

Psychological Factors in the Antarctic

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ABSTRACT. For the people who live and work in the Antarctic, isolation and extreme physical conditions cause considerable stress. This article reviews psychological research on Antarctic residents, focusing on factors related to the isolation (effective personnel selection, positive adjustment, conflict, and reintegration into the home environment) and factors related to the physical environment (the extreme cold, high altitude, increased radiation, sensory deprivation, and seasonal changes in activity level). Finally, Antarctic research has been applied to the study of future space travel and space station habitation.

[The Antarctic is characterized by] . . . lack of novelty, and the social stresses encountered by a collection of heterogeneous strangers in developing a distinct microculture adapted to this unusual human situation.

Natani and Shirley, 1974, p. 89

ANTARCTICA contains one tenth of the earth's land surface. Ice covers more than 98% of the continent; in fact, the Antarctic contains 90% of the world's ice and 68% of the world's fresh water locked up in the ice. It is the world's coldest, highest, and driest continent (Laws, 1987). Antarctica has never had a native culture and was an isolated land mass for 140 million years. Surrounded by one of the roughest oceans in the world, travel to the region remains difficult despite modern technology such as radar and icebreakers.

Virtually unexplored until this century, Antarctica was not fully mapped until the 1950s. The first half of the 20th century was marked by exploration, but people who come to the Antarctic today spend from several weeks to several years engaged in scientific research or related support activities. Living conditions are luxurious compared to the early days of exploration. Ant-

This article was written while Esther Rothblum was a Kellogg National Fellow and the recipient of a Kellogg Foundation Small Grant on the Antarctic.

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arctic stations are permanent, insulated, and heated buildings that may include such material comforts as greenhouses, bulk food storage, movies and videos, athletic facilities, and a library.

Nevertheless, for people who stay long and particularly for those who winter over, several factors contribute to stress and maladjustment. Antarctica is thousands of miles from all continents except South America, where the closest large city is more than 1,000 miles away. There is no vegetation or wildlife except on the coast. Temperatures range from 40° above zero in the summer on the warmest part of the peninsula to more than 100° below zero in winter. There are frequent blizzards, with winds that may exceed 200 mph. The scenery is a monotonous sheet of white ice, and it is easy to get lost when the winter night sets in. The Antarctic is extremely dry, so that the threat of fire is severe. It is impossible to leave the confines of the indoors in most stations during the winter.

This article reviews psychological research conducted on Antarctic residents since the 1950s. There have been two types: studies that focus on the isolation of life in the Antarctic, such as personnel selection, positive adjustment, conflict, and reintegration to the home environment; and studies that focus on human adjustment to the unique geographic factors of the Antarctic, such as consequences of the high altitude, cold climate, and atmospheric conditions.

Research Methods

Researchers in Antarctica have had to adapt to the restrictions of the environment. Stations vary in size from less than 10 to over 1,000 inhabitants, but most stations have less than 50 residents. In summer, about 2,000 people live at the approximately 40 Antarctic bases, but most researchers are limited to studying the personnel at one base. In winter, the period that most interests psychologists because of the additional stress of darkness, isolation, and inactivity, the total number of people in the Antarctic dwindles to 800. Some researchers have dealt with the small subject size by increasing the number of clinician raters to ensure high interrater reliability (Gunderson & Nelson, 1964) or by increasing the number of sources of data and then examining whether the data from different sources converge to yield similar results (Doll, Gunderson, & Ryman, 1969).

Psychologists in the Antarctic have been most interested in effective personnel selection, and the predictive validity of selection criteria has been a priority (Gunderson & Kapfer, 1966). Little research has been done on individuals who are unwilling or unable to survive in that extreme environment. It is also difficult to find an appropriate control group for Antarctic residents, and consequently most studies have compared pre-post scores of the individuals who were selected for Antarctic stations. Shears and Gunderson (1966)

have recommended factor analysis to reduce large numbers of heterogeneous variables to a few dimensions.

The people living on Antarctic stations tend to be military personnel (navy transport personnel, helicopter pilots, members of the coastguard), scientists (primarily marine biologists, meteorologists, geologists, physicists, and atmospheric chemists), and support staff (cooks, physicians, laboratory technicians, mechanics, radio operators), and all have multiple tasks to perform to fulfill their short stays in Antarctica. Thus, any psychological questionnaires or observations must be kept at a minimum or they will not be completed. Rivolier (1974) indicated that personnel at French stations during the winter can only be given a few proficiency tests because they are too busy and reluctant to participate in longer interviews or questionnaires. Often, the psychologist interviews personnel before and after the Antarctic visit or arrives on the first transport ship or airplane after the winter is over. Once Antarctic personnel have returned home, it is difficult to obtain their permission for participation in further research (Rivolier).

