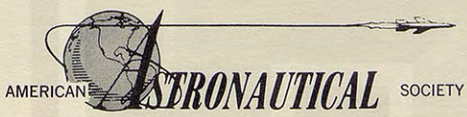

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EFFECTS OF ISOLATION ON MAN'S PERFORMANCE*

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ABSTRACT

Effects of isolation on man's performance depend upon the isolation situation and on relevant attendant circumstances. Three separate aspects of the isolation situation involve social isolation: separation from familiar social supports; confinement: restraint and restricted mobility; and sensory restriction: decreased sensory variation. Relevant circumstances include motivation of the isolated persons, goal orientation, preparation, duration of exposure, threat, social conditions, support conditions, personnel characteristics, group organization, and technology. Many accounts of isolation in the anecdotal literature are confounded with circumstances of disaster experienced by unprepared individuals. Appraisal of effects relevant to extended-duration space missions should be focused upon effects related to voluntary, goal oriented, planned expeditions by highly qualified, well-trained, disciplined crews, with sophisticated equipment and technological preparation, in a highly prestigious, reasonably feasible, but risky enterprise of long duration. Effects reviewed include social deprivation and dependency, acceleration of interpersonal information exchange, territoriality, status leveling, displacement of hostility on headquarters personnel, enforced intimacy, monotony, and boredom. Mitigation measures include selection, crew assembly, organizational measures, habitability measures, and almost all other measures related to crew effectiveness under nonisolated conditions. Until scientific solutions to many problems are found, respect for crew preferences is recommended on these measures.

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Research on isolation has been impeded in large part by ethical attitudes regarding human experimentation. Indeed, the imposing problems of simulating realistic conditions in the laboratory have influenced many investigators to look with interest at reports of field situations in which people have experienced isolation. These have been extremely diverse, including patients in "iron-lung" respirators, elderly persons in old-age homes, incarcerated prisoners and prisoners of war, patients in hospitals and mental hospital wards, lone sailors on solo voyages, survivors of shipwrecks and other disasters, as well as explorers and members of expeditions. A major difficulty in drawing conclusions from this literature involves distinguishing effects atttibutable to isolation per se from those accounted for by other factors present, such as danger, discomfort, illness, deprivation, and social disorganization.

Wheaton[60], whose review is probably the most comprehensive analysis of the isolation literature up to the time of his publication, emphasized the fact that an individual's response reflects the complex interaction with isolation variables, of other variables, such as personality, other stresses, social relations among the members of the isolated party, and duration of exposure, which define specific situations. Within the past fifteen years, concern with space and remote military

operations has led to new studies focused on social isolation of small groups, sensory restriction, and performance of remote task groups in submarines, Arctic and Antarctic duty stations, and other isolated situations. These reports have confirmed the occurrence among even these isolated personnel of a wide range of subjective symptoms, including sleep disturbance, restlessness, inability to concentrate, fatigue, muscular weakness and soreness, boredom, monotony, feelings of dirtyness, headaches, dizzyness, psychosomatic reactions, apathy, low morale, time disorientation, frustration, anxiety, irritability, hostility, displaced aggression, depression, and withdrawal. On the other hand, in situations involving trained, disciplined personnel and in the absence of major disorganizing forces of disaster, the occurrence of serious overt interpersonal conflict, deterioration of interpersonal behavior, and group disorganization, frequently mentioned in the anecdotal literature, has been rare.

Isolation associated with disaster, as in shipwrecks and marooned expeditions, has almost always involved participants unprepared for the rigors encountered. Whether many of these would have come to the fates experienced if adequate planning and preparation had been made is problematic. It is not possible to foresee every contingency and to eliminate risk entirely. Nevertheless, in the design of hazardous missions, such as long-duration space missions, one does not plan for disaster, but attempts to minimize risk by controlling all known factors through

appropriate design and management. Effects of isolation associated with disaster are somewhat academic in this framework. The more pertinent question concerns the effects that may occur under optimal operational conditions.

First, we need to ask what effects may be expected for an optimally qualified, well organized, and trained crew, functioning under effective leadership, in an optimally designed space ship, but locked in space and confined to the ship environment for the duration of a long mission, possibly two years or longer. And second, it is necessary to determine the factors that may moderate and mitigate such effects. Although critical research has been limited, there is a basis for formulating useful hypotheses that can be tested and revised as on-board space missions proceed to longer and more isolated mission profiles than those accomplished to date.

