

Adaptation of Small Groups to Extreme Environments

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RECENT TECHNOLOGICAL developments have forced medical and behavioral scientists to give serious consideration to problems of human adaptation in restricted or unusual environments. With the advent of space craft, nuclear submarines, isolated radar and missile stations, and remote scientific outposts where monitoring of automated equipment is frequently the primary task, the problem of efficient functioning in exotic or restricted, monotonous settings is no longer merely of theoretical or academic interest. Efficient personnel selection and utilization in a wide variety of these circumstances require development of research programs dealing with reactions to limited sensory and social environments.

The studies to be described in this paper are part of a research project conducted by the U. S. Navy Neuropsychiatric Research Unit concerned with psychological problems engendered by isolation, confinement, and other unusual environmental stresses.

Three major studies are summarized in later sections of this report. They are concerned with the measurement of emotional reactions, individual performance, and group effectiveness in several groups of scientists and Navy men who experienced prolonged isolation and confinement at scientific stations in Antarctica. The stations of primary interest in our research were those ranging in size from approximately 15 to 40 men.

During the International Geophysical Year of 1957 and 1958, when twelve nations carried out an extensive cooperative scientific program in Antarctica, the United States established seven year-round bases on the Antarctic continent. At these stations scientists and technicians carried out research programs sponsored by the National Science Foundation. Navy personnel provided logistic support and maintained the stations.

The Antarctic continent is the most rugged and inhospitable environment inhabited by man. The Amundsen-Scott Station at the South Pole is located at the exact geographical pole at nearly 10,000 feet above sea level on top of an ice sheet more than 6,000 feet thick. Temperatures well below -100 degrees Fahrenheit are not unknown, and winds of more than 100 miles per hour have been recorded. At the South Pole there is one day and one night per year. The station is completely isolated and inaccessible from the outside world, except for intermittent radio communication, from February until November.

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Conditions at the other stations are slightly less extreme, but all groups are completely isolated and confined to close quarters for many months, facing danger, hardship, restricted activity, and periods of inevitable monotony. Each group is completely dependent upon its own resources and committed to accomplishing important scientific and technical tasks.

In the Antarctic research program, as in a number of other programs which involve exposure to hazardous or unusual environments, such as nuclear submarines and space flight, the United States relies entirely upon volunteering to obtain the necessary personnel. As in the submarine and astronaut programs, volunteers for the Antarctic are generally of high quality. Furthermore, a recent study has shown that after the novelty and glamor of the Antarctic program had presumably diminished, the quality of volunteers remained high and probably improved.¹

EXPERIMENTAL EFFECTS OF RESTRICTED STIMULATION

Within the past decade a high degree of interest has been shown, both by behavioral scientists and the public, in the rather dramatic changes in thought and behavior induced by what has often been referred to as "sensory deprivation." This term covers a variety of methods by which intensity or variety of stimulus input in one or more of the sense modalities is reduced.

Kubzansky and Leiderman² in a critique of experimental work reported in the recent Harvard symposium on sensory deprivation, stated that studies thus far indicated that the absence of stimulation leads to the debilitation of behavior, making the individual less efficient and inducing strong affective states which are associated with marked changes in motivation. In terms of motivation theory, varied environmental stimulation seemed to be vital in maintaining the efficiency and stability of behavior. The studies they reviewed suggested that the cognitive, perceptual, and emotional changes associated with and consequent to deprivation leave the subject less competent to meet the adaptational demands of his environment.

Almost all experimental work thus far has involved only one subject at a time exposed to the sensory deprivation situation, usually for only a few hours or at most a few days. In operational settings, where groups of persons live and work together in isolated, restricted environments for weeks or months at a time, research efforts must take into account personality characteristics and group or social influences upon responses to restricted stimulation.

Wheaton,⁸ after a thorough review of the anecdotal and experimental literature on sensory deprivation, reported two conclusions of particular interest concerning inadequacies of our present knowledge in this area, first, that there is no adequate in-

formation on the role of individual personality factors in ability to resist the effects of aloneness, confinement, or social isolation, and secondly, that at present there are no experimental data dealing with group interaction under conditions of prolonged isolation.