Many researchers have used peer nomination lists to investigate popular and unpopular personnel. However, this method proved so threatening to the participants that it was discontinued (e.g., Nardini, Herrmann, & Rasmussen, 1962) or has been altered to include only positive responses (e.g., Seymour, 1971). Shurley (1974) indicated that common obstacles to conducting research in the Antarctic include the high cost of research in remote areas, poor communication between base and field stations, and the reluctance of station personnel to self-disclose.

The overwhelming proportion of Antarctic personnel have been men. Although women have recently been included in greater numbers, they are still in the minority, and there has been no research on women in the Antarctic other than studies that happen to include the few women present at the time of the research (but none have analyzed gender differences). Finally, station personnel differ widely in age, educational background, occupation, and motivation for being in the Antarctic. Consequently, it is difficult to find appropriate research materials that reflect the demographic diversity of the small population and individual differences often outnumber group consistency. Thus, researchers (Gunderson, 1974) have developed scales specific to the work and social environment of the Antarctic.

Nevertheless, the novel Antarctic environment, the extreme climate, altitude, isolation, and living conditions have prompted a number of psychological research studies.

Personnel Selection

In an environment in which people cannot be replaced once winter has begun, appropriate personnel selection becomes vital. Psychological adjustment and

social compatibility are as important as technical competence (Biersner & Hogan, 1984). Early expedition members were chosen by the leader, and were often people the leader knew personally (Smith, 1961). One of the first to be confronted with selection criteria may have been Shackleton in 1913. He placed a newspaper ad that stated:

Men wanted for hazardous journey. Small wage, bitter cold, long months of complete darkness, constant . . . Safe return doubtful . . . and recognition in case of success.

He received about 5,000 applicants for 28 positions (Taylor, 1987, p. 17).

Early personnel selection studies (e.g., Nardini, et al., 1962) indicated that personal motives for seeking Antarctic duty varied widely. Many of the men who adapted successfully to Antarctic conditions were not sure why they volunteered; others cited such motives as opportunity to save money, possible career advancement, and the challenge of an unusual experience. Motives that were related to poor performance in the Antarctic included escape from marital conflict, transfer from an undesirable job, and search for adventure (Nardini et al., 1962). More recent studies on the motives for going to the Antarctic include earning and saving money, increased experience, career advancement, prestige, and intellectual knowledge (see Natani & Shurley, 1974, for a review). Conversely, individuals may seek escape, with the belief that "social graces cease to have significance, the Antarctic station thus becoming a haven for the technically competent individual who is deficient in social skills" (Natani & Shurley, 1974, p. 90). Volkov, Matusov, and Riabinin (1974) found the motives for joining a Soviet Antarctic Station to be material gain, experience, professional goals, and prestige, with fewer applicants citing life goals, beginning a new life, and scientific reasons as motives. Gunderson (1974) found that task motivation, especially the willingness to work hard under extremely adverse conditions, was an important factor.

Paterson (1978) assessed selection criteria for successful Antarctic winter-over service for men at a British station. The British Antarctic Survey regularly selects men for 2-year rather than 1-year tours of duty, and thus selection becomes particularly important. Based on previous research on positive adjustment, selection criteria have focused on the ideal candidate as introverted, reserved, trusting, intelligent, self-sufficient, independent, and forthright (Paterson).

Crocq, Rivolier, and Cazes (1974) described the elaborate selection procedures for French stations, which are among the most isolated in the world (some stations are on Subantarctic islands over a thousand miles from land, with unchanging views and little mobility). Each applicant completes medical and biographic questionnaires, followed by an interview with a psychiatrist, and completes personality and intelligence tests, followed by an interview with a psychologist. This data is then matched with the subjects' performance

in the Antarctic, including medical and emotional symptoms, station leader's report, physician's report, and efficiency, to validate the selection criteria. The results of Crocq et al.'s research indicate that previous social adjustment is related to social adjustment at the stations, and that adjustment is positively correlated with intelligence scores. Furthermore, because group dynamics are so important and because a poorly composed group "can compromise an entire season's work," Rivolier (1981, p. 238) has included group dynamics as part of the selection criteria of French Antarctic personnel.

Isolation

Introverted? Dull? Messy? Try the South Pole.

