



Antarctica Meta-analysis: Psychosocial Factors Related to Long-duration Isolation and Confinement

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Acronyms

ANARE	Australian National Antarctic Research Expeditions
BHP	behavioral, health, and performance
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition
ICE	isolated, confined, and extreme
PANAS	Positive Affect Negative Affect Schedule
POMS	Profile of Mood States
REM	rapid eye movement
16PF	Sixteen Personality Factor Questionnaire
SSAD	subsyndromal seasonal affective disorder

Abstract

The purpose of this study was to examine the psychological effects of wintering-over in Antarctica. We considered the feasibility of a meta-analysis for combining the results of relevant empirical studies in this area. As an ICE [isolated, confined, and extreme] environment, Antarctica provides invaluable opportunities to experience stressors more common to spaceflight than to the average person's everyday life. The increased prevalence of psychological symptoms, syndromes, and psychiatric disorders, as well as positive salutogenic effects, were expected to be associated with various demographic and environmental factors. The great disparity between experimental design, statistical methodology, and reporting details led to the conclusion that a traditional meta-analysis was not feasible. Possible forward work considerations include a systematic literature review, a re-analysis of the data (for certain individual measures) using modern longitudinal techniques, an alternative meta-analysis method (for certain individual measures), and/or a qualitative literature review. NASA's BHP [behavioral, health, and performance] Element is planning to conduct the systematic review in FY10.

Introduction

NASA is committed to longer-duration spaceflight, including astronauts returning to the moon and crewed flights to Mars. All of this requires a deeper understanding of the impact extended missions pose for astronauts. A primary concern is the effect that extended periods of isolation will have on astronauts' psychological well-being. Predicting the psychological impact of longer-duration missions must include a consideration of space environment factors, which will likely intensify feelings of isolation. These factors include: longer periods away from family and friends, absence of earthly conveniences and daily routines, as well as time spent confined in the spacecraft due to living in a potentially dangerous environment. Evidence gathered in space analogs such as the Antarctic provides insight into psychological issues that might arise during such longer-duration missions.

Antarctica as a Space Analog

The Antarctic is physically remote from the rest of the world, and during winter months it is further isolated since the weather precludes travel to and from the continent. Additionally, 24-hour periods of darkness prevent travel on the continent. It is the coldest, windiest, and highest of Earth's continents; therefore, outdoor excursions are limited even when there is daylight. Living and working space also provides relatively small and limited areas in which to live and work. These attributes define the Antarctic as an isolated, confined, and extreme (ICE) environment, thereby making it an important analog for spaceflight because long-duration missions will inherently present similar challenges.

Documentation of psychological effects in Antarctica

Psychological effects of Antarctic expeditions have been well documented from anecdotal accounts recounted by the earliest explorers. Frederick Cook, the physician of the multinational crew aboard the *Belgica*, described the psychological state of his crew as follows: "The curtain

of blackness which has fallen over the outer world of icy desolation has descended upon the inner world of our souls. Around the tables, in the laboratory, and in the forecabin, men are sitting about sad and dejected, lost in dreams of melancholy from which, now and then, one arouses with an empty attempt at enthusiasm” (Cook, 1909). Men from Sir Ernest Shackleton’s Imperial Trans-Antarctic Expedition of 1914–1917 were stranded on Elephant Island after their ship, the *Endurance*, was destroyed after it was trapped in ice in the Weddell Sea. The carpenter for the Expedition, Harry McNeish, wrote of being on the island saying, “I don’t think there are ever many fine days on this forlorn island... I don’t think there will be many survivors if they have to put in a winter here” (American Museum of Natural History, 2001).

It was not until the late 1950s and 1960s, however, that these psychological effects were documented for research purposes by investigators such as Gunderson, Taylor, and Rivolier (Gunderson and Nelson, 1962; Taylor, 1969; Rivolier, 1963). Although research needs began to be addressed by collecting data relating to psychological well-being, the findings from these initial research efforts seem only to raise more questions than answers. Often, data were inconsistently collected and analyzed and research methodologies were not reliably administered. Additionally, due to the specific samples used, it is difficult to generalize results across population groups. In more recent research, an effort has been made to systematically examine psychological effects on well-being. For example, Suedfeld et al. (1992) looked at emotional stability and Mocellin, et al. (1991) examined anxiety in polar environments. Nonetheless, even at the present time, a complete understanding of how (and to what extent) the characteristics of ICE environments impact psychological well-being remains unknown. As Palinkas and Suedfeld (2007) note, “Apart from anecdotal reports of polar madness and cabin fever, little is known about the psychological demands people face on polar expeditions ...”

