

**IN THE WAKE OF THE *ASTROLABE*:**  
**REVIEW AND ANALYSIS OF DIARIES MAINTAINED BY THE  
LEADERS AND PHYSICIANS OF FRENCH REMOTE DUTY STATIONS**



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LEADERS AND PHYSICIANS OF FRENCH REMOTE DUTY STATIONS**

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Cover illustration:

The corvettes *Astrolabe* and *Zélée* in Antarctica, 9 February 1838,  
by Louis Lebreton, the assistant surgeon onboard the *Astrolabe*.



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## **INTRODUCTION**

The research documented in this report was funded by the Space Life Sciences Division of the National Aeronautics and Space Administration (NASA). The research involved the analysis of personal journals that were maintained for this purpose by the station leaders and medical officers of the Dumont d'Urville Antarctic facility and three other French remote duty stations in the South Indian Ocean. The diaries were maintained during the 1993-1994 expedition as part of the International Antarctic Psychological Program (IAPP). The objective of the study has been to further our understanding of the human requirements for long duration space exploration. Although the research has involved collaboration among NASA, the French Space Agency (CNES), Territoire des Terres Australes et Antarctiques Françaises (TAAF), and Institut Français Pour La Recherche Et La Technologie Polaires (IFRTP, the French Polar Institute), the opinions and observations presented in this report are those of the authors, and do not necessarily represent the positions of any company, institution, or government agency.

### **BACKGROUND**

In September of 1993 Dr. Stuster was one of several scientists who were invited by CNES and the French Polar Institute to submit proposals for cooperative research projects at Dumont d'Urville, the French Antarctic research station, and three smaller stations located on remote islands in the South Indian Ocean. Dr. Stuster's proposal to conduct an analysis of diaries that would be maintained especially for this purpose by French remote duty personnel was one of only two selected by the French Polar Institute for immediate implementation. Participants would be asked to record relevant experiences and observations during their period of isolation and confinement, focusing their comments on a list of behavioral issues with design and procedural implications for space craft and planetary habitats. The scientists of the French Polar Institute were particularly receptive to this proposal, due in part, to their previous experiences with journals as valuable sources of behavioral information during the International Biomedical Expedition to the Antarctic (IBEA) in 1980 - 1981.

Study materials were prepared, including a memorandum of agreement that described the research to be performed, and protocols and orientation materials for participants. All materials were translated from English into French, then approved by NASA and the representatives of the French Polar Institute and CNES. Approved materials were shipped to France for implementation of the study during the impending Antarctic season.

Dr. Claude Bachelard, Medical Director of the French Polar Institute, coordinated the field component of the study and later translated and helped code the diary entries. Dr. Bachelard, who was a participant in the IBEA a dozen years earlier, maintained a diary as the expedition physician on a traverse of similar duration to the IBEA during the current study. Dr. Bachelard's personal experience in isolation and confinement and as chief medical officer for four remote duty stations contributed to the project.

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## SUMMARY OF INTEREST IN ISOLATION AND CONFINEMENT

Although people have lived and worked under conditions of isolation and confinement for countless generations, only within the past four decades has there been a scientific interest in the problems associated with human adjustment to those conditions. Many explorers, including Christopher Columbus, were aware of the effects that isolation and confinement can have on crew adjustment and behavior; some expedition leaders implemented insightful procedures to counter those effects. For the most part, however, modern interest in isolation and confinement can be traced to two “events”: 1) The hypothesis, later disproved, that isolation and confinement played integral roles in the “brainwashing” of POWs during the Korean War; and, 2) The development of a highly disruptive schizophrenia by a member of the U.S. Antarctic team while preparing for the 1957 International Geophysical Year.

Interest in brainwashing led directly to a series of studies during the 1950s involving individual isolation and sensory deprivation. Early studies reported a variety of unusual subjective phenomena, such as vivid and highly structured hallucinations, delusions, and gross alterations in perception upon emerging from isolation. Although Suedfeld (1980) found the extreme effects to be influenced largely by subjects’ expectations, evidence indicated impairment in some cognitive and perceptual functioning, and a progressive slowing of alpha frequencies with increasing duration of sensory deprivation (Zubek, 1973). It was later learned that although some functions are temporarily impaired, others show improvements (Suedfeld, 1980; Suedfeld and Borrie, 1998; Barabasz and Barabasz, 1996).

The Antarctic incident in the group preparing for the IGY, however, did lead to an area of study directly relevant to the problems associated with long duration space exploration. Psychological studies, sponsored by the Navy Bureau of Medicine and Surgery (later the Naval Health Research Center), were begun at U.S. Antarctic stations in 1957 and continued through the mid-1990s when the Naval Support Force Antarctica relinquished responsibility for Antarctic operations. Research at U.S. Antarctic stations now is conducted by the National Science Foundation.

Since 1961, the bulk of all U.S. research involving the behavior and selection of Antarctic personnel has been conducted by E.K. Eric Gunderson of the Naval Health Research Center. Gunderson’s objectives were to study the nature and degree of stress experienced in the Antarctic environment, to construct improved selection methods, and to develop effective performance measures. Gunderson studied groups ranging in size from eight to 36 men, and composed of approximately 60 percent Navy personnel and 40 percent civilian scientists and technicians. Sources of data for these studies were clinical examinations, military records, questionnaires, station leaders’ logs and diaries, debriefing interviews, and observations made during site visits (Gunderson, 1973). Gunderson and his colleagues found that although cases of psychosis or severe neurosis were extremely rare at the early Antarctic stations, minor emotional disturbances were very common (Gunderson, 1963).

More recently, Lawrence Palinkas conducted a longitudinal study, examining the health and service records of more than 300 enlisted Navy personnel who wintered-

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over at small, isolated Antarctic stations between 1963 and 1974. He found that their winter-over experience did not place them at any greater risk for first hospitalization subsequent to their return from Antarctic duty than those who applied and were found qualified for Antarctic duty but did not serve. Also, no significant differences were observed on any of the long-term performance indicators reviewed. Further, it was found that individuals with high needs for achievement and control over others were likely to experience a reduced risk for long-term disease incidence (Palinkas, 1987a). Palinkas also has discussed the relevance of Antarctic stations as models for the human exploration of Mars (1987b).

In other research programs, Jean Rivolier (e.g., 1954, 1975) considered the issue of appropriate personnel selection for polar work and recently (1997) provided a detailed discussion of the selection techniques used by various national space and Antarctic programs. Rivolier, Cazes, and Bachelard (1995) present a summary of the extensive medical and psychological research program conducted in the French Antarctic and Austral Territories for more than four decades. The French approach has been to focus on the stressors and coping mechanisms of isolated and confined living, with the objective of developing better personnel selection techniques and countermeasures to instances of maladjustment. Of particular relevance, Rivolier and Bachelard (1988) described the similarities between living at an Antarctic scientific base and on a space station. They drew on their many years of support to the French polar programs to develop recommendations concerning the design and operation of remote-duty stations, such as space facilities.

Palmai (1963) studied a small Australian contingent that wintered on Macquarie Island. He reported a decline in morale and increases in interpersonal conflict and psychosomatic complaints. Owens (1966, 1968) studied four winter-over groups of the Australian National Antarctic Research Expedition. He made the important distinction between living at a permanent station and participating in more dangerous work in the field. He also reported evidence that single men adapted better to the isolation and confinement of Antarctica than their married comrades, who were separated from their wives. Later, Desmond Lugg studied the psychological adaptation of expeditioners using innovative methods, such as unobtrusively noting the topics of group discussion (1973, 1977). Lugg's subsequent research among Australian Antarctic personnel has found a relatively low incidence of mental disorders (Lugg, 1991) but a disturbing depression of immune response (Pitson, Lugg, and Muller, 1996). Lugg also has written of Antarctica as a laboratory for space-related research in psychology and medicine (1994).

A.J.W. Taylor writes with insight about his experiences in the New Zealand Antarctic Program (e.g., 1978, 1987). For example, he has suggested that crews be selected on the basis of optimum compatibility. Taylor's notion of selecting crews, rather than individuals, is a good one and predates the introduction of this concept in the field of aviation personnel selection. Particularly relevant to the current study is Taylor's emphasis on unobtrusive indicators of adaptation to the special conditions of isolation and confinement. In one example, Taylor described a man who had performed well during the Antarctic summer, but who had not been prepared to stay through the winter:

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He reacted badly, became untypically coarse in his speech, slovenly in his behaviour, and slack in his work. Perhaps the clue to his deterioration was the following Shakespearean quotation that he left above his bunk: “Ah, when will this weary life end and lend me leave to come unto my love?” (Taylor, 1987, 75)

Taylor maintains that graffiti, such as this<sup>1</sup>, and messages on bulletin boards, drawings, letters, log books, presentations, diaries, and other “artifacts” often give tangible evidence about the quality of personal adjustment and interpersonal behavior in a group. He writes that, “such ‘debris’ is more often the material for anthropologists, archaeologists, and historians than for psychologists,” but he considers it rich in introspection. Taylor reminds us that personal diaries and log books once were the supreme sources of information about polar explorers and their activities, but they have become neglected in favor of psychological tests and other easily quantified measures.

There have been few studies of multicultural groups in isolation and confinement. The most notable example was documented by Rivolier, Goldsmith, Lugg, and Taylor (1988), who describe the International Biomedical Expedition to the Antarctic (IBEA), an overland excursion performed during a six-month period in 1980–81. The IBEA was conducted, in part, to demonstrate the relevance of Antarctic conditions to space programs:

While it is important to ensure that in future development of Antarctica humans are not the weakest link, it is possible to envisage the isolation, uniquely available there, as a model for long term space travel. (Rivolier et al. 1988, xxv)

Rivolier et al. discuss and explain the physiological and psychological responses to expedition conditions, including serious individual and interpersonal problems that occurred among the twelve men from five countries. They report, “Some developed physical problems, others withdrew into themselves and one withdrew from the scene entirely.” The international composition and high workloads of the IBEA make this well-documented experiment particularly relevant to the planners of future space expeditions.

Several additional conditions characterized by long-duration isolation and confinement have been the objects of behavioral analysis. These include remote military outposts, submarines, saturation chambers, fishing vessels, and underwater habitats, to name a few (Stuster, 1986, 1996).

### **JOURNALS, DIARIES, AND LOGS AS SOURCES OF BEHAVIORAL INFORMATION**

In 1969 the NATO Symposium on Man in Isolation and/or Enclosed Space essentially defined the field of study described by the title of the edited collection of papers that emanated from that symposium, *Man in Isolation and Confinement* (Rasmussen, 1973). In that important collection, Paul Nelson (1973) suggested the use of several indirect methods for the study of isolated and confined groups, including interview, questionnaire, site visit (i.e., observation), organizational records, and diaries.

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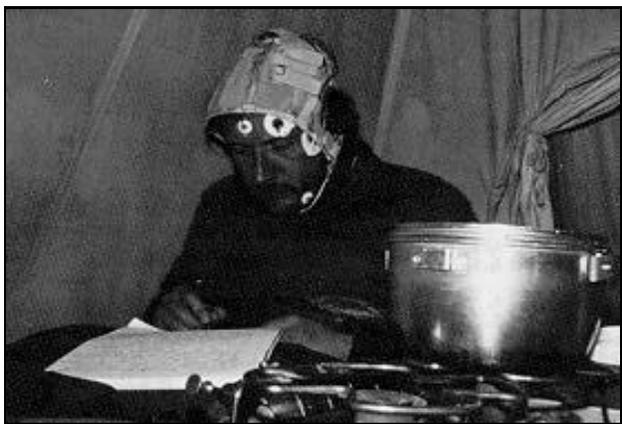
<sup>1</sup> It is unlikely that many members of remote duty crews maintain repertoires of quotations that would permit them to give voice to their emotions as eloquently as in Taylor’s example. Less erudite crew members might resort to popular music for their inscriptions (e.g., “I can’t get no satisfaction”).

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Self-initiated diaries and official logs usually provide descriptive accounts of events in a chronological sequence; whether nautical, meteorological, logistic, or personal, they are always responding to the question, “And then what happened?” (Labov and Waletzky, 1967). This is precisely the question that behavioral scientists would ask if they had access to the isolated and confined group described; instead, the answer is provided in the form of a narrative account, or record. The level of detail provided in a well-written narrative can be considerable, sometimes overwhelming. Most explorers’ accounts were written in simpler times, before electronic communications had reduced the arts of letter writing and journal keeping; that is, before the advent of the telephone, most literate people wrote long and thoughtful letters about the important issues in their lives. Further, travelers typically maintained a journal of their experiences that was often rich in detail, and often illustrated by pencil or charcoal sketches. The ubiquitous camera replaced the diary or journal, as the telephone eliminated the need to compose one’s personal thoughts and observations for another on paper. However, a common response of modern folks to isolation and confinement is to become avid letter writers and journal keepers. Even the most unlikely candidates have been known to develop latent writing skills and conduct lengthy correspondence when isolated and confined for long periods. Some members of expeditions use their diaries as outlets for the feelings they dare not permit be exposed or acted upon. In this way, maintaining a diary can serve a therapeutic purpose for some individuals (Pennebaker, 1990).

Riessman (1993) maintains that traditional research methods are limited in their abilities to provide an understanding of social life; she suggests that the analysis of narratives, such as found in letters and diaries, can transcend those limitations, revealing the organizing principle for human action. Further, reviewing diaries, logs, journals, and other archival sources is a less obtrusive method for obtaining information about individuals and groups than either interviews or questionnaires. Perhaps more important, archival materials can be the only sources of information about previous experiences, such as the voyages of discovery conducted in the historical past, or current expeditions in remote locations. The diaries maintained by the French remote duty leaders and medical officers on behalf of NASA are in this latter category.



Claude Bachelard writing in his journal during the IBEA; note the electrodes on face and chin for measurement of EEG and EMG.

All three authors of this report have reviewed diaries and journals during previous research. Despite the reams of psychological test data he collected, Claude Bachelard found the diaries maintained by the participants of the IBEA to be the richest and most reliable sources of information concerning individual adjustment and group dynamics during that arduous, 71-day traverse. The IBEA’s extensive program of physiological and psychological research, with the members of the international crew serving as subjects, distinguishes the IBEA from all

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other expeditions. Peter Suedfeld, a leading expert on content analysis, has analyzed political speeches, terrorists' statements, and the content of diaries kept by whalers, polar explorers, and Holocaust survivors. In a particularly relevant study, Mocellin and Suedfeld (1991) performed content analyses of original diaries maintained by members of British polar expeditions from the mid-19th to the early 20th centuries.

Jack Stuster reviewed several diaries during previous research for NASA to identify lessons learned about behavioral issues that might be applied to future space expeditions. A broad range of materials was reviewed, from a recent translation of Columbus' log of his first voyage of discovery (Fuson, 1987), to the diary of a Russian cosmonaut (Lebedev, 1988). One of the most interesting documents reviewed during the study was the Commanding Officer's Log for the Williams Air Operating Facility on Ross Island, McMurdo Sound, Antarctica. The log was maintained during the period that the U.S. Navy was preparing for the International Geophysical Year (from 20 December 1955 through 24 March 1957). In 374 single-space typed, legal-size, onion-skin pages, the young lieutenant commander described the complete sequence of events for the first establishment of a permanent human presence in Antarctica. The log begins with the anchoring and unloading of the ship that brought the Navy Mobile Construction Battalion, and associated civilians, to Ross Island, and continues with daily descriptions of the progress made and the problems encountered as the men established a temporary base camp, then struggled to build an airfield and a permanent facility to protect them from the hostile Antarctic environment. The leader describes the reaction of the men to the accidental death of a young equipment operator in their third week on the ice and many additional crises, including a highly disruptive psychosis that emerged only three months into the 15 month mission.

The similarities between the pioneering experiences described in the commanding officer's diary and what might be expected of lunar and planetary exploration are clear. This unique journal describes many of the problems that are likely to confront the astronauts who will establish the first lunar base or Martian outpost. Similarly, the diaries of the French physicians and leaders at remote research stations in Antarctica and on small islands, that were analyzed during the current study, describe conditions and events analogous to what will be experienced by the future explorers of space.

#### **THE FRENCH REMOTE-DUTY STATIONS**

History's first polar explorer sailed in about 330 B.C. from a port now known as Marseilles, France. Pytheas of Massilia had used the principles of astronomy and geometry to calculate the latitude of his home and he knew that the Earth was round long before others. He applied that knowledge as a navigator to venture through the Pillars of Hercules (the Strait of Gibraltar), trading along the way on a voyage to the northern seas. His descriptions of the places he visited, the Arctic ice pack in particular, were so alien they were disbelieved by his contemporaries. There have been many French polar explorers since Pytheas, and the tradition is continued in the modern era by annual expeditions to Antarctica and three remote islands in the Far South, as described in the following paragraphs.

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## Dumont d'Urville Base, Adélie Land, Antarctica

In 1840, the French explorer, Jules Sebastien-César Dumont d'Urville, in command of the corvettes *Astrolabe* and *Zélée*, was among the first to see the Antarctic continent. He named the area Adélie Land, a touching tribute to his wife who had endured his absence during three long expeditions. The French returned to Adélie Land in 1948, and established a permanent base in 1956 as part of the International Geophysical Year (IGY). The base was named in honor of the explorer who discovered the region.<sup>2</sup>



The Dumont d'Urville station (Terre-Adélie) is located on Pétrels Island, a few hundred meters from the Antarctic coast at longitude 140° 01' East, latitude 66° 40' South. The temperature of still air in winter ranges between zero and -40° C (32° to -40° F), but the air rarely is still at Dumont d'Urville where the winds can reach 300 kilometers per hour (186 miles per hour). A crew of 30 to 35 scientists and technicians staff the base during the eight-month winter; the

population sometimes reaches three times that number during the brief Austral summer. The scientific work consists of biological, meteorological, physiological, geophysical, and glaciological research. Annual, mechanized traverses of more than 1,000 kilometers (621 miles) are made to Dome C, the site of a planned French-Italian research station, named Concordia. The Dumont d'Urville station is supplied by ship from Hobart, Tasmania, the same port from which Captain Dumont d'Urville launched his Antarctic campaign 150 years ago.

## Port-Aux-Francais, Kerguelen Island, French Southern Territories

Yves Joseph Kerguelen de Trémarec, in command of the *La Fortune*, en route from Ile de France (now Mauritius) to the Terra Incognita Australis, sighted an island in the South Indian Ocean in 1772, but could not land; he called it New France in hopeful anticipation of a prosperous colony. When he returned the next year he found such a barren collection of rocks, Kerguelen renamed it Land of Desolation. The name later was changed again in honor of its discoverer, but it still is known to many as Desolation Island.

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<sup>2</sup> Among his many accomplishments, Dumont d'Urville also discovered the Venus de Milo, in 1819, and named the racial groups of the Pacific (Polynesian, Micronesian, Melanesian, and Malay). He was a courageous explorer and a benevolent leader who was quick to share any honors with his subordinates.

Port-Aux-Français station (Ile Kerguelen) is located at longitude 69° 30' East, 49° 15' South on Kerguelen Island. Kerguelen is approximately 160 kilometers (100 miles) long and 80 kilometers (50 miles) wide at its widest point; the remainder of the archipelago consists of nearly 300 islets. Kerguelen is the largest of the French islands in the South Indian Ocean (6,700 square kilometers; 4,163 square miles). The climate is Subantarctic, with a mean temperature of 4° C (39° F) and near-permanent winds that average 30 kilometers per hour (19 mile per hour) and can exceed 230 kilometers per hour (143 mile per hour). Island features include the Cook Glacier, Mt. Ross (1,850 meters/6,070 feet), and a very rugged coastline. Captain James Cook explored the uninhabited island in 1776, and in 1875 it was visited by American, English, and German scientific expeditions to observe the transit of the planet Venus.<sup>3</sup> Attempts to establish commercial sheep raising were abandoned in 1932 because of adverse environmental conditions.



Ile Kerguelen has been the site of a French research station since 1950. A crew of 60 scientists and technicians staff the station during the winter, but the population increases to 85 during the summer months. Work consists of biological, oceanographic, geophysical, meteorological, and physiological research. Since 1994, CNES (French National Center for Space Studies) has operated a satellite tracking station on Kerguelen Island. The Port-Aux-Français station is supported by ship from La Reunion Island (near Madagascar) 3,490 kilometers (2,169 miles) to the northwest.



<sup>3</sup> Throughout the 19th Century, Desolation Island provided a countermeasure to scurvy, in the form of a unique native cabbage, to countless whalers, sealers, and others, including Patrick O'Brian's fictional crew of the H.M.S. *Leopard*.

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### Base Alfred Faure, Crozet Island, French Southern Territories

Captain Nicolas-Thomas Marion-Dufresne discovered the small, volcanic archipelago in 1772, naming the island group for his first officer. Alfred Faure station was established in 1964 on Possession Island, which at 146 square kilometers (91 square miles) is the largest in the 20 islands that compose the Iles Crozet; the group is located at longitude 50-53° East, 46° South. The climate is Subantarctic, with a mean temperature of 4° C (39° F), near-permanent winds, and heavy rainfall. The terrain is rugged and the coastline defined by steep cliffs. Between 16 and 35 scientists and technicians occupy the station throughout the year, conducting research in the fields of meteorology, geomagnetism, seismology, ornithology, and marine biology. The station is supported by ship from La Reunion Island 2,860 kilometers (1,777 miles) to the north.