Gannon, 1976, p. 237

When Admiral Byrd explored the Antarctic in the 1920s, he is said to have brought along a dozen strait jackets and two coffins (Mullin, 1960). Although his clinical predictions were wrong, the extreme isolation of the Antarctic and its possible negative effects on the people who spend time there has intrigued psychologists. Beginning in 1957, small groups of people have staffed the Antarctic stations during the winter. Despite the increasing comfort of these stations, ". . . the isolation imposed by the harsh environment is rarely experienced outside nonpenal conditions" (Biersner & Hogan, 1984, p. 491). Not only is travel to and from the Antarctic impossible during the winter (which lasts up to 9 months in some parts of the continent), but radio communications may be interrupted by the atmospheric conditions in winter (Biersner & Hogan). A number of researchers have investigated psychological factors related to the prolonged isolation.

Strange and Youngman (1971) found that the three main stressors in the Antarctic environment were isolation, the sameness of the environment, and the lack of usual sources of satisfaction. Taylor and Feletti (1976) studied 30 men who had wintered over at one of two Australian stations during the period between 1969 and 1972. Those men who were rated as performing poorly during their stay had higher scores on emotional flatness, surly attitudes, relative inefficiency at work, and group alienation compared with those who were rated as performing well. These variables that discriminated between poor and good performers were included in a form, the Victoria Isolation Scale, which has subsequently been used for selection of subjects who perform well under the condition of isolation (Taylor & Feletti).

Sasaki and colleagues (Sasaki et al., 1980) studied psychological factors in 30 members wintering over at a Japanese station. Mean scores on the State-Trait Anxiety Inventory were stable while the members were aboard the transport ship, but increased just after arrival at the station and continued to increase as time went on. Scores on anxiety and depression were highest during the last three months of the stay.

Biersner and Hogan (1984) assessed psychological adjustment among 24 men and 1 woman at two U.S. stations at the end of the 1980 Antarctic winter. Subjects were given questionnaires about adjustment to the living conditions, alcohol and marijuana use, peer nominations, and a personality inventory adapted for Antarctic use. Highest adjustment was reported by subjects who scored low on depression and divergent thinking and high on cheerfulness, trust, and caution. Poor adjustment, depression, and high scores on imagination were correlated with high marijuana use. Alcohol use was correlated with high scores on caution, but was unrelated to adjustment (Biersner & Hogan).

Subjects who received the most positive peer nominations were those who scored low on self-reflection and emotional expressiveness. The most negative peer nominations were received by subjects who scored low on status seeking and high on self-reflection, experience seeking, divergent thinking, and challenge. Biersner and Hogan (1984) concluded that

Individuals with high needs for novelty and new sensations, whose thoughts and actions are routinely unconventional, who are emotionally unstable, or who are unconcerned with social approval seem unsuited for work in such environments regardless of their technical competence. The opposite is true for those who adjust well. (p. 495)

High rates of alcohol consumption among men in the Antarctic has also been described by Natani and Shurley (1974). It is difficult to estimate rates of alcohol use since participants may fear being labelled as alcoholic; nevertheless, the largest station, the U.S. McMurdo Station, has regular meetings of Alcoholics Anonymous (Robertson, 1988).

Fifteen men who wintered at the U.S. South Pole Station during the winter of 1970 were compared with 20 male college students on the MMPI and Personality Research Form (PRF; Butcher & Ryan, 1974). The South Pole Station is a 20-person underground station that is inaccessible for 8.5 months during the winter. The Antarctic group scored lower on anxiety, psychasthenia, hysteria, hypochondriasis, psychopathic deviancy, and schizophrenia on the MMPI, compared with the college students. On the PRF, the Antarctic group scored higher on desirability and achievement, and lower on play and succorance (seeking sympathy) than the college students (Butcher & Ryan). MMPI and PRF scores of the Antarctic group did not change significantly during the winter, indicating stability of personality even during prolonged isolation.

Actual psychopathology in the Antarctic is rare, due to improved selection methods. Strange and Klein (1974) described the "winter-over syndrome" in the Antarctic as consisting of depression, hostility, sleep disturbance, and impaired cognitive function. The most common types of mental health disorders at the U.S. Antarctic stations are depression, alcohol abuse, paranoia, and psychosomatic disorder (Strange & Klein).

Two behaviors that have been anecdotally reported to occur during Antarctic winters are staring (gazing with unfocused eyes) and drifting (detachment and apathy). Popkin, Stillner, Osborn, Pierce, and Shurley (1974) examined the frequency of these behaviors among the 22 men who wintered over at the U.S. South Pole Station during 1972. Sixty-four percent of members had observed others engaged in staring, and 50% reported themselves engaged in staring. Staring was brief (several minutes), easy to interrupt, and without a predictable onset. It was associated with depression and lower educational levels, but was unrelated to age, weight, number of hobbies, religion, use of medications, alcohol, smoking, sleeping pills, marital status, thyroid or thiamine function, or drifting (Popkin et al., 1974).