Purpose of the study

The purpose of this study was to examine the effects that wintering-over in Antarctica has on psychological well-being, and to relate the findings to longer-duration spaceflight. The aim was to employ meta-analytic techniques to synthesize existing empirical research, thus affording a more complete understanding of the data than can be provided by one study alone in an effort to apply these findings to astronauts on long-duration missions. The study is addressed by the Behavioral Health and Performance (BHP) Element within NASA’s Human Research Program. Specifically, this study addresses the Risk of Behavioral and Psychiatric Conditions; Gap 6: What psychosocial characteristics predict success in an ICE environment?

The hypotheses initially developed for this study were generated based on the authors’ intent to account for factors that are directly relevant to spaceflight dynamics (eg, duration of mission, individual selection, harshness of climate, etc.). These hypotheses are supported by the literature summarized below as well as by a *Lancet* article by Palinkas and Suedfeld (2007) in which the authors discussed many of the psychological effects experienced on polar expeditions. Although data limitations in this study prevented hypothesis testing, these hypotheses are provided for background information, as they were foundational to the initial project.

Categorization of psychological effects experienced in Antarctica

Psychological Symptoms

Most of the literature gathered for this study addresses psychological symptoms experienced in the Antarctic. Somatic symptoms such as fatigue, headaches, and weight gain are often listed. Disturbed sleep – including phenomena such as difficulty falling or staying asleep, loss of slow-wave sleep, loss of rapid eye movement (REM) sleep were common problems (Polosatov, 1973; Usui et al., 2000). Expeditioners have also experienced impaired cognition such as: reduced accuracy and short-term memory, increased response time for cognitive tasks and spontaneous fugue states; the latter of which has often been referred to as “the Antarctic stare” (Reed et al., 2001; Sandal, Leon, and Palinkas, 2006) or, more recently, as “toast” (Cravalho, 1996). Other symptoms reported include depressed mood, anger and irritability, and anxiety. Interpersonal tension and conflict toward both group members and non-group members (ie, replacement personnel and support personnel located elsewhere) was reported in much of the literature (Lugg, 1987; Palinkas and Suedfeld, 2007).

Syndromes

Psychological effects experienced on polar expeditions may also be categorized as syndromes; these are often cited within this body of literature. Three syndromes experienced by persons living in the Antarctic are winter-over syndrome, polar T3 syndrome, and subsyndromal seasonal affective disorder (SSAD). Winter-over syndrome consists of impaired cognitive functioning, disturbed sleep, interpersonal tension and conflict, and negative affect. However, this syndrome is not usually severe enough to warrant a DSM-IV [Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition] diagnosis. The term “third quarter effect” is often used because the symptoms associated with the winter-over syndrome appear to peak in the third quarter of the mission. Polar T3 syndrome occurs when long-term exposure to cold temperatures produces changes in thyroid functioning with effects similar to those seen in hypothyroidism (eg, mood disturbances and reductions in cognitive performance). Complaints include fatigue, memory problems, weight gain, dulled thinking, lethargy, and depression. Finally, SSAD is related to variations in the amount of daylight, and is associated with depressive symptoms.

Psychiatric Disorders

The literature also discusses psychiatric disorders as another type of psychological effect that expeditioners may experience while in the Antarctic. The most common psychiatric disorders reported in the literature that are severe enough to warrant DSM-IV diagnoses include: mood, personality, substance-related, sleep, and adjustment disorders. The incidence rates of all the diagnoses revealed that 5.2% of people wintering-over in Antarctica met criteria for at least one DSM-IV diagnosis (Palinkas et al., 2004). The rate of mental disorders, including depression, was 4.5% according to ANARE [Australian National Antarctic Research Expeditions] and 6.4% at McMurdo Station (Otto, 2007). Based on 12 years of South Pole data, the overall incidence rate for depression that required pharmacological intervention was 2.03% (Otto, 2007). These rates reflect vulnerability to the stress associated with long-duration isolation and confinement in a harsh environment, combined with limitations in screening procedures designed to select-out individuals with such vulnerabilities.

Positive Effects

To depict polar service accurately, it is important to evaluate both positive and negative reactions that expeditioners may experience. Research has been primarily focused on the negative challenges in ICE environments. However, not all effects experienced are negative and, in fact, anecdotal evidence – including diaries, journal entries, and autobiographies – demonstrate salutogenic effects (Palinkas and Suedfeld, 2007). Salutogenic effects enhance rather than challenge psychological well-being. These inherently enjoyable aspects in the Antarctic environment include: success in overcoming the challenges inherent in the situation, in-group solidarity, cohesiveness, shared values, hardiness, resiliency, and coping. Results from one Antarctic survey suggest that positive reactions were experienced more often than negative ones, although the range of negative reactions reported was broader (Wood et al., 2000).