THE NATURE OF ISOLATION. IDENTIFICATION OF SIGNIFICANT VARIABLES

Students of isolation, such as Sells[49], Lilly[32], Wheaton[60], Gunderson and Nelson[21], Schultz[48], Haythorn[27], Fraser[17], and others have distinguished between social isolation, emphasizing separation from significant people, groups, activities, and social situations, confinement, emphasizing restraint and restricted mobility, and sensory restriction, in which the variation of environmental stimulation is reduced. Basically, all forms of isolation involve states in which individuals or groups are in some sense cut off from significant and subjectively

important elements of the environment, producing experiences of aloneness or apartness, with consequent effects on behavior.

However, the psychological significance of isolation depends also upon the circumstances which structure the meaning of the situation for the individuals involved. It is possible to identify a number of dimensions of isolation on the basis of which a working taxonomy could be developed. These are as follows:

1. Motivation. The isolation may be voluntary, as in the case of astronauts, explorers, seamen, and monks, or involuntary, as in the case of exile, banishment, imprisonment, ostracism, or shunning.

2. Goal orientation. The experience may range from goal oriented and related to accomplishment of a particular goal, to goal obstructive, in which the isolation prevents accomplishment of existing goals.

3. Preparation. The experience may, at one extreme, involve a carefully planned enterprise, as in the case of space missions, voyages, and expeditions; at the other extreme, it may be unplanned or accidental. The latter usually involve insidious incidents and are best characterized by natural disasters.

4. Duration. Isolation may extend from brief exposures, as in many experiments, to extremely long periods, as in certain classical cases of imprisonment; stress of isolation is believed to increase as a function of duration.

5. Confinement. Confinement relates to physical restriction and space available and involves restraint and restricted mobility. At the extreme, confinement is exemplified by iron lung-type respirators and shackles.

6. Threat. The subjective character of isolation involves both physical threat as well as threat related to separation. The physical aspect may vary from safety and shelter, at one pole, to extreme danger at the other; threat related to separation may be minimal in some cases, and extend to feelings of deprivation, frustration, and even supreme defeat in others. Additional interpersonal threat and stress may arise in the isolated situation, particularly under conditions of confinement.

7. Social conditions. Important considerations here are the number and nature of the persons present, communications, interpersonal and role relations. The pattern of social conditions may contribute to the support or degradation of the adjustive capabilities of the individual or individuals involved.

8. Support conditions. Variation of supports includes supplies, equipment, and other logistic aspects which may determine how long the party can hold out under existent conditions of isolation.

9. Environmental variability. The final dimension involves the variability of the environment which is related to the phenomenon of sensory deprivation, and affects level of arousal and compensatory functions when sensory input variation is minimal, producing monotony,

boredom, and even hallucinatory experiences in rare cases. Even when monotony is only moderate, however, social and behavioral effects may be significant.

If the characteristics of personnel involved and of group organization and technology are included along with the nine characteristics of isolated situations outlined, the analysis of isolation can be shown to be a special subdomain of the broader study of social systems preposed earlier as the appropriate frame of reference for studying problems of "capsule society"[52]. It is possible to define this subdomain in terms of a number of different patterns or combinations of the elements outlined. When this is done, one can infer that the patterns obtained would be differentially related to the significant issues involved in planning for long-duration space missions. Primary interest in the present reference should be focused on those patterns that involve voluntary, goal oriented, planned expeditions by highly qualified, well trained and disciplined crews, with sophisticated equipment and technological preparation, in a highly prestigious, reasonably feasible, but risky enterprise of long duration.

The three aspects of isolation recognized in the literature, social deprivation, confinement, and reduced sensory variation are the focus of the discussion since they reflect the defining conditions. However, the remaining factors are equally important in structuring the relevance of reports considered and in guiding interpretation and extrapolation to the space situation.