Drifting was self-reported by 75% of subjects and was viewed as of longer duration than staring. It was associated with memory loss, personality change, verbal nonsense, lethargy, and procrastination. Drifting was unrelated to staring, depression, age, weight, marital status, educational level, number of hobbies, religion, use of medications, use of sleeping pills, smoking, or thyroid or thiamine function. Drifting was marginally associated with alcohol use. In contrast to staring, drifting was openly discussed among the men (Popkin et al., 1974).

Prolonged sensory and perceptual deprivation has been found to contribute to hypnotizability (Barabasz, 1980). Consequently, Barabasz assessed nine men (who were naive to the purpose of the study) wintering over at a New Zealand Antarctic base. Prewinter hypnotizability scores of these men, who were mostly scientists and technicians, were significantly lower than a control sample of university students. Results indicated a significant increase in hypnotizability scores and EEG alpha scores, which Barabasz attributed to the lack of sensory and perceptual input during the Antarctic winter (Barabasz, 1980). In contrast, people who spend only brief periods in the Antarctic during the summer do not demonstrate a change in hypnotic susceptibility (Barabasz, Barabasz, & Mullin, 1983).

Ryman and Gunderson (1979) examined attitudes towards work during the Antarctic winter among U.S. personnel. Job morale and ratings of job importance of navy personnel deteriorated significantly during the winter but there was no change in job attitudes among scientists. Probably, scientists' work roles were more constant across the seasons than were those of navy personnel, who were more inactive during the winter. Similarly, Kitamura (1981) found work conditions and weather patterns to affect morale at a Japanese station.

Gunderson (1974) investigated the use of leisure time in the Antarctic. Navy and civilian personnel at U.S. stations were asked to indicate time spent in each of 20 leisure activities. The larger stations had more available leisure activities and opportunities for social activity, but leisure activities at the smaller stations were severely limited. McGrael (1976) found a difference

between expectancy and productivity in actual activities that men engaged in during the winter. Many expected to read and study but rarely accomplished their goals during the Antarctic winter.

Although there has been no research on sexual activity and sexual deprivation at Antarctic stations, a number of researchers have anecdotally mentioned the stress of lack of sexual activity (e.g., Rivolier, 1976b). Torres (1976) described the sexual deprivation at Argentine stations and Hachisuka (1974) indicated that "sexual frustration" was a problem at the Japanese station. Hachisuka also found that the length of telegrams home increased with length of stay. Finally, Owens (1979) and Gunderson (1974) found that being married rather than single correlated with negative performance among Australian and U.S. personnel.

The unique isolation of the Antarctic, in which winter residents do not come in contact with any other humans, has interested virologists who investigate the pathways of disease communication. In addition, due to the extreme cold, bacteria do not exist in the interior except for those brought in by humans. Allen (1974) demonstrated a relationship between frequency of colds at British stations and visits from outsiders. Boriskin (1976) found that cold symptoms became milder as the winter progressed, and were more severe when relief parties arrived. Muchmore, Blackburn, Shurley, Pierce, and McKown (1970) found the five men who spent the winter at the U.S. South Pole Station to have a reduced white blood cell count due to the infrequency of disease. Once the men returned to other social contacts, white blood cell counts increased to normal levels (Muchmore et al., 1970).

Mullin and Connery (1959) investigated psychological factors among 39 men (9 civilians and 30 military personnel) who spent 12 months at an isolated U.S. station with only an occasional visitor from a nearby station until the relief ship arrived 1 year later. They found no evidence of psychiatric disorders at the end of the 1-year period and little evidence of any medical illness during the year. Characteristics related to adjustment included tolerance for others, discretion, hard work, technical competence, and an ability to use leisure time effectively either alone or with others (Mullin & Connery). In contrast, qualities that detracted from adjustment were contentiousness, lack of respect for authority, oversensitivity, and aggression. The focus on work, technical knowledge, and respect for authority may have been related to the military status of most of the station members.

More recently, psychological adjustment under extreme conditions of isolation was investigated by the Argentine Antarctic Institute (Isuardi, 1989). An expedition of 10 men and 1 woman stayed for 6 weeks at an isolated camp on the Antarctic peninsula, without contact from the outside world. The investigating psychologist was included as a member of the team to examine group dynamics and tension during the isolation period.

The research on isolation indicates that little psychological adaptation occurs once the winter has begun. At best, winter residents maintain their initial level of coping and adaptation (Natani & Shurley, 1974). Taylor and Shurley (1971, p. 143) stated of members of a New Zealand station: "The effect of the winter was to make the Scott Base group more taciturn and emotionally stable and to induce already self-sufficient, controlled, calm men to become even more so."