EMOTIONAL CHANGES IN ANTARCTIC GROUPS

In view of the absence of systematic information on the effects of prolonged isolation and confinement in natural operating groups, it was of considerable scientific and practical interest to obtain quantitative data concerning the subjective reactions of most of the participants from two expeditions spending the winter in Antarctica. Questionnaires indicating the presence and intensity of a variety of common somatic and emotional symptoms were administered to a number of Antarctic groups on three occasions during each of two years. Responses were given on a four-point scale: No Complaint, Slight, Moderate, and Severe. The questionnaires were administered by medical officers assigned to each of several Antarctic groups at three points in time during the year. The first testing took place at the end of the Antarctic summer, near the close of an active period of preparation for the oncoming winter. The second testing occurred at mid-winter, after three to four months of absolute physical isolation for all members and relative inactivity for some. The final testing came at the end of the long winter and after the beginning of limited outdoor activities once again. Thus, the second, or mid-winter, testing presumably would reflect the most pronounced effects of group isolation and confinement.

Among the most prevalent symptoms at mid-winter in both expeditions were sleep disturbances (difficulty in falling asleep or staying asleep, waking up at night, feeling tired during the day), depression (feeling blue, feeling lonely), and irritability (feeling easily annoyed or irritated, feeling easily annoyed or irritated, feeling critical of others, finding others short-tempered or unkind).

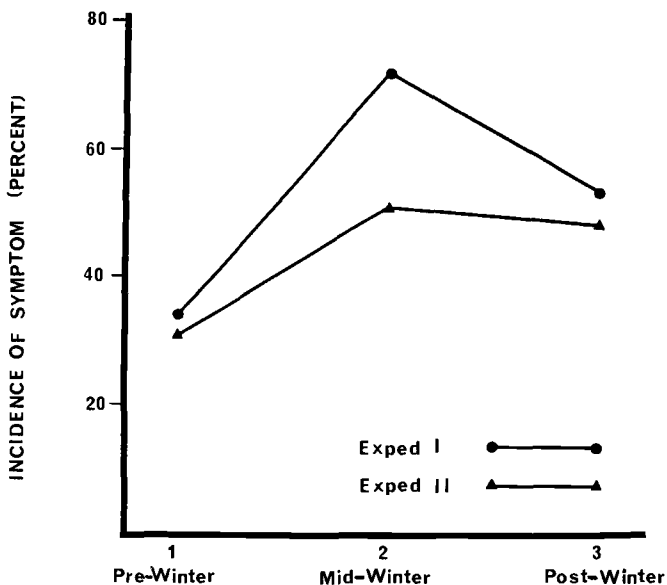


Fig. 1. Reported incidence of "Difficulty in Falling Asleep or Staying Asleep" for Antarctic groups at three time periods.

Figures 1, 2, and 3 show the incidence of "complaints"

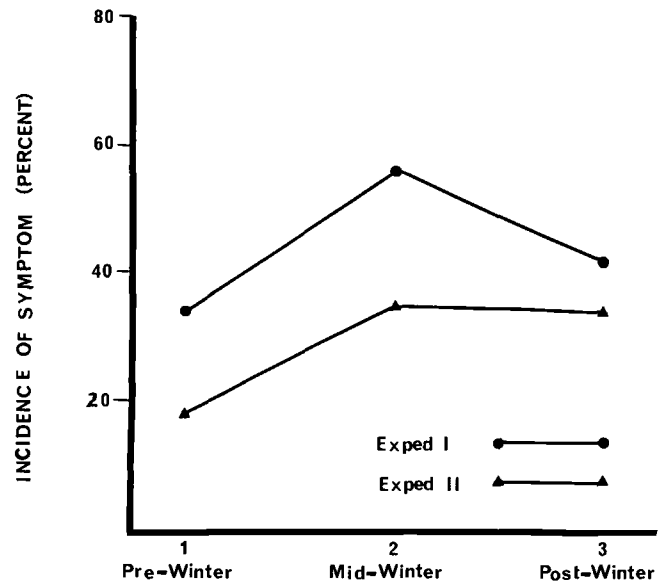


Fig. 2. Reported incidence of "Feeling Blue" for Antarctic groups at three time periods.