### Base Martin-De-Vivies, Amsterdam Island, French Southern Territories

Juan Sebastian de El Cano, in command of the *Vittoria*, discovered Ile Amsterdam in 1522 as he completed the first circumnavigation of the globe. El Cano had set a southerly course across the Indian Ocean to avoid Portuguese ships, following the death of the expedition's leader, Ferdinand Magellan, in the Philippine Islands.



Martin-De-Vivies station (Ile Amsterdam) was established in 1949 as a weather station, and is located at longitude 77° East, 37° South on Amsterdam Island (85 square kilometers/53 square miles). Nearby is Saint Paul Island (7 square kilometers /4 square miles), the nearly submerged cone of an ancient volcano. Amsterdam-Saint Paul is the most northerly of the three, French island groups, with a relatively mild Oceanic climate; mean

temperatures range from 8° C (46° F) in winter to 20° C (68° F) in summer. Between 16 and 30 scientists and technicians occupy the station; fields of research include meteorology, geomagnetism, seismology, ornithology, and marine biology. The base is supported by ship from La Reunion Island 2,880 kilometers (1,790 miles) to the northwest.

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## Personnel

The members of the French expeditions to Antarctica and the insular stations range in age from 20 to 60 years, with a mean of 30 years of age. Increasing numbers of women are participating in the expeditions, but crew composition remains predominantly male. About half of the personnel are scientists and half are engaged in support work, including facilities and equipment maintenance, logistics, power generation, communications, and food preparation. Until recently, all stations had a leader (usually a veteran of previous expeditions) and a physician (who received three-months of special training). The expeditions documented by the diarists in the current study were the last to enjoy this arrangement. The roles of leader and physician subsequently were combined in an effort to reduce costs.

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## THE RESEARCH

Anecdotal comparisons frequently are made among future space missions, Antarctic winter-over experiences, and the expeditions of the past. However, few attempts have been made to formally study the personal accounts of remote duty experiences. In one notable example, anthropologists Jeffrey Johnson and Ben Finney (1986) analyzed Huntford's (1984) account of the Amundsen and Scott race to the South Pole. They focused on the relationship between prescribed or formal hierarchical structure and informal, emergent structure; they also identified and discussed the implications of the emergent structure to group effectiveness. In addition, they analyzed the contributions of different status positions within the parties to group cohesiveness.

As mentioned previously, Mocellin and Suedfeld (1991) performed content analyses of 13 original diaries maintained by members of British polar expeditions from the mid-19th to the early 20th centuries. Journal entries were categorized into five areas and individual words were rated in terms of pleasantness and arousal. Results of the content analysis indicated that Antarctic expedition members were more negative about their experiences than were their colleagues who ventured to the Arctic, but both polar regions generated many positive and negative reactions. The authors concluded that popular conceptions about the difficult living conditions of explorers in polar regions are at least partially the result of overgeneralization and dramatization. Later, Johnson and Suedfeld (1996) conducted a content analysis of diaries and correspondence written by early Arctic whalers and explorers and found that those voyagers attempted to reconstitute parts of their home life while they were isolated in the Arctic.

Finally, Stuster's (1996) study of diaries and secondary accounts of expeditions resulted in the identification of several habitability principles and more than 200 specific recommendations for the design of equipment and procedures to facilitate human adjustment during future long duration space missions. Stuster found that interpersonal and psychological problems are common under conditions of isolation and confinement, but serious problems can be avoided if proper precautions are taken. The research also showed that humans are capable of enduring conditions that are far more arduous and dangerous than those anticipated for future space expeditions.

The current study likewise is based on the premise that the introspective accounts of personnel operating under conditions of isolation and confinement can provide useful information about the factors that affected individual and group performance during the confinement. Many important lessons relevant to future space missions have emerged from previous research. However, because the journals and accounts reviewed were prepared as general records of missions, the proportions of the narrative that pertain to behavioral issues can be quite low.

In the current study, we have attempted to increase the useful content of the journals by sensitizing the participants to the relevant behavioral and human factors issues, and encouraging them to discuss those issues in their journals when warranted by events. Orientation materials were provided to the participants that identified the

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categories of issues of greatest relevance to the planners of space missions; brief questionnaires also were provided to obtain quantitative measures of expectations just prior to the mission, and measures of both objective and subjective experiences at the mid-point and conclusion of the mission. The statement of guidelines for maintaining a personal journal from the English version of the protocol is reproduced below.

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FRENCH POLAR INSTITUTE/CNES/NASA  
SPACE ANALOGUE RESEARCH PROGRAM

*GUIDELINES FOR MAINTAINING A PERSONAL JOURNAL*

Thank you for agreeing to maintain a personal journal for later review and analysis. Human performance and adjustment to isolation and confinement are the focus of this research project. The purpose of the study is to obtain information about the personal experiences and observations of key members of remote duty teams. The study is based on the assumption that there are important similarities between existing remote duty stations and planned inter-planetary space craft, and lunar and Martian out-posts.

It is true that making regular entries in a personal journal requires a degree of commitment--not all people are capable of the task. However, many people have found maintaining a personal journal or diary to be a valuable experience. Making regular journal entries provides a certain personal discipline, even therapy, that can assist one in adjusting to, or at least enduring, extremely austere conditions. Further, journals maintained during special periods (like an expedition, or an Antarctic winter) are highly-valued souvenirs and memory aids to those who make a careful written record of their daily activities, observations, and feelings. In short, not all station leaders and medical personnel who are asked to maintain a journal can or will do so. But those who do maintain a journal as part of this research project will find it a comforting and rewarding experience, *and* they will likely provide NASA, CNES, and future generations of space craft designers with valuable insights regarding human performance that could not be obtained in any other way.

Confidentiality will be ensured by requesting that xerographic copies of the journals be provided to the project director at the conclusion of the mission with either all personal names omitted, or with names omitted in certain sensitive entries (i.e., names are not necessary--any approach to preserving confidentiality that is determined to be appropriate by the participating station leaders, medical personnel, and program managers will be acceptable).

The following guidelines are offered to assist participating personnel and to focus the effort on issues of particular interest to space craft designers and mission planners.

- You may either type or write your journal entries. If you hand write your journal, please write as legibly as possible to facilitate later analysis. Pencil or indelible ink are recommended to preserve the writing if the pages become wet.
- It is helpful to set aside a few minutes at the end of each day to make your journal entries. But, it is also a good idea to record important thoughts and observations when they occur (before you forget about them).
- Do not feel obligated to write lengthy entries. Brief comments that are to the point will be easier to analyze. You may, however, write as much as you believe is necessary to accurately record your experiences and impressions.
- If a problem arises (e.g., lack of cooperation, etc.) write about it, but do not let your journal writing cause you to focus excessively on negative issues. We are as interested in your solutions to problems as we are in identifying the kinds of problems that occur in isolation and confinement.

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- Here is a list of some of the issues that are of particular interest to the designers of space craft and lunar bases, and to space mission planners.
    - SLEEP
    - EXERCISE
    - CLOTHING
    - LEADERSHIP
    - MEDICAL SUPPORT
    - PERSONAL HYGIENE
    - FOOD PREPARATION
    - GROUP INTERACTION
    - HABITAT AESTHETICS
    - RECREATION/LEISURE
    - PERSONNEL SELECTION
    - SCHEDULING/WORKLOAD
    - PRIVACY/PERSONAL SPACE
    - PSYCHOLOGICAL SUPPORT
    - OUTSIDE COMMUNICATIONS
    - INTERNAL COMMUNICATIONS
    - PRE-MISSION TRAINING/PREPARATION

One final note: As you may already know, there is a tendency for trivial issues to be exaggerated when living in isolation and confinement. It will be helpful for you to maintain a sense of humor to keep any problems that might occur in proper perspective.

We are grateful for your participation in this research project. And, we eagerly await your safe return so that we may learn from your experiences.

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## **PROJECT TASKS**

The following paragraphs summarize the major project tasks.

### **Task 1: Translated diaries**

The diaries first were organized, then assigned inventory numbers to facilitate the processing of derivative data, and to maintain the strict confidentiality throughout the analysis that was promised in the research protocol. The materials then were translated by Dr. Bachelard.

### **Task 2: Performed Level I allocation of entries to the inventory of categories**

The first step in the content analysis was to define the inventory of behavioral issues with design and procedural implications for future space missions. The process began with the 17 issues on the protocol that provided guidance to the diarists. Additional issues were identified and added to the list as they emerged from the review. Issues added to the list during review of the diaries are listed below.

- Event (Holidays and other milestones, but mostly weather-related events)
- Adjustment (Entries related to the personal adjustment of the diarist or others)
- Organization/Management (Entries concerning issues with headquarters)
- Hygiene (Entries concerning facility hygiene, to distinguish from personal hygiene)
- Safety

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During the Level I analysis, relevant entries, passages, and comments were allocated to the various categories of issues based on a rational assignment process. Entries that involved more than one category of issue were assigned to a secondary category. Drs. Stuster and Bachelard together reviewed the diaries to perform the Level I allocation of entries to the list of behavioral issues. All diary entries and associated data then were entered into formatted, computer-based spreadsheets. Data fields included for each entry are listed below.

Diarist Name (Coded)

Role (M for medical officer; L for station leader)

Mission Day (0 - 363 maximum)

Category 1 (The primary category of behavioral issues to which the entry was assigned)

Category 2 (The secondary category of behavioral issues to which the entry was assigned, if relevant)

Page (The page number of the diary on which the entry can be found)

Entry (The English translation of the diary entry)

Certain forms of content analysis are subject to investigator bias, and usually require two or more independent raters to ensure an objective evaluation. Coding by multiple researchers is particularly important when the unit of scoring is the word. In contrast, the method used in this study largely avoids this threat to validity, and the prohibitively expensive requirement for multiple scoring, by focusing on the passage or comment as the primary unit of analysis. Passages, composed of complete thoughts, are usually unequivocal in the context of a larger journal entry. It is nearly always possible to discern about what issue a diarist is writing in a specific entry, and a passage can be abandoned on the occasions when one is found to be too vague for categorization. The Level I allocation process was greatly facilitated by the orientation materials and protocol that provided guidance to the participants about the issues of greatest relevance to space mission planners. The same categories that focused the diarists' efforts were used to organize their comments.

### **Task 3: Performed Level II categorization of entries within each issue**

The next step in the process was to review the diary passages within each of the issue areas, assigning the passages to themes that are identified from the material reviewed; passages could be assigned to more than one theme within an issue area.

Only the simplest of categorization schemes can be defined before the materials have been reviewed, for example, positive vs. negative comments regarding an issue. In practice, however, a set of several consistent themes usually emerges from a review of journal entries. For example, entries regarding "sleep" might involve passages that relate to an individual's difficulty in falling asleep due to scheduling, and others that relate to sleep disturbances caused by the noise of equipment or other crew members. Similarly, comments about workload might be categorized as either high or low workload-related, further categorized as having a positive, negative, or neutral valence, and possibly further categorized by a precipitating event or phase of the mission.

Level II categorization of diary passages (as opposed to words) is a relatively straightforward and objective process. All categorization was performed by the same

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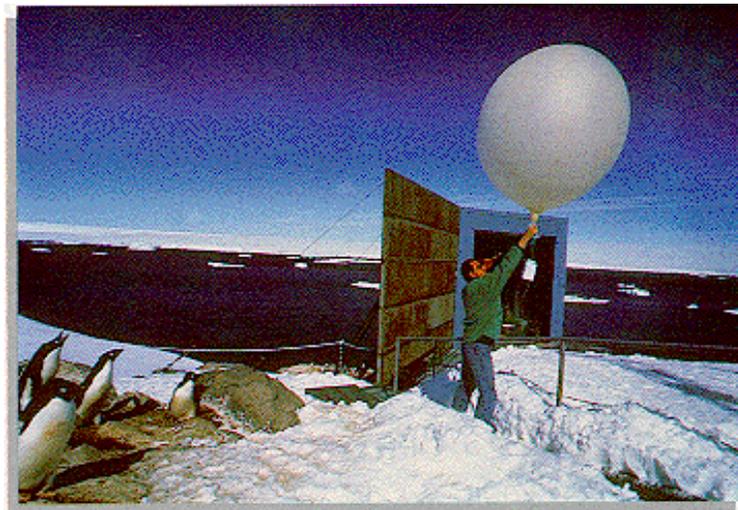
investigator to ensure that the same categories and criteria were used throughout the process. Equivocal or problematic passages were identified during the Level II categorization and set aside for later review. Dr. Suedfeld and Ms Karine Weiss, a doctoral candidate from the University of Paris, participated during this project task to ensure that the process was free of investigator bias. Ms Weiss independently rated and categorized the diary entries and found compatible results and conclusions, which validated the original research.<sup>4</sup>

**Task 4: Quantified and described the diary content matrix**

The product of Task 3 was a relational data base containing diary passages organized by primary behavioral issue, with indicators of Level II categories and sub-categories. It might be useful to imagine the data base as a large, multi-dimensional matrix that contains the relevant comments of the French remote duty leaders and medical personnel. The basic organization of the matrix is provided by the Level I categories; further organization and access to the matrix is provided by the Level II categories and sub-categories. The conceptual matrix permits simple quantification of comments regarding the various Level I categories of behavioral issues, as well as quantification of comments in Level II categories and sub-categories within the primary issue area.

**Task 5: Prepared final report**

Preparation of this report was the final step in the research process.



Launching a weather balloon near Dumont d'Urville station, Terre-Adélie, Antarctica.

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<sup>4</sup> The authors gratefully acknowledge this important contribution to the study.

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## RESULTS

The data from the nine diaries were assembled into a master data base containing 1,810 entries. Simple sorts and tallies then were performed to characterize the data base and to help plan further analyses. For example, Table 1 provides a summary of the nine diaries listing the durations of the various expeditions (which ranged from a 69-day Antarctic traverse to more than a year on a remote island) and the numbers of diary entries identified as relevant and included in each component data file; the numbers of entries per day also were calculated. The table shows that the number of entries per day ranged from a low of .34 by a physician during a 230-day expedition on an island station, to a high of 2.86 by a physician during the 69-day traverse.

TABLE 1  
NUMBER OF ENTRIES PER EXPEDITION DAY

Diary	Entries	Days	Entries/Day	Role
A	78	230	0.34	M
B	88	254	0.35	L
C	138	330	0.42	M
D	83	180	0.46	L
E	160	230	0.70	L
F	288	249	1.16	L
G	550	363	1.52	M
H	228	82	2.78	M
I	197	69	2.86	M
Mean	201.11	220.78	1.17	

### CATEGORY ANALYSIS

A total of 22 categories of relevant behavioral issues emerged from the translation and analysis. All entries were assigned to a primary category; 62 percent of the entries also were assigned to a secondary category. The combined data base was sorted by assigned primary and secondary categories and the entries in each category were counted. The results of the counts were assembled to form the diary content matrix, included as Appendix A. The numbers of primary and secondary assignments for each of the 22 categories are presented in Table 2; the categories are listed in descending order of the total number of category assignments.

Table 2 shows Group Interaction to be the most frequently-assigned primary and secondary category. Further, the content matrix, which is a summary of primary and secondary category assignments, shows that for the 330 entries assigned to Group Interaction, the most frequent secondary category was Adjustment (n=53), followed by Recreation & Leisure (n=51). Similarly, for the 226 entries assigned to Recreation & Leisure as the primary category, the most frequent secondary category was Group Interaction (n=90). It must be noted that the numbers of entries assigned to Medical Support and Leadership categories probably were influenced by the sample of diarists, which was limited to expedition physicians and leaders.

**TABLE 2**  
**CATEGORIES RANKED BY TOTAL NUMBER OF ASSIGNMENTS**

	<b>Primary</b>	<b>Secondary</b>	<b>Total</b>
Group Interaction (GI)	330	275	605
Outside Communications (OC)	315	58	373
Workload (W)	169	180	349
Recreation & Leisure (RL)	226	101	327
Medical Support (MS)	217	55	272
Adjustment (AD)	138	134	272
Leadership (L)	160	68	228
Event (E)	71	22	93
Food Preparation (FP)	43	47	90
Organization/Mgt. (OM)	17	59	76
Equipment (EQ)	20	45	65
Sleep (S)	30	19	49
Safety (SA)	29	14	43
Personnel Selection (PS)	6	20	26
Waste Management (WM)	9	3	12
Internal Communications (IC)	6	4	10
Exercise (EX)	3	7	10
Habitat Aesthetics (HA)	8	1	9
Hygiene (HY)	5	2	7
Personal Hygiene (PH)	4	0	4
Privacy/Personal Space (PP)	1	3	4
Clothing (C)	3	0	3
<i>Totals</i>	1810	1117	2927

**Category Analysis: Co-Assigned Categories**

Table 2 presents the total numbers of diary entries assigned to each of the 22 categories as primary and secondary assignments. The diary content matrix, presented as Appendix A, provides the numbers of entries assigned to each secondary category for each primary category. In other words, the diary content matrix permits the identification of secondary categories that tend to co-occur with primary categories. For example, Adjustment, and Recreation & Leisure were the leading secondary assignments for entries assigned to the primary category, Group Interaction. Similarly, Adjustment, Organization & Management, and Group Interaction were the leading secondary assignments for entries assigned to Outside Communications. Group Interaction received the most secondary category assignments overall, and the largest number of secondary assignments with a primary category, Recreation & Leisure (90 secondary assignments).

Table 2 shows that a few of the categories received more secondary assignments than primary assignments, including Workload, one of the most frequently-assigned categories overall. Sorts and tabulations were performed to identify the primary categories co-assigned with Workload as the secondary category. Medical Support was found to be the leading primary category (50 entries) for secondary assignments to

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Workload, followed by Leadership (30 entries), and Group Interaction (23 entries). Reviewing the text of the entries revealed that 48 of the 50 entries (with Workload as a secondary category) that were assigned to Medical Support (as the primary category) were written by physicians, primarily describing their work; only two were written by station leaders describing work performed by a physician. In contrast, of the 30 entries assigned to Leadership, 21 were written by leaders describing their work, and nine were written by physicians, discussing their leaders.

The categories Food Preparation and Organization & Management also received more secondary than primary category assignments. Group Interaction was the leading primary category for the secondary assignments to Food Preparation, accounting for two thirds of the total. Nearly all of these entries referred to special meals and celebrations. Outside Communications was the leading primary category for the secondary assignments to Organization & Management, accounting for more than half of the total. These entries concerned directives from and other communications with the administrative headquarters of the program.

The key category labeled Adjustment received nearly equal assignments of entries as a primary and secondary category. Group Interaction was the leading primary category for the secondary assignments to Adjustment, followed by primary assignments to Outside Communications. The text of the entries reveals the Group Interaction entries to be comments on the adaptation of individuals to living in their isolated and confined groups; the comments were about equally divided between statements of positive and negative adjustment. Nearly all of the entries that were assigned to Outside Communications as a primary category and Adjustment as a secondary category referred to the negative effects of communications with headquarters or family on individual adjustment.

### **Category Analysis: Mission Duration**

Because the durations of the missions documented by the diarists varied from 69 to 363 days, the data base was divided between the three missions with a maximum duration of 180 days and the six missions with a minimum duration of 230 days, creating derivative data sets defined as short duration and long duration missions. The purpose of separating the shorter and longer missions was to identify any differences in the frequency of category assignments that might be attributable to mission duration.

Also, each mission was divided into first and second halves and the numbers of category assignments in each half were tallied, then combined with the corresponding half of all other missions in each of the two derivative data sets. Additional analyses are reported later in which missions were divided into quarters, but the purpose of dividing each diary into first and second halves was to identify any major changes in the frequency of category assignments over time.

Tables 3 and 4 present the results of this procedure. The tables show only two identifiable differences between short and long duration missions. The first apparent difference is in the proportions of diary entries assigned to the category Recreation &

Leisure: six percent of all entries from short term missions were assigned to this category, compared to 13 percent of the entries from the long duration missions. Clearly, there is less time for recreation and leisure during short duration missions because of the intense work schedule. A second difference is suggested by the proportions of assignments to the Leadership category: four percent from the short duration missions compared to nine percent from the long duration missions. Some of this apparent difference might be attributable to the fact that the short duration data set contained the diary entries of two physicians and only one station leader, whereas the long duration data set contained the entries of equal numbers of physicians and leaders (three each). Differential composition of the short duration sample probably accounts for some of the difference because the diaries from the long duration missions contained similar proportions of entries assigned to the categories Leadership and Medical Support, .093 and .085, respectively.