Conflict

Conflict is present in interpersonal relationships, but because it is perceived as negative, it is often denied by group participants. Furthermore, conflict can vary considerably in severity and duration and is thus difficult to assess empirically. The isolation of the Antarctic winter places groups at particular risk for conflict, since there is no possibility of leaving other group members and because there is little communication with the outside world (Seymour, 1971). Additionally, potential conflict can be due to the inherent difference between the discipline and structure imposed on navy personnel and the more unstructured and independent life styles of scientists from academic institutions (Natani & Shurley, 1974). Navy personnel also tend to be older than civilians and thus have different interests and values (Gunderson, 1974). Law (1960) has similarly observed this occupational split in social conflicts at Australian stations.

Greater hostility has been found among military personnel at small rather than large U.S. stations (Doll & Gunderson, 1971), probably due to the limited number of activities and space at the smaller stations. Seymour (1971) investigated conflict among the members of six U.S. stations during the winters of 1964 to 1969. Stations ranged in size from 8 to 30 men, who varied considerably in professional discipline. At the end of the winter (September), the station leader administered questionnaires of hostility and compatibility, as well as a peer nomination questionnaire, which was individually sealed and mailed by each station member. One of the items on this form stated: "Sometimes our first impressions about people turn out to be wrong. Perhaps you had some early impressions about one or more of the men at this station that turned out to be wrong. If so, could you indicate who these persons were and how your impressions were wrong." Results indicated that a high proportion of subjects did not complete this item, and of those who did, choices tended to be within the subjects' own professional subgroup. The larger the station, the greater were the number of positive choices on this item, indicating a more compatible station and lower perceptions of conflict. More negative ratings of individuals indicated a less compatible station. Seymour concluded:

Station size, not surprisingly, was an important variable. Small groups under stress were most apt to develop intragroup conflict. On the other hand, the tendency for subgroup members to express hostility toward their own group contradicts previous findings that hostility tends to be directed toward out-group members. (p. 435)

McGuire and Tolchin (1961) investigated the group dynamics among 17 men at the U.S. South Pole Station. They found that a few men received negative ratings from many of their peers and thus were the social isolates of the group. Most people indicated that they thought they had close friends in the group but stated that they did not think these same people would be their friends, given a larger choice.

Shears and Gunderson (1966) studied 83 men who were wintering over at three U.S. stations, using numerous attitudinal scales. Factor analyses of the results indicated that social compatibility was the most important factor for station effectiveness, followed by motivation, personal satisfaction, and group accomplishment. Thus, conflict-free interpersonal functioning was the priority of station personnel. Similarly, Vallacher, Seymour, and Gunderson (1979) found that cohesiveness ratings among members of a U.S. station were negatively related to symptomatology but were unrelated to ratings of performance by supervisors and peers. However, ratings of conflict were related to supervisors' ratings of poor performance but were unrelated to symptomatology. De Monchaux, Davis, and Edholm (1979) found tolerance of others to be the most common characteristic of men who were rated as most popular at a British station.

Shevshchenko, Moshkin, and Khriashcheva (1979) found that frequent radio and telegram contact with family or friends was not satisfactory for members of a Soviet station. The station personnel were more anxious and tense in anticipation of these communications from the outside world, and "distant, non-committal and tense" during the conversations (p. 223).

Antarctic stations have certainly increased in comfort, and as physical danger from the immediate environment has decreased, residents feel most threatened by social isolation (Natani & Shurley, 1974). Macpherson (1979) found that Antarctic residents developed their own language idioms and humor to deal with the interpersonal conflict. Similarly, Taylor (1978) found few changes in personality or coping styles among New Zealand residents during the Antarctic winter; rather, they adapted their interpersonal interactions to avoid conflict.

Altitude

The ice in the Antarctic is over two miles thick in some regions; thus, the continent has the highest mean altitude on earth (for example, the U.S. South

Pole Station is at an elevation of 9,100 feet). Additionally, atmospheric or barometric pressure affects the pressure of oxygen in the air, and in the Antarctic, the barometric pressure is about 12% lower than the pressure of oxygen at similar altitudes in temperate or tropical areas (Moyer, 1976). Thus, the amount of oxygen available at the South Pole is equivalent to the oxygen at 10,200 feet at the Equator.

Acute altitude sickness (hypoxia) often occurs in people arriving at inland stations. Symptoms include headache, lightheadedness, sleeplessness, nausea, vomiting, fatigue, irritability, rapid breathing, and dehydration (Moyer, 1976). Symptoms usually begin within 4 hr of reaching the high altitude, peak after one or two days, and resolve after a week, when the individual acclimatizes. Research on hypoxia in the Antarctic has shown that it is difficult to predict who will experience hypoxia, but that almost everyone will experience it at 13,000 feet (equivalent in height to Mt. Erebus in the Antarctic). At this high elevation, mental performance will decrease but will not be noticed by the individual. Memory and judgment are affected, fine motor coordination is poor, night vision decreases, and mood may be depressed or euphoric (Moyer). People in their 30s acclimatize better than younger adults, and women have greater resistance to cold and hypothermia, which is also usually present at high altitudes (Moyer). Hypoxia may be life-threatening, particularly if people are engaging in vigorous activity at high altitudes.

