	27	Social	Demographic: Age by occupation (Young scientists expressed a higher need for privacy whereas older technicians preferred places for social leisure)
32	Sandal, 2004	Simulation	Longitudinal	12	Social	Group: Crew homogeneity related to culture (Language, attitudes toward the experiment, privacy, emotional expressiveness, hygiene, appropriate gender behavior, coping in relation to conflict and housekeeping)
34	Leon & Scheib, 2007	Polar	Longitudinal	2	Social	Group: Crew homogeneity related to personality traits and expedition goals
35	Atlis et al., 2004	Polar	Longitudinal	2	Social	Group: Equality of dyad

36	Kanas, 1998	Space	Review	n/a	Social	Group: Crew homogeneity related to gender, culture, work experience, language and dialect, and task vs supportive leadership
38	Kanas, Salnitskiy, Weiss et al., 2001	Space	Cross-sectional	71	Social	Clinical: Positive affectivity, low work pressure
39	Oberg, 1981	Space	Anecdotal	3	Social	Group: Crew homogeneity related to language, culture and political orientation
40	Chaikin, 1985	Space	Anecdotal	n/a	Social	Group: Crew homogeneity related to language, culture and political orientation
41	Bluth, 1981	Space	Anecdotal	n/a	Social	Group: Crew homogeneity related to language, culture and political orientation
42	Bluth, 1984	Space	Anecdotal	n/a	Social	Group: Crew homogeneity related to language, culture and political orientation
43	Radloff & Helmreich, 1968	Undersea	Cross-sectional	n/a	Social	Demographic: First born individuals
44	Kelly & Kanas, 1992	Space	Cross-sectional	54	Social	Other: Shared experience (ES = 3.13), excitement of space flight (ES = 1.52), close quarters (ES = 1.91), and isolation from Earth (ES = 1.45)
45	Kelly & Kanas, 1993	Space	Cross-sectional	54	Social	Other: Shared experience (ES = 1.90) and excitement of space flight (ES = 1.61)
46	Gushin et al., 1998	Simulation	Longitudinal	6	Social	Personality: Ability to make personal self-concept more like concepts of other crew members
48	Rose et al., 1994	Space	Cross-sectional	65	Social	Personality: Low PCI score on impatience/irritability ($r = .32$), and negative instrumentality ($r = .25$); Low NEO score on Openness ($r = .22$); high NEO score on Agreeableness ($r = .41$)
49	McFadden et al., 1994	Space	Cross-sectional	66	Social	Personality: High positive instrumentality and expressivity
50	Sandal et al., 1999	Undersea	Cross-sectional	50	Social	Personality: High positive instrumentality and expressivity ($r = .32$); strong achievement motivation ($r = .15$)
50	Sandal et al., 1999	Undersea	Cross-sectional	50	Social	Coping: Use of problem-solving strategies ($r = .13$)
52	Sandal et al., 1995	Simulation	Longitudinal	12	Social	Personality: Dominance and task motivation
53	Sandal et al., 1998	Undersea	Longitudinal	50	Social	Personality: High PCI scores on positive instrumental/expressive personality and low motivation
53	Sandal et al., 1998	Undersea	Longitudinal	50	Social	Coping: High social support