**TABLE 3**  
**CATEGORY ASSIGNMENTS FROM THE THREE 180-DAY (MAXIMUM) DIARIES**

	First Halves of Missions				Second Halves of Missions				Change	Total	%
	Prim	Sec	Total	1st %	Prim	Sec	Total	2nd %			
Group Interaction (GI)	69	31	100	0.21	56	42	98	0.25	0.04	198	0.23
Recreation & Leisure (RL)	13	15	28	0.06	17	5	22	0.06	0.00	50	0.06
Outside Communications (OC)	39	10	49	0.10	44	14	58	0.15	0.04	107	0.12
Workload (W)	31	43	74	0.16	16	25	41	0.11	-0.05	115	0.13
Leadership (L)	13	6	19	0.04	14	4	18	0.05	0.01	37	0.04
Adjustment (AD)	18	25	43	0.09	13	26	39	0.10	0.01	82	0.10
Medical Support (MS)	38	15	53	0.11	33	10	43	0.11	0.00	96	0.11
Food Preparation (FP)	10	5	15	0.03	7	8	15	0.04	0.01	30	0.03
Organization/Mgt. (OM)	2	10	12	0.03	2	3	5	0.01	-0.01	17	0.02
Event (E)	15	7	22	0.05	10	4	14	0.04	-0.01	36	0.04
Exercise (EX)	0	7	7	0.01	1	3	4	0.01	0.00	11	0.01
Safety (SA)	8	0	8	0.02	0	4	4	0.01	-0.01	12	0.01
Sleep (S)	11	5	16	0.03	3	6	9	0.02	-0.01	25	0.03
Personnel Selection (PS)	0	6	6	0.01	3	4	7	0.02	0.01	13	0.02
Equipment (EQ)	9	4	13	0.03	6	2	8	0.02	-0.01	21	0.02
Internal Communications (IC)	1	0	1	0.00	0	0	0	0.00	0.00	1	0.00
Habitat Aesthetics (HA)	0	0	0	0.00	0	0	0	0.00	0.00	0	0.00
Hygiene (HY)	0	0	0	0.00	0	0	0	0.00	0.00	0	0.00
Waste Management (WM)	2	2	4	0.01	1	1	2	0.01	0.00	6	0.01
Personal Hygiene (PH)	0	0	0	0.00	0	0	0	0.00	0.00	0	0.00
Clothing (C)	0	0	0	0.00	0	0	0	0.00	0.00	0	0.00
Privacy/Personal Space (PP)	0	0	0	0.00	1	2	3	0.01	0.01	3	0.00
			470				390		0.00	860	

Comparing the short and long duration data sets reveals that all other categories of diary entry are within three percentage points in their frequencies of assignment. For example, Group Interaction comprised 23 percent of the entries from the short duration missions and 20 percent from the long duration missions. Similarly, the category

Outside Communications accounted for 12 percent of the assignments from the short duration missions and 13 percent from the long duration missions.

**TABLE 4**  
**CATEGORY ASSIGNMENTS FROM THE SIX 230-DAY (MINIMUM) DIARIES**

	First Halves of Missions				Second Halves of Missions				Change	Total	%
	Prim	Sec	Total	1st %	Prim	Sec	Total	2nd %			
Group Interaction (GI)	111	95	206	0.18	94	107	201	0.22	0.04	407	0.20
Recreation & Leisure (RL)	107	48	155	0.13	89	33	122	0.13	0.00	277	0.13
Outside Communications (OC)	119	19	138	0.12	113	15	128	0.14	0.02	266	0.13
Workload (W)	85	77	162	0.14	37	35	72	0.08	-0.06	234	0.11
Leadership (L)	75	36	111	0.10	58	22	80	0.09	-0.01	191	0.09
Adjustment (AD)	55	47	102	0.09	52	36	88	0.10	0.01	190	0.09
Medical Support (MS)	84	19	103	0.09	62	11	73	0.08	-0.01	176	0.09
Food Preparation (FP)	13	22	35	0.03	13	12	25	0.03	0.00	60	0.03
Organization/Mgt. (OM)	6	23	29	0.03	7	23	30	0.03	0.01	59	0.03
Event (E)	24	6	30	0.03	22	5	27	0.03	0.00	57	0.03
Exercise (EX)	0	16	16	0.01	0	16	16	0.02	0.00	32	0.02
Safety (SA)	7	8	15	0.01	14	2	16	0.02	0.00	31	0.02
Sleep (S)	10	3	13	0.01	6	5	11	0.01	0.00	24	0.01
Personnel Selection (PS)	2	4	6	0.01	1	6	7	0.01	0.00	13	0.01
Equipment (EQ)	1	4	5	0.00	4	0	4	0.00	0.00	9	0.00
Internal Communications (IC)	5	0	5	0.00	0	4	4	0.00	0.00	9	0.00
Habitat Aesthetics (HA)	8	1	9	0.01	0	0	0	0.00	-0.01	9	0.00
Hygiene (HY)	4	2	6	0.01	1	0	1	0.00	0.00	7	0.00
Waste Management (WM)	2	0	2	0.00	4	0	4	0.00	0.00	6	0.00
Personal Hygiene (PH)	3	0	3	0.00	1	0	1	0.00	0.00	4	0.00
Clothing (C)	1	0	1	0.00	2	0	2	0.00	0.00	3	0.00
Privacy/Personal Space (PP)	0	1	1	0.00	0	0	0	0.00	0.00	1	0.00
	722	431	1153		580	332	912			2065	

Comparisons of data from the first and second halves of missions also show only small differences in the proportions of category assignments between the short and long duration missions, and only slight differences in frequency of assignments between first and second mission-halves. Comparisons of the change in proportions reveal no differences in entry assignments greater than .02, with most being identical. The changes from the first to the second halves of the missions include increases in the proportions of entries assigned to Group Interaction (.04 for both short and long duration missions) and Outside Communications (.04 for short duration and .02 for long duration missions); and, decreases in the proportions of entries assigned to the Workload category (-.05 for the short duration missions and -.06 for the long duration missions).

The consistent correspondence of the two data sets suggests that the differences in the frequencies of category assignments between the short and long duration missions are limited to differential proportions of entries concerning Recreation & Leisure, and possibly Leadership. Also, the two data sets reflect nearly identical shifts in the proportions of category assignments from the first to second halves of the missions. The category of entries labeled Adjustment is particularly revealing, in this regard, as it

comprises nine percent of first half and ten percent of second half entries in both the short and long duration data sets. Table 5 presents the combined data from the previous two tables.

**TABLE 5**  
**CATEGORY ASSIGNMENTS FROM ALL DIARIES**

	First Halves of Missions				Second Halves of Missions				Change	Total	%
	Prim	Sec	Total 1st	%	Prim	Sec	Total 2nd	%			
Group Interaction (GI)	180	126	306	0.19	150	149	299	0.23	0.04	605	0.21
Recreation & Leisure (RL)	120	63	183	0.11	106	38	144	0.11	0.00	327	0.11
Outside Communications (OC)	158	29	187	0.12	157	29	186	0.14	0.03	373	0.13
Workload (W)	116	120	236	0.15	53	60	113	0.09	-0.06	349	0.12
Leadership (L)	88	42	130	0.08	72	26	98	0.08	0.00	228	0.08
Adjustment (AD)	73	72	145	0.09	65	62	127	0.10	0.01	272	0.09
Medical Support (MS)	122	34	156	0.10	95	21	116	0.09	-0.01	272	0.09
Food Preparation (FP)	23	27	50	0.03	20	20	40	0.03	0.00	90	0.03
Organization/Mgt. (OM)	8	33	41	0.03	9	26	35	0.03	0.00	76	0.03
Event (E)	39	13	52	0.03	32	9	41	0.03	0.00	93	0.03
Exercise (EX)	0	23	23	0.01	1	19	20	0.02	0.00	43	0.01
Safety (SA)	15	8	23	0.01	14	6	20	0.02	0.00	43	0.01
Sleep (S)	21	8	29	0.02	9	11	20	0.02	0.00	49	0.02
Personnel Selection (PS)	2	10	12	0.01	4	10	14	0.01	0.00	26	0.01
Equipment (EQ)	10	8	18	0.01	10	2	12	0.01	0.00	30	0.01
Internal Communications (IC)	6	0	6	0.00	0	4	4	0.00	0.00	10	0.00
Habitat Aesthetics (HA)	8	1	9	0.01	0	0	0	0.00	-0.01	9	0.00
Hygiene (HY)	4	2	6	0.00	1	0	1	0.00	0.00	7	0.00
Waste Management (WM)	4	2	6	0.00	5	1	6	0.00	0.00	12	0.00
Personal Hygiene (PH)	3	0	3	0.00	1	0	1	0.00	0.00	4	0.00
Clothing (C)	1	0	1	0.00	2	0	2	0.00	0.00	3	0.00
Privacy/Personal Space (PP)	0	1	1	0.00	1	2	3	0.00	0.00	4	0.00
	1001	622	1623		807	495	1302			2925	

The combined data presented in Table 5 show increases from the first halves to the second halves of the missions in the proportions of diary entries assigned to the categories Group Interaction (.04) and Outside Communications (.02). The largest change indicated by the data is a decrease from the first to the second halves of the missions in the proportion of entries concerning Workload (-.06).

### **POSITIVE - NEGATIVE ANALYSIS**

Each diary entry was assigned a code to indicate whether the statement was neutral, positive, or negative in its tone or content. All 1,810 entries were reviewed and the codes assigned during the same session in an attempt to maximize the consistency of the code assigning process. The numbers of the three coded categories then were tallied, and proportions calculated, by quarter, for all missions. A metric, defined as Net Positivity/Negativity (NPN), was calculated by subtracting the proportion of negative entries from the proportion of positive entries. Three sets of positive-negative analyses were performed: 1) Long vs short duration missions, 2) Antarctic vs insular bases, and 3) Physicians vs leaders.

### Positive - Negative Analysis: Long vs Short Duration Missions

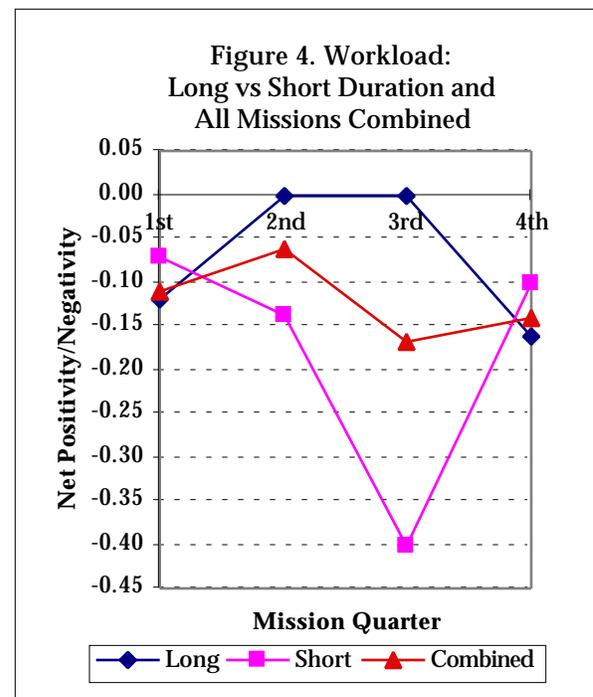
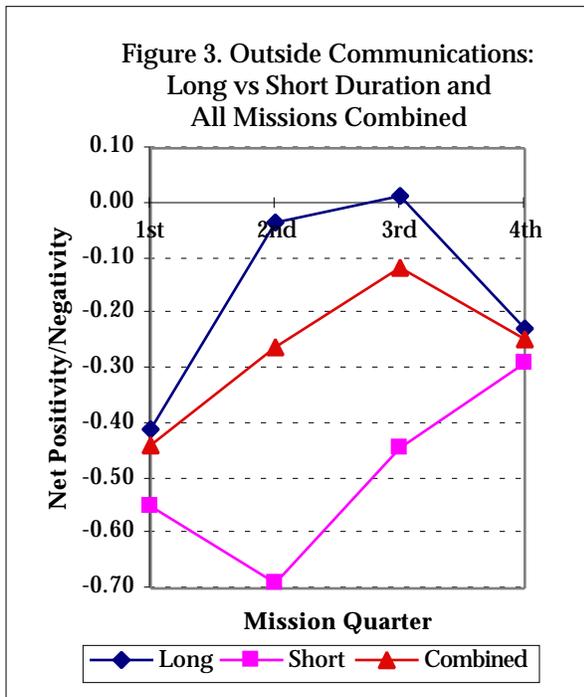
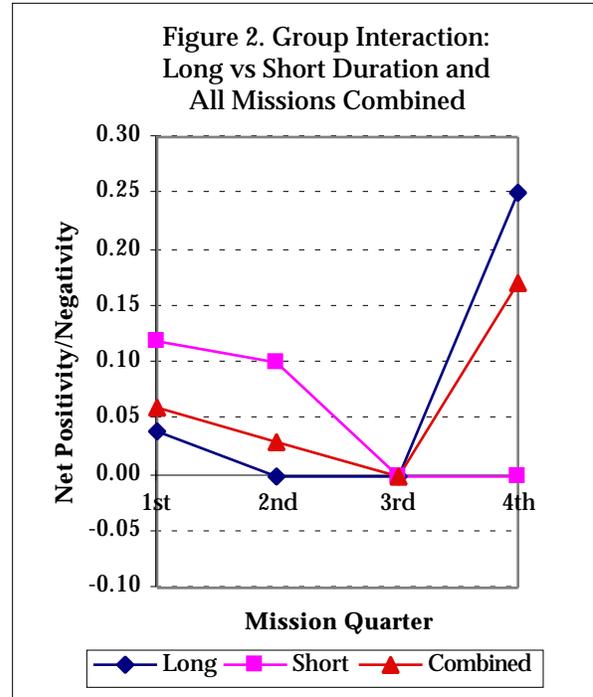
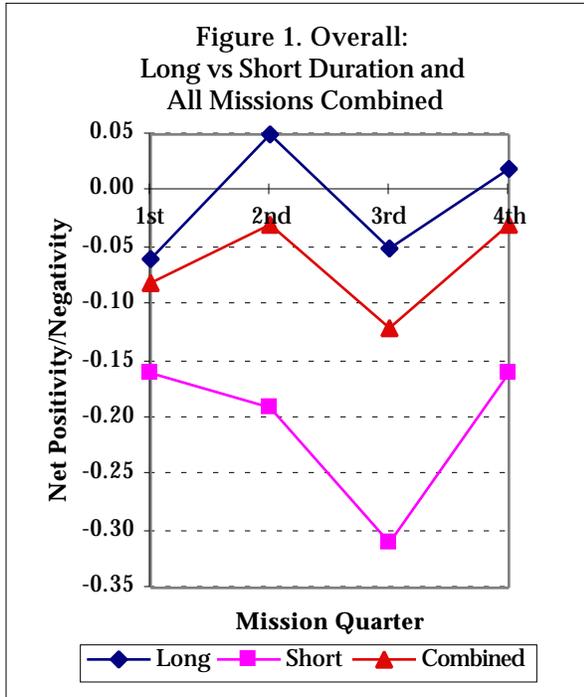
Table 6 and Figure 1 present the results of the positive-negative analysis for all diaries combined, and for the short and long duration missions separately. The table and figure show a similar pattern of Net Positivity-Negativity, by mission quarter, for all diary entries during the long and short duration missions. However, the shorter missions are characterized by substantially greater negativity, especially during the third quarter of the missions. The third quarter dips in this overall measure appear to support hypotheses of a third quarter phenomenon (Bechtel and Berning, 1991).

**TABLE 6**  
**RESULTS OF THE POSITIVE - NEGATIVE ANALYSIS BY MISSION QUARTER**

	<b>Proportion of Diary Entries by Mission Quarter</b>			
	<b>1st Quarter</b>	<b>2nd Quarter</b>	<b>3rd Quarter</b>	<b>4th Quarter</b>
<b>Long Duration</b>				
Positive	0.38	0.45	0.42	0.45
Negative	0.44	0.40	0.47	0.43
Net Pos/Neg	-0.06	0.05	-0.05	0.02
<b>Short Duration</b>				
Positive	0.29	0.36	0.27	0.35
Negative	0.45	0.55	0.58	0.51
Net Pos/Neg	-0.16	-0.19	-0.31	-0.16
<b>Combined</b>				
Positive	0.36	0.42	0.38	0.42
Negative	0.44	0.45	0.50	0.45
Net Pos/Neg	-0.08	-0.03	-0.12	-0.03

The proportions of positive, negative, and neutral diary entries also were calculated for each behavioral category, on the assumption that the relative frequency of positive and negative entries is influenced by fundamental characteristics of the categories. Both primary and secondary category assignments were included in this analysis. Figure 2 illustrates the results of the positive-negative analysis for the entries with either primary or secondary assignments to Group Interaction. The figure reveals a similar pattern of positive, but declining values, for both long and short duration missions, with the exception of a substantial positive spike in the final quarter of the long duration missions.

Figure 3 shows similar measures of NPN during the first and fourth quarters of all missions. However, the long duration missions increase on this measure in the second quarter and decline in the fourth, while the short duration missions decline in the second quarter and increase in the fourth. The figure further reveals that the diary entries associated with Outside Communications are predominantly negative in tone or content during both the long and short missions. Figure 4 shows similar patterns for entries assigned to the Workload category as illustrated for Outside Communications in Figure 3. First and fourth quarter values are about the same for long and short duration missions, however, the long duration missions increase in NPN in the second quarter and decline in the fourth, while the short duration missions again perform in the reverse, and again, with greater overall negativity.



Figures 5 and 6 show similar patterns during the long and short duration missions for the categories of Recreation & Leisure and Medical Support. The nearly identical patterns for Recreation & Leisure include the most positive values measured during the analysis, suggesting the importance of this category to all isolated and confined personnel. Similar patterns for long and short duration missions also are evident in entries assigned to the category of Medical Support. The values are among

the most negative to emerge from the study, but are biased to the negative by the decision to code all medical treatments and consultations as negative.

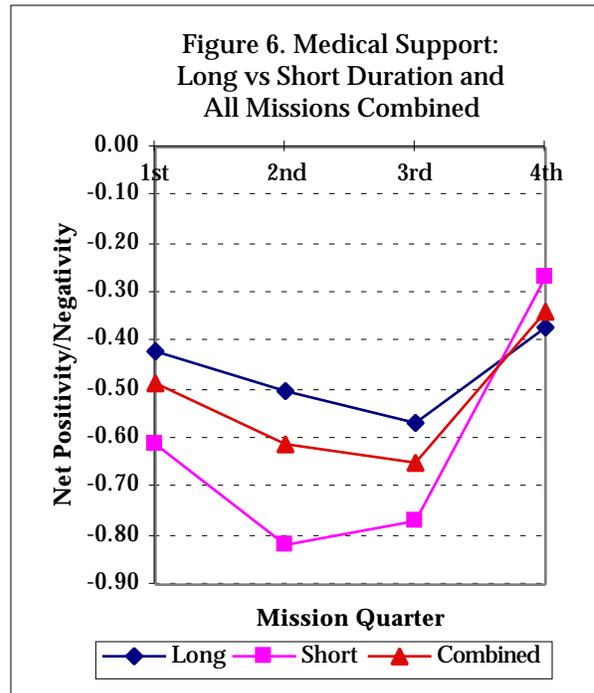
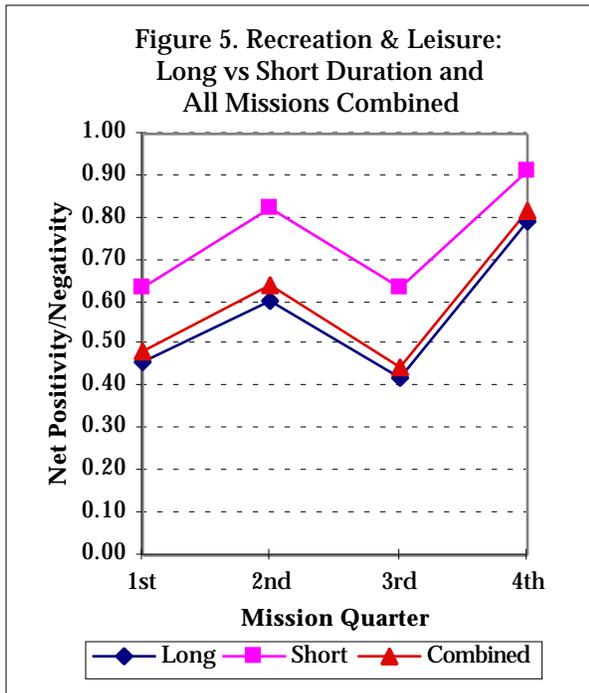
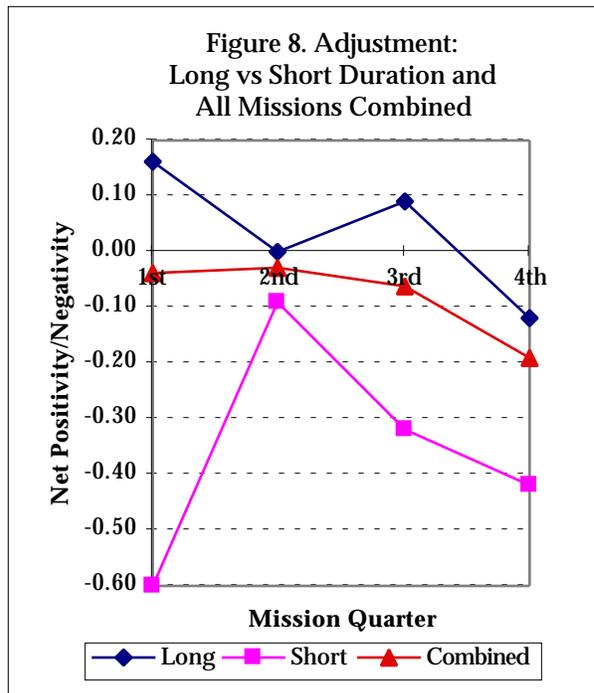
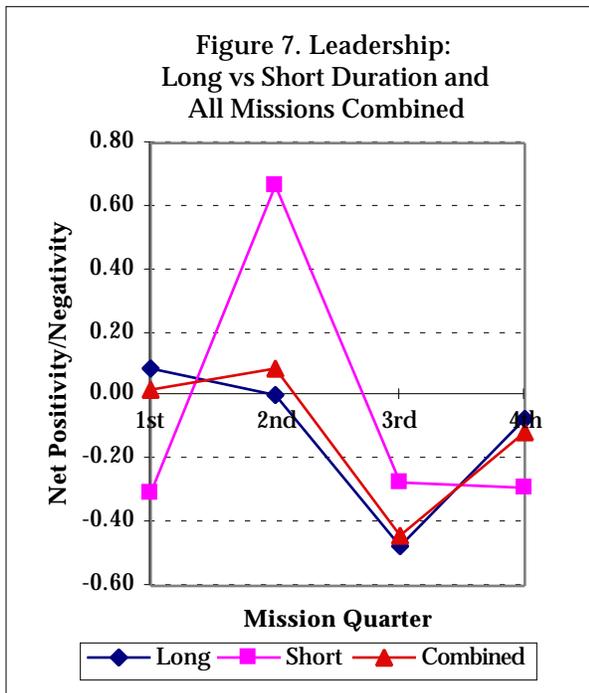


Figure 7 reveals similar patterns during long and short duration missions for entries assigned to the Leadership category, with a positive spike in the second quarter of the short duration missions. Figure 8 reflects a greater initial and overall negativity during short duration missions for diary entries assigned to the Adjustment category.