Outcomes of Psychological Effects

In addition to examining the psychological effects experienced by participants in the Antarctic, reviewed studies also included important behavioral outcomes resulting from the changes experienced in the individual's psychological well-being. In particular, evidence suggests that gender and military differences as well as an individual's prior experience in a polar environment and the size of the expedition crew may all relate to the psychological symptoms that are experienced (Gunderson, 1970; Gunderson, 1962). Results also suggest that selection screening, duration, station accessibility, and station latitude are all also related to psychological effects (; Suedfeld and Palinkas, 2007).

Based on this evidence as well as the review by Palinkas and Suedfeld (2007), the following hypotheses were formulated:

Hypothesis 1: Incidence of negative psychological symptoms is positively associated with the duration of residence in Antarctica, third quarter of Antarctic residence, and station latitude. Negative psychological symptoms are higher in women and military personnel. Negative psychological symptoms are negatively associated with size of crew, station accessibility, and prior experience.

Hypothesis 2: Incidence of negative syndromes is positively associated with duration of residence in Antarctica and station latitude and negatively associated with screening processes for selection.

Hypothesis 3: Incidence of psychiatric disorders is positively associated with duration of residence in Antarctica and station latitude. Psychiatric disorders are higher in women and military personnel. These psychiatric disorders are negatively associated with station accessibility, selection process, and prior experience.

Hypothesis 4: Incidence of salutogenic effects is positively associated with station accessibility and severity of station environment.

Methodology

Search Criteria

The authors of this project first attempted to identify and obtain all published and unpublished empirical studies of the psychological effects of Antarctic stays. This search effort resulted in a collection of 516 articles, books, presentations, and papers on psychological effects of Antarctic missions ranging from 1959 through 2007. Of these, 362 articles contained numerical data and were, therefore, chosen for inclusion. Qualifying data constituted any reported numerical findings (ie, means, standard deviations, numerical tables of results, etc.) applicable for a quantitative meta-analysis. Search terms used for the database were: Antarctica, polar, and winter-over. The search locations included: PsycInfo, Medline, and other similar search engines. Prominent researchers in the field were contacted, and the following databases held by countries involved in Antarctic research were explored: Australian Antarctic Division, British Antarctic Survey, New Zealand Antarctic Bibliography, Antarctic Bibliography, and the U.S. Defense Technical Information Center.

Current Status of Meta-analysis

Statisticians¹ evaluated the feasibility of traditional meta-analysis (the measures most frequently used within the 362 articles were chosen: 16PF [Sixteen Personality Factor Questionnaire], POMS [Profile of Mood States], and PANAS [Positive Affect Negative Affect Schedule]) after completing coding, which involved identifying and coding the relevant data found in each study. Based on this evaluation, a traditional meta-analysis was not feasible due to inconsistent measurement of data and a lack of critical information reported in research articles. Although a large number of articles were identified, there was little consistency across the articles; it was thus impossible to generalize across subjects. Differences in the data reported, measures used, and methodological rigor of the studies all contributed to an inability to perform a meta-analysis.

Alternative methodologies to the traditional meta-analysis are being considered for forward work. One possibility is a quantitative literature review. Although the data in these studies do not lend themselves to the stringent requirements of the meta-analysis methodology, a less-formal version of a quantitative literature review remains a possibility. This less-rigorous quantitative literature review would use descriptive statistics (eg, percentile and frequency) to summarize research findings.

Similarly, a qualitative review, which would incorporate the qualitative articles that were originally removed from consideration for the traditional meta-analysis, remains a possibility. Alternatively, a modern longitudinal technique could be conducted whereby the data for the POMS would be re-analyzed. This methodology might be possible if sufficient raw data is obtained from researchers for each measure considered. To this end, discussions are under way with prolific Antarctic researcher(s); if obtained, these data will be reanalyzed in an effort to establish meaningful statistical inferences.

A third alternative is a systematic review and comparison to evaluate both process and content. The content might be evaluated using techniques that attempt to quantify qualitative assessments,

¹Alan H. Feiveson, PhD, NASA-Johnson Space Center; Robert Ploutz-Snyder, PhD, USRA [Universities Space Research Association].

such as Delphi Technique or Concept Mapping. However, this cannot be approached without caution due to the fact that reported data may contain heterogeneous subsamples.

Without discounting the qualitative review and modern longitudinal technique methodology, NASA's BHP Element is currently planning to conduct the systematic review in fiscal year 2010, which will necessitate an effort to update the literature review subsequent to 2007. This particular methodology was chosen as forward work because it will take into account all of the literature gathered in the database as opposed to furthering examination of a limited number of studies or one particular measure. Additionally, this systematic review is planned to begin after completion of two other NASA literature reviews related to the same risk of behavioral and psychiatric conditions. It is believed that these other literature reviews may assist in informing the risk and aid in focusing the subsequent planned systematic review.

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