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REVIEW/SUBMARINE

Duffner, G.J.

PURPOSE

To report group research on personnel selection and to deal with problems of the submarine environment, existing assessment processes, and research hypotheses related to certain development methodology.

CONFINEMENTS REVIEWED

Submarine

REVIEW OF STUDIES

STRESS FACTORS

- a) Instability of the submarine as a weapon.
- b) Nature of submarine operations.

EXISTING ASSESSMENT PROCESSES

- a) Psychologic tests.
- b) Physical examination.
- c) Sensory testing.
- d) Fifty pound pressure test.

CRITERION RESEARCH METHODS

- a) Pools of traits, defining the good and the poor submariner.
- b) Performance and achievement criteria.
- c) Sociometric criteria.

PREDICTOR RESEARCH

PRESENT PREDICTOR COMBINATIONS

- a) Training task observations.
- b) Base battery.
- c) Mental tests (Arithmetic, etc.)
- d) Personal history.
- e) Semi-structured interviews by submarine medical officers, candidates assessed on background factors, job history, etc.

PREDICTOR VARIABLE USED EXPERIMENTALLY

- a) Semi-structured T.A.T.
- b) Modified picture completion.
- c) Masculine role test.

PREDICTOR VARIABLES USED ON OPERATION HIDEOUT

- a) Basic battery.
- b) Manual dexterity.
- c) Rigidity.
- d) Sentence completion.
- e) Rorschach (individual).

REFERENCES

- DUFFNER, G.J. 1954.
Crew selection for submarine duty.
U.S. Armed Forces Medical Journal 5:1192-1198.

PURPOSE

This study analyzes the available off duty time in long duration space missions and suggests ways to use off duty time.

CONFINEMENTS REVIEWED

- a) Arctic
- b) Antarctic
- c) Ships
- d) Submarines
- e) Missile bases

REVIEW OF STUDIES

TIME FINDINGS

- a) There are two components of off duty time in the long duration studies:
 - 1) Scheduled off duty time.
 - 2) Unscheduled free time resulting from the excess time scheduled for other activities.
- b) Men in general and men in special environments have approximately 5 hours a day free time.
- c) Crew size is based upon heavy work phases of the mission.
- d) Men in confined space with little work to do are unwilling to share their work load.
- e) Reduced sleep time requirements may result from a weightless environment and from the problems of confinement and boredom in long duration missions.
- f) Off duty time may exceed 10 hours per day during deep space periods of the mission.

ACTIVITY FINDINGS

- a) Discretionary activities should depend upon the free choice of each crew member.
- b) Men in confinement prefer work to free time.
- c) Talking, reading fiction, watching movies and television are the most frequently performed activities by confined groups.
- d) Men in confinement take almost twice as long to eat as men in the general population.

- e) Exercise is an infrequently performed activity for all of the adults studied.
- f) Recreational facilities have historically been the source of significant morale problems for confined groups.

PRINCIPLES RELATED TO OFF DUTY TIME

- a) The amount of free time for each crew member should be determined in light of scheduled opportunities and contingencies.
- b) In long duration space flights, due to the reduced activity possibilities, free time should be limited to about 5 hours per day.
- c) The mission time line should be designed to insure that the maximum amount of social interaction is possible during off duty times. In extreme cases of interpersonal conflict, off duty times can be rearranged to reduce the amount of off duty interaction.
- d) Task rotation should be considered a normal routine to curtail the unwillingness of crew members to share their limited work load should contingencies arise which limit a crew member's work opportunity.

PRINCIPLES IN DESIGNING DISCRETIONARY ACTIVITIES

- a) Selection of discretionary activities must take into account crew members' preferences and the influence of long duration confinement on these preferences.
- b) Discretionary activities should be selected that tend to reduce the anticipated monotony and increase sensory stimulation.
- c) Rules relative to activity performance should be considered in the design, integration, and use of activities in the spacecraft.

REFERENCES

- EBERHARD, J.W. 1967.
The problem of off duty time in long duration space missions. Volume I: Summary and research recommendations.
Serendipity Associates, McLean, Virginia. 33 pages.
[NASA CR-93834]
- EBERHARD, J.W. 1967.
The problem of off duty time in long duration space missions. Volume II: Final Report.
Serendipity Associates, McLean, Virginia. 104 pages.
[NASA CR-96721]
- EBERHARD, J.W., and K.T. SMITH. 1967.
The problem of off duty time in long duration space missions. Volume III: An annotated bibliography.
Serendipity Associates, McLean, Virginia. 202 pages.
[NASA CR-96737]

PURPOSE

- a) To study the contribution which the leader and the members of a group make to the task performance under varying conditions of stress in small group situations.
- b) To discuss the type of leadership style which is most appropriate to group performance.

REVIEW OF STUDIES

Effect of Stress on the Leader's Contribution to the Task

- a) Mann has stated that the relationship between all personality attributes of the leader and group performance has generally been low and he cites medians of only .15 to .25 for even the best measures.
- b) Fiedler and Meuwese (1963) have shown that the leader's intelligence and ability scores correlate highly with group performance primarily when the group environment is pleasant and relaxed, and when good interpersonal relations exist within the group.
- c) Meuwese and Fiedler (1964) studied seniors in the Army and Navy ROTC programs at University of Illinois. The experiment involved 54 three-man groups, with sets of 18 groups randomly assigned to one of three conditions:

- 1) low stress.
- 2) internal stress.
- 3) external stress.

Each group performed two creative tasks in succession 1) Pay Proposal of ROTC program (equalize benefits among Army, Navy, and Air Force cadets) and 2) Fable task (write down a fable or story). The results suggest that the stress of the situation caused the leader to be anxious, and that the leader's anxiety, in turn, interfered with his ability to concentrate his efforts on the task. The major importance of the data is that the intelligence of leaders on their task relevant abilities is utilized by the group primarily under conditions of minimal stress.

- d) Meuwese and Fiedler (1964) showed that the effectiveness of the group is contingent upon the interaction of the leadership style and the difficulty of the group situation for the leader.

CONCLUSIONS

- a) It seems likely that the group, operating under serious threat and external stress, might require a therapeutic leadership which will enable the members to reduce their anxiety level to manageable size so that task relevant activities can be tackled.
- b) In general, a highly structured and controlling leadership is most effective under either conditions of high or low stress.
- c) Under intermediate conditions of stress, a more permissive, less structured style of leadership is most efficient.

REFERENCES

- FIEDLER, F.E. 1965.
The effects of stress on small group performance.
Texas Christian University, Fort Worth, Texas. 33 pages.
[NASA CR-76333]

PURPOSE

To discuss problems of choosing individuals who can perform the required tasks of space flight under psychological stress.

CONFINEMENT

SAM

In SAM illusions of body image, distortion of space and time and hypnagogic-like imagery have occurred as a result of the stresses of confinement fatigue and the restricted perceptual field.