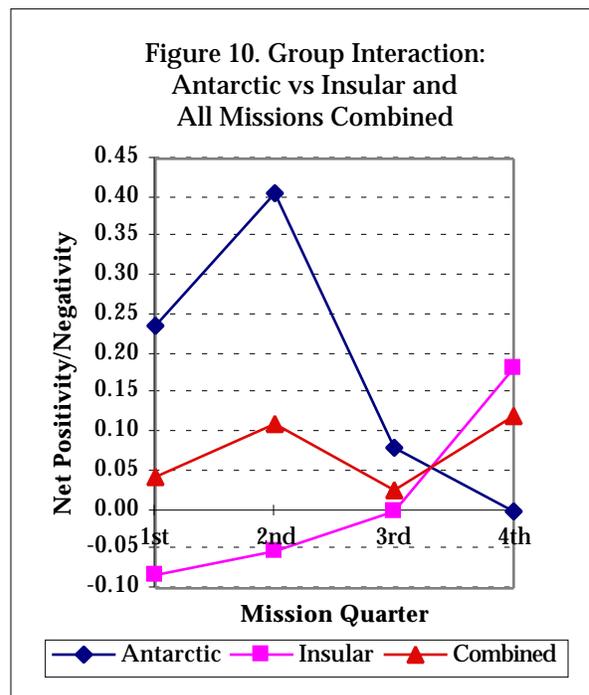
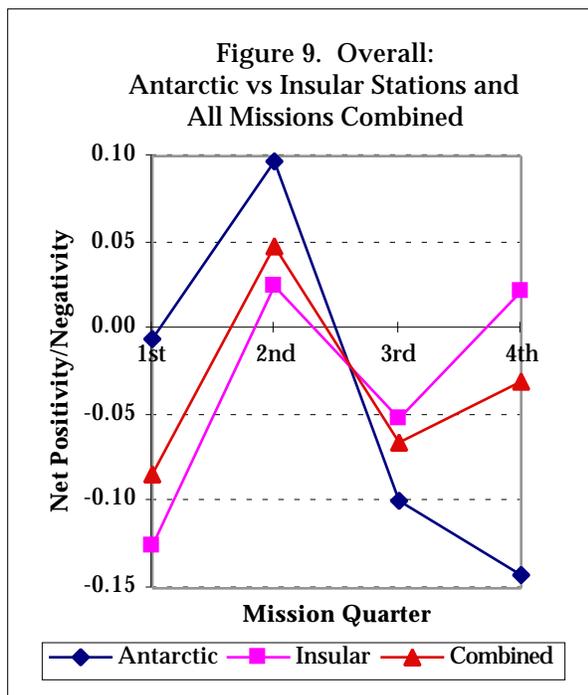
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## Positive - Negative Analysis: Antarctic vs Insular Stations

Positive-negative analyses were performed to compare the diaries from the three insular stations to those from the Antarctic base, to identify any differences that might be attributable to differential conditions. Although all four bases are located in remote and hostile environments, the hostility of the environment and degree of isolation are greater at the Dumont d'Urville base than at any of the insular stations. In addition to more extreme weather in Antarctica, Dumont d'Urville is visited by ship only twice each year, during the Austral summer; in contrast, ships stop at the insular stations almost monthly. The diary maintained by the physician on the 69-day traverse from Dumont d'Urville was excluded from this analysis because of the extremely arduous conditions, resulting in a comparison of data from six insular diaries to data from two Antarctic diaries.

Figure 9 presents the results of the overall positive-negative analysis, comparing all entries from the Antarctic base diaries to all entries from the diaries maintained at the insular bases. The patterns revealed by the figure are similar, with the exception of a positive spike in the fourth quarter of the insular missions and a continued decline in NPN during the fourth quarter at the Antarctic base. Figure 10 presents the results of the positive-negative analysis for entries assigned to the primary and secondary categories of Group Interaction. The figure illustrates two distinct patterns, with NPN increasing during the second quarter at the Antarctic base, then declining precipitously during the third quarter, and continuing the decline into the fourth quarter; however, a steady increase in NPN is exhibited by the diaries from the insular bases. It is important to note that the NPN values are substantially more positive at the Antarctic base than the insular bases during the first two mission quarters, and remain more positive than the insular values during the third quarter, despite the sharp decline.



Figures 11, 12, 13, and 14 present the results of the positive-negative analysis for the categories, Outside Communications, Recreation & Leisure, Medical Support, and Leadership, respectively. The figures show similar NPN values and patterns of change for both the Antarctic and insular bases; depressed third quarter values are evident under both conditions in three of the behavioral categories.

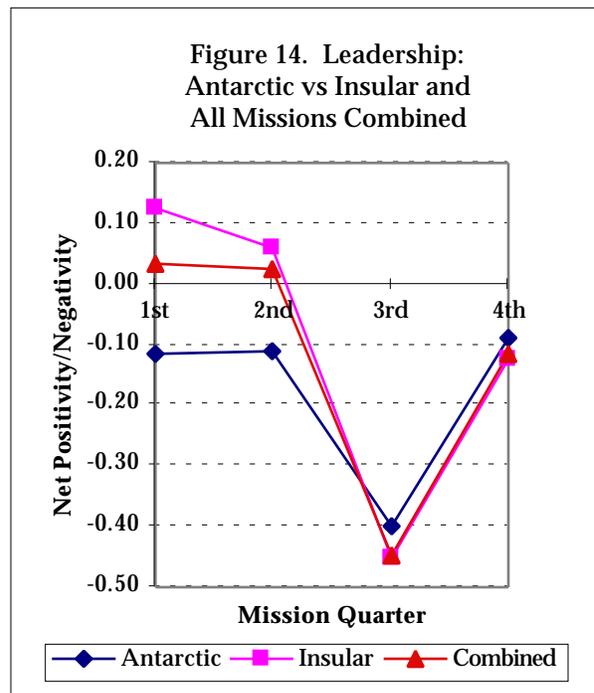
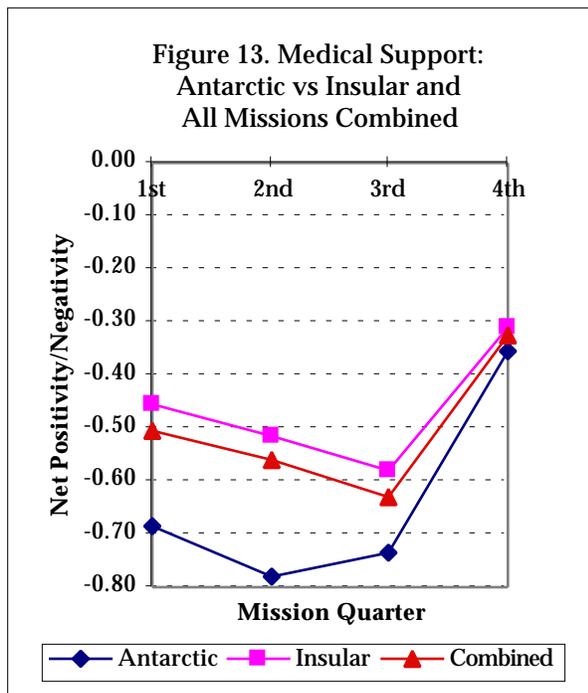
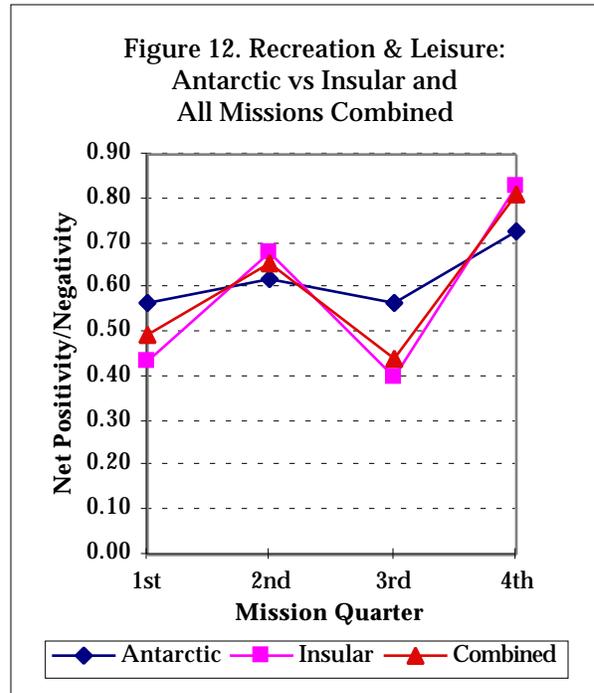
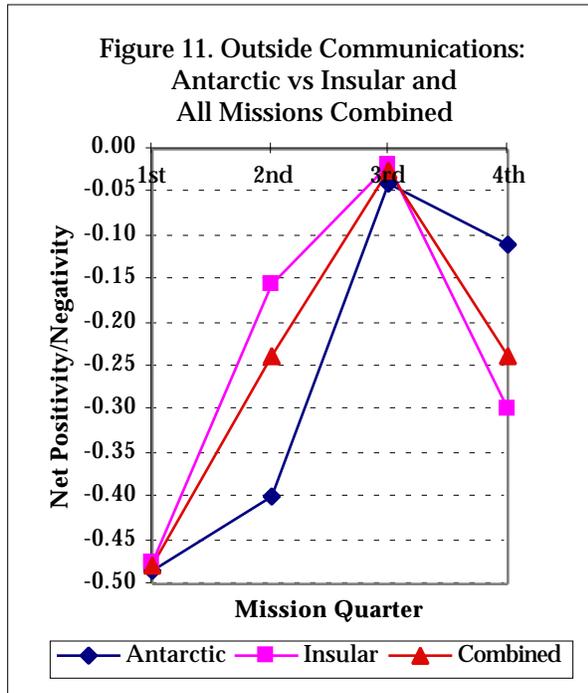
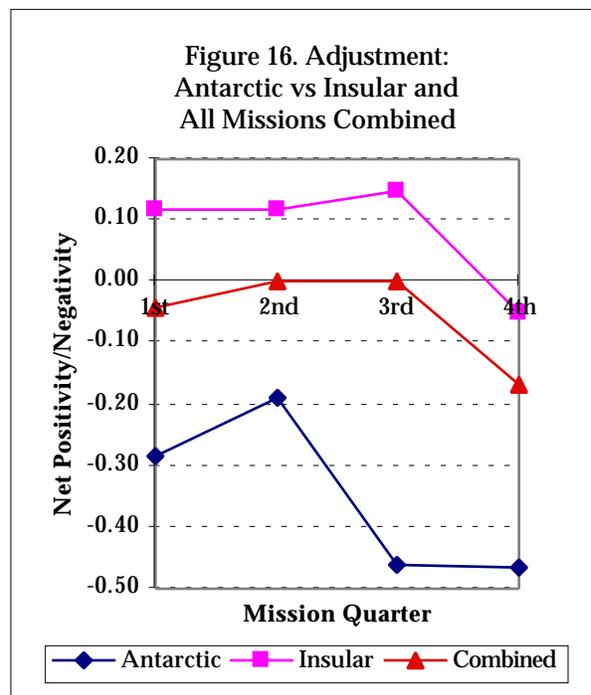
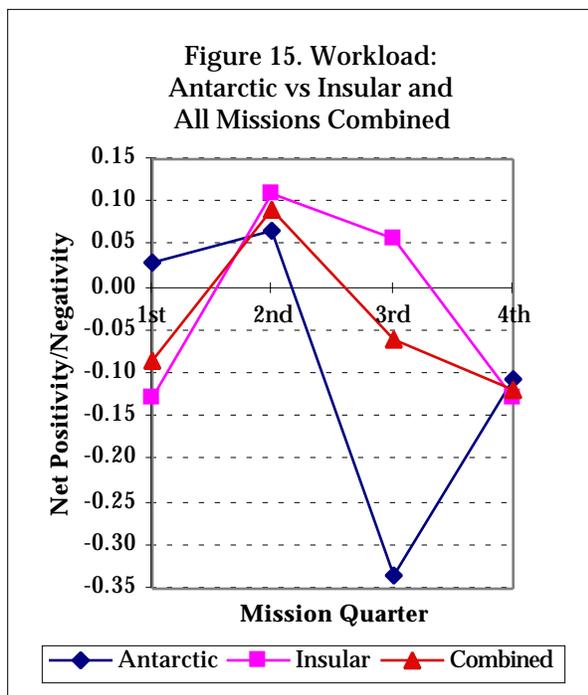


Figure 15 also shows similar NPN values and patterns of change for entries concerning Workload, with the notable exception of the substantial dip during the third quarter at La Base Dumont d'Urville. The third quarter corresponds with the Austral winter, during which workloads are lower than in the other quarters; during the winter, even scheduled work sometimes is rendered impossible by climatic conditions.

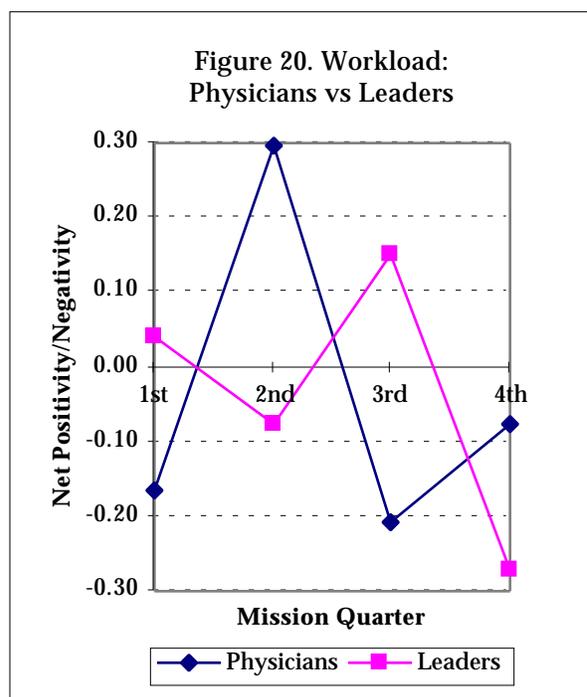
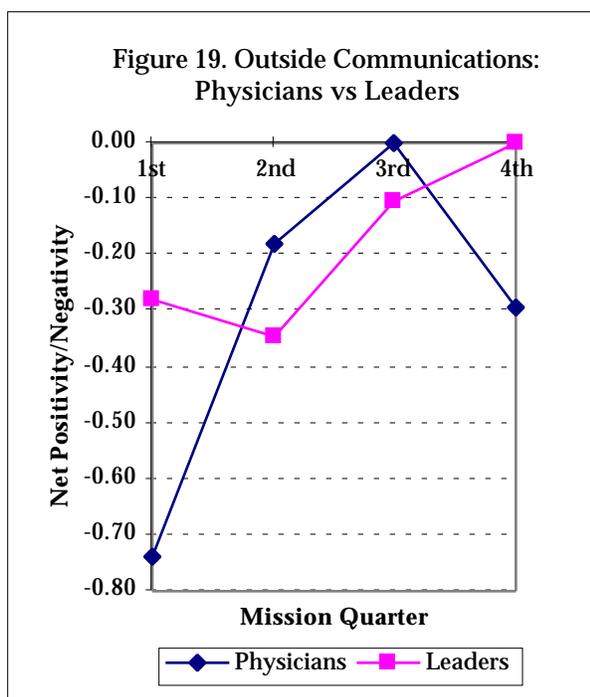
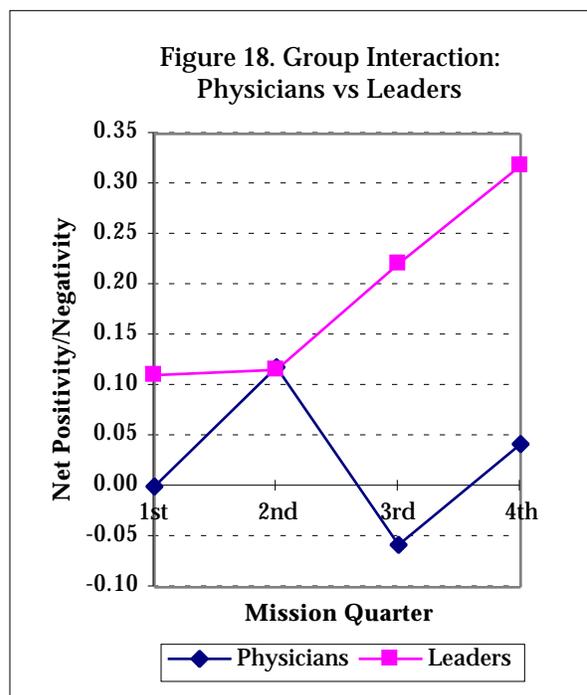
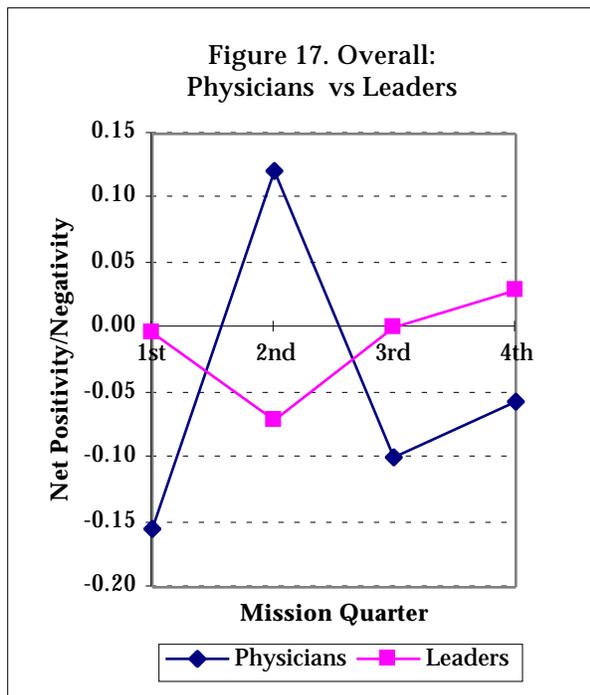
Figure 16 illustrates different NPN values and patterns of change for the Antarctic and insular diaries for entries assigned to the Adjustment category. The insular values are positive and steady through the first three quarters, with a dip in the fourth quarter. In contrast, the NPN values for Adjustment in the Antarctic diaries increase in the second quarter then decline in the third quarter, and remain steady through the end of the mission. All values of the metric for the Adjustment category are negative for the Antarctic diaries.