EFFECTS OF ISOLATION

Social deprivation. This is an effect of the state of isolation rather than of remoteness per se and often occurs even in centers of busy social activity. Indeed, there are, throughout the world, many men and women who, although their entire lives are spent in remote, out-of-the-way existence, nevertheless show no evidence of social deprivation, because their hamlets are their homes. On the other hand, "homesickness" and related experiences are relatively common among individuals cut off from their familiar surrounds. Apparently, familiarity and dependence on the familiar for support are essential for adjustment, and remoteness is involved only as it is associated with deprivation. There are, of course, extreme individual differences in dependency and choice of dependency objects.

Social deprivation as a general concept involves separation from any significant supports, which may include significant persons and role partners in family, work, and social relationships, as well as statuses, activities, objects, and surrounds on which the individual has learned to depend for feelings of well-being and security. The general hypothesis is that such separation is a source of stress to the individual to the extent that the present situation calls for modes of personal problem-solving that are not available and for which suitable alternatives cannot be found.

To the extent that social deprivation, as defined, leaves the individual deprived of effective and previously depended upon modes of coping with problems, it is related to the concepts of alienation and anomie[12, 34, 57] that have received extensive attention by sociologists and which Jessor et al[29] consider conducive to deviance in the sense of absence or lessening of effective (normative) control of behavior.

For men entering long-duration expeditions requiring extended absence from home base, social deprivation is a potential problem. Individuals without family ties might appear to be best suited because of their lack of encumbrances. However, this is doubtful inasmuch as the lonely state frequently reflects other problems. However, men whose professional identifications and career goals take precedence over wife, family, and home may be better adapted to endure extended isolation than those who depend heavily on family ties for their sense of well-being. A colleague suggested in a recent conference on this topic[53] that the practice of early sailing ship captains to bring their wives on voyages may have developed as a means of compensating for deprivation. Then, at least the captain would remain sane.

The two major issues for space mission planners in relation to social deprivation are (1) to select personnel least vulnerable to stress from this source, and (2) to program the crew composition and on-board work and living experience to provide maximal compensatory support for social needs of the crew. Both of these require extensive information that is

presently only spottily available. It is believed that some of the problems will be minimized by the practice of using volunteers. Indeed, at the present "state of the art," self-selection in choice of crew members and in crew assembly, particularly with reference to identification with professional role as a supreme value, and compatibility among crew members must be regarded as virtually a saving grace. Further, there is at least some basis for expecting that men dedicated to goals of supreme importance to them could endure deprivation of sexual gratification and other personal satisfications in the course of participation in a great adventure of top historical significance.

However, in view of the gravity of the unprecedented situation implied by possibly a two-year mission, prudence demands that no possible sources of future problems be overlooked. Haythorn[27] has emphasized the importance of compatible personalities in the limited social situation and has made a significant start in the quantitative study of this problem. Both Cowan and Strickland[9] and Dunlap[11] have reported that compatibility had a favorable effect on experimental isolated groups. Wheaton[60] has noted instances in which participation in group activities was a significant source of support for group members.

Several writers have commented on dependencies related to various personality traits. Gunderson[20] reported that men with high affectional needs experienced problems in wintering-over situations in the Antarctic. Miller[35], in a study of Arctic AC&W site personnel, reported comparable

problems in relation to individuals high in dominance and high in dependency. Mullin[36], who interviewed scientists and naval personnel in the Antarctic, reported that neither physical danger, nor hardship, nor extreme cold were the most serious stresses mentioned, but that individual adjustments to the group, the sameness of the environment, and the absence of many usual sources of gratification were more important. In an exploratory inquiry, Rawls[42] asked 20 college and professional men, "If you were going on a trip into outer space of extended duration, what items of a personal nature would you want to take with you?" Of 76 items of clothing, personal hygiene and care, and reading and recreational significance mentioned by at least one respondent, only 15 were mentioned by at least 15 of the 20 persons interviewed. These were: soap, toothbrush and dentifrice, deodorant, comb, nail trimmers, aspirin, watch, T-shirts, briefs, pants, shoes, books, and pencil and paper. It is interesting that personal mementos, pictures, talisman, and souvenirs of symbolic value were omitted from the list. These results are not surprising for subjects who have not experienced isolation and urge caution in research on this problem.

Observations of the type cited must be supplemented by systematic analyses and research on measurement and other approaches not only to understand the full implications of social deprivation, but also to be able to implement such understanding in crew selection, crew composition, habitability provisions, and other measures to optimize performance.