Guenter, Joern, Shurley, and Pierce (1970) found that the 22 men wintering over at the U.S. South Pole Station showed evidence of hypoxia in blood samples as well as hyperventilation due to the reduced oxygen at the high altitude. Furthermore, increased levels of carbon dioxide levels in the blood (even of the nonsmokers) occurred, possibly due to the need to spend large amounts of time indoors in poorly ventilated underground buildings.

Aidaraliev, Maksimov, and Chernook (1987) compared members of a Soviet Antarctic expedition who had either a high or low level of hypoxic tolerance before they embarked on a mountain climbing trip in Antarctica. After one month in the high altitude, subjects with high hypoxic tolerance were working normal periods; by the middle of the winter, the low hypoxic tolerant group had attained this same level of adaptation. Similarly, Agadzhanian, Davydov, and Kaluzhenko (1976) examined hypoxia among personnel at the Soviet Vostok Station, which is the "Cold Pole" of the Antarctic (coldest mean temperature). Those who had low hypoxic tolerance felt faint and in some cases lost consciousness at the high altitudes, compared with high-tolerant personnel, who were able to work without discomfort.

The high altitude of the Antarctic, in combination with the constant daylight in summer and constant darkness in winter, has been a source of interest to sleep researchers. Sleep difficulties and insomnia are a frequent source of distress to Antarctic residents (McGrael, 1976; Natani & Shurley, 1974; Ri-

volier, 1974). Podolian (1974) found sleep problems to be one of the frequent complaints during the winter at a Soviet station.

Shurley, Pierce, Natani, and Brooks (1970) asked 32 men at the U.S. South Pole Station to monitor their sleep, feelings of drowsiness, and waking activities during the summer. Despite constant sunlight, mean hours of sleep were comparable to temperate zones. The men worked longer hours than expected by the researchers (Shurley et al., 1970), perhaps to take advantage of the daylight months or perhaps because of high work motivation. Soviet psychologists have suggested that sleep disruptions may be social rather than physiological in origin (Semagin, in Natani & Shurley, 1974).

Cold

The extremely cold air temperature and high wind chill factor in the Antarctic affect the ability of humans to survive outdoors in the winter. The coldest conditions become life-threatening after only 20 min, even if the individual is healthy and wearing polar clothing (De Freitas & Symon, 1987). At most stations, the cold can be lethal during half the year; at the South Pole Station, conditions are lethal all year long (De Freitas & Symon). Consequently, researchers have studied individual differences in peripheral circulation to investigate whether Antarctic residents acclimatize to the cold weather conditions (see Edholm, 1974, for a review). The cold can cause allergies in some people (cold meteorosensitivity; Rivolier, 1976a) but can also reduce allergic symptoms in individuals who are sensitive to common allergies not present in the cold environment (Lund & Dowdle, 1979). Wounds also heal more slowly in extremely cold weather (Barashkov, 1976).

Taylor (1984) randomly assigned 6 men from a 12-member male international Antarctic expedition to a condition in which they received a series of daily cold baths to examine whether this cold immersion would acclimatize them better to the upcoming cold weather than the controls. The same subjects were also exposed to extreme humidity, in case it was the secondary sweating in protective clothing during the cold adaptation to which adaptation was required. Results indicated no group differences in cold adaptation in the Antarctic (Taylor).

In the absence of clear demarcations between night and day and between the home and work environment at Antarctic stations, Gunderson (1974) found that the work role was important in organizing the social structure and adjustment. When work roles shifted (e.g., when work was markedly reduced during the winter), this affected self-perceived usefulness, motivation, and evaluations by others. Gunderson found a decrease in morale in navy men but not in civilians during the winter at U.S. Antarctic stations. This is probably due to the change in the occupational role of navy personnel during the win-

ter, when their work load decreases markedly, compared to the year-round unchanging work roles of scientists and technical personnel.

Atmospheric Conditions

There has been a great deal of recent media attention on the depletion of the ozone layer in the atmosphere over Antarctica. In fact, there has always been more radiation there because the earth is closest to the sun at the Antarctic. Senin (1973) examined radiation levels at two Soviet stations and found it to exceed radiation at sea level by a factor of seven. Nevertheless, even this level of radiation was not considered by Senin to be harmful.