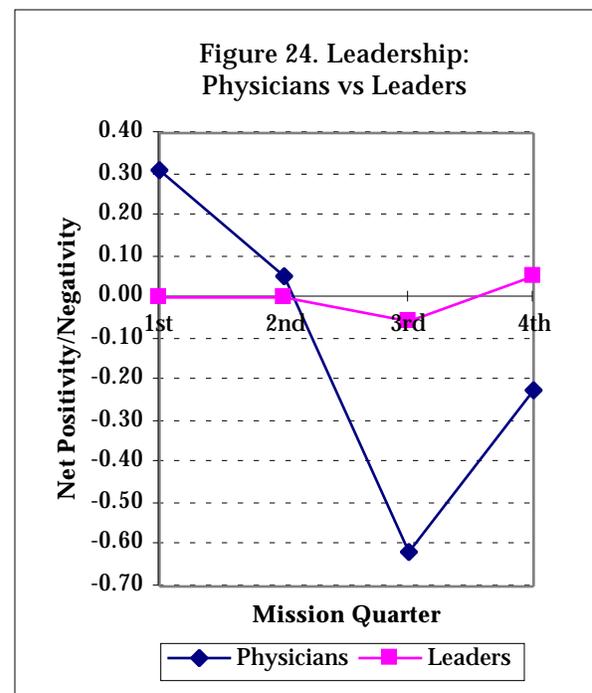
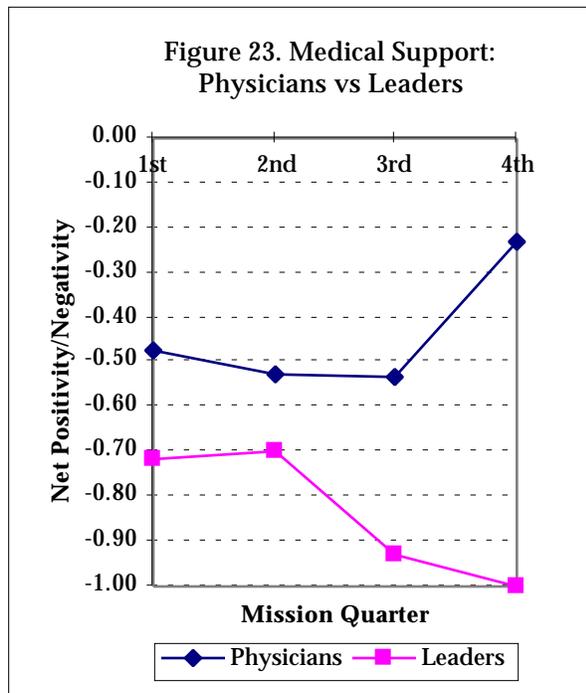
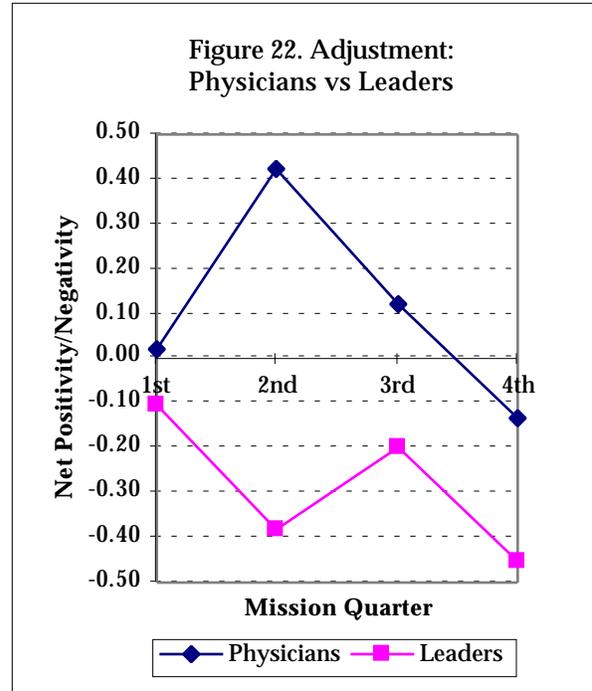
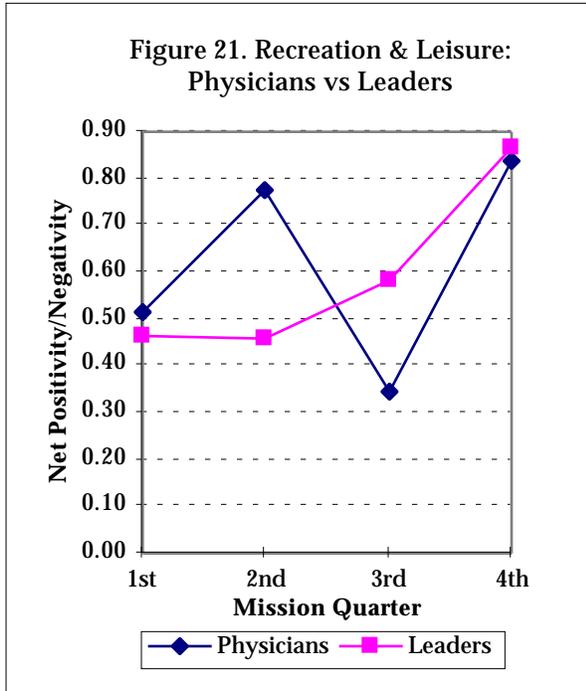


### Positive - Negative Analysis: Physicians vs Leaders

As is evident from the results summarized in Figures 1 through 16, the differences between long and short duration missions, and the differences between Antarctic and insular bases can be characterized as differences in degree; that is, the patterns of change are similar, although on some measures they are more or less positive than the comparison value. However, the positive-negative analysis comparing the diary entries of physicians and leaders found distinctly different NPN values and patterns of change. Figure 17, the overall comparison of all primary category assignments of entries, reveals the general pattern of these comparisons for all of the main behavioral categories, illustrated by Figures 18 through 24: NPN increases for physicians in the second quarter (overall and in five of the seven main categories), but decreases for leaders (overall and in five of the seven categories). Similarly, physicians'

diaries exhibit a third quarter decline in NPN overall and in six of the seven main categories, compared to an overall increase in the leaders' NPN and increases in six of the seven main categories during the third quarter. In other words, the experiences of physicians and leaders in isolation and confinement appear to be very different, at least as measured by the positive-negative analysis of diary entries. The data suggest that expedition physicians experience a third quarter phenomenon, but leaders tend to experience their decline during the second quarter of their missions.





**Positive - Negative Analysis: Overall**

Table 7 shows that nine of the behavioral categories listed had overall proportions of positive or negative entries of at least .50. Categories with predominantly positive entries were Recreation and Leisure, Food Preparation, and Adjustment. The relatively high proportions of positive entries reflect the importance of recreation and food to isolated and confined personnel, and the successful adjustment of the individuals who participated in the expeditions described by the diarists.

Behavioral categories with predominantly negative entries were Equipment, Sleep, Organization-Management, Medical Support, Outside Communications, and Group Interaction. The relatively high proportions of negative entries in these categories reflect the high incidence of equipment malfunctions in extreme environments, inevitable misunderstandings with management and other problems involving communications with the outside world, and the fact that most medical events (i.e., treatment of injury or illness) were categorized as negative. The proportion of negative entries concerning sleep is in response to the crowded conditions and shift work performed at the remote duty stations. The proportions of positive and negative entries concerning group interaction, along with the total number of entries, suggest the extraordinary importance of this category of behavior.

**TABLE 7**  
**POSITIVE VS. NEGATIVE ANALYSIS OF DIARY ENTRIES**  
**BY BEHAVIORAL CATEGORY**  
 (Some categories excluded due to small numbers of entries)

Category	Proportions of Entries in Each Category		
	Positive	Negative	Neutral
Group Interaction (GI)	.46	.50	.04
Outside Communications (OC)	.31	.54	.15
Workload (W)	.31	.29	.40
Recreation & Leisure (RL)	.78	.11	.11
Medical Support (MS)	.14	.66	.20
Adjustment (AD)	.50	.46	.04
Leadership (L)	.39	.43	.18
Event (E)	.42	.49	.09
Food Preparation (FP)	.53	.42	.05
Organization/Management (OM)	.06	.82	.12
Equipment (EQ)	.00	1.00	.00
Sleep (S)	.10	.83	.07
Safety (SA)	.11	.48	.41

### THEMATIC ANALYSIS

The preceding paragraphs described the categorical content of the diaries that were maintained by the nine leaders and physicians who participated in expeditions at French remote duty stations. The remainder of this section of the report addresses the main themes, or specific issues, that emerged from the review of entries within the primary categories. Not all entries could be assigned to an emergent theme, and relatively few entries were assigned to two themes. Results of this analysis are presented by category in the following tables, beginning with Group Interaction, the primary category with the greatest number of diary entries. The numbers of primary category assignments and examples of entries are included in the tables. For some themes, more than one example is provided to illustrate the theme's range.

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**TABLE 8**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: GROUP INTERACTION**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Interpersonal conflict	40	Open conflict among physiologists; a fax war. <i>Also</i> , Conflict between radio operator and power crew has misunderstandings and exaggeration; I try to moderate. <i>Also</i> , B threatened to stop his greenhouse work because the leader would not excuse him from [kitchen duty].
Celebration/special meal brings us together	36	Birthday Saturday; food not so good, but good atmosphere. [ <i>Many similar in RL and FP</i> ]
Teamwork/solidarity	31	The expeditioners show much solidarity.
Group discussion	31	Ardent discussion re environmental issues.
Not fitting in	28	T still is isolated, but trying to do his best. <i>Also</i> , C is not well-accepted by the others.
Problems with crew-relief/switchover	20	New crew cannot feel at home until previous mission personnel depart.
Fitting in	18	The Italians are integrated and learning French.
No, or resolved, interpersonal conflict	14	Most of the crew are making big efforts to cope with the bad habits of others and tolerate them. <i>Also</i> , B apologized to the leader [for the greenhouse dispute] and gave him a special gift.
Trivial issues are exaggerated	14	I have words with P about a fax and realize I am giving too much importance to this issue.
Withdrawal from the group	13	D stays apart, bad mood, and will not participate in planning Midwinter celebration. <i>Also</i> , There is a tendency for retirement within oneself.
Group activity	11	The trips away from the station help us to know each other better.
Spirit is good/high morale	11	There is a very good spirit in the team.
Mocking or derisive behavior	10	Newspaper is divisive, critical; leader stops it.
Good-natured joking	10	April Fool's Day--many tricks.
Spirit is bad/low morale	8	The atmosphere is changing negatively as we approach Midwinter.
Lack of cooperation/teamwork	8	Many of the expeditioners are not cooperating with me; they say they have too much work.
Subgroups	5	Same groups always eat together: military, young technicians, older expeditioners.

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**TABLE 9**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: OUTSIDE COMMUNICATIONS**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Receive replacement personnel or visitors	61	The ship has gone; at last I can read my mail.
Receive information from outside	50	Life at the station was quieter when there were fewer visits. <i>Also</i> , Received good wishes from HQ and Pres. Clinton--a grand honor for us.
Receive mail or fax from friends or family	31	I receive a fax from my son and a drawing from my daughter.
I write, fax, or telephone to friends or family	25	I am writing to friends partly because I have the time, but also because I need to write.
Angry or confused by message from HQ	25	What HQ is asking is unrealistic; they don't understand the conditions here; I had been warned of this, but didn't expect the problem to be so big.
Good news or pleasant message from home	19	I receive good news from my wife; we are exchanging telexes regularly.
Bad news or unpleasant message from home	16	Received fax re death of G's father; I must inform him and look after him. <i>Also</i> , Very unpleasant phone conversation with my wife; I realize I am on the other side of the world.
I call or fax HQ	15	I choose to fax rather than phone to avoid the negative consequences of a hurried conversation inducing critical questions.
HQ does not respond in timely fashion	14	The leader is not happy with delays in communications from HQ; I agree with him.
No mail or news from home	10	No news from home; I am not willing to call by phone; I am tired of this situation.
Communications with other remote stations	10	I feel new energy after discussing D's medical condition with physician at [other station].
Communications-induced thoughts of home	8	In France, the children are returning to school; I very much think about my son. <i>Also</i> , The distance is digging a big trench between us with the time.
Communications procedures	8	L is unhappy because some people are sending messages that are too long.
Communications problems	8	One week communications blackout; some people are unhappy about it.
News and current events	7	We receive the results of the Winter Olympics, but not the "magic images."

**TABLE 10**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: WORKLOAD**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Work described	52	Performed duty planning; not many problems. <i>Also</i> , Everyone is working on inventories. <i>Also</i> , Performed administrative work and reviewed reports. <i>Also</i> , Prepared equipment for the traverse. <i>Also</i> , I am on duty at the power station tonight.
Teamwork/cooperation/communal tasks	43	I help the glaciologist dig a pit--good exercise! <i>Also</i> , I help the meteorologist launch a weather balloon. <i>Also</i> , My turn to clean common areas, help prepare and serve food, and wash dishes.
High workload or too much work	18	I am overloaded with work; I was not expecting that. <i>Also</i> , So much work--and they say the doctor has nothing to do--not true! <i>Also</i> , Time is running quickly; I cannot cope with all that I have to do. <i>Also</i> , I instructed overloaded personnel to periodically leave the station for short walks.
Lack of teamwork or conflict about work	17	There are tensions re communal duties; the quantity of work is unequal.
Work is good or enjoyable/making progress	17	I am happy after a good day of hard work. <i>Also</i> , The hospital is more and more operational; I am pleased with that. <i>Also</i> , We did a good job of organizing the waste department.
Low workload	10	The activity in the station is low and routine. <i>Also</i> , The general tensions in the group are less as the workload decreases.
Work prevented/interrupted by conditions	8	The geologists are having difficulties reaching their site due to storm. <i>Also</i> , The noise and vibration prevent me from performing my psychological research; I must completely revise the protocol.
Work schedules	8	A part of the expedition is living at night (photo lab, snow clearing). <i>Also</i> , The problem with general duty is having to eat one hour earlier (and cope with the cook and bakers, who are very unpleasant).

**TABLE 11**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: RECREATION AND LEISURE**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Special meal, celebration, or party	38	Birthday party: good meal, good wines, good cigars, good celebration! <i>Also</i> , Bastille Day: mock judgments (I am first to the guillotine). <i>Also</i> , For Midwinter, each expeditioner is preparing a gift for another (selected by lot).
Physical activity/sports	31	Skiing on the ice shelf. <i>Also</i> , Table tennis tournament. <i>Also</i> , Volley ball matches played in "la bon humer."
Excursion away from the station	27	The walk was difficult physically, but emotionally intense; we encountered the adventure. <i>Also</i> , I went out for three days--very pleasant; when out, I am me again. <i>Also</i> , As the weather is very bad, my excursion will be difficult, but I will do anything to go and get some oxygen.
Short walk from the station	21	Morning promenade with the doctor.
Videos/films	20	Three movies on same night, interrupted by onion soup, dinner, cakes; a success! <i>Also</i> , Bat Night, complete with two Batman films.
Group service as recreation	16	F is in charge of group photo; took four times! <i>Also</i> , A new newspaper is published; less aggressive and offensive.
Enjoying the view as recreation	15	The view through the window is wonderful; it is always a pleasure to look at it.
Cards, board or group games	14	Playing cards in the bar is a good way to get to know the people better.
Hobbies	13	Some greatly enjoy tending the vegetable garden, which supplements our meals.
Planning of special celebration	12	Preparation for the Midwinter leader election: speeches, video clips, big fun!
Construction/renovation as recreation	11	I organized chapel repair and plan new décor.
Reading	8	Reading books.
Listening to music	8	Leisure today: lecture and music.
Presentation or lecture to group	8	Presentation by summer party about their penguin research; good and interesting.
Alcohol consumption as an issue	8	It is a real problem to find the right balance between too much alcohol and the correct amount for good social effects.

**TABLE 12**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: MEDICAL SUPPORT**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Injury treated	56	Twisted ankle while jogging. <i>Also</i> , Wrist injury. <i>Also</i> , CO intoxic while cleaning chimney. <i>Also</i> , Ornithologist received cut on hand. <i>Also</i> , Eye injury on the traverse; consultation by radio is not easy. <i>Also</i> , Infected nail; the patient faints.
Illness treated/consultation	42	Everyone is ill with the flu following ship's visit. <i>Also</i> , B has headache, F has hemorrhoids, A has conjunctivitis, P has shivers & fatigue. <i>Also</i> , We have an increase in consultations for psychosomatic reactions.
Routine medical tasks described	34	Conducted systematic med survey; sent reports to Paris. <i>Also</i> , Made inventories.
Doctor trains or provides medical info to crew	20	Medical assistant training; we practiced in the field-good results. <i>Also</i> , Dr. posted info on ideal weights; someone removed it & threw it away.
Doctor stressed about role or workload	18	It is not easy being a multi-skilled doctor-having to solve all kinds of problems. <i>Also</i> , I am stressed knowing I am the only doctor here. <i>Also</i> , Dr. is stressed by [visitor's] appendicitis, which affects others. <i>Also</i> , The variety of medical problems is psychologically stressful for the doctors. <i>Also</i> , I am in the well-known position of the isolated physician: limited investigative means & access to experts.
Reorganizing infirmary or medical supplies	14	Reorganized emergency equipment. <i>Also</i> , I spend all my days organizing the hospital. <i>Also</i> , I checked all of the medical equipment & labeled them with names & numbers.
Doctor feels good about role or performance	9	I open tooth and remove nerve; first time for me (I use a good dentistry book). As treatment is successful, two others have come to me with dental problems; confidence is growing.
Doctor comments on someone's mental state	9	D really is not well, his personality is fragile.
Doctor performs research tasks	7	Psychological testing is progressing slowly; participation is not enthusiastic.
Doctor consults with other physician(s)	6	It has been very good to discuss with C the medical problems I am confronting.
Low workload	1	Someone came to fetch me; I thought it was a medical problem, but it was an injured penguin--nothing to do.

**TABLE 13**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: ADJUSTMENT**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
An activity helps individual adjustment	37	[Nearly all of the entries in this theme are references by the same person to religious ceremonies that he conducted at the chapel he renovated during the mission; very few other expeditioners ever attended, but the activity clearly was an important factor in the diarist's personal adjustment to the conditions.]
Low morale	21	My mood is bad. <i>Also</i> , Some who received no mail were very disappointed. <i>Also</i> , Winter is here now, outside and in the people's spirits. <i>Also</i> , I read my diary and it shows the real life here: routine, repetition, monotony. <i>Also</i> , The morale is decreasing, which is normal for May.
Beauty/special experience/wonderment	17	The landscape is more beautiful at night, as the lights give the feeling of being in a lunar environment. <i>Also</i> , Here, things and people are back to a simple, transparent, and elementary state.
Thoughts of home	16	My mind and my dreams are in France. <i>Also</i> , I stay in my office on my 25th wedding anniversary; I hope my wife received the flowers.
Time	14	We are quickly losing the notion of time; it is a good thing the weekends remain to us [to mark the passage of time]. <i>Also</i> , Time becomes not a concept, but almost a solid object, like the frozen sea. <i>Also</i> , There is the perspective of a long straight line away in time. <i>Also</i> , The days were running in the beginning, now they are passing slowly.
High morale	11	The general atmosphere of the expedition is good. <i>Also</i> , I am happy because I do not have time to be annoyed.
Lack of adjustment	9	Those with adjustment problems complain a lot and search for scapegoats. <i>Also</i> , F is more and more isolated because of his outbursts.
Successful adjustment	8	Only very small problems in the group.
Fatigue	6	A decrease in my energy approaching winter.
Sexual deprivation	3	Love frustration is omnipresent. <i>Also</i> , Sexual frustration frightens the people, but is in fact easy to cope with.

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**TABLE 14**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: LEADERSHIP**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Comments about responsibilities and tasks	35	I conduct another meeting of department chiefs to establish new objectives and reorganize. <i>Also</i> , I visit all workplaces; everyone is working. <i>Also</i> , I visit the radio station each morning to collect messages.
Comments about management issues	25	Water is scarce; I establish procedures. <i>Also</i> , I had to refuse mechanic's request for an excursion; he took it well.
Leader facilitates adjustment or group harmony	22	I learned the leader organized things to permit my walk away from the station. <i>Also</i> , I change tables each day at lunch [to eat with different groups]. <i>Also</i> , When a conflict emerges, I try to give it a less dramatic turn.
Others believe the leader is doing a bad job	20	The new leader is behaving as if we were a summer party full of energy; we need some rest. <i>Also</i> , Leader reacted too strongly; he lost credibility and control of the expedition.
Leadership qualities noted	18	As in chess, the leader must anticipate moves (problems) and react appropriately. <i>Also</i> , A leader must be vigilant, ready to listen, impartial, focused, and close to the people. <i>Also</i> , I must adjust my leadership style to the individual.
Others believe the leader is doing a good job	17	L is doing well and considered to be the leader of the team by everyone. <i>Also</i> , The new ops leader is impressive; he is strong and charismatic, giving confidence in this hostile environment.
Leader believes he is doing a good job	16	It feels good to be esteemed by the expeditioners; I must maintain the course. <i>Also</i> , I am happy with my performance; I reached my objectives.
Leader's problems with others	8	P refused to work outside his specialty; leader threatened to send him home on next ship, with positive results.
Leader questions his abilities	4	Some consider me too flexible, others too strict.