59	Smith & Haythorn, 1972	Simulation	Experimental	56	Social	Leadership characteristics: Older age
59	Smith & Haythorn, 1972	Simulation	Experimental	56	Social	Group: Compatible groups
61	Altman & Haythorn, 1967a	Simulation	Experimental	36	Social	Group: Crew heterogeneity related to personality, egocentric characteristics (dominance and dogmatism), and homogeneity on sociocentric characteristics (affiliation and achievement)
68	Weybrew, 1991	Undersea	Review	n/a	Social	Leadership characteristics: Participative/supportive style of leadership
70	Kanki & Gregorich, 1992	Expedition	Longitudinal	n/a	Social	Group: Team preference for its leader
72	Palinkas, Gunderson, Johnson et al., 2000	Polar	Longitudinal	657	Social	Demographic: Military service ($r = .13$)
72	Palinkas, Gunderson, Johnson et al., 2000	Polar	Longitudinal	657	Social	Personality: Low FIRO-B score on affection wanted ($r = .11$); low need for achievement ($r = .15$), and boredom ($r = .10$); high wanting optimism in friends ($r = .14$)
73	Johnson et al., 2003	Polar	Longitudinal	64	Social	Group: High role complementarity, consensus, redundancy, latency, and isomorphism
74	Gunderson & Kapfer, 1966	Polar	Longitudinal	62	Social	Personality: High emotional control and alert; low hostility against self ($r = .38$)
79	Leon et al., 1994	Polar	Longitudinal	12	Social	Demographic: Cultural background (Russians treated women as subordinates; Americans treated them as equals)
81	Schmidt et al., 2005	Polar	Cross-sectional	187	Social	Demographic: Male gender
83	Palinkas, Johnson et al., 2004	Polar	Longitudinal	217	Social	Demographic: Collective cultural orientation ($r = .37$)
83	Palinkas, Johnson et al., 2004	Polar	Longitudinal	217	Social	Demographic: Cultural background (Russians report more seeking advice ($ES = 0.81$) and interaction ($ES = 0.47$) from other crew members than Americans)
83	Palinkas, Johnson et al., 2004	Polar	Longitudinal	217	Social	Demographic: Cultural background (Indians report more seeking advice ($ES = 0.73$) and interaction ($ES = 1.67$) from other crew members than Americans)
83	Palinkas, Johnson et al.,	Polar	Longitudinal	217	Social	Demographic: Cultural background (Chinese report more

	2004					interaction (ES = 1.53) from other crew members than Americans)
85	Haythorn & Altman, 1967	Simulation	Experimental	36	Social	Group: Compatible isolated dyads
91	Taylor, 1993	Polar	Review	n/a	Social	Demographic: older age
93	Gushin et al., 1996	Simulation	Longitudinal	6	Social	Group: Regarding one another as close or similar
94	Gushin et al., 1997	Simulation	Longitudinal	6	Social	Group: Sharing common values and beliefs
95	WHO, 1985	Polar	Review	n/a	Social	Personality: Tolerance, flexibility, sense of humor, balance of motivational factors
95	WHO, 1985	Polar	Review	n/a	Social	Other: Lack of major recent life event change
96	Rivolier et al., 1999	Polar	Longitudinal	27	Social	Personality: Low self-centeredness, criticism of others, aggressiveness, withdrawal to oneself, distrust
99	Natani et al., 1974	Polar	Longitudinal	62	Social	Group: Crew homogeneity in Occupation
103	Natani, 1971	Polar	Longitudinal	21	Social	Demographic: occupational differences in between group interaction
104	Harrison, 1980	Mixed	Review	n/a	Social	Group: size
105	Kanas & Feddersen, 1971	Space	Review	n/a	Social	Group: size
106	Smith, 1969	Mixed	Review	n/a	Social	Group: size
107	Lozano & Wong, 1993	Space	Cross-sectional	37	Social	Group: Crew homogeneity related to culture (personal hygiene standards and grooming habits, verbal and nonverbal communication, gender roles, norms and stereotypes, professional background, decision-making processes and religious beliefs) (ES = 0.68 - 0.93)
113	Weybrew et al., 1961	Undersea	Longitudinal	n/a	Social	Demographic: unmarried
1	Doll & Gunderson, 1971a	Polar	Longitudinal	245	Task	Group: Group size (ES = 0.49)
3	Doll & Gunderson, 1969	Polar	Longitudinal	195	Task	Demographic: Civilians (ES = 0.44)
7	Gunderson, 1973	Polar	Cross-sectional	240	Task	Personality: Low expressed emotion (r = .25; low FIRO-B score on affection – expressed (r = .20)
9	Gunderson & Ryman, 1967	Polar	Longitudinal	270	Task	Group: Crew heterogeneity related to personality (FIRO-B score on inclusion – expressed (r = .45) and control – expressed (r = .42))