Confinement. The term confinement refers both to the physical arrangements of the isolated situation and to the implications of close physical confinement for the social system existing in the enclosed space. Both have extremely important effects on behavior.

Physical confinement implies restraint, restriction of freedom of movement and action, enforced closeness with other crew members, and reduced social variation. For men of action, such as aggressive combat and test pilots, from whose ranks most of the astronaut complement has been drawn, extended confinement in the space capsule may be regarded as a challenge to develop effective compensatory modes of behavior. The close quarters, with incident status leveling, familiarity, reduction of privacy, enforced intimacy, absence of shelter from interpersonal conflict, and limited opportunity for recreational pursuits, present numerous problems in relation to personal conduct, interpersonal interaction, leadership, organization, and group management.

Haythorn[27] has observed, in experimental studies of small groups in confinement, a speeding up of the acquaintance process, marked by an accelerated rate of interpersonal information exchange. The depth and breadth of exchange of confidences under such enforced closeness is impressive. A difficulty resulting from such speeded acquaintanceship among experimental subjects was that information acquisition frequently exceeded the rate at which an individual could learn to accept idiosyncracies of another person or to cope with values markedly different

from his own.

Under such circumstances, among individuals capable of controlling extrapunitive, aggressive impulses, the tendency to withdraw is a reasonable alternative and leads to breakdown of communication, guarding of personal possessions and prerogatives, and territoriality, in the sense of establishment of propriety in respect to use of personal items and areas of space not to be intruded upon by others. Observations of these phenomena are common in the literature and have even been translated into formal provisions against the forces toward intimacy on ships, which have evolved designated areas for high rank officers, noncommissioned officers, and rank and file crew. The "captain's territory" is a sanctuary within which he can attempt to function impartially and defend his authority against informal, personal influences in the closeness of the ship environment. Both Altman and Haythorn[4] and Cowan and Strickland[9] have reported that territoriality occurred earlier and more extensively among their isolated experimental subjects than among controls, and that it increased with time. It began with the claiming of fixed geographic areas and highly personal objects and extended later to more mobile areas (personal distance) and less personal objects. Cowan and Strickland mentioned that their isolated subjects in the UCLA Penthouse Experiment actually staked out areas of exclusion of others and acted with marked hostility toward trespassers.

Such reactions can apparently be reduced by selection of members of isolated groups who are compatible with each other, reported by the investigators already mentioned. Knowledge of the basis for such selection is presently grossly insufficient, although Altman and Haythorn[4] have shown that positive results can be attained using personality measures. At this time, however, crew composition based on self-selection and expression of member preferences, as implemented by Roby[44] in composition of B-29 crews, and Sells and Templeton[54] in assigning flight students to instructors, may still be the most dependable approach.

The general effects of the enforced intimacy of confined groups are multifaceted. Not only are personal rights and privileges vulnerable to to violation, giving rise to the defense of privacy and territoriality, and the need for greater personal space, but strong forces toward informality and intimacy are generated which threaten formal command structure. The process of status leveling (Torrance[58, 59], Rohrer[46], Sells[51, 52], Wilkins[61]) makes it difficult and sometimes impossible to achieve and maintain the social distance between superior and subordinate in a command relationship needed to support the authority of the superior. Many questions concerning the basis of social power and leadership style appropriate to such situations can presently be answered by educated guesses and without hard data. A study of this problem is in progress in our laboratory.

Mullin[36], who interviewed wintering-over scientists and Navy men in the Antarctic, recorded an observation frequently mentioned in the literature, that group and individual tensions and irritations are ever-present, but that the most important lesson a member of such a group could learn was that he could not afford to alienate himself from the support of the group. In such microsocieties, each individual is highly dependent on the good will of the others and of the group as a whole for his feelings of acceptance, worth, and security.