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**TABLE 15**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: EVENT**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Bad weather	28	Bad weather is inducing bad[morose] moods. <i>Also</i> , Snow storm; the station is paralyzed.
Human activities and milestones	20	Special event: Birthday celebration, very good, many gifts, music, good fun; this is a necessary event. <i>Also</i> , Departure: hand signs and war cries from those staying-silence from those who are leaving. <i>Also</i> , Death Day: one minute of silence for the two who died in Adelie Land (in 1959 and 1993).
Natural event (other than weather)	14	The Emperor Penguins are arriving in a long column; all expeditioners are watching this marvelous show. <i>Also</i> , The sea is more and more freezing. <i>Also</i> , Beautiful Aurora Australis.
Good weather	5	Spring is here; mild temperature.

**TABLE 16**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: FOOD PREPARATION**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Special meal	12	P and S transformed the restaurant into a truck stop, with special music. <i>Also</i> , Hamburger Party--good atmosphere, country music, our own orchestra, very pleasant. <i>Also</i> , The men from La Reunion prepared roast mutton for everyone. [Many similar in GI and RL]
Good food	10	Excellent repas in honor of the visitors. <i>Also</i> , The food is very good this year (a little bit too many calories, though). <i>Also</i> , Christmas: excellent meal, but rather solemn due to holiday and thoughts of home.
Eating together	8	Dinner is the only meeting of all the team each day. <i>Also</i> , During a party some of the men got into a food fight--big mess.
Bad food	7	The food is less and less good and more and more strange.
Weight gain	4	The expeditioners often weigh themselves; a 5 kg increase in weight is the mean. <i>Also</i> , More and more men are not eating as before because they want to lose weight before going home.

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**TABLE 17**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: ORGANIZATION/MANAGEMENT**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Procedures, policies, directives from HQ	17	The next doctor also will be the station leader-- it seems the decision was made without reflection; it was tried in the past with negative results. <i>Also</i> , The station is old and needs maintenance; repair, repair, always repair-- bothersome. <i>Also</i> , Some of the team will not work this way unless paid more; we need to reorganize traverse work to avoid problems and accidents.

**TABLE 18**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: EQUIPMENT**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Equipment problems/breakdowns	20	My computer broke down; the geophysicists helped me repair it. <i>Also</i> , The traverse team had a near miss; a tractor slid down an ice slope close to a group of workers; tractor out of service, no one injured. <i>Also</i> , C and D worked on the heating system in the Italian caravan all day, but it is too complicated to adjust.

**TABLE 19**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: SLEEP**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Workload/shiftwork interferes with sleep	11	The night shift is difficult for me; I can hardly stay awake. <i>Also</i> , Working at night on hospital reorganization and sleeping all morning; I am desynchronized with the group. <i>Also</i> , We switch back to 24-hour operations; it will be difficult because we already are tired.
Tired and sleep well	5	Now that I am out and exercising, I sleep deep and long.
Sleeping arrangements affect sleep	5	Sleep problems due to noise in the building.
Someone sleeps-in too late	4	T is getting up very late and lets the others work.
Trouble sleeping	4	Bad sleep last night, and a headache.

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**TABLE 20**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: SAFETY**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Safety plans or inspections	15	Fire-fighting exercise; some problems, but the medical part went perfectly. <i>Also</i> , Mark trail so as not to become lost in fog. <i>Also</i> , Performed safety and power station survey during the night.
Unsafe behavior by someone	5	Two men took a zodiac for work without permission, safety equipment, or spare [for rescue, if necessary].
Unsafe conditions	4	When I returned to the caravan, the door was blocked by ice [frozen]; safety conditions are not perfect.
Communications	4	I arrange for three radio contacts each day that I am away from the station. <i>Also</i> , No news from two groups for several days; we are preoccupied with this.

**TABLE 21**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: PERSONNEL SELECTION**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Personnel selection issues	6	[Three of the six entries refer to separation from family as a problem.]

**TABLE 22**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: WASTE MANAGEMENT**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Cooperative work re waste management	5	We have completed our work of collecting and sorting the [accumulated] waste material.
Waste management procedures	4	I inform the crew of the need to separate the trash into categories.

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**TABLE 23**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: INTERNAL COMMUNICATIONS**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Radios tested or used	3	I tested the radio the doctor will use when he is away from the station. [ <i>Other in EQ and SA</i> ]
Internal communications	3	There are three local FM stations now [for a station population of 30]; good fun.

**TABLE 24**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: EXERCISE**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Exercise	3	I take a 2.5 k walk each day to keep in shape. [ <i>Many similar entries in RL about walks and hiking.</i> ]

**TABLE 25**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: HABITAT AESTHETICS**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Making changes to improve aesthetics	4	Expeditioners have many plans for decorating their new rooms.
What is needed	4	There is a need for specially-made furniture, walls covered with wood, to create a warm and human atmosphere.

**TABLE 26**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: HYGIENE**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Public health issues	5	We must remain vigilant about hygiene in the kitchen, remote shelters, food stores, and buildings.

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**TABLE 27**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: PERSONAL HYGIENE**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Personal hygiene issues	4	Twenty out of 30 expeditioners have beards; there is less attention to their physical appearance. <i>Also</i> , It is pleasant to have a shower and rest in a comfortable place after an outing.

**TABLE 28**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: PRIVACY AND PERSONAL SPACE**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Privacy and personal space	1	We are sleeping in the dormitories; it is fine for summer, but could be very small if used in winter, as in the old days.

**TABLE 29**  
**MAIN THEMES OF DIARY ENTRIES**  
**BEHAVIORAL CATEGORY: CLOTHING**

<b>Theme</b>	<b>Number of Entries</b>	<b>Example</b>
Clothing	3	The clothing could be more effective; the boots are not warm enough. <i>Also</i> , The protective clothing is very effective.



Working in Antarctica.

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## **IMPLICATIONS**

In previous studies of space analogue conditions it has been impossible to support with objective evidence any scheme that places relative priority on the many behavioral issues that must be considered when designing procedures and equipment for long duration isolation and confinement. Suedfeld (1998) voiced the concern of behavioral scientists and perplexed aerospace engineers when he commented that a particular study, "...does not communicate judgments about the relative importance of the various problems, so the reader is often left wondering about what design or preparation or intervention goals should have priority if one has to make choices--as one often does because of restrictions of time, space, payload capacity, personnel, funds, and so forth." The current study provides an opportunity to identify the relative importance of the behavioral issues, if one assumption is accepted:

- The frequency that an issue or category of issues is mentioned in a diary reflects the importance of that issue or category.

Additional guidance about the processes by which individuals and groups adapt to isolation and confinement can be found in the results of the positive-negative analyses if it is accepted that the general tone of a diary entry conveys information that can be used to further characterize the experience. It is the experience of individuals in isolation and confinement that is central to the current study. In this regard, it is important to note that the sample of diarists was restricted to expedition leaders and physicians; no technicians or scientists participated by maintaining diaries for analysis. Although the sample of diarists is not representative of the expeditions, as a whole, the research provides clear indications about the behavioral issues and adaptive processes from the perspectives of two key roles. Despite this limitation, the current study provides quantitative data on which to base judgments about the relative importance of the various behavioral issues to individuals living and working in remote, isolated, and confined conditions.

The following pages present discussions of the implications of specific study results. These discussions primarily are intended for the planners of future space expeditions and the designers of remote duty environments. The results also will be of interest to a broad range of disciplines. Studying small groups in isolation and confinement is like viewing society through a microscope; there is much to learn about human behavior, in general, by analyzing the diaries of remote duty leaders and physicians.

### **IMPLICATIONS OF THE CATEGORY ANALYSIS**

The category analysis, as summarized previously in Table 2, confirms the extraordinary importance of issues related to group interaction that has been suggested by extensive subjective research and the personal experiences of isolated and confined personnel. The category, Group Interaction, received 330 primary and 275 secondary

category assignments, for a total of 605 diary entries, which is nearly twice the number assigned to the second-ranked category, Outside Communications.

Focusing on total numbers of primary and secondary category assignments of diary entries provides a list of behavioral issues in the relative order of their salience, and assumed importance. The extraordinary importance of group interaction is revealed by the singularly high frequency of assignments to this category. The six next-highest categories in total numbers of assignments have far fewer entries than Group Interaction, and are separated from each other by an average of only 25 entry-assignments, forming a continuum in apparent salience. The numbers of diary entries, and presumed importance of the issues, decline precipitously beyond the seven most frequently-assigned behavioral categories, which are defined as “major categories” and serve as the focus of the analysis. Figure 25 provides a graphic representation of the relative salience of the 22 categories of behavioral issues that emerged from the content analysis. The identification of the categories’ constituent themes is necessary to fully understand the results of the category analysis. The themes were presented previously in Tables 8 through 29; the implications of the thematic analysis are discussed in a subsequent section.

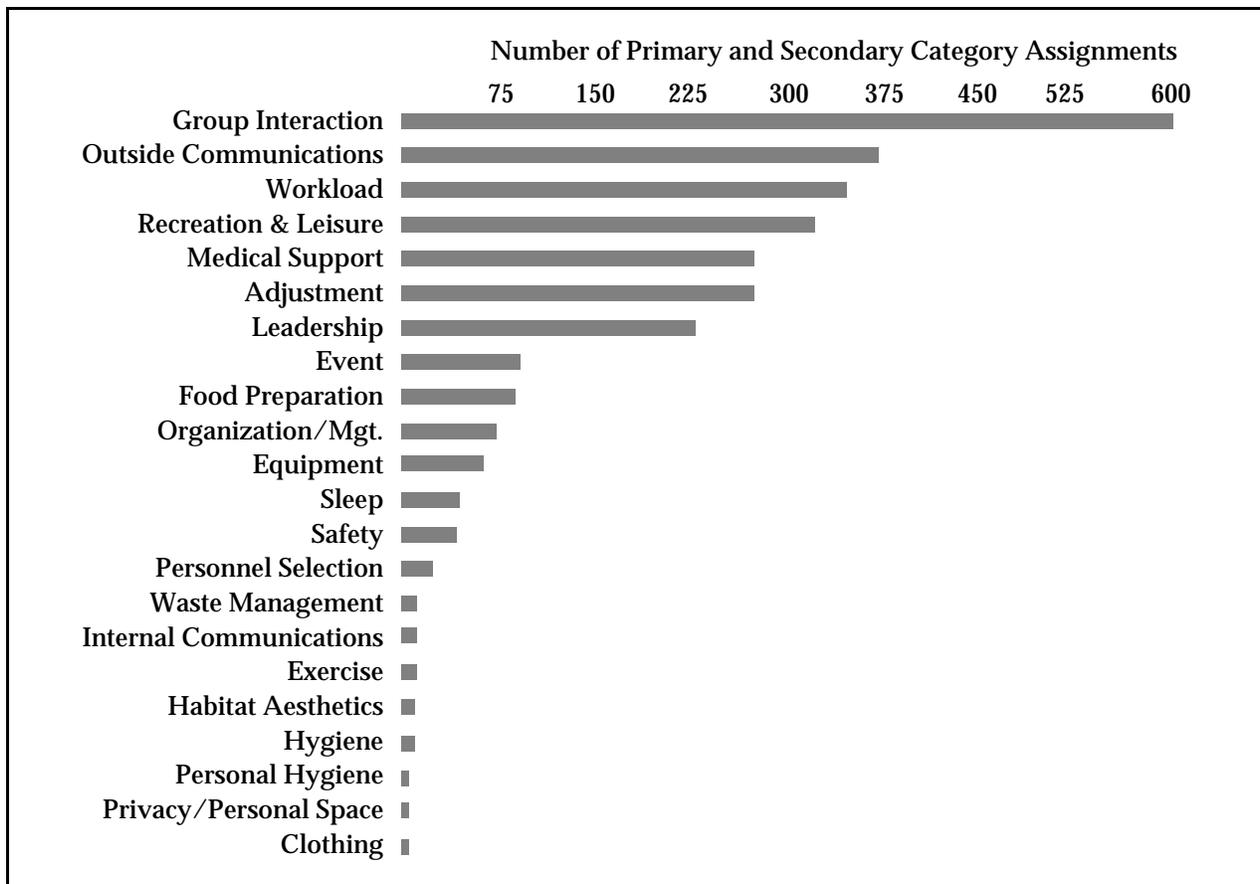


Figure 25. Numbers of primary and secondary category assignments, from Table 2.

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## IMPLICATIONS OF THE POSITIVE - NEGATIVE ANALYSES

The results of the positive-negative analyses suggest that mission duration, environmental conditions, and role in the group influence the tone and content of diary entries. Differential responses to differences in these factors might reasonably be expected, but the specific results obtained from the positive-negative analyses were contrary to the usual expectations.

### Long vs Short Duration

The comparison of diaries from the long and short duration missions found that the shorter missions (69 to 180 days) were characterized by greater negativity than the long duration missions (230 to 363 days); the diaries from the shorter missions were more negative than the long duration diaries in the overall comparison and for all of the main behavioral



Mechanized traverse in Terre Adelie

categories except Recreation and Leisure and Leadership. The patterns of change in net positivity/negativity experienced during the long and short missions were similar, but the NPN values for the shorter missions were more negative, and substantially more negative for certain categories, such as Workload and Outside Communications. Because the effects of stress tend to be cumulative, most behavioral scientists probably would predict greater negativity (lower NPN values) during the longer, rather than the shorter duration missions. The results of the current analysis, however, show that shorter missions can generate greater negativity than longer missions, most likely in response to tighter work schedules, overly optimistic goals for the relatively brief time spent at a remote base, and problems arising from communications with the outside world. An alternative explanation is that there is a critical period for accomplishing good adjustment to the conditions and some (perhaps more) of the people in the shorter missions are not present in the expedition long enough to achieve it.

### Antarctic vs Insular

The comparison of diaries from the Antarctic and insular bases found the insular missions to be described in slightly more negative terms than the missions conducted in Antarctica, despite the greater isolation and more extreme weather at the Dumont d'Urville station. Again, a reasonable expectation might be that the greater isolation and more severe environmental conditions at the Antarctic base would result in greater negativity than at the insular bases; this expectation is met by the diary entries assigned to the Workload and Adjustment categories (see Figures 15 and 16). A sharp third quarter decline in the Workload NPN in the Antarctic diaries corresponds with the Austral winter and the resulting decline in work tempo at Dumont d'Urville.



Fieldwork on Ile Amsterdam

The lower NPN values for entries in the Adjustment category reflect the cumulative effects of mission duration, dipping sharply in the third quarter and remaining low through the ends of the missions. Despite the pronounced negativity in some categories in the Dumont d'Urville diaries, the overall comparison of the Antarctic and insular stations is affected by the relatively low NPN values for entries assigned to Group Interaction during the

first and second quarters at the insular stations (see Figure 10). These negative values largely are attributable to problems arising from frequent visits to the stations by scientists and others who are not a part of the main expedition. As one diarist wrote, "*Quand il n'y avail pas de bateau, c'était plus tranquille...*" (Life in the station was quieter when there were fewer [visits by] ships). In contrast to life at the insular stations, weather, ice, and distance limit access to the Dumont d'Urville station in Antarctica, and insulate the expedition from the perturbations of frequent visits from the outside world.

### Physicians vs Leaders

The comparison of diaries maintained by physicians and leaders found physicians to be more negative in their tone and content than leaders, which largely is attributable to the decision to code medical treatments as negative; the proportions of positive entries were about the same for physicians and leaders (.408 and .404, respectively). It is the difference in patterns of change for physicians and leaders, rather than the NPN values, that is the most striking result of this comparison. It is clear from Figures 17 through 24 that the experiences of physicians and leaders at remote duty stations are vastly different when measured unobtrusively over time by content analysis.



Dumont d'Urville station, Terre Adelie, Antarctica

## Positive - Negative Overall

The overall results of the three sets of positive-negative comparisons are summarized in Table 30. The table presents the proportions of diary entries coded as positive, negative, and neutral, and the NPN derived from those values, for each of the comparison categories in the three sets of analyses. The table shows the highest proportions of positive entries in the long duration missions (0.420), and the highest proportions of negative entries in the diaries from the short duration missions (0.526). Net positivity/negativity, the primary figure of merit for the analyses, shows the overall difference between the Antarctic and insular bases to be small (-0.029 vs -0.042, respectively). The overall difference in this metric between physicians and leaders also is small (-0.053 vs -0.013, respectively), despite different (mostly opposite) patterns of change. The overall differences between Antarctic and insular bases and between the experiences of physicians and leaders are small, particularly when compared to the difference in overall NPN between the long and short duration missions (-0.015 vs -0.210, respectively). Some of this difference is attributable to the special conditions of the arduous, 69-day traverse (included as a short duration mission in this analysis), and some to the negative reaction of a physician to a change in staffing plans. The results clearly show that the short duration missions were described more negatively, overall, than the long duration missions.

**TABLE 30**  
**OVERALL RESULTS OF THE POSITIVE - NEGATIVE ANALYSES**

	Proportion of Diary Entries					
	Duration		Location		Role	
	Long	Short	Antarctic	Insular	Physicians	Leaders
Positive	<b>0.420</b>	0.316	0.398	0.410	0.408	0.404
Negative	0.435	<b>0.526</b>	0.427	0.452	0.461	0.417
Neutral	0.145	0.157	0.176	0.137	0.132	0.179
Net Pos/Neg*	-0.015	<b>-0.210</b>	-0.029	-0.042	-0.053	<b>-0.013</b>

\*Net positivity/negativity = Positive - Negative proportions

## IMPLICATIONS OF THE THEMATIC ANALYSIS

As described previously, diary entries were assigned to categories of behavioral issues on the basis of similar content. Subsequent review of the entries within each category led to the identification of specific themes, or clusters of entries concerning similar topics. Themes were labeled as they emerged from the review of diary entries; that is, there were no a priori judgments or expectations concerning themes, and no theme was imposed on the data set. The nine diaries contain more than 1,800 entries, which were assigned to 22 behavioral categories; a total of 113 specific themes emerged from the 22 categories. The number of themes to emerge from the categories ranged from a low of one to a high of 17; generally, more entries in a behavioral category resulted in larger numbers of emergent themes. The process is summarized by Figure 26.

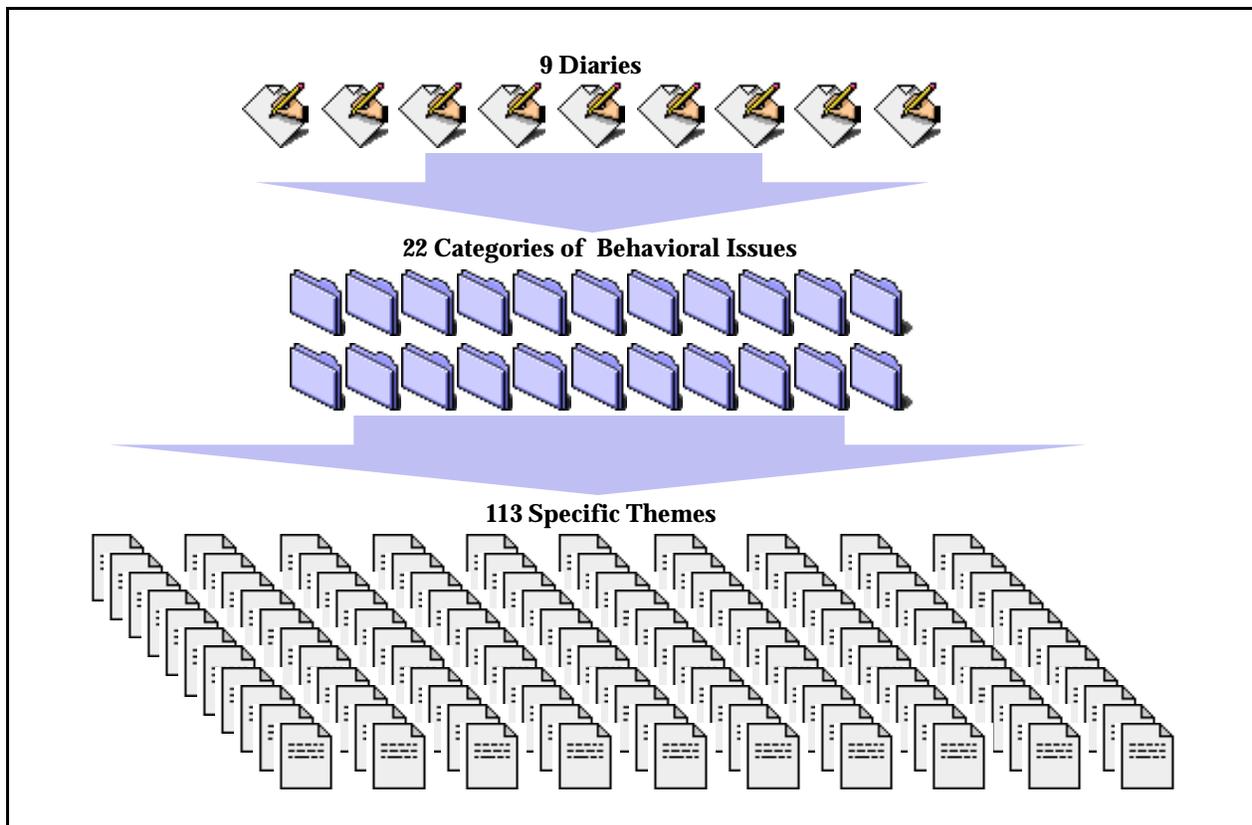


Figure 26. Summary of process from diaries to themes.