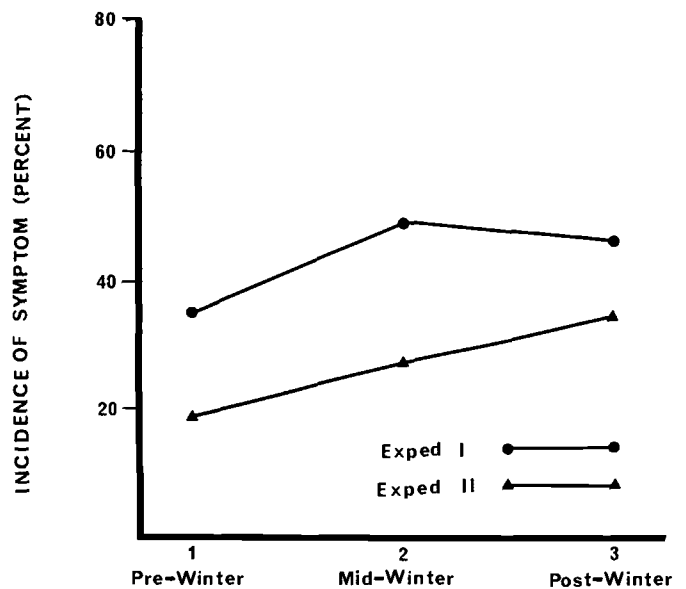


Fig. 3. Reported incidence of "Easily Annoyed or Irritated" for Antarctic groups at three time periods.

reported by all respondents from two expeditions on items representative of the three most prevalent symptom areas, sleeplessness, depression, and irritability. Sample sizes were 90 or larger for all test administrations.

The percentage of persons reporting sleep difficulties, feeling blue, and feeling irritable at mid-winter was considerably higher during the mid-winter period than during the pre-winter period in both expeditions, although irritability did not reach a high point until the end of winter in the second expedition.

The percentages shown in the Figures represent group trends. Individual symptom changes also were analyzed using the binomial sign test.⁷ Responses shifted toward the "severe" end of the scale from pre-

winter to mid-winter more frequently than expected by chance on many of the 54 items studied. Change occurred most frequently on items reflecting sleeplessness, depression, irritability, and anxiety.

The symptoms reported by Antarctic groups after long term isolation and confinement bear a striking resemblance to symptoms observed under conditions of laboratory manipulation in milder forms of "sensory deprivation." It was not possible to identify what parameters of Antarctic station life are crucial for induction of emotional changes, but from many first hand reports it is known that variety in cognitive and affective stimulation was certainly reduced and that restrictions in physical activity were inevitably present, particularly at mid-winter. It is clear that a number of individuals were susceptible to emotional disturbances in this setting, although wide individual differences were apparent.

Independent data consisting of symptom check lists filled out by the station leader and medical officer provided additional evidence that emotional symptoms were more widespread and severe during the mid-winter period than earlier in the year.

MEASUREMENT OF INDIVIDUAL PERFORMANCE

The vast majority of volunteers for Antarctic duty are initially acceptable from the point of view of physical, psychiatric, and job capabilities. The problem remains to select those individuals with the highest potential for effective performance at a small station. What, then, constitutes effective performance and, if there are individual differences in such behavior, how can they best be measured?

Fortunately, survival itself has not served as a useful criterion on which to differentiate adaptation nor has incidence of gross physical or psychiatric malfunctioning. From the point of view of task accomplishment, it has been difficult to assess the extent to which individuals accomplished predetermined goals. It is not usually known in advance what every man will have to accomplish except in a broad sense. Unpredicted events beyond the individual's control can disrupt his achievement efforts, and, with the different types of tasks to be performed, it is difficult to establish a standard criterion common to all personnel. In addition, adaptation and performance are recognized as continuing and varying processes.

It was assumed that the most meaningful criterion of effective performance should be one reflecting the individual's behavior over the entire Antarctic year. The only available source of information about the individual's performance over the entire year is the station membership itself. It furthermore seems quite reasonable to assume that the station leaders or supervisors and the other station members (peer group) are as capable as anyone of observing whether or not an individual becomes emotionally distressed, disruptive socially, or is ineffective or incompetent. This is not, of course, a new technique for obtaining such information. Supervisor evaluations are obtained extensively in industrial and military settings, and much evidence of

the value of peer evaluations has been gathered in recent years.