A mechanism of displacement of hostility frequently observed among isolated groups is the tendency to direct anger, scorn, and even ridicule, with intensity often out of proportion to the focal issue, on external competitors and superior authorities. The naval literature, as well as reports of expeditions and military operations, are replete with reports of antagonism toward headquarters by field parties, of complaints about "excessive demands" by outside persons who are said to be "unaware" of the ongoing realities. Some occurrences of this type have already occurred in the space program and may be expected with greater vehemence as distances increase. Such observations have been made by Strickland[9], David[10], Farrell and Smith[15], Hanna[24], McGrath et al[33], Rodgin and Hartman[45], and Smith[56]. While the effects may be hygienic, insofar as they furnish a common target for the venting of repressed hostility, the positive values for group mental health may be more than offset by disruption of significant communications with base support groups.

Confined social systems. Goffman, whose book, Asylums[19], has become a classic of sociological research, has developed the concept of the "total group," which is cut off from society and leads a closed existence. While part of Goffman's basic formulation is focused on hospitals and custodial institutions, in which the staff-inmate distinction is critical, there are, nevertheless, several aspects that have important implications for confinement in a space ship. According to Goffman, one effect of a total institution is that it places many human needs under bureaucratic control. In a hospital, the staff are the managers and the patients, the managed. Staff surveillance of patients encourages conformity to staff desires, but engenders hostility, with the result that each group develops stereotypes, misunderstanding, and mistrust in relation to the other. Communication is restricted and inmates are commonly excluded from information and decisions concerning their fates. The closed society has no opportunities for discontinuity or escape, such as in open societies, in which individuals routinely move from home to office, to coffee break, to lunch, to clubs, and the like, with consequent release from tension. Instead, tensions boil up, as in a pressure cooker.

The absence of discontinuities in the hospital or prison is equally apparent in the space ship and may be equally significant. In addition, despite the obvious social differences between the capsule and institutional societies, there are analogues of more than academic interest with reference to the perceived relations between commander and crew, between

astronaut and scientist crew members in relation to maintenance of discipline, control of significant information, decision-making, and influence by example. There is great need for the capsule community to be truly a therapeutic community rather than a pressure cooker.

Reduced sensory variation. As in all confined situations, life in a space ship must necessarily involve extended sameness, monotony of social stimulation, reduced opportunities for social comparison, and minimal diversion in work and recreational activity. Although such situations are on a continuum with those involving the classical sensory deprivation cubicles, reviewed definitively by Schultz[48], the monotony of the space capsule does not even approach the extremity of restriction obtained by Heron, Bexton, and Hebb[28], Lilly[32], and other sensory deprivation investigators. The problem appears rather to involve "the same faces, the same personalities, the same surrounds, the same routine" over and over, accompanied by minimal physical mobility and activity, that is, restriction of the amount and variety of meaningful sensory stimulation over a prolonged period.

Fraser[17] concluded after reviewing a number of studies of confined groups, that perceptual aberrations are related to reduced or distorted sensory input and do not occur in the presence of good consensual validation. This is at least in part related to the fact that fewer problems have been observed for small groups in isolation and confinement than for individuals, as reported by Fraser[17], Smith[55], and others. The presence

of at least one other person tends to enrich the environment and make it more tolerable. In pronounced contrast to the profusion of symptoms described for individuals experiencing sensory deprivation, studies of groups in isolation have reported few incidents of unusual visual and auditory sensations, perceptual distortions, difficulties in distinguishing between sleep and waking states, unusual dreams, and other distorted experiences.

Most writers on isolation have noted the prevalence of monotony and boredom as pervasive problems. As a result, much interest has been focused upon effects on intellectual functioning and on performance, as well as provision for leisure and recreation, and morale. Mullin[36] noted a widespread lack of intellectual energy among Antarctic personnel despite the fact that most of the men had planned to engage in intellectual pursuits such as learning a language, correspondence courses, and the like. This may simply reflect the effects of new surrounds and not restricted environmental input, as such. Indeed, evidence of performance deterioration based on objective data is hard to find among isolated groups, while many reports make specific mention that deterioration did not occur. Reports by Eilbert and Glaser[13], Mullin[36], Rohrer[47], Burns and Kimura[7], and Gunderson and Nelson[21] have included descriptive accounts of morale problems affecting performance. Other studies of both short-term and moderate exposure have revealed no clear evidence of decrement of intellectual performance in isolation over time (Faucett and Newman[14],

Hanna and Gaito[25], McGrath et al[33], Zubek et al[62], Agadzhanian et al[2], Alluisi et al[3], Hammes[23], Hartman et al[26], and Rodgin and Hartman[45]).

MITIGATION MEASURES

Perhaps the strongest statement concerning measures to minimize disturbing effects of isolation on long-duration space missions would be to direct attention to the requirements of the on-board social system. This would at once provide a systematic and internally consistent framework for planning, in contrast to a string of unrelated and possible contradictory piecemeal individual measures. In general, it appears that whatever would produce greater crew competence, compatibility, and cohesiveness would also contribute to greater resistance to isolation effects. Further, many issues not discussed here, because of the special focus of the present paper, would be relevant from this broader orientation. For example, the entire area of communication with the ground and information support, including mission performance, goal attainment, and provision of current and timely information about world and home conditions is highly important to reduce isolation effects as well as to promote crew effectiveness in general.

The analysis of isolation effects presented here may be regarded by some as a debunking of the exaggerated predictions based on disaster accounts. At the same time there are serious challenges that must be faced, not only to prevent disorganization of the crew in the pressure cooker confinement, but even more to optimize behavior effectiveness

despite the inevitable monotony of the situation. Not the least of the problems will be to minimize the danger of deterioration of capsule-ground communications as the tendency to repudiate headquarters develops among the isolated crew. This problem indicates a need to train headquarters personnel to deal effectively with the remote crew as well as to moderate crew attitudes.

A major point was made concerning separation anxiety as an individual hazard, although it was recognized that this may be greatly reduced by self-selection of volunteers. Selection measures focused on this problem appear to involve principally value orientations of crew members, and research on assessment of relevant values is needed. Personality and background factors were also mentioned, and present knowledge concerning these is very limited. Positive measures also appear possible through efforts to obtain compatible crews, also by self-selection until objective means are developed, and by organizational measures to promote crew cohesiveness, solidarity, and morale. Fortunately, the general esprit of the small but elite astronaut corps favors the accomplishment of these goals.

Although it is apparent that focused consideration must be given to questions of organization, command structure, leadership style, and the entire area of organizational behavior (see Sells[52]), the questions are still more easily available than effective answers. This area appears to abound in contradictions, as between the pressures for informality and

permissiveness, on one hand, and the need for a strong command structure on the other, as in the traditional military model which has prevailed among space crews to date. Until strong scientifically developed arguments for another approach can be offered, our recommendation is to follow the traditional pattern. This has not only the acceptance of the personnel involved, but also the added advantage of providing a normative structure that is needed to reduce tendencies toward deviant behavior. The space program has succeeded well up to this time in following a "cut-and-try" philosophy, tailored to the individual participants. In the areas of crew control and interpersonal behavior, individual beliefs, traditions of service, and idiosyncratic preferences must be respected.

Much thought has been given to questions of crew size, habitability of the capsule, provisions for privacy and solitude, recreation and exercise, food preparation, enrichment of the sensory environment, programming of tasks, watches, and work schedules. Discussions of these areas suggest that at present, significant contributions can be expected in planning and design of an amazingly comfortable and efficient habitation within which groups of 5 to 15 men could live and work on an interplanetary mission. The changes expected from the Apollo ship of the 1960's to the Mars-type ship of the 1980's will probably involve new technology still on the drawing board, involving recycling of water and possibly food, laser communications, miniature tape libraries, new recreational and exercise devices and the like. Important contributions in these areas

include those of Adams and Chiles[1], Nelson[37], Bloom[6], Findley et al[16], Gunderson and Nelson[21], Levine[31], Fraser[18], Radloff and Helmreich[40], and others.

As in the past, human factors engineering expertise continues ahead of human relations engineering. The most important problems requiring increased attention and research are therefore in the human relations area. In addition to those mentioned, the sources of interpersonal conflict and methods of conflict resolution discussed recently by Rawls et al[43] must receive a high priority.

In summary, it is necessary to view isolation, manifested through social deprivation, confinement, and reduced environmental stimulation, as a significant obstacle to be overcome in long-duration space missions. The longer the exposure, in general, the more stressful the experience is expected to be. On the other hand, identification of the problems in most cases suggests avenues of approach to their solution. Despite the impressive accomplishments of the space technologists to date, however, the successful solution of the problems created by isolation must be regarded as deserving the highest priority.

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