The component themes of the major behavioral categories were presented previously in Tables 8 through 29, along with representative examples of diary entries for each theme. Discussions of the emergent themes are presented in the following sections devoted to the behavioral categories.

### Group Interaction

It is instructive, and a bit disturbing, to note that “Interpersonal conflict” is the most frequent theme to emerge from the most frequently-assigned category of behavioral issues. The salience of this theme is particularly noteworthy because the expeditions described by the diarists were considered to be relatively harmonious. The instances of interpersonal conflict mentioned by the diarists are not terribly serious, nor was any a threat to safety or mission success. However, the number of instances reported and the amount of attention devoted to them in the diaries suggests that interpersonal conflict was both relatively frequent during the expeditions and of great concern to the diarists.

It is equally instructive to note that the second, third, and fourth highest-ranked themes within the category of Group Interaction all refer to activities that imply getting along with each other, rather than conflict. “Celebration/special meal brings us together,” “Teamwork/solidarity,” and “Group discussion” contain entries that describe camaraderie in social exchange and cooperation in work. There are more

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references to “Not fitting in” than to “Fitting in,” which reflects the emphasis on getting along with each other, and in this way, the salience of the incidents. This interpretation is supported by the larger numbers of references to “Teamwork/ solidarity” and “Spirit is good/high morale” than to “Lack of cooperation/ teamwork” and “Spirit is bad/low morale.”

Johnson and Suedfeld (1996) found that Arctic explorers and whalers attempted to reconstitute a part of their home while they were isolated in the Arctic. In this attempt, they engaged in activities that were similar to accustomed activities. The celebration of special occasions is, in part, an expression of the tendency to create a bit of familiar home life when living and working in isolation and confinement. Events and special celebrations are mentioned 200 times in the diaries, and most of these entries are positive in tone. The members of the French expeditions found numerous occasions to celebrate: birthdays, religious and national holidays, special theme dinners, feasts and parties, and sometimes with no pretext except to break the monotony of their routine. The event that was most frequently mentioned in the diaries is Midwinter, an occasion unique to the polar regions. All of the diarists wrote about it except the two who were not present at Midwinter. Midwinter is discussed in psychological terms only six times; among these entries, five are negative in tone because the diarists were reminded of the long time remaining in the missions. Other negative midwinter entries concerned either the preparation for the feast, or the feast itself, in which some individuals did not want to participate.

National and religious holidays, including Christmas and New Year’s Day, appear 47 times. Among these holidays, Christmas and New Year’s Eve are the most salient celebrations. They are always mentioned when diarists were in Antarctica at this time. The few negative entries were linked to homesickness, especially at Christmas time, which is a traditional family feast (for instance, one diarist wrote: “Christmas is the first recall of our isolation from people we love”). Also, each month, a party and/or special dinner was held to celebrate the birthdays among the crew during the month, sometimes with handmade gifts.

The salience of “Problems with crew relief/switchover” and “Trivial issues are exaggerated” confirms the results of previous research and operational experience. Crowded conditions, disruption of work schedules, and ambiguity concerning roles all occur during periods when new personnel occupy a remote duty station along with those who are being relieved. Similarly, the tendency for remote duty personnel to exaggerate trivial issues beyond reasonable proportions has been elevated to a principle of habitability. The results of the current analysis suggest the topics should be of particular concern to mission planners and the designers of remote duty habitats.

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Many of the diary entries concerning interpersonal conflict describe incidents that occurred between members of subgroups within the expedition. Generally, the support personnel believe the scientific staff do not fully appreciate their contributions to the expedition, so they complain about their work and ridicule the scientists. There have been conflicts between ships' personnel and civilians onboard since the earliest explorers included scientists in their expeditions. For example, both Lt. Charles Wilkes, of the U.S. Exploring Expedition of 1838-42, and Lt. George Washington DeLong, captain of the *Jeannette* in 1879, failed to do anything to stop their sailors' incessant scornful comments about the "scientifics" onboard, and even participated in the teasing. On the *Jeannette*, some of the scientists became increasingly withdrawn and estranged from the crew, which contributed to the disaster that followed when the ship was beset in the Arctic ice. A desire to eliminate the squabbles and tensions of previous expeditions motivated the French Navy in 1826 to send only Navy personnel with Dumont d'Urville on his voyages to the Far South. Officers with the appropriate scientific and artistic skills were selected to ensure that the expedition leader had complete control and would not have to contend with independent and difficult civilians.



Jules Sebastien-César Dumont d'Urville

"Beakers" is the term now used in reference to the scientific personnel at U.S. polar stations, but the term has fewer derisive connotations since the National Science Foundation assumed complete management of the expeditions. The formation of subgroups is a natural phenomenon and can contribute to individual adjustment, if not permitted to develop to the extreme. The main subgroups that routinely form at the French remote duty stations are, 1) support personnel, 2) military personnel on temporary assignment, and 3) scientific staff. Figure 27 is a drawing by one of the diarists that illustrates the mealtime seating pattern at an insular station (this diary was illustrated throughout by interesting and clever drawings). The drawing, included as Figure 27, shows the support personnel, primarily from La Reunion Island, seated at Table A, military personnel seated at Table B, and scientific personnel (*les VAT*, a category of government service) seated at Table C. Seating at Tables D and E was more variable and less influenced by occupational role.

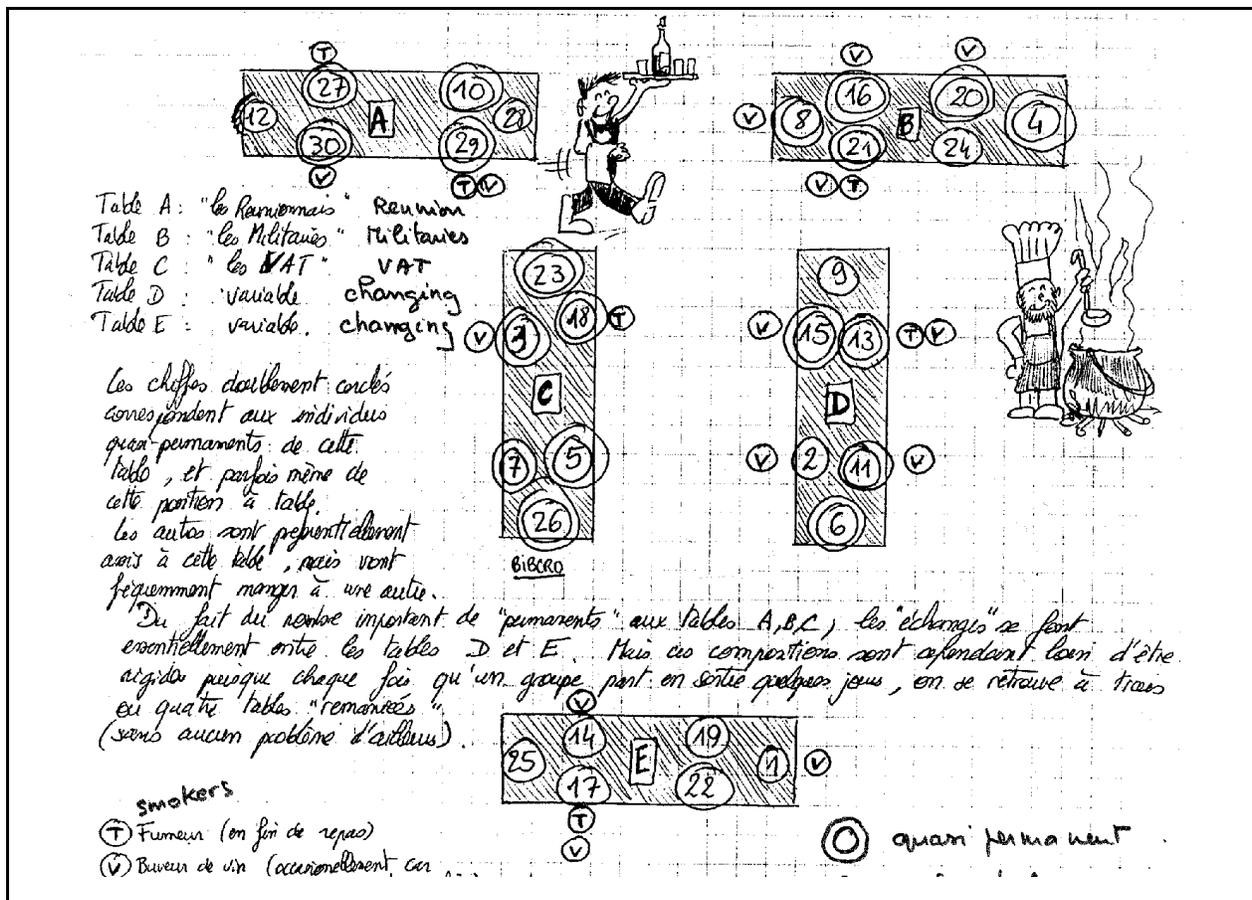


Figure 27. Illustration depicting mealtime seating pattern at an insular station.

### Outside Communications

References to ships' visits lead the themes in this category of issues with the greatest number of entries of any of the 113 themes that emerged from the diaries. Although the Dumont d'Urville station in Antarctica usually is resupplied only once each year, the three insular stations are visited monthly by the supply ship and occasionally by fishing vessels, yachts, and infrequently, naval ships. The salience of this theme, also represented in the previous category, indicates the noteworthiness of visits from outsiders when living and working in isolation and confinement, and the disruptive effects of the visits on the remote duty crew.

The large numbers of entries related to sending and receiving messages will not be surprising to anyone familiar with the operation of ships or other remote duty assignments. Handling the message traffic, primarily concerning routine, administrative matters, is a full-time job, even in relatively small, forward-deployed units; the need for managing outside communications is far greater when personal messages are permitted. Mission planners should anticipate the labor requirements for managing message traffic when assigning responsibilities and calculating workloads for future expeditions.

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Many diary entries refer to problems with communications between the remote station and headquarters. The two themes, “Angry or confused by messages from HQ,” and “HQ does not respond in timely fashion,” reflect a fundamental relationship, as described below.

Communications problems and strained relations between remote-duty staff and their support or headquarters personnel occur whether the relationship is between an Antarctic research station and program managers in the U.S., a field office of a corporation and company headquarters in another state, or a government research center and the agency headquarters in the nation’s capital. As a consequence of the structural relationship, hypersensitivities will occur, and delays of any type that affect the remote-duty group will be perceived as insults.” (Stuster, 1996: 214)

In addition, headquarters frequently serves as a scapegoat for remote duty personnel. Communications with headquarters can relieve individual and intra-group stress by providing an outlet that is external to the group. Directing one’s hostility toward headquarters is an adaptive response that is far healthier than internalizing the stress, and less threatening to group solidarity and mission success than inflicting frustrations on one’s comrades. Sandal, Værnes, and Ursin (1995) report that several crew members in a simulator study conducted for the European Space Agency consciously used the managers as an “enemy” to provide an outlet for interpersonal tension that developed within the group. Psychiatrist Nick Kanas (1990) agrees that in some cases, the anger expressed to headquarters personnel by isolated and confined crew members can be understood as “displacement of interpersonal tensions to safer, more remote individuals outside.” These events usually are distinguished from other conflicts by their abrupt onset and apparent lack of explanation, for example, a sudden outburst that takes everyone by surprise. Sol Sells (1973) described this phenomenon earlier, but warned that, “While the effect might be hygienic, insofar as they [support personnel] furnish a common target for the venting of repressed hostility, the positive values for the group mental health may be more than offset by disruption of significant communications with base support groups.” Suedfeld suggests designating a member of the ground crew as the scapegoat for a mission, as a possible solution.

The frustration, anxiety, and some pleasure associated with sending and receiving personal messages is reflected in the number of diary entries devoted to communications with friends and family. Although the number of entries describing “Good news or pleasant message from home” is slightly greater than the number referring to “Bad news or unpleasant message,” the references to “No mail or news from home” and “Communications-induced thoughts of home” contribute to the generally negative tone of entries concerning outside communications, as reported in Table 7 (.31 positive, .54 negative, and .15 neutral). Also, the many instances of expeditioners receiving negative information, such as reports of an illness at home or the death of a loved one, suggests that mission planners should anticipate similar occurrences during future long duration expeditions.

Incidents of negative news inevitably will increase with mission duration, but already there is considerable experience with the issue on which to base procedures. For example, Dr. Michele Raney learned of her mother’s illness the day she arrived at the

U.S. South Pole Station to be the first woman to spend the winter there. She was initially anxious, then relieved to learn the surgery went well. Although her comrades assumed she would leave for home, Dr. Raney never considered abandoning her responsibility to the station. Later in that mission, one of her crew mates learned that his father had died. The man's mother had concealed the death during several previous conversations to avoid upsetting her son. The man retreated to his quarters and kept to himself for a few days, but otherwise his behavior was unaffected (Raney 1998, personal communication). A similar reaction was reported for a Russian cosmonaut onboard the Mir space station when he learned of his mother's death.

Table 31 lists three categories of outside communications and the proportions of positive, negative, and neutral entries in each category, from all diaries. The table also includes the NPN values for each type of outside communication. The table shows that the diarists recorded more positive than negative entries concerning personal communications with friends and family, resulting in a relatively high NPN value. In contrast, the lower proportions of positive and higher proportions of negative entries concerning communications with headquarters and general administrative communications result in very low NPN values.

**TABLE 31**  
**OUTSIDE COMMUNICATIONS: OVERALL POSITIVE - NEGATIVE ANALYSES RESULTS**

	<b>Proportion of Diary Entries</b>		
	<b>Type of Outside Communication</b>		
	<b>Personal (n=119)</b>	<b>Headquarters (n=85)</b>	<b>General Admin. (n=112)</b>
Positive	0.462	0.212	0.214
Negative	0.437	0.647	0.554
Neutral	0.101	0.141	0.232
Net Pos/Neg*	0.025	-0.435	-0.340

\*Net positivity/negativity = Positive - Negative proportions

The data summarized in Table 31 clearly show that personal communications are positive, overall, despite several instances of negative news and many entries expressing frustration about misunderstandings with loved ones at home and other problems with personal communications. The table also shows that communications problems with headquarters are nearly matched in contributing to overall negativity by the content of entries concerning general administrative messages. It is apparent from the diaries that much of what the remote duty personnel hear from the outside world is negative (e.g., the ship will be late, a duty assignment has been changed, operating instructions for an item of equipment were not sent). Negative messages of this general type, combined with the usual problems concerning communications with headquarters, make outside communications particularly important to mission planners, who should expect similar factors to influence the attitudes and behavior of the crews of future space expeditions and other remote duty assignments.

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A final note about outside communications: All three of the positive-negative analyses (Long vs Short, Antarctic vs Insular, and Physicians vs Leaders) found third quarter declines in NPN overall and in each major category of behavioral issues, except Outside Communications. Diary entries assigned to Outside Communications consistently increased in net positivity-negativity during the third quarters of the expeditions, while all other categories experienced declines.

### **Workload**

Most of the diary entries assigned to the Workload category are descriptions of tasks performed by the diarists and other members of the expeditions. Apart from these descriptions of work, the most salient theme in this category is labeled “Teamwork/cooperation/communal tasks.” Many of the entries that compose this theme refer to the performance of *Petite Marie*, or general kitchen duty, which involves assisting with the preparation and serving of meals and cleaning up afterwards. The duty is shared on a rotational basis, and all members of the expedition are expected to cooperate; most leaders and physicians take their turns in the rotation to set an example for the others.

In addition to performance of communal tasks, many of the diary entries describe voluntary cooperation and assistance to other members of the expedition in the performance of their work. Helping a scientist with an experiment or lending a hand to a construction crew provides welcome variety in a monotonously routine schedule. Although some instances of “Lack of teamwork or conflict about work” were reported by the diarists, many more entries commented on teamwork and cooperation. Also, the entries that compose the theme, “Work is good or enjoyable/making progress,” are reminders that satisfaction with one’s work is a primary source of reward, under most conditions, and might assume added importance in isolation and confinement, where normal sources of gratification are denied.

The entries that compose the two themes, “High workload” and “Low workload,” describe routine conditions that are punctuated by seasonal pulses of high tempo activity and periodic restraints on even routine work, imposed by weather. The diary entries illustrate the stress associated with too much work and the lethargy that results from too little. Mission planners should be concerned with maintaining an appropriate workload on future space expeditions, which might involve unplanned periods of low workload resulting from environmental conditions or equipment failure, in addition to planned periods of low workload. It will be necessary to devise procedures for keeping crew personnel occupied with meaningful activity in the event of circumstances that prevent the performance of planned tasks, a practice of many previous explorers to mitigate the negative effects of extreme boredom.

### **Recreation and Leisure**

The high importance of recreation and leisure to isolated and confined personnel is indicated by the large number of diary entries in this category, and the proportion of the entries considered to be positive in tone, .78, which is by far the highest proportion

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of positive entries among all 22 of the categories. References to “Special meal, celebration, or party” compose the most frequently-mentioned theme in this category, and several entries compose a related theme, “Planning of special celebrations.” It is important to note that many additional references to special meals are represented as leading themes in the categories, Group Interaction and Food Preparation.

The many diary entries that compose the themes, “Excursions away from the station” and “Short walk from the station,” describe activities that appear to be motivated by a desire for exercise and a need to get away from the constant proximity of comrades in the station. In some instances, the longer excursions also were attempts to experience some of the *valorisant* (giving honor) of earlier expeditions.

At most remote duty stations safety, logistics, and staffing responsibilities make it necessary to obtain approval well in advance of personal excursions, as described in the diary entries from the French stations that compose this theme. For example, at the U.S. McMurdo Base, one must sign up one month in advance to visit ice caves only 30 minutes away by tractor. Individuals are disappointed when they learn they cannot depart the station or when their planned excursion is cancelled because of weather, equipment problems, or administrative policy. It is important to understand that some things that headquarters might consider to be a “frill” are viewed by the remote duty personnel as central motivating factors for their involvement in the mission. The conflict between different expectations and perceptions can be a source of stress for both managers and crew. Individuals and organizations tend to consider recreation as non-essential activity—something to be done only when work has been completed. Although this is an acceptable approach under normal conditions, recreation and leisure time are necessary in isolation and confinement to “re-create” the individual and adjust to the special circumstances.

Despite the need for recreation, there is evidence that some individuals derive similar benefits from work-related tasks performed during leisure time. For example, Suedfeld (1998) found that Canadian astronauts spent their leisure time working on mission-related activities during a seven-day simulation of a shuttle mission. The human requirement for recreation and leisure probably increases with mission duration.

The theme, “Physical activity/sports,” is composed of a large number of entries, some describing truly ingenious adaptations of well-known games to local conditions (e.g., using red wine to mark the boundaries of a soccer field on the ice shelf). It probably will be inadvisable to attempt soccer, skiing, volley ball, and the other sports played at the French remote duty stations, at lunar or Martian outposts of the future. However, mission planners should anticipate similar desires and requirements to those described by the diarists. For example, golf again will be played on the Moon, and it can be assumed that, eventually, excursions from Martian bases will be made for recreational, as well as, work-related purposes.

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“Hobbies” should be a theme of particular interest to the planners of future long duration expeditions because of the need for personnel to remain engaged in meaningful activity, despite problems that prevent the performance of planned tasks. Suedfeld (1997) found that good adjustment to Arctic remote duty was positively related to developing hobbies that could be pursued in the remote environment, and many of the hobbies had Arctic content (e.g., history, botany). The hobbies described by the French diarists were photography and gardening. An interest in gardening is particularly appropriate for future expeditions because the activity contributes to food production for the group as well as individual adjustment for the gardener. One of the station leaders wrote that, “Some [members of the expedition] greatly enjoy tending the vegetable garden, which supplements their meals.” Similarly, a physician reported, “The greenhouse has good production: salads, tomatoes, herbs, and flowers.” He later wrote, “I visited the greenhouse today and took some plants for the hospital.”

Clearly, the benefits of onboard food production are not limited to nutrition, but this fact has been known to explorers for many years. For example, before departing France in 1826, two boxes containing specially selected olive and fig trees were loaded onboard the *Astrolabe*. The trees were to be carried, as a favor, to Port Jackson, Australia. Captain Dumont d’Urville later wrote in his journal,

Despite the jolting they have suffered on the trip they have flourished and are covered with the loveliest green leaves. In the dreary monotony of the ocean, their greenness delights the eye, lifts the jaded spirit and brings back happier thoughts. If I were in command of a frigate or any ship, I would like to decorate my cabin with several flower boxes, regardless of the cost, just for their greenness. (Dumont d’Urville, 1987: 19 [1826])

### **Medical Support**

This category primarily includes diary entries that describe the work performed by the physicians and physicians’ comments about their roles in the expeditions. The most-frequently mentioned themes are “Injury treated” and “Illness treated/consultation.” The numbers of entries assigned to these themes are slightly inflated by references to treating the injuries and illnesses of Ukrainian fishermen whose vessels periodically visited the insular stations. However, the bulk of the entries concerning injuries, illnesses, and other consultations involved the expeditioners and provide insight to the types of medical problems that will confront physicians on future space expeditions. Kidney stones, dental problems, twisted ankles, exposure to toxic fumes, and colds and flu following resupply visits, all are possible, and indeed likely to occur, among the crews of space stations and lunar and planetary outposts. The details and contexts will be different, but the types of medical problems will be very similar to those described by the diarists at the French remote duty stations.