During the first three years of Antarctic station activity, attempts were made to collect supervisor and peer evaluations of station members' overall performance and of their emotional, social, and work characteristics. Although these data were incomplete, the results indicated that station members could reliably differentiate individuals on performance quality, that individual differences were consistent over time, and that a general measure of performance could probably be found which would reflect the individual's effectiveness in social and work areas of behavior.⁵

During the past three years, while a variety of assessment techniques has been utilized, certain evaluation items have been standardized to provide necessary continuity of information. From seven of nine stations two leaders or supervisors at each station independently rated all personnel on 21 behavior characteristics or traits and independently ranked all station members in the order in which he would choose them for wintering-over duty again were he to return to an Antarctic station. Peer evaluations, including choice of station members with whom one would want to return to the Antarctic, were also obtained.

Based on our studies to date the best single criterion of effective individual performance at small Antarctic stations appears to be a standard score derived from a combination of peer and supervisor choices on the item indicating whom they would prefer to be with if they were to winter-over again in the Antarctic.⁶ Three clusters of items have been derived from a factor analysis of supervisor and peer ratings. Of all items presently available, these clusters appear to have the highest multiple relationship with the composite criterion. Their moderate intercorrelations suggest that each behavior area contributes some unique variance to the effective performance criterion scores. The three distinctive behavior areas have been labelled emotional composure, social compatibility, and task motivation. The items contributing to each of these cluster scores are supervisor ratings of emotional control and acceptance of authority, supervisor ratings of industriousness and achievement motivation, and supervisor rating of likability plus a peer nomination item of friendship-compatibility. The three behavior clusters are in stand-and score form and can be used to compare personnel within groups and between groups.

A major task at present is that of relating a variety of predictor variables to the behavior cluster scores. Studies from earlier years indicated that the best single predictor of station supervisor evaluations in the Antarctic was a joint rating made by a psychologist-psychiatrist assessor team.³ It should now be possible to find a variety of other predictor variables which correlate with one criterion behavior area and not others, and which perhaps would be dropped by the investigators if their relationship to an overall composite criterion were low.

MEASUREMENT OF GROUP EFFECTIVENESS

In another study the authors developed a set of attitude measures designed to reflect individual reactions

to and satisfaction with Antarctic station life and to assess several aspects of the group's affective and work relationships. Attitude questionnaires tapped perceptions of living conditions, motivational states, personal usefulness, quality of relationships among group members, and group productivity or effectiveness. Responses to a total of 119 items were given on continuous, five-category rating scales. As the experimenters wished to delineate and measure a number of different attitude areas, ten homogeneous clusters of items were derived for study. Internal consistency reliability estimates average .77 for these clusters.

Nine groups from three Antarctic expeditions were included in the study; attitude questionnaires had been administered at least twice to each of these groups. Test results were related to an independent criterion of group effectiveness. Through information available from official reports, assessments by psychiatric teams at the sites, and post-expedition interviews with members and station leaders, it was possible to identify that group in each expedition which was least effective.

Attitude scales designed to measure group cooperation and effectiveness (Teamwork, Efficiency, and Achievement) and administered at the end of winter related consistently over all three expeditions to the independent criterion of group effectiveness. Scales reflecting individual levels of satisfaction (Motivation, Usefulness, Boredom) were not consistently related to the group effectiveness criterion.

TABLE I. ATTITUDE MEASURES OVER TWO TIME PERIODS FOR GROUPS VARYING IN EFFECTIVENESS

Scale		All Groups	Group A	Group B*
Motivation	Mid-winter	60.7**	64.3	57.1
	Post-winter	57.1	60.7	57.1
Usefulness	Mid-winter	60.7	71.4	57.1
	Post-winter	57.1	67.9	53.6
Boredom	Mid-winter	62.5	70.8	58.3
	Post-winter	54.2	66.7	50.0
Compatibility	Mid-winter	61.8	69.7	57.9
	Post-winter	52.6	63.2	48.7
Achievement	Mid-winter	68.8	87.5	56.2
	Post-winter	56.2	75.0	43.8
Egalitarian	Mid-winter	55.6	63.9	52.8
	Post-winter	47.2	55.6	41.7

* Least effective group in terms of independent criterion.