The frequent blizzards and lack of observable landmarks may interfere with visual perception. Smith (1966) found that Antarctic personnel on field expeditions consistently overestimated sizes of objects and underestimated distances from objects. Whiteouts and errors in estimation of distance were sources of irritation to expedition members.

Activity and Inactivity

Weight changes have been studied both during the winter, when outside temperatures do not permit outdoor activity, and during the summer, when field research teams may exert considerable energy to collect data. Compared with the existing research on body weight, the Antarctic environment allows investigation of weight changes under extreme conditions of activity change and also allows researchers to control for amount of food intake, fluid intake, and air temperature. In addition, most other literature on body weight focuses on individuals who are dieting to lose weight for aesthetic or health reasons. In contrast, the Antarctic conditions permit investigation of body weight for adaptation and survival.

Early Antarctic field travel was by dogsled, which necessitated long periods of running and pushing the sleds. Considerable weight loss (7 to 8 kg during a trip with as much as 3 kg of weight regained during the first day back at the station) was not uncommon (Boyd, 1975). Current transportation is by mechanical transport, such as motorized toboggans. Even on these toboggans, field parties spend long periods (up to 24 hr) inactive and exposed to the weather (Boyd). Consequently, the French stations now use tractor-drawn trailers that have heated passenger compartments (Rivolier, 1974).

Brotherhood (1974) reported that a number of factors contribute to the change in activity and metabolism, including heavy manual labor, mountainous terrain, and the increased weight and restriction of the layers of polar clothing. Loots, Van der Merwe, and Kruger (1969) found that members of a South African expedition gained weight during the first 3 months in the Ant-

arctic but reduced their skinfold thickness, indicating that weight gain was the result of changes in muscle, not fat. During the second half of the year, skinfold thickness increased and weight remained the same, indicating increased body fat. Loots et al. attributed the increased body fat to possible cold adaptation. On the other hand, Boriskin (1974) has argued that metabolic changes are due to acclimatization rather than to the extreme cold.

Boyd (1975) studied three male members of a field party at an Australian station during the summer of 1970, and compared them with one man who remained at the base. Body weight was assessed daily for 3 days before arrival at the station, for 42 days in the field, and for 16 days after return to the station. Energy intake was from standard field ration packs, consisting of 4,700 calories and 193 grams of protein. Time spent in activity was assessed and classified according to the strenuousness of the activity. Air temperature, windspeed, humidity, fluid intake, and urination were also monitored.

The results indicated considerable variability in the weight lost by the three expedition members (9.2, 5.0, and 4.4 kgs, respectively) and in the weight regained (4.1, 6.5, and 6.0 kgs, respectively). Changes in skinfold thickness, hip girth, and arm circumference were related to changes in body weight. However, daily changes in weight were not related to food intake or activity level but to fluid intake along with air temperatures and windspeeds.

Exact daily energy expenditure was investigated by Acheson, Campbell, Edholm, Miller, and Stock (1980b). Twelve men at a British station were asked to record daily activities by accounting for each 5-min period. The men's heart rate, air volume, and percent oxygen in exhaled air were measured for each activity to assess energy cost to each individual. Acheson et al. found that food intake and energy output were unrelated to body weight and body fat changes. Predictions could be made with some accuracy only for the group as a whole.

When Acheson, Campbell, Edholm, Miller, and Stock (1980a) examined weight changes over the course of a year spent at a British base, the pattern of weight change of the group was predictable. Body weight reached its peak in August (midwinter) and then decreased steadily until December when outside activity and field trips were most frequent. Nevertheless, no consistent individual pattern was evident. Seven men lost weight and five gained weight over the course of the year. The individual patterns of when weight was lost or gained varied widely.

Intervention

Both medical and mental health treatment are difficult to perform in the Antarctic because of the limited facilities and the small staff. Consequently, programs rely on adequate personnel selection to screen out applicants who might need such intervention. Law (1976) reported that recruiting physicians

who will adapt to the Antarctic is as difficult as recruiting other effective personnel.

Lloyd (1974) found that the most frequent medical problems at British stations were fractures and dislocations. The high incidence of dental caries, which has been postulated to occur as the result of the fibrous diet (Beynon, 1974), and the tendency for tooth enamel to crack under the severe cold (Wirthlin, 1981), has resulted in the need to train station physicians in dentistry.

Makarov (1974) has recommended nutritional changes for Antarctic personnel, including an increased intake of protein, fat, carbohydrates, and vitamins to combat the weight and metabolic changes. In emergencies, Argentine stations have relayed EEGs via radio to Buenos Aires, a distance of over 2,000 miles (Carrera, 1974), and Australian stations have used fax transmission to send X-rays (Lugg, 1976). Medical emergencies have occasionally required multinational rescue operations (Podkolinski & Semmens, 1981).