The physicians remained extremely busy throughout their missions, despite anecdotal reports that remote-duty medical personnel usually have little to do. Fridtjof Nansen (1897) joked about how little work there was for the ship’s physician during the Norwegian Polar Expedition, “He looked long and vainly for patients and at last had to give it up and in despair take to doctoring the dogs.” It is common practice on modern expeditions to assign collateral duties to the group’s physician to ensure that this key individual remains fully engaged with meaningful work.

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In addition to treating injuries and illnesses, the physicians at the French remote-duty stations conducted “Routine medical tasks” (primarily a periodic medical survey of all personnel), “Trained or provided medical information to the crew” (e.g., first aid training to assistants and field teams), “Performed research tasks,” and spent considerable time “Reorganizing the infirmary or medical supplies.” Several physicians commented that they were “Stressed about their role or workload,” in particular, the responsibility for providing dental treatment and medical support without access to specialists. Most of the expedition physicians expressed a desire to speak with other physicians, sometimes about a specific medical problem, and sometimes the motivation was just to speak with someone outside the small society with whom they shared interests. These themes and physicians’ expressed concerns, indicate requirements for telemedicine and teledentistry, and suggest that scheduled teleconferences among remote duty medical personnel might facilitate their adjustment and technical performance.

As reported previously in Table 7, the diary entries assigned to the Medical Support category were predominantly negative in tone, largely because nearly all treatments were judged as negative events (even though nearly all treatments had positive results). Despite this coding bias, the physicians reported several instances of “Feeling good about their role or performance.”

### Adjustment

Adjustment is one of the five categories of behavioral issues added during the initial review of the diaries. This category encompasses references to individual and group morale, and to responses to the stressors associated with living and working in isolation and confinement. As reported in Table 13, the most frequent theme in this category was the result of one physician’s religious activities. A case could be made for including this theme in the Recreation and Leisure category because the religious services were performed during off-duty time, and many of the entries categorized as Recreation and Leisure also describe “Activities that help individual adjustment,” such as special meals, celebrations, and excursions away from the station.

Nearly twice as many entries refer to “Low morale,” as to “High morale,” however, references to “Lack of adjustment” and “Successful adjustment” are almost equal in number. Overall, approximately equal proportions of all entries assigned to the Adjustment category were judged as positive and negative in tone (.50 positive, .46 negative, and .04 neutral). The themes related to “morale” in this category refer to individual adjustment; similar themes emerged from the entries assigned to Group Interaction, but those themes concerned group morale. A comparison of the corresponding themes in the two categories, Adjustment and Group Interaction, shows that the diarists commented more frequently about good than bad *group* morale, but far more frequently about bad than good *individual* adjustment.

Several entries in this category compose a theme labeled, “Beauty/special experience/wonderment,” which summarizes references in which the diarists describe an appreciation for the special experience of living and working in a remote, hostile, and unspoiled environment. The entries that compose this theme primarily refer to

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feelings of awe concerning natural phenomena, such as violent storms and breathtaking views. Appreciating the beauty of the environment or the special conditions of the experience seem to imply personal adjustment.

A particularly interesting theme that emerged from this category of entries was named, simply, "Time." This theme is composed exclusively of references that describe the diarists' perceptions of the passage of time. Examples include, "losing the notion of time," time becoming "not a concept, but almost a solid object, like the frozen sea," and "during this expedition, time for me sometimes stopped." Admiral Richard E. Byrd described this theme when he wrote of his experience at Advance Base in 1934, "Time was no longer like a river running, but a deep, still pool." Mission planners, and future explorers, should be aware of the effects of isolation and confinement on perceptions of time.

### **Leadership**

Together, the nine themes that emerged from diary entries assigned to the Leadership category describe the business of operating a remote duty station. The most frequent theme provides "Comments about responsibilities and tasks," which are primarily routine administrative functions, such as setting schedules, organizing and conducting meetings, and supervising and coordinating the activities of department heads. The next most-frequent theme is composed of "Comments about management issues"; these entries refer to problems that arose during the expedition that required the leaders' attention. Examples include a water shortage and the imposition of conservation procedures, concern about the training of medical assistants, and interventions in conflicts over work responsibilities.

Several diary entries, from the diaries of both leaders and physicians, were combined to form the theme labeled, "Leader facilitates adjustment or group harmony." This theme comprises entries that describe actions by a leader that were intended to overcome interpersonal problems, facilitate an individual's adjustment to the conditions, or foster group solidarity. Examples include successful mediation of disputes, ensuring that overworked individuals receive needed relief and leisure time, and providing an example to others by volunteering for communal tasks (e.g., "I must organize the safety and duty schedule; I am first on the list"). Entries also describe the personal involvement of leaders in station activities, such as helping to sort vegetables, organizing contests, and providing lectures and presentations to the group. The diaries contain many examples of inspired leadership.

The seriousness with which the leaders performed their work is reflected in several entries that compose the themes, "Leadership qualities noted" and "Leader questions his abilities." The entries are introspective comments about, 1) the personal qualities of effective leaders (e.g., "Leader qualifications: a democratic leadership style--but not too much"); 2) instrumental leadership techniques (e.g., "I must work hard so the expeditioners respect me"); and, 3) the leader's performance (e.g., "I must avoid being paranoid--interpreting everything as being done against me personally").

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Approximately equal numbers of entries compose the themes, “Others believe the leader is doing a good job” and “Others believe the leader is doing a bad job.” The words “bad job” in this label actually are an overstatement because the entries primarily refer to instances in which a physician disagrees with or criticizes specific actions of a leader. Some entries, however, refer to patterns of behavior, such as, “The leader ignores interpersonal problems in favor of ‘all went well.’” It is revealing that physicians were uninhibited about criticizing leaders, but leaders tended not to criticize physicians.

This issue was addressed by Baron Gaston de Gerlache, son of the leader of the Belgian Antarctic Expedition of 1898-99. Baron de Gerlache wrote,

...the medical officer in a polar expedition must be interested in research and take part in the general scientific programme so as not to find himself with nothing to do when the expedition members are in good health and not in need of his services. Lack of occupation is not only frustrating for the man himself but it often has the effect of developing in him a critical attitude towards the way the expedition is being run, which then communicates itself to his colleagues. (Cook, 1980, I [1900])

The relationship between an expedition leader and physician either can mitigate or exacerbate the stress caused by isolation and confinement. Leaders and medical personnel with relevant experience have referred to the characters in the original *Star Trek* television series as defining the appropriate relationship between leaders and physicians in future expeditions. The physician of the fictional *Enterprise* was outside the ship’s main chain of command, which facilitated confidential consultations with all crew members; and, he was close enough to the captain, professionally and socially, to offer a dissenting opinion (usually several each episode) without appearing as a direct threat to the captain’s judgment or status.

The leaders of expeditions and remote duty stations have a difficult and lonely job. Typically, remote leaders are deprived of the tools on which most leaders rely in the performance of their leadership tasks. First, they are denied the asset of punishment because in an isolated and austere environment, crew members believe that almost everything they have is essential to survival. Privileges, such as recreation, that would be trivial if withheld as punishment in a normal environment, are regarded as unacceptable deprivations at a remote duty station. Further, the leaders of small, isolated and confined groups also are denied the customary status that is conveyed by leadership roles in normal settings. The interpersonal distance that can be instrumental to a leader under normal conditions erodes with time in isolation and confinement, as a consequence of living in close proximity and sharing experiences. Most important, remote duty leaders operate in the absence of the normal network of other leaders who can provide support and validation of specific decisions and actions. This is one of the reasons why remote duty leaders (and physicians) often spend considerable time communicating with headquarters or other remote stations. Perhaps a need for validation also is reflected in the theme, “Leader believes he is doing a good job,” which is composed of such self-affirming statements as, “There are more advantages than disadvantages to my leadership style, so far.”

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## Event

Nearly half of the entries assigned to this category refer to weather as an event worthy of note (“Bad weather,” 28; “Good weather,” 5). An additional 14 entries describe natural events other than weather (e.g., return of the penguins). A theme emerged from the entries concerning “Human activities and milestones” during the expeditions. Entries that compose this theme include descriptions of the departure of crew members and commemorations of events, such as the annual ceremony to honor those who died during previous expeditions. Although this category received substantially fewer assignments than the seven previously-discussed categories, the entries all refer to events that were perceived by the diarists to mark the passage of time.

## Food Preparation

The preparation of “Special meals” emerged from this category with the greatest number of entries, followed by themes labeled, “Good food,” “Eating together,” “Bad food,” and “Weight gain.” Entries were assigned to primary and secondary categories, depending on the emphasis of the diarist. The number of entries assigned to Food Preparation does not accurately reflect the importance of this category as a consequence of the decision to code only two possible categories for each entry. In addition to the 43 primary and 47 secondary category assignments, food also was involved in more than 50 entries assigned to primary categories, such as Group Interaction (“Celebration/special meals bring us together”), Recreation and Leisure (“Special meal, celebration”), and Workload (“Teamwork/cooperation”), that were assigned to secondary categories other than Food Preparation. A coding scheme that includes tertiary category assignments would reveal the unusual supporting role of food in other, extremely important categories, as well as in providing important life support requirements to the crew.

Food is the quintessential habitability issue. The food systems designed for long duration expeditions must provide a disproportionate share of the psychological support to crew personnel because food naturally assumes additional importance as a substitute for denied sources of gratification.

## Organization/Management

All 17 of the diary entries that received primary category assignments to Organization-Management concerned “Procedures, policies, or directives from headquarters.” Entries include complaints about pending changes in staffing policies, maintenance and logistics procedures, and the compensation schedule. All but three of the entries are negative in tone. An additional 59 entries received secondary assignments to this category.

## Equipment

All 20 of the diary entries assigned to Equipment as the primary category describe “Equipment problems or breakdowns,” and all 20 are negative in tone or content. Examples include the loss of a tractor when it slid down a steep slope (almost

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taking two men with it), mechanical breakdowns of vehicles, malfunctioning scientific instruments (in particular, a pesky “bio analyzer” at one station), computer crashes, and trouble with the plumbing. These are precisely the kinds of equipment problems that will confront the future explorers of the Moon and Mars.

### **Sleep**

All of the entries assigned to Sleep as the primary category refer to problems involving sleep. More than half of the entries are about sleep that is disturbed by shiftwork or noise. A few entries describe trouble sleeping because of headache, and an equal number are complaints about comrades whose sleeping patterns interfere with the performance of cooperative tasks. A few entries describe a good night’s sleep as a consequence of fatigue from heavy work. These also are likely to be the experiences of future explorers and the inhabitants of lunar and planetary bases, for the same reasons.

### **Safety**

The diary entries assigned to Safety as the primary category are about equally divided between themes concerning safety precautions and safety problems, including a few infractions of safety rules. One of the diarists reported, “Too much concern for safety is not good for safety; not enough concern is worse.” The importance of safety precautions and the risks associated with errors and accidents increase with the hostility of the environment and the remoteness of the location. Safety and contingency planning will continue to be a primary concern of all explorers.

### **Personnel Selection**

All six entries assigned to Personnel Selection as the primary category describe the separation from one’s family as a major obstacle to individual adjustment to remote duty. An additional 20 entries received secondary assignments to this category. Those entries refer to the positive and negative traits of expeditioners. For example, “T [a leader] is not too old, interesting (he has done many things), cool but able to be strict and make decisions,” and “The people recruited [for support roles] are not sufficiently informed about living and working conditions.”

### **Waste Management**

Only a dozen entries received either primary or secondary assignments to the category, Waste Management. Many additional entries describe cooperative efforts to consolidate and remove old waste dumps near the stations and were assigned to the categories Workload and Group Interaction, rather than Waste Management. The processing and proper disposal of waste material, and the clean-up of previously-disposed waste, are important issues at remote duty stations, wherever they are located. Waste management will be one of the concerns of future space explorers.

### **Internal Communications**

A few of the entries assigned to Internal Communications are about the mobile radios used by personnel while away from the station. Several additional references to radios were assigned to the categories, Equipment and Safety.

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### **Exercise**

Only three entries received primary assignments to Exercise on the basis of the content (i.e., an emphasis on exercise). Many additional entries that refer to short and long walks away from the station, and other entries that describe sporting activities, were assigned to other categories, such as Recreation and Leisure, Group Interaction, and Adjustment. Exercise rarely was emphasized by the diarists.

### **Habitat Aesthetics**

Only a few diary entries concern habitat decor or decoration. Half of the entries describe expeditioners' plans for decorating their private quarters, and half comment on the aesthetics of the common areas, for example, "There is a need for specially-made furniture, and walls covered with wood to create a warm and human atmosphere."

### **Hygiene**

A few entries discuss the requirement to remain vigilant about hygiene in the kitchen and other areas of the station.

### **Personal Hygiene**

A few entries describe changes in the amount of attention some expeditioners devote to physical appearance. A decline in standards of personal hygiene has been a major source of conflict in some remote duty environments. There is almost no evidence of this phenomenon in the diaries from the French stations.

### **Clothing**

Only three entries refer to clothing. A diarist at the Antarctic station complained that the clothing and boots assigned to him were not warm enough, while a diarist at an insular station (where the weather is less extreme) described his clothing as "very effective." As the Norwegians are reported to say, "There is no bad weather, only bad clothes."

### **Privacy and Personal Space**

The assignment of only one diary entry to the primary category, Privacy and Personal Space, is the most unexpected result of the content analysis. Apparently, the requirements for privacy and personal space are satisfied for station leaders and physicians by their small, but private, quarters. Crowding only became a problem during the brief periods when both the out-going and in-coming expeditions occupied the stations. Comments about crowding during the transition periods were assigned to Group Interaction and Outside Communications.

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## SUMMARY

- Group Interaction is the most salient (i.e., important) category of issues, by far.
- Other important behavioral issues are, in order of their salience:
  - Outside Communications
  - Workload (i.e., work performed)
  - Recreation and Leisure
  - Medical Support
  - Adjustment
  - Leadership
  - Food
- All expeditions, short and long, Antarctic and insular, decline in overall net positivity/negativity (NPN) during the third quarter (i.e., regardless of duration and location).
- Physicians experience the third quarter phenomenon, but leaders experience their greatest decline in NPN during the second quarters of their missions.
- Relatively frequent visits by outsiders are disruptive and contribute to the greater negativity experienced at the insular stations, compared to the more isolated Antarctic base.
- The greatest overall difference in NPN was found between short and long duration missions, with the shorter missions characterized by substantially greater negativity.
- Meals, special meals, and celebrations are extremely important to the members of the expeditions and contribute to group solidarity and individual adjustment.
- The celebration of traditional holidays is not very enjoyable to remote duty personnel because it causes them to think of what they are missing at home. It is the celebration of expedition-unique events, such as Midwinter and special theme dinners, that is enjoyed, talked about, and remembered.
- Trivial issues are exaggerated.
- Subgroups will form and can negatively affect group harmony, if permitted to develop to an extreme.
- Communications between headquarters and remote duty personnel frequently are sources of frustration for remote duty personnel. Some instances of communications problems are primarily the displacement of hostility outside the group, others are a consequence of exaggerating trivial issues, and still others are rational responses to remote managers' lack of understanding or sensitivity to the special conditions of isolation and confinement.
- Communications with loved ones also can be problematic for remote duty personnel (e.g., misunderstandings, negative news, stimulating longings for

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home). Despite the problems described by the diarists, personal communications received positive values.

- Outside Communications increase substantially in NPN during the third quarters of expeditions, at the same time the values of other behavioral categories decline.
- Work is a primary source of satisfaction. Too much or too little work results in negativity and can threaten individual adjustment.
- Helping others with novel tasks provides welcome variety in a monotonously routine schedule.
- Recreation and Leisure provide variety of experience and contribute to group solidarity and individual adjustment. Excursions away from the station are favored by remote duty personnel, as are sporting activities, parties, group discussions, videos, and personal pursuits, such as reading and gardening.
- A broad range of medical problems occurs at remote duty stations.
- Physicians experience considerable anxiety about their abilities to handle medical problems that are outside their specialties, and with limited diagnostic resources. Physicians also experience great satisfaction when they successfully respond to the emergencies.
- Physicians, and to a lesser extent, leaders benefit from opportunities to communicate with the physicians and leaders of other remote duty stations.
- Some individuals adjust quickly to isolation and confinement; others adjust slowly; a few fail to adjust and remain miserable.
- Some individuals derive great satisfaction and enjoyment from natural surroundings, even when they are bleak or hostile.
- Time seems to slow down in isolation and confinement.
- Milestones, celebrations, and other events help mark the passage of time.
- Leaders of remote crews can contribute to individual and group performance by mediating disputes, fostering solidarity, and providing an example for others to emulate.
- Food assumes added importance when customary sources of gratification are denied.
- The sleep of some individuals will be disturbed by noise made by equipment and crew mates.
- Bad weather and other events outside the control of the expedition will occur and will prevent, or make more difficult, the completion of some mission objectives.

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- Equipment will break down, spares will be unavailable, and written procedures will be missing or inadequate, regardless of the amount of preparation.
  - Private sleeping quarters satisfy requirements for privacy and personal space.

## CONCLUSIONS

The research documented in this report provides quantitative data on which to base judgments concerning the relative importance of the behavioral issues associated with long duration isolation and confinement. Although study results provide clear indications of the priority that should be placed on the various behavioral issues, this work represents only the beginning of what must be accomplished to prepare adequately for expeditions to the Moon and Mars.

Further research is required to assess the experiences of other members of analogous expeditions, in addition to leaders and physicians, the roles that served as the focus of the current study. The research also should address inter-cultural issues by studying crews of international composition, because future expeditions to the Moon and planets will be conducted by crews drawn from the spacefaring nations.

The research methods and analytical techniques developed during the current study have resulted in new and valuable information, and will further extend our understanding of human performance in isolation and confinement if applied to other roles and international crews. Our understanding, however, will not be sufficient to send humans on interplanetary expeditions until full-mission simulations are conducted under operational conditions. The ideal, informed research program leading to long duration space missions should culminate in high-fidelity simulations of space expeditions performed in a remote and hostile environment. A facility located in Antarctica, such as the planned French-Italian Concordia Base, would provide the force and fidelity of conditions necessary to complete our understanding of the relevant issues, and for future space explorers to discover if they are prepared for long duration isolation and confinement.



Model of the planned Concordia Base, Dome C, Antarctica

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**APPENDIX A**

**DIARY CONTENT MATRIX**

APPENDIX A, CONTENT MATRIX

Primary Assignments		Secondary Category Assignments																				No Secondary	% No		
Categories	Totals	AD	C	E	EQ	EX	FP	GI	HA	HY	IC	L	MS	OC	OM	PH	PP	PS	RL	S	SA	W	WM	No Secondary	% No
Adjustment (AD)	138			2		1		17		1			4	5	1				7	4		12		84	61%
Clothing (C)	3														1									2	67%
Event (E)	71	2				1	1	4											6	1		8		48	68%
Equipment (EQ)	20			1				1					1	2								6		9	45%
Exercise (EX)	3							1											1					1	33%
Food Preparation (FP)	43	1		1				24					1						3	2				11	26%
Group Interaction (GI)	330	53		3			30				20	10	19	8			1	12	51	4	1	23		95	29%
Habitat Aesthetics (HA)	8	3																						5	63%
Hygiene (HY)	5						1				1											1		2	40%
Internal Communications (IC)	6				3			1			1								1					0	0%
Leadership (L)	160	6					1	48					5	2	9			5	7	2	3	30		42	26%
Medical Support (MS)	217	8			2	1	1	20			1	4		20					2	3	8	50		97	45%
Outside Communications (OC)	315	33		9	1		2	32				12	17		33			2	4			14		156	50%
Organization/Mgt. (OM)	17							2			2			1				1	1	1	1	4		4	24%
Personal Hygiene (PH)	4																		2			1		1	25%
Privacy/Personal Space (PP)	1																							1	100%
Personnel Selection (PS)	6	1						1					1	1	1									1	17%
Recreation & Leisure (RL)	226	14		1	35		7	90	1			3	3	5								10		57	25%
Sleep (S)	30				2	2		1					1				2					13		9	30%
Safety (SA)	29				1	1		2			3	5	6		2							2		7	24%
Workload (W)	169	13		5	1	1	4	31		1		20	6	3	4				16	2	1		3	58	34%
Waste Management (WM)	9																					6		3	33%
<b>Totals</b>	<b>1810</b>	<b>134</b>	<b>0</b>	<b>22</b>	<b>45</b>	<b>7</b>	<b>47</b>	<b>275</b>	<b>1</b>	<b>2</b>	<b>4</b>	<b>68</b>	<b>55</b>	<b>58</b>	<b>59</b>	<b>0</b>	<b>3</b>	<b>20</b>	<b>101</b>	<b>19</b>	<b>14</b>	<b>180</b>	<b>3</b>	<b>693</b>	<b>38%</b>