9	Gunderson & Ryman, 1967	Polar	Longitudinal	270	Task	Group: Crew homogeneity related to personality (FIRO-B wanted control (r = .49), autonomy (r = .55), motivation (r = .44))
9	Gunderson & Ryman, 1967	Polar	Longitudinal	270	Task	Group: Crew homogeneity related to personality (describing friends as efficient)(r = .54)
9	Gunderson & Ryman, 1967	Polar	Longitudinal	270	Task	Group: Crew homogeneity related to urban-rural residence (r = .62) and number of hobbies (r = .85)
13	Nelson & Gunderson, 1963a	Polar	Longitudinal	64	Task	Demographic: No record of delinquency/truancy (OR = 2.62)
14	Nelson & Orvick, 1964	Polar	Longitudinal	48	Task	Other: High religiosity (r = .46)
19	Kahn & Leon, 1993	Polar	Longitudinal	4	Task	Clinical: Positive affectivity (r = .16)
29	Sauer et al., 1999	Polar	Cross-sectional	16	Task	Demographic: Occupation (Scientists)
31	Sarris, 2006	Polar	Cross-sectional	117	Task	Demographic: Occupation (Scientists) (r = .41)
31	Sarris, 2006	Polar	Cross-sectional	117	Task	Personality: High role clarity (r = .38) and low role conflict (r = .25)
31	Sarris, 2006	Polar	Cross-sectional	117	Task	Personality: Perceived fit with station culture (r = .48)
31	Sarris, 2006	Polar	Cross-sectional	117	Task	Demographic: Male gender (r = .25), older age (r = .41), number of expeditions (r = .20)
31	Sarris, 2006	Polar	Cross-sectional	117	Task	Personality: High extraversion (r = .20)
33	Rosnet et al., 2000	Polar	Cross-sectional	16	Task	Personality: Low assertiveness (ES = -2.07) and extraversion (ES = -2.02), concordance between real and ideal self (r = .55)
48	Rose et al., 1994	Space	Cross-sectional	65	Task	Personality: Low PCI scores on negative expressivity - communion (r = .35); low NEO score on Openness (r = .38), high NEO score on Agreeableness (r = .27)
49	McFadden et al., 1994	Space	Cross-sectional	66	Task	Personality: High PCI scores on instrumentality and expressivity and low levels of motivation/high adaptability
55	Gunderson, 1974	Polar	Review	n/a	Task	Personality: High achievement motivation
62	Altman & Haythorn, 1967b	Simulation	Experimental	36	Task	Group: Crew homogeneity related to personality (dogmatism, achievement affiliation, and dominance)
62	Altman & Haythorn, 1967b	Simulation	Experimental	36	Task	Group: Groups high in affiliation
70	Kanki & Gregorich, 1992	Expedition	Longitudinal	n/a	Task	Group: Team preference for its leader

72	Palinkas, Gunderson, Johnson et al., 2000	Polar	Longitudinal	657	Task	Military ($r = .13$), years of service ($r = .19$), low boredom ($r = .10$) and low FIRO-B score of affection - wanted ($r = .12$)
74	Gunderson & Kapfer, 1966	Polar	Longitudinal	62	Task	Personality: High emotional control and alert; low hostility against self ($r = .43$)
85	Haythorn & Altman, 1967	Simulation	Experimental	36	Task	Group: Compatible isolated dyads
96	Rivolier et al., 1999	Polar	Longitudinal	27	Task	Personality: Low ritualization of activities, concentration difficulties, hypo or hyperinvestment in work
114	Owens, 1975	Polar	Longitudinal	n/a	Task	Demographic: Unmarried
114	Owens, 1975	Polar	Longitudinal	n/a	Task	Personality: Low neuroticism

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13. ABSTRACT (Maximum 200 words) The Behavioral Health and Performance (BHP) element addresses human health risks in the NASA Human Research Program, including the risk of behavioral health and psychiatric conditions. BHP supports and conducts research to mitigate the behavioral medicine risk for exploration missions and, in some instances, current flight medical operations. BHP has identified research gaps within the behavioral medicine risk. Gap BMed6: What psychosocial characteristics predict success in an isolated, confined environment (ICE), as defined in the BHP Integrated Research Plan, outlines a research strategy that primarily incorporates identifying the most malleable psychosocial characteristics in isolated, confined, and extreme environments to develop and/or strengthen these characteristics to serve as countermeasures of possible decrements in BHP success. The first step in addressing this gap is to conduct an extensive and exhaustive literature review to identify the most malleable psychosocial characteristics that predict success when considering the context of an ICE. This report addresses two specific aims: identify psychosocial characteristics that predict success in ICEs; and identify those characteristics that are most malleable				
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