Reintegration to the Home Environment

Popkin, Stillner, Hall, and Pierce (1978) discussed the similarities between the reintegration of men returning home from the Antarctic and prisoners of war (POWs) released from North Vietnam. Both groups exhibited cognitive slowing, emotional withdrawal, indecisiveness, and poor communication. Neither group found these variables disturbing; it was the spouses and physicians of the POWs and the researchers investigating former Antarctic personnel who became aware of the symptoms. POWs and Antarctic residents also exhibited sleep disturbances and abnormal sleep-EEG patterns. Occasionally, these symptoms persisted for up to 1 year after return home for subjects who had spent a year in the Antarctic.

Natani and Shurley (1974) found that Antarctic personnel who are returning to their previous places of employment often resent authority after a long period of relative freedom. Furthermore, Antarctic residents returning home may yearn for praise and recognition for the work they have done and for a secure reentry into their family and community.

Taylor and McCormick (1987) investigated reactions of spouses of 12 male expedition members from various nations who were unable to communicate by mail or radio for 72 days. In general, the women reported confidence about handling family affairs alone and were more satisfied with their husbands' decision to join the expedition than were the men themselves. Both the men and the women were confident that their relationships would withstand the period of absence, but the women were less anxious than the men about the possibility of illness or injury to the men during the trip. At a 16-month follow-up, both the men and women reported increases in both pleasure and distress upon the return of the men (Taylor & McCormick).

In general, there has been almost no research on the reintegration of Antarctic residents into their home and work environment. Yet it seems that this period of reintegration may be as stressful as the original adaptation to the Antarctic.

Applications for Other Settings

The environmental features of Antarctica— isolation, close confinement, repetition of work routines, and inability to leave— may change with improved technology and increased size and luxury of accommodations. Nevertheless, Antarctic research has applications for other settings, such as isolated field and weather stations, submarines, offshore drilling rigs, space vehicles, and space stations. The practical implications of life in restricted or monotonous settings concern behavioral scientists in a variety of institutions (e.g., the navy, NASA). Researchers who speculate on life in such settings consistently cite studies of Antarctic personnel as supporting data.

As early as 1968 (before people had landed on the moon), NASA researchers had begun to describe human factors that needed to be taken into account on space missions of long duration (Fraser, 1968). In 1978, the first Conference on the Human Experience in Antarctica: Applications to Life in Space was sponsored by NASA and the National Science Foundation's Division of Polar Programs, which administers all U.S. Antarctic research. The purpose of the conference was to identify and prioritize directions for research that would have implications for human life in space. Finally, recent reports on space station habitability in the United States (Stuster, 1986) and the Soviet Union (Tereliak, 1985) rely heavily on results of research conducted in the Antarctic.

Conclusion

Antarctic personnel selection criteria have been sharpened over the years so that incidences of severe psychopathology are rare. Psychologists who are involved in selecting the few individuals necessary for Antarctic service have a large pool of potential volunteers who could manage the required technical work, yet who may have difficulty coping with the extreme isolation. Individuals who adapt best to the Antarctic are those with good social skills who can also function in a monotonous, crowded environment without irritating their co-workers. Natani and Shurley (1974) label the individuals who adapt well to Antarctic living conditions as "professional isolates" (p. 90).

It is difficult to predict results of research on women or gender differences in adjustment to the Antarctic. Women have wintered over since 1946, but it was not until 1970 that they began to arrive in larger numbers (Taylor, 1987). There has been no research on children in the Antarctic. Argentina

and Chile have established bases with facilities for childbirth and with schools, and entire families have spent 1-year tours of duty in the Antarctic.

Antarctic research necessarily focuses on the stressful living conditions and predictors to eliminate possible "trouble-makers." Nevertheless, several researchers (e.g., Natani & Shurley, 1974; Taylor, 1987) describe the positive experiences of residents and the number of people who reapply for duty. The majority of the personnel describe positive events that happened to them as a result of being in Antarctica, such as the development of greater self-discipline, tolerance, flexibility, patience, and self-understanding (Natani & Shurley, 1974). Natani and Shurley state:

... those men who choose to return to the Antarctic may also seek the special qualities of family living to be found when effective, stable, coherent, well-functioning groups develop. In the Antarctic, bonds of mutual concern and obligation as well as those of common interests and values allow the whole sum of experience to be tied together and shared. These processes of intimacy have been seriously restricted and enfeebled by modern metropolitan society (p. 90).

Many Antarctic residents do choose to reapply for duty (Taylor, 1969) and most consider it one of the best years of their lives (West, 1984).

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Received October 10, 1989