** Mean scores are expressed as per cent of maximum possible favorable response. Lower scores are less favorable.

Table I illustrates group differences within one expedition on six of the attitude measures studied. Mean scores at mid-winter and end of winter, expressed as per cent of maximum possible scores, are shown for all groups of the expedition combined and for Group A and Group B which were differentiated on the independent criterion of effectiveness, Group B being the less effective group. Lower scores indicate less favorable attitudes.

Mean scores for Group B at the post-winter period were far below those for Group A and consistently below those for all groups combined on each of the scales except Motivation. The largest differences between Group B and other groups appeared on the Achievement Scale.

The attitude testing revealed that a general decline in work satisfaction, social relationships, and group

accomplishment typically occurred in Antarctic groups after prolonged isolation. However, the fact that a few groups showed little change and maintained relatively high scores at end of winter suggested that this group deterioration need not take place.

Under the conditions of long term physical restrictions and lack of variety in social stimulation experienced in small Antarctic groups, it seems clear that maintenance of group organization, harmony, and efficiency present a very difficult, but not impossible, problem. The rigors and deprivations of the Antarctic small station environment would appear to demand extraordinary personal qualities and leadership abilities in the participants and to fully justify efforts to select highly qualified group members.

Certain desirable attributes of leader behavior were identified in a study of ten small station leaders.⁴ For both military and civilian leaders, the following behaviors were highly correlated with esteem for leaders by station members: daily contact with the men, participation with the men, seeking the advice of their men, personal praise for the men, and impartial decision-making ability. Leaders capable of functioning in this manner would appear to be well accepted in a closely confined group situation and their decisions would be based on the best information available and would be personally supported by the men.

SUMMARY

In three studies at the Neuropsychiatric Research Unit we have measured subjective emotional responses, individual performance, and several aspects of group functioning in extremely isolated Antarctic groups.

Under conditions of restricted stimulation and activity for prolonged periods, participants reported an increase in the incidence and severity of emotional and somatic symptoms, particularly on items reflecting sleep disturbances, depression, irritability, and anxiety.

The best single measure of effective individual performance was a standard score derived from peer and supervisor choices on an item indicating whom they would prefer to be with if they returned to the Antarctic. Three behavior areas each contributed unique variance to the composite criterion. The three item clusters, labelled emotional composure, social compatibility, and task motivation, were based on peer and supervisor ratings and yielded high multiple correlations (median $R = .88$) with the overall criterion for different station groups and for military and civilian personnel.

Attitude measures revealed a general decline in work satisfaction, social relationships, and group accomplishment. Maintenance of group harmony and efficiency would appear to be a difficult, but not impossible, task in extremely isolated groups. Attitude measures of group cooperation and achievement related consistently to an independent criterion of group effectiveness.

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REFERENCES

1. GUNDERSON, E. K. E.: Personal and social characteristics of Antarctic volunteers. *J. Soc. Psychol.* In press.
 2. KUBZANSKY, P. E., and LEIDERMAN, P. H.: In SOLOMON, P., (Ed.): Sensory Deprivation. Cambridge: Harvard University Press, p. 221, 1961.
 3. NARDINI, J. E., HERRMANN, R. S., and RASMUSSEN, J. E.: Navy psychiatric assessment program in the Antarctic. *Amer. J. Psychiat.*, 119:97, 1962.
 4. NELSON, P. D.: Leadership in Small Isolated Groups. U. S. Navy Medical Neuropsychiatric Research Unit, San Diego, Report No. 62-13, 1962.
 5. NELSON, P. D., and GUNDERSON, E. K. E.: Analysis of Adjustment Dimensions in Small Confined Groups. U. S. Navy Medical Neuropsychiatric Research Unit, San Diego, Report No. 62-3, 1962.
 6. NELSON, P. D., and GUNDERSON, E. K. E.: Effective Individual Performance in Small Antarctic Stations: A Summary of Criterion Studies. U. S. Navy Medical Neuropsychiatric Research Unit, San Diego, Report No. 63-8, 1963.
 7. SIEGEL, S.: Nonparametric Statistics. New York: McGraw-Hill Co., 1956.
 8. WHEATON, J. L.: Fact and Fancy in Sensory Deprivation Studies. *Aeromedical Reviews* 5-59, Air University School of Aviation Medicine, USAF, Brooks AFB, Texas, 1959.
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