BASIC PERSONALITY STABILITY

- a) To be effective and reliable, the astronaut must be free of significant emotional conflicts and anxiety.
- b) He must be able to work with others under stress during training period.
- c) A subject that will do well in space is one who:
 - 1) Is mature.
 - 2) Is well integrated.
 - 3) Is motivated.
 - 4) Has a normal self critical faculty.
 - 5) Is capable of forming group identification.
 - 6) Has ability and developmental experiences.
 - 7) Is able to rely on others (ground crew).
- d) A pilot's flying experience may not serve as an effective screening device since space flight missions involve relative passivity and require that the pilot be more of a monitor than a pilot.

CONCLUSIONS

- a) Test pilots are considered to be good applicants for space crews because they already possess highly developed skills and a high level of adaptability.
- b) The astronaut assessment program should be one which differentiates between high levels of adaptability to the stresses of military flight, considers the candidate in terms of psychological requirements that are relatively unique to space flight, and assesses basic personality stability in an attempt to predict maladaptive behavior.

REFERENCES

- FLINN, D.E. 1961.
 Psychiatric factors in astronaut selection.
 In: B.E. Flaherty, ed. Psychophysiological Aspects of Space Flight (Symposium
 on Psychophysiological Aspects of Space Flight, Brooks Air Force Base, Texas,
 1960). Columbia University Press, New York. pp. 87-95.

PURPOSE

- a) To define the nature of confinement stress and to make an examination of its psychophysiological effect on man.
- b) To critically review the literature making analysis of data from many sources.

REVIEW OF STUDIES

- a) The 60 or so studies reviewed can be classified as simulator studies, confined chamber studies, cockpit studies, vehicle studies, submarine studies, spacecraft studies, etc.
- b) The operational conditions of the studies reviewed range from those of bedrest to those of Gemini spacecraft.
- c) The focus of this review is to integrate the findings of the various studies with respect to physiological and psychological effects of confinement and tolerance to confinement.

CONCLUSIONS

PSYCHOLOGICAL RESPONSE TO CONFINEMENT

- a) The effects of perceptual aberrations on the single isolate can be reduced with motivation and experience.
- b) The occurrence of perceptual aberrations is greatly reduced when two subjects are isolated together, and it disappears in larger groups.
- c) Psychological factors affecting group performance should be investigated and integrated into the astronaut selection process.
- d) While confinement, in itself, has little effect on intellectual or complex psychomotor performance, perceptual isolation reduces these types of performance.
- e) Confinement probably has little effect on time perception, while perceptual isolation may cause gross errors in time estimation.

PHYSIOLOGICAL RESPONSE TO CONFINEMENT

- a) In confinement, the response to stress is non-specific (viz: changes in pulse rate, blood pressure, EEG, etc.) and combined with specific changes due to the reduced mobility.
- b) An important area for investigation is the possibility of reduced resistance to new forms of stress associated with the "resistive stage" of stress theory.
- c) In situations involving long-duration confinement, the "initial heightened activity begins to show the effects of an adaptive process during the second week and appears to be maintained for about 2 months before a resurgence of stress phenomena occurs."
- d) Due to the paucity of data on the effects of long-duration confinement, studies should be performed to evaluate the effects suggested in this study.

TOLERANCE OF CONFINEMENT AND VOLUME REQUIREMENTS

- a)"Above the threshold of acceptability, volume is not a major constraint regardless of duration. Below the threshold of unacceptability, volume is the major constraint regardless of duration. Between the thresholds, the effects of volume may be modified by other factors."
- b)Confinement induces stress to an extent dictated by factors such as severity and duration, habitability, and personal factors.
- c)Tolerance threshold curves show that for periods of confinement of 30 to 60 days, about 150 cubic feet of free volume space per man is needed.
- d)Tolerance was modified by habitability, work, rest, recreation, and exercise schedules.
- e)It is suggested that weightlessness may improve tolerance to confinement by alleviating the restrictive aspects of confinement.

REFERENCES

- FRASER, T.M. 1966.
The effects of confinement as a factor in manned space flight.
National Aeronautics and Space Administration, Washington, D.C. 176 pages.
[NASA CR-511]

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REVIEW/HUMAN CONFINEMENT EXPERIENCE Fraser, T.M.

PURPOSE

To outline the nature of the problems resulting from confinement on the basis of 60 studies of operational and experimental human confinement.

CONFINEMENTS STUDIED

Human confinement experience

Type of Study	Confinement Conditions	No. of subjects per run	Volume per man (cu. ft.)	Duration days
Simulator	SAM one-man space simulator	1	47	7
Single man	SAM one-man space simulator	1	47	1½
	Vostok spacecraft simulator	1	90	21
Simulator	Lockheed-Georgia crew system mock up-OPN 360	5,6	250, 183	15
Several men	Ditto - HOPE II	6	187	15
	Ditto - HOPE III	10	110	30
	Ditto - HOPE IV & V	10	110	12
	Ditto - HOPE VI & VII	6	187	12
	U.S. Navy ACEL converted pressure chamber	6	75	7
	Ditto	6	75	8
	North American Aviation conical mock-up	3	67	7
	North American Aviation cylindrical mock-up	4	375	7
	North American Aviation disk-like mock-up	2	800	4
	SAM two-man simulator with simulated mission	2	106	14, 30, 17
	Republic converted altitude chamber	6	211	14
	Douglas orbiting vehicle simulator	4	250	30
	General Electric two-compartment simulator	4	215	30
	Martin Baltimore lunar mission simulator	3	133	3, 7
	NASA Ames conical capsule	2	61.5	7
	NADC long range mission simulator	5	140	5
Confinement Chambers	University of Maryland programmed environment	1	1368	152
	University of Georgia simulated fall-out shelter	10	65	3
	Ditto	10	65	3
	Ditto	10	52	3
	Ditto	30	52	4
	Ditto	30	52	14
	Ditto	30	52	14
	Ditto	30	39	7

(continued)

Type of Study	Confinement Conditions	No. of subjects per run	Volume per man (cu. ft.)	Duration days
	USNRDL fall-out shelter	100	117	14
	Ditto	100	117	5
	Lockheed Georgia flight station mock-up	8	125	4
	Coffin-like open capsule	1	28	7
Aircraft cockpit	F-84 aircraft cockpit	1	30	2½
	WADD aircraft escape capsule	1	27.5	2
Armored Vehicle	Armored personnel carrier:			
	Type M 59	10	30	4 hrs
	Type M113, in motion	12	23.3	8 hrs
	Type M113, stationary	10	28	12 hrs
	Type M113, in motion	11	25.5	24 hrs
	Type M113, in motion	11	25.5	24 hrs
Submarine	Submarine Nautilus, 1956, submerged and cruising	36	1600	11
	Submarine Seawolf, 1957, submerged	100	570	60
	Submarine Nautilus, 1958, submerged under ice-cap	100	570	4
	Submarine Triton, 1960, submerged around world	100	570	83
Chair rest	SAM: overstuffed back-tilted chair	1	25	4
Bed rest	Lankenau hospital, continuous bed rest, no sitting	1	25	45
	SAM: continuous bed rest, no sitting	1	25	28
	SAM: bed rest studies with and without prophylaxis	1	25	14
Spacecraft	Mercury, MA-6	1	47	8 hrs
	Mercury, MA-7, MA-8	1	47	12 hrs
	Mercury, MA-9	1	47	1½ days
	Vostok I	1	90	12 hrs
	Vostok II	1	90	1 day
	Gemini III	2	40	5 hrs
	Gemini IV	2	40	4 days
	Gemini V	2	40	8 days
	Gemini VI	2	40	1 days
	Gemini VII	2	40	14 days

REVIEW OF STUDIES

PSYCHOLOGICAL EFFECTS

a) If habitability is close to acceptable in confinement for a well-motivated trained individual, overt psychological effects may not be observed, and even covert effects, as judged by interview, diary evaluation, psychological testing, and performance measures may be negligible except in extremes of confinement.

b) Monotonous environment has deleterious effects as evidenced by impairment of thinking, childish emotional responses, and disturbances of visual perception leading to the occurrence of both unstructured and fully structured visual illusions.

c) A man, even though alone, can apparently learn to cope with perceptual aberration.

d) Apart from emotional reactions, the sheer discomfort of confinement can be severe.

INTERPERSONAL RELATIONSHIPS

- a) Feelings of resentment and hostility either directed at individual colleagues in confinement or projected to the external investigators in an experimental situation have been fairly common in confinement and isolation research.
- b) In the SAM two-man chamber the investigators found that the subjects maintained a high morale and demonstrated few emotional changes.
- c) Lawton found that during the confinement period cohesiveness deteriorated steeply with a sharp rise beginning as the flight was about to end. In spite of this trend, personal emotional defenses were sufficient to maintain each individual's stability.
- d) Flinn in one study and Tiller and Figur in another found that the significance of motivation and discipline as factors in masking the expression of hostility and resentment is obvious, but should not be relied upon to ensure success in a mission.

INTELLECTUAL CAPACITY

- a) In the General Electric study significant performance decrements were observed during the simulation period as compared with a pre-simulation control run.
- b) Hanna and Gaita found no performance decrement in complex arithmetical tasks during their 7-day space cabin simulation.

FACTORS WHICH CAN MODIFY TOLERANCE OF CONFINEMENT

- a) Motivation and experience.
- b) Activities and tasks during confinement.
- c) Knowledge of duration.
- d) Exercise and physical fitness.
- e) Number of subjects confined.

CONCLUSIONS

In view of the 60 operational and experimental studies analyzed and reviewed, the physiological and psychological responses of the subjects in various confinement situations are discussed. Also discussed are some measures to reduce undesirable responses (in terms of modifying tolerance to confinement).

REFERENCES

- FRASER, T.M. 1968.
Confinement and free-volume requirements.
Space Life Sciences 1(2/3):428-466.

R-11
REVIEW/SELECTION

Hartman, B.O.

PURPOSE

To review factors in influencing the aircrewman's capacity to perform useful work.

Topics covered:

- a) Psychological selection and training of aerospace crews.
- b) Characteristics of the human operator.
- c) Psychologic effects of physiologic stress.
- d) Psychologic factors in spaceflight.

SUMMARY OF REVIEW

I. Psychologic Selection and Training of Aerospace Crews

AIRCREW SELECTION PROGRAMS

a) Requirements for an effective selection program:

- 1) Pool of applicants must be larger than the number of jobs to be filled.
- 2) Job analysis must be available.
- 3) Candidates must vary in their ability to perform the job.
- 4) Procedures or tests which measure the variability to perform the job must be available.

b) Typical selection procedures:

- 1) A minimum level of education; frequently 2 years of college.
- 2) A test which measures equivalent achievement, emphasizing acquired information and general intelligence.
- 3) A battery of tests, each designed to measure a component of the job.
- 4) A battery of tests measuring both job components and special technical background factors.
- 5) A battery of tests with interest and personal history elements added.
- 6) A battery with psychomotor apparatus tests added.
- 7) A battery of tests supplemented by a short training and performance period, as for example 10 hours in light planes.
- 8) A special battery of tests, with results provided to a selection board.

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c) An example of a good selection program: U.S. Air Force Requirements.

1) Air Force Officer Qualifying Test (AFOQT).

2) Commissioned officer.

3) Physical examination.

d) Special Selection Programs. A good example is the procedure used by the U.S. Air Force School of Aerospace Medicine in evaluating space flight candidates including NASA astronauts.

1) Intensive physical examination including psychiatric evaluations.

2) Tests of intelligence:
Wechsler Adult Intelligence Scale;
Miller Analogies Test;
Doppelt Mathematic Reasoning Test;
Minnesota Engineering Analogies Test.

3) Projective tests:
Rorschach Psychodiagnostic Test;
Thematic Apperception Test;
Draw a Person Test;
Bender Visual-Motor Gestalt Test.

TRAINING

a) Little substantial progress in the application of psychologic principles to flying training has been made since World War II.

b) Most training devices are designed to improve a pilot's performance rather than to measure it.

c) Although not applied to flight training as yet, programmed learning is a likely candidate for "ground school" phases.

II. Characteristics of the Human Operator

a) Operator delays and lags are a key area of concern in the use of man in complex systems.

b) Delays vary across sensory systems and can be substantial. For example, receptor delay is 15 times longer for visual than for auditory transduction, although this is offset by the ability of the visual system to process exceedingly complex inputs.

c) Central nervous system delays are the longest, the most variable, and therefore the least predictable.

d) Man may be described as fundamentally a single-channel sequential responder with a reasonably wide base and low sensitivity input-output capacity in relation to his cost and size.

III. Psychologic Effects of Physiologic Stress

a) Low levels of biodynamic stressors such as acceleration and vibration alter crew performance because they "load" the limbs and interfere with coordination.

b) Low levels of other stressors like hypoxia compromise crew performance by inducing fatigue.

c) Any stressor producing unpleasant subjective states and bodily discomfort or pain distracts an aircrewman and creates a situation in which a substantial possibility of poor performance exists.

d) Fatigue.

- 1) Performance becomes poorer during an extended period of work due to fatigue.
- 2) Fatigue causes disruptions in timing, losses in fine motor control, increased variability in performance, and a lowering of standards.
- 3) Tasks based on gross, discrete cues are more resistant to fatigue than tasks based on minute cues, in which vigilance and alertness are important.
- 4) Duty schedules containing programmed periods of rest can be carried out quite effectively for many hours.
- 5) Cumulative fatigue is the result of inadequate recovery from several successive periods of acute fatigue and appears gradually over several days or weeks. Performance effects are like those seen in acute fatigue, including poorer airmanship, and degraded management and judgment during flight. Impairment in motivation, emotional control and interpersonal relationships can develop.

e) Diurnal Effects

- 1) Diurnal variation is another factor involved in prolonged work. Losses in proficiency are generally found when operators have already been on duty for some time or when tasks are very demanding.
- 2) If the operator's performance is at normal levels and other primary stressors such as fatigue are not taking their toll, no significant diurnal effects are likely.

f) Work/Rest Schedules

The important factor with respect to work/rest schedules is the maximum time on duty. Duty schedules should not require continuous work to the point where significant fatigue effects occur.

g) Performance Upon Awakening

- 1) Having to work in a concentrated fashion after sudden awakening interferes with the capacity to perform effectively.
- 2) A few minutes of nonworking time when the crewman can devote himself exclusively to waking up offsets performance decrements.

h) Maintenance of Skill

In order to maintain an acceptable level of performance, Fitts suggests engineering the job to reduce overload and augment low-load conditions and then to train as frequently and intensively as possible.

i) Alterations in perceptions

Alterations in an aircrewman's perception of his surroundings are best characterized as undue narrowing of attention, inability to focus attention properly, or actual distortions of sensory input.

j) Other Problems

1) Such problems as irritation with routine operations, an increase in physical complaints, and interpersonal friction have been evident in small groups assigned to remote duty sites.

2) Aircrewman report significant losses in morale and job satisfaction due to the frustrations of unavoidable delays.

IV. Psychologic Factors in Spaceflight

a) Three psychologic problems were considered critical in the early days of manned spaceflight:

1) Gross disruptions in emotional status as a result of prolonged isolation and sensory deprivation.

2) Difficulties in neuromuscular function in the weightless condition.

3) The possibility of undefined performance disturbances related to prolonged exposure to radiation.

Experience has relegated these to problems of minor concern at least in relation to the lunar program.

b) Present psychologic problems are work/rest schedules and the relationship between work, fatigue and sleep.

1) This problem is concerned with how to arrange the duty day to provide sleep periods, housekeeping periods, and still provide coverage throughout the day, for many days in succession.

2) Ground-based studies have demonstrated that man can perform acceptably on schedules as unusual as 4 hrs. on duty, 2 hrs. off or even 2 hrs. on duty 2 hrs. off, but the sleep schedule which goes with this does not permit adequate recovery.

3) The subject of what constitutes adequate sleep and sleep deprivation are areas of concern today. (1971)

REFERENCES

- HARTMAN, B.O. 1971.
Psychologic aspects of aerospace medicine.
In: H.W. Randel, ed. Aerospace Medicine, 2nd edition. The Williams and Wilkins Company, Baltimore, Maryland. pp. 565-585.

PURPOSE

To present a systematic and selective review of research bearing on the hypothesis that the behavior, compatibility and effectiveness of a group is dependent on a particular combination of individuals.

REVIEW OF CREW STUDIES

THE COMPOSITION OF GROUPS

- a) The presence of others in the perceptual field of an individual affects his performance, but this effect depends on characteristics of the individual, the others, and the task.
- b) The behavior of other people is a determinant of a subject's behavior. Individuals in groups composed of members with heterogeneous attitudes and values may be less subjected to the pressure to conform than individuals in homogeneously composed groups.
- c) Individuals develop a complex set of needs, the satisfactions of which require particular kinds of relations with other individuals. On the whole, behavior conducive to effective leadership is clearly a function of the situation.
- d) Inability of group members to get along frequently results in failure in achieving the group goals.
- e) Socioeconomic level, educational level, intelligence and vocabulary all may be expected to relate to the ability of individuals to communicate with each other.
- f) Differences in objectives among group members generate conflict which could result in not achieving the goal.
- g) Group activity allows individuals with complementary skills to assist each other in attaining goals.
- h) Every group has certain informal social skills that have to be played by individuals for the success of the group.
- i) The behavior of the groups varies as a function of the personality characteristics of group members.
- j) The personality of the leader significantly determines the group climate that develops.
- k) Under some conditions, assembling groups on the basis of personal preferences produces more effective groups.
- l) If a leader is to be effective, group members must have some confidence that he is seeking at least some of the same goals that they are seeking.
- m) When dissimilar attitudes exist, pressures toward balance tend to generate interpersonal hostility or disliking.
- n) Individuals homogeneous with regard to fundamental value systems relevant to the nature of their interaction tend to be more compatible than groups heterogeneous with regard to such values. In some situations, members of groups can to a degree complement each other's weaknesses.

- o) Daily contact among persons with different outlooks and professional backgrounds provides mutual stimulation which results in higher research performance.
- p) Crew morale is lower when leadership roles are limited to a few crew positions, but instructors give the crew a higher performance rating.
- q) Crews in which relatively little informal interaction among crew members was reported were likely to have crew personal liking.
- r) It is useful to consider compatibility in three dimensions:

- 1) Congruency vs. incongruency.
- 2) Complementary vs. non-complementary.
- 3) Competitive vs. non-competitive needs, values, and cognitive styles.

s) Interpersonal attractiveness and performance effectiveness must be distinguished in the composition of a group since the results for one are different from those for the other.

RELATION TO ISOLATION AND CONFINEMENT

a) Men that are required to function for long periods of time in narrowly confined spaces under great degrees of isolation from the rest of society are entirely dependent on each other for:

- 1) Social interaction.
- 2) Gratification of social needs.
- 3) Testing of social reality.

b) The boredom resulting from long periods of inactivity in the military system which places few demands on the operator for long periods of time tends to make individuals look to one another to provide necessary stimuli to counteract the performance and morale-degrading effects of monotony.

CONCLUSIONS

a) The literature survey finds that research supports the view that group composition significantly determines group member behavior; that both homogeneity and complementary hypotheses regarding the bases of compatibility and group effectiveness are tenable.

b) Group behavior is a function of the modal characteristics of the individual group members.

c) Group characteristics are directly dependent on individual member's characteristics and interpersonal relations among members.

REFERENCES

- HAYTHORN, W.W. 1968.
The composition of groups: A review of the literature.
Acta Psychologica 28:97-128.

PURPOSE

To identify some of the sources of psychological stress in isolated groups, and to point out their probable implications for systems design.

VARIABLES DISCUSSED

Stimulus reduction, social isolation, and interpersonal conflict are sources of stress which seem particularly noteworthy with regard to their implications for systems design.

a) Stimulus Reduction.

- 1) Under conditions of extreme stimulus reduction, a variety of perceptual and intellectual decrements, and various bizarre behaviors and experiences are reported.
- 2) Under less extreme conditions of stimulus reduction, reports of a reduction in motivation, morale, and performance have been reported.
- 3) Stimulus reduction effects accumulate over time.

b) Social Isolation.

Social need satisfaction and opportunities for social reality testing can be seriously impaired in small socially isolated groups. This can result in: a heightened sense of frustration; decreased accuracy and stability of self-concepts; and the development of invalid group norms.

c) Interpersonal Conflict.

- 1) Interpersonal conflict is heightened under conditions of isolation and confinement.
- 2) Minor irritations accumulate to the point of being major sources of tension.
- 3) The following factors contribute to interpersonal hostilities: lack of privacy; inability to establish and maintain territorial ownership; inability to find scapegoat outside group to displace aggression; and restricted opportunities to release tension through muscular activity.

CONCLUSIONS

The stress caused by the stimulus reduction, social isolation, and interpersonal conflict should be considered when designing any system for small groups for a long period of time. Possible implications for design are:

STRESS	CAN BE REDUCED BY:
1) Stimulus reduction	Stimulus enrichment procedures: music visual stimuli (TV, movies) radio programs intellectual puzzles reading material choice of operation mode (automatic, manual)

2) Social isolation

Some degree of communication with outside world
Crew size (at least 15) for long duration missions
Reminders of larger cultural identity - insignia, labels and procedures reflecting identity within larger group.

3) Interpersonal tensions

Provision of active recreation.
Provision of privacy
Identifiable boundaries between working areas.
Identification of equipment as belonging to one crew position.
Limiting necessity to share equipment and living facilities.
Provision of ample space to permit men to maintain preferred distances from each other.

REFERENCES

Haythorn, W.W. 1966.
Isolation, stress, and the design of closed ecologies.
Presented at the Human Factors Society Convention, Los Angeles, California, November 2-4, 1966.

PURPOSE

To review various studies concerning interpersonal stress.

CONFINEMENTS REVIEWED

Various kinds with various numbers of subjects in small groups.

REVIEW OF STUDIES

SOURCES OF INTERPERSONAL STRESS

- a)Competitive needs of group members.
- b)Incongruencies between need patterns.
- c)Complementarity of need patterns.
- d)Social isolation.
- e)Lack of privacy.

A VIEW OF PERSONALITIES IN GROUPS

- a)Personality is seen as a concept used to reference the organizing function in individual development.
- b)With increasing freedom from physical threat, it is assumed that the individual becomes increasingly concerned with self-identity.
- c)A higher level of differentiation and integration is shown by the individual who is primarily concerned with interpersonal relationships as these are expressed in affiliative, affectionate, group oriented behavior.

A STUDY OF ISOLATED DYADS

- a)Social isolation was expected to be stressful. A pure test of this, however, was obtained only for hypothetically compatible dyads.
- b)Interpersonal incompatibility was also expected to generate elevated levels of subjective stress and symptomatology. The expectation was confirmed.
- c)Both sources of stress applied in hypothetically incompatible isolated dyads.
- d)This study supported the general hypothesis that social isolation and interpersonal incompatibilities elevate subjective experiences of stress.

CONCLUSIONS

- a)Social isolation and interpersonal incompatibilities produce high levels of subjective stress and isolation symptomatology.
- b)The task of social psychologists is to identify the environment and group compositional situations which generate interpersonal stress.
- c)Not much is known about group behavior under stress, for there have not been many longitudinal, intricate studies.

REFERENCES

- HAYTHORN, W.W. 1970.
Interpersonal stress in isolated groups.
In: J.E. McGrath, ed. Social and Psychological Factors in Stress. Holt,
Rinehart and Winston, New York.

PURPOSE

To review studies on the effects on performance of confining two or more people in a restricted area for a prolonged period of time as they pertain to the U.S. Army's interest in performance during and after prolonged confinement in armored vehicles.

CONFINEMENTS REVIEWED

- a) Submarine.
- b) Laboratory.
- c) Fallout shelter.
- d) Spaceflight simulation.
- e) Antarctic.

REVIEW OF STUDIES

GROUP BEHAVIOR UNDER STRESS

- a) Submarine-Kinsey confined 23 men together for 2 months. He evaluated group behavior with interviews, daily diaries, casual observation, and a structured questionnaire.
- b) Laboratory - Lanzetta imposed threat on groups of three students doing a highly structured task. Threatened groups attacked problems less forcefully, assertively, and actively than unthreatened groups. A second lab experiment by Lanzetta used four people working on a task. Both the observers and the participants saw the groups as less competitive, more cooperative, and more friendly under increased stress. The results from the above two studies are directly opposed to findings when groups are confined under high threat in real-life conditions.
- c) Laboratory - Ruff studied confinement by placing five-man groups in a small compartment for 5 days. Three definite conclusions emerged: that different groups behave differently; that there is a great increase in interest in food; and that hostile feelings aroused by fellow crew members were not expressed overtly but in sarcasm, in comments in diaries, and on projective tests.
- d) Simulated Shelter - Altman made auditory and visual observations of 30 people for 1 to 2 weeks. The observers found that agitation and tension were greatest just after the subjects entered the shelter and just before they left it.
- e) Simulated Flight Chamber - Flinn reported that two subjects who were confined for 14-30 days showed only covert antagonisms, which they displaced toward monitoring personnel outside the chamber.

TASK PERFORMANCE

- a) Simulated space-cabin - six men were confined for 7 days. They worked in pairs. Each member of the pair tested, scored, and timed the other's performance. The mean findings are: intellectual functions did not deteriorate; subjects performed as well on the seventh day as on the first; and variable performance on psychomotor tasks probably reflected boredom.
- b) Simulated space capsule - Ormeston and Finkelstein confined subjects for 48 hours while measuring their performance on a variety of tasks. They found that 48 hours of close confinement had no effect on intellectual functioning.

c) Submarine - Weybrew confined 23 men for 50 days. He found that, although psychomotor or manipulative ability changed little, other variables did show changes.

d) Summary of Task Performance

1. Confined subjects' intellectual performance will not necessarily deteriorate, even though the environmental conditions are not optimum.

2. Confinement has little effect on tasks such as radar monitoring, vigilance, discrimination, problem solving, aerial-reconnaissance perception, rapid and accurate perception, form discrimination, tracking, and time estimation.

3. Confined subjects can perform complex tasks, if they are of particular interest to them, effectively for long periods. Variable performance on psychomotor tasks probably arises from boredom. Thus, simple routine tasks should be supplemented with more complex tasks which require higher-level behavior.

4. When perceptual and motor-skill performance did degrade during prolonged confinement, certain kinds of changes were characteristic:

a) Omitting portions of simple tasks, or parts of complex perceptual-motor tasks. These omissions may indicate general inattentiveness or boredom.

b) Approximation. The subject's responses became less accurate and his performance less precise, but they remained minimally adequate to meet the proficiency requirement of the task.

c) Longer response time. This increase may be due to gross misjudgments of the passage of time or to general lethargy.

d) Larger and more frequent errors.

e) Queuing. The subject may delay responding during peak loads, then catch up during lulls.

f) Lapses. Sometimes subjects' performance showed exaggerated variability.

g) Stereotyped responses and movements, regardless of the stimulus. The subject may treat all stimuli as if they were equivalent.

h) Filtering. Subjects may systematically omit certain categories of stimulation and response, according to some subjective priority scheme. Subjects frequently showed this filtering when stresses increased markedly.

i) Operating controls unintentionally.

j) Failing to detect and respond to stimulus changes.

PREDICTING ADJUSTMENT TO CONFINEMENT

a) Well adjusted men perform best and adapt most easily to confined situations.

b) Relatively few variables are systematically related to confinement adjustment. However, men who adjust to confinement better are older than 21, married, and have more than 2 years of Armed Force service.

c) The men who adjusted best to confined conditions at Antarctica had above average intelligence test scores, low interest in organized sports, high rating of ability to communicate, high rating of ability to cope with aggression, low rating on overt hostility, and less than a college education.

ANNOTATED BIBLIOGRAPHY

- a) General Problems in Confinement, Isolation, and Sensory Deprivation.
- b) Physical Environment of Confined Spaces.
- c) Effects of Confinement.
- d) Predicting Adjustment to Confinement.

CONCLUSIONS

- a) When people are highly motivated, they can maintain effective working relationships during confinement.
- b) People in confinement will undoubtedly develop feelings of resentment, but will displace most of the negative feelings towards outside sources.
- c) As stress increases, individuals seem to make more effort to control interpersonal tensions.
- d) The Army has highly specialized problems of confinement and isolation. Due to the unique character of the operational situations which may present themselves, few studies have been performed. Questions posed are, for example: what if, in a combat situation, one member of a tank crew decides to "drop-out" and what are the effects on the rest of the tank crew?
- e) Because in simulated field studies subjects are aware of their roles, operational field studies produce more satisfactory data. Subjects know this is the "real thing" and are not controlled by factors such as the experimenter's expectations.

REFERENCES

- HONIGFELD, A.R. 1965.
Group behavior in confinement: Review and annotated bibliography.
Human Engineering Laboratories, US Army, Aberdeen Proving Ground, Maryland.
116 pages. [Technical Memorandum 14-65]

PURPOSE

- a) A literature search was made of isolated behavioral, psychiatric, and sociological problems to be expected on a future long duration space mission.
- b) An attempt was made to draw conclusions pertinent to a prototype mission to Mars.

CONFINEMENTS REVIEWED

- a) Short term space flights
- b) Submarines.
- c) Antarctic expeditions
- d) Isolation chambers
- e) Space flight simulators
- f) Russian hypodynamic work

REVIEW OF STUDIES

Tests (Measurement of Psychological and Social Stress)

a) Psychophysiological Tests

Test	Psychic Correlate
Catecholamines (urine or blood)	inc. norepinephrine--anger inc. epinephrine--fear inc. levels in stress
ACTH or Adrenal Corticosteroid Levels (urine or blood)	inc. related to anxiety
Protein-bound Iodine (serum)	dec. with arousal usually inc. in stress
Skin Resistance	variable
Heart Rate	inc. in fear or anger
Blood Pressure	related to motivation
Respiratory Rate	alertness related to frequency
EMG	
EEG	

It appears that psychophysiological tests for stress measuring external stressors must also take into account internal stressors rooted in the personality of the subject.

b) Psychological Tests.

Perceptual Tests	Motor Tests
1) Threshold	Steadiness
2) Flicker fusion	2) Tracking
3) Perceptual speed	3) Coordination
4) Perceptual retention	
5) Attention	Perceptual-Motor Tests
6) Discrimination	1) Reaction time

Cognitive Tests

- 1) Problem solving
- 2) Concept formation
- 3) Conditioning and learning

Personality Tests

- 1) Direct observation and interviewing
- 2) Self-ratings (e.g., MMPI, Edwards Personal Preference Schedule)
- 3) Projective Tests (e.g., Rorschach, TAT)

c) Social Tests

- 1) Direct Observations.
- 2) Bales Interaction Process Analysis.
- 3) Ranking Scales.
- 4) Interpersonal Projection Test.

RESULTS

1) Physical and physiological stressors are

- a) weightlessness
- b) circadian rhythms
- c) hypodynamia

2) Psychological and social stressors are

- a) low sensory input
- b) lack of motivation
- c) confinement
- d) isolation
- e) monotony
- f) free time
- g) unconscious conflicts
- h) blocked drives
- i) dangers and emergencies
- j) interpersonal relationships
- k) crew size
- l) crew structure

3) Weightlessness can cause

- a) physiological problems
- b) some visual disorientation
- c) irritability
- d) nervousness
- e) increased hostility

4) Disruption of circadian rhythm periodicities affects

- a) sleep cycles
(difficulty sleeping)
- b) work cycles
- c) performance
(produces variations)

5) Hypodynamia results in

- a) poor time estimates
- b) irritability
- c) negative behavior
- d) headaches, nausea and dizziness
- e) such physiological effects as:

- 1) weight loss
- 2) muscle atrophy
- 3) joint pains
- 4) cardiovascular difficulties

- f) inability to think
- g) depression

6) Low sensory input can cause

- a) apathy
- b) restlessness
- c) tension, anger
- d) anxiety
- e) auditory and visual hallucinations
- f) distorted time-sense
- g) depersonalization
- h) defects of body image
- i) perceptual difficulties
- j) inability to concentrate
- k) a preoccupation with food and sex

These studies were performed mostly with individuals, but were felt to be pertinent to groups on a mission to Mars.

The author concludes that the conditions on a mission to Mars will not be quite so severe due to the addition of a buddy, the duty of monitoring instruments, and other various activities that astronauts have to perform.

7) In Antarctic confinement, isolation and monotony caused

- a) disruption of sleep
- b) apathy
- c) tenseness
- d) restlessness
- e) complaining
- f) irritableness
- g) mistrust
- h) uncooperativeness

8) In the Antarctic, monotony and boredom resulted in

- a) widespread daydreaming
- b) sensitivity
- c) desire for a change
- d) erroneous interpretation of familiar sounds
- e) a tendency to choose those physically remote as companions for a future trip

9) In submarine studies it was found that

- a) psychomotor efficiency coordination decreased slightly
- b) psychological problems such as anxiety, depression, insomnia, and headaches occurred frequently

10) In space simulation studies it has been found that

- a) tension existed between the men but they usually used displacement
- b) minor perceptual problems appeared
- c) monotony increased fantasy, reading or cat-napping
- d) boredom produced some decrement in performance
- e) fatigue increased

11) Generalizations concerning confinement, isolation and monotony

- a) interpersonal stresses developed
- b) three stages in this order seemed to develop:

- 1) anxiety
- 2) depression
- 3) anticipation

c) high levels of arousal (noise) or low levels (sleep deprivation) caused performance decrement

12) Sociological stresses

- a) small groups restrict interpersonal contacts and produce tension more than large groups
- b) if the informal structure deviates too far from the formal one, stress will develop
- c) lack of social role (father) may produce stress

13) Personality traits that are important in selecting crew for long-duration space flights are

- a) youth
- b) single
- c) good family history
- d) few diseases
- e) no serious injuries or stresses
- f) college education
- g) good at manual dexterity
- h) active life
- i) healthy home life
- j) extreme moderation in the use of alcohol and tobacco
- k) good appetite
- l) normal sleep patterns

CONCLUSIONS

On a long-duration space mission, the three important stressors that the crew will have to deal with are:

confinement
isolation
monotony

The literature on Antarctic, submarine, and space simulation studies shows that behavioral, interpersonal, and psychiatric problems occur more frequently when these stressors are present than when they are not. But performance levels remain high enough to complete the mission if the men are so motivated. Reaction to isolation seems to follow three stages:

- 1) heightened anxiety
- 2) depression
- 3) anticipation

The final stage is particularly important for long space missions because of the presence of hostility, a decrement in performance, and adolescent behavior, which would interfere with required performance. Monitoring instruments and improperly used leisure time contribute to the problem of monotony, but this can be alleviated through such things as:

short work/rest schedules
improved selection of personnel based on personality variables
varying sensory input
inclusion of practical activity aboard a space mission such as music, reading, etc.

REFERENCES

- KANAS, N.A., and W.E. FEDDERSON. 1971.
Behavioral, psychiatric, and sociological problems of long-duration space
missions.
Manned Spacecraft Center, Houston, Texas. 90 pages.
[NASA TM X-58067]

PURPOSE

- a) To summarize the literature on the experimental investigation of problem solving by small groups.
- b) To consider a broad range of factors which are known to affect group processes and to examine them as they relate to group problem solving.

REVIEW OF STUDIES

EXPERIMENTAL COMPARISONS OF INDIVIDUAL AND GROUP PROBLEM SOLVING

- a) It appears that a variety of factors may affect the group product and account for its unique character as compared with a simple pooling of individuals.
- b) These factors can be analyzed in terms of whether they affect:
 - 1) The individual solutions, judgments, opinions, etc. which are available to be combined into the group product.
 - 2) The actual combination or voting process in which individual contributions are "weighted" in some way to determine the final group outcome.

SOME SPECIFIC FACTORS AFFECTING GROUP SOLUTIONS

As compared with working alone, working before a passive audience or with other persons at the same task seems to have the following effects:

- 1) Greater quantity of work where physical outputs are involved, suggesting increased motivation to perform the task.
- 2) Lesser quantity or quality of work where intellectual processes or concentration are involved, suggesting that social stimuli are able to compete successfully with task stimuli.
- 3) Inhibition of responses and qualitative changes in work, which suggest that the person somehow "takes account" of others as he goes about his work.
- 4) Greater variations through time in his output, indicating the presence of periodic distractions and/or the effects of working under greater tension.
- 5) Evidence that these effects wear off as the person adapts to the social situation.

INDIVIDUAL MOTIVES IN RELATION TO GROUP GOALS

- a) The interdependent relationship in which cooperation is rewarded seems to lead to strong motivation to complete the common task and to the development of considerable friendship among the members.
- b) Group decision studies suggest that member acceptance of group goals is heightened by a goal setting procedure involving discussion and participation in selecting the goal.

TYPE OF TASK

Deutsch found a higher volume of interaction and greater attentiveness to one another's contributions on the human relations problem than on the puzzle problem, presumably because the solution to the former depended on consensus.

GROUP SIZE

The available investigations of group size and participation suggest that as size increases, the most active member becomes increasingly differentiated from the rest of the group, who become increasingly similar to one another in their participation output.

GROUP RELATIONS FACTORS

- a) Friendship among members.
- b) Communication.
- c) Group standards.
- d) Group majority.
- e) Treatment of deviates.
- f) Initial attitudes.
- g) Status differences.
- h) Leadership.

REFERENCES

- Kelley, H.H., and J.W. Thibaut. 1954.
Experimental studies of group problem solving and process. Chapter 21.
In: G. Lindzey, ed. Handbook of Social Psychology, Vol. II. Addison-Wesley
Publishing Company, Cambridge, Massachusetts. pp. 735-785.

PURPOSE

To review general principles which are applicable to habitability of space vehicles.

REVIEW OF STUDIES

- a) Problems of habitability develop from habitat-tenant interactions.
- b) As applied to spaceflight, proposed changes in the spacecraft or in the astronaut are subject to well-defined constraints of technological capability and human tolerances.
- c) The spacecraft-astronaut interaction is compounded by a number of stresses rarely or never experienced by man before.
- d) Habitability requirements vary, depending in the main on the goals and purposes of the spaceflight.
- e) Considered globally, habitability involves four basic types of components: physical, physiological, psychological and social.
- f) A system is considered habitable if man can function as man within its environmental confines. Whatever the goal of a space mission may be, the primary objective is to preserve man's integrity and his dignity.

REFERENCES

- KUBIS, J.F. 1967.
Habitability: General principles and applications to space vehicles.
In: H. Bjurstedt, ed. Proceedings of the 2nd International Symposium on Basic Environmental Problems of Man in Space, Paris, France, June 14-18, 1965. Springer-Verlag, Vienna. pp. 399-427.

PURPOSE

To point out the importance of research and information pertaining to small group interaction under conditions of confinement and isolation.

RESULTS

Experience in the Arctic, in the Antarctic and on submarines submerged for long periods of time has shown that:

- a) Isolation is a much more significant stress factor than extreme cold or any other adverse environment.
- b) Lack of sensory stimuli sometimes causes disturbances akin to insanity which are generally of a temporary nature.
- c) Inactivity for long periods is demoralizing.
- d) An area providing privacy for the individual is important.
- e) A cardinal point in controlling stress in a group is to provide relief goals.

CONCLUSIONS/RECOMMENDATIONS

- a) Problems and solutions can be identified by studying the composition of groups, living conditions, communications, and motivation.
- b) A high level of training as a group is invaluable.
- c) Psychiatric selection methods are effective in eliminating men who might experience severe emotional or mental disturbances during isolation.
- d) Capable leadership can prevent stress from reaching the danger zone.
- e) This research is needed because future weapon systems will involve small groups of men operating for extensive periods of time under conditions of both social and geographic isolation.

REFERENCES

- LEVINE, A.S. 1965.
Prolonged isolation and confinement.
Navy - The Magazine of Sea Power 8(1):26-28, 44-45.

PURPOSE

- a) To review a number of studies in the area of habitability.
- b) To extract from these studies findings which are relevant to any long-term mission in confinement.

CONFINEMENTS REVIEWED

- a) Underwater (Tektite, Sealab etc.)
- b) Spaceflight.

REVIEW OF STUDIES

HABITABILITY - Definition

- a) Fraser (1968) - Habitability describes the qualities of an environment with respect to the acceptability of that environment for man.
- b) Johnson (1969) - The major elements of habitability are: 1) the environment (noise levels, lighting, temperature, etc); 2) architecture; 3) mobility, restraint and equipment handling; 4) food, its storage, preparation, serving, eating arrangements, and facilities; 5) clothing and personal accouterments; 6) personal hygiene; 7) housekeeping; 8) communication; 9) off-duty activity provisions.
- c) Habitability depends on the interaction between the individual and the environment.

PHYSICAL FACTORS

- a) The necessary crew volume requirements for long term missions have been established in earth-bound spacecraft simulations at from 350 to 700 cubic feet, but this requirement appears to be reduced by conditions of weightlessness.
- b) Space should be provided for mission related tasks, vehicle management, bio-medical support, storage areas, rest and off-duty time, dining and food management, personal hygiene, and privacy and territorial needs, but some of these areas may overlap.
- c) Provisions should be made for mobility and restraint devices, suitable garments, light intensity and color, and noise control.

CREW STRUCTURE

The presently used military structure seems to be an effective and acceptable method of crew structure.

FOOD PREPARATION

- a) Weber and Gatts (1969) - provided an excellent review of the considerations in developing a food service program for long missions. Concepts must be developed for cooking and baking equipment, so food will be as attractive and palatable as possible.
- b) Preparation of food underwater presented some unique problems:
 - 1) Frying of food is prohibited because of the release of acrolein.
 - 2) Certain foods such as toast, when burned, release CO which, even in small concentrations, at high pressures can cause severe problems.

LEISURE TIME ACTIVITIESa) Eberhard - summary of activity findings:

- 1) Men in confinement prefer work to free time.
- 2) There is a higher incidence of abnormal symptoms among men in confinement without adequate work opportunities than with those who have such opportunities.
- 3) Discretionary activities should depend upon the free choice of each crewmember.
- 4) Confined individuals create some free time activities of their own.
- 5) Off-duty time and activity patterns of isolated groups differ from those of the general population; furthermore, the activity patterns of the individuals in confinement change over time.
- 6) Talking, reading fiction, watching movies, and television are the most frequently performed activities by confined groups.
- 7) Men in confinement take almost twice as long to eat as men in the general population.
- 8) Exercise was a necessary but infrequently performed activity for all of the adults studied.
- 9) Interest in educational activities is highly individualistic; however, it is generally sought infrequently.
- 10) Individuals who regularly use religion, or those who do not, adjust best to confinement.
- 11) Activities such as painting, playing cards, chess and checkers, are relatively infrequently mentioned by most of the individuals studied.
- 12) Recreational facilities have historically been the source of significant morale problems for confined groups.

CONCLUSIONS

- a) The crews involved in both space and undersea missions have been extremely work-oriented and have shown little inclination for any other activity, with the exception of sleep and self-maintenance. However, as mission lengths increase, so will the need for adequate leisure time activities.
- b) Certain behavioral patterns among the crew in relation to mission support personnel have become evident during both space and undersea missions.
- c) When provisions for personal needs, such as food preparation, waste management, hygiene, maintenance, warmth and privacy, fail to meet expected standards, they can become a cause of morale decline and performance degradation.

REFERENCES

- PARKER, J.F., Jr., and M.G. EVERY. 1972
 Habitability issues in long duration undersea and space missions.
 BioTechnology, Inc., Falls Church, Virginia 52 pages.

PURPOSE

The present effort involves a focused review of a selected group of problems that are believed to be peculiarly important under conditions of isolation and confinement, with particular interest in principles that have demonstrated effectiveness in the mitigation and management of these problems across situations.

REVIEW OF STUDIES

SOCIAL DISTANCE

- a)Fitzgerald 1963 - found that self disclosure, as a dimension of social distance could be used to determine how close one person felt to another.
- b)Taft 1958 - investigated differences between high, intermediate, and low tolerance subjects. Intolerant subjects appeared to be more pessimistic, ego-defensive and extrapunitive rather than impulsive. Tolerant subjects did not dwell on frustrating obstacles. They were ego-defensive as was the intolerant group but were more forgiving.
- c)Photiadis and Begger 1962 - found that church participation was negatively correlated with social distance, whereas orthodoxy and extrinsic belief were not related.
- d)Rao 1960 - found that the correlation between radicalism and "tough mindedness" was .39; between radicalism and social distance, .03; and between "tough mindedness" and social distance, .42.

SOURCES OF SOCIAL DISTANCE

- a)Banton 1960 -
Social distance:
 - 1)Resulted from person's negative attitude.
 - 2)Reflected a lack of common interests and experiences.
 - 3)Was characteristic of certain types of social relationships.
 - 4)Was caused by self interest.

RELEVANCE TO LONG-DURATION SPACE FLIGHT

- a)Social distance measures could seemingly be utilized to optimize interpersonal relations and maximize group effectiveness in a variety of ways.
- b)Taro 1960 - concluded that the behavior of the leader is the most important factor in unit morale and effectiveness among isolated and confined groups.

IMPLICATIONS OF PERSONAL SPACE FOR LONG-DURATION SPACE FLIGHT

- a)Pollack and Kiev 1963 - individual's modification in shape, area, or penetrability of personal space has been utilized as an index of his present clinical state.
- b)Man's utilization of space appeared neither meaningless nor random, for spatial behavior has been shown to represent a means of communication as well as a modifier of behavior.

- c) A large portion of the literature centered around two inquiries: (1) what factors directly influence personal space, and (2) what reactions occur to invasions of personal space?

INTERPERSONAL ATTRACTION

- a) Haythorn and Altman 1967 - indicated that under conditions of isolation, good interpersonal relations were important to group productivity and effectiveness.
- b) Wilkins 1967 - reported that in studies of groups in the Antarctic, interpersonal relationships occurred mainly between work partners; and, as smaller groups were investigated, the number of men chosen as off-duty associates also became smaller.
- c) Isolation studies have shown that as length of time in isolation increased group cohesiveness decreased and then showed a sharp increase toward the end of the mission.
- d) Similarity of attitude was an important factor in determining interpersonal attraction.

CONFLICT AND CONFLICT RESOLUTION

- a) The following represent the constructive range of functions served by conflict:
- 1) Conflict results in the establishment of group norms.
 - 2) Conflict clarifies objectives.
 - 3) Conflict sets group boundaries by strengthening group cohesiveness and separateness.
 - 4) Without conflict, accommodative relations would result in subordination rather than argument.
 - 5) Conflict reduces tension and permits maintenance of social interaction under stress.
- b) Theodorson 1962 - found that conflict in such groups may lead to either cohesion or disintegration.
- c) Kinds of conflict:
- 1) Substantive and affective conflict.
 - 2) Conflict of interest and conflict of values or belief.
- d) Altman and Haythorn 1965-1967 - found that interpersonal compatibility within dyads was an important dimension of behavior in isolation.
- e) Shepard 1963 - posed four means of resolving conflicts:
- 1) Suppression.
 - 2) War.
 - 3) Limited war.
 - 4) Bargaining.
- f) Douglas 1962 - analyzed psychologically the interaction of bargainers and mediator. Three stages in the mediation process were identified:
- 1) Establishing the range.
 - 2) Reconnoitering the range.
 - 3) Decision - reading crises.

CONCLUSIONS

SOCIAL DISTANCE

It seems likely that social distance measures provide insights related to the optimization of interpersonal relationships through selection, crew composition, leadership style, group structure, spatial arrangement, crew scheduling, and capsule design.

PERSONAL SPACE

Of paramount importance at this stage of development is the need for studies of personal space variables as they are related to conditions of isolation and confinement.

INTERPERSONAL ATTRACTION

It seems that interpersonal attraction between members of the space crew would be expected to lead to greater group unity and, consequently, to less interpersonal conflict.

CONFLICT

a) A number of group composition factors are associated with low incidence of conflict (e.g., proficiency in group activities, interpersonal compatibility, etc.).

b) Selection of the group should be on the basis of mutual attraction and common interest, attitudes, and goals, rather than on the individual's psychological profile per se.

REFERENCES

- RAWLS, J.R., C.N. MCGAFFEY, R.E. TREGO, and S.B. SELLS. 1968.
Some determiners of interpersonal climate in relation to long-duration space missions: A review of constructs and research.
Institute of Behavioral Research, Texas Christian University, Fort Worth, Texas. 72 pages.

PURPOSE

- a) To review the effects of polar isolation and submarine habitability as received in 12 pieces of literature.
- b) To apply social and psychological material to living in a fallout shelter.

CONFINEMENT REVIEWED

First study: polar isolation
Second study: submarine

VARIABLES STUDIED

- a) Anxiety
- b) Boredom

RESULTS

POLAR ISOLATION

- a) Persons exhibited psychiatric symptoms to which they were predisposed.
- b) For some, increased anxiety resulted in aggression.
- c) If there was a need for aid, anxiety motivation might have been channeled to this goal.
- d) The effect of anxiety plus impersonality of a large group might lead to nuclear formal organization.
- e) Increased anxiety resulted in headaches and sleeplessness.

SUBMARINE STUDIES

- a) Anxiety was greatest when the subjects entered isolation.
- b) There was a desire for communication with the outside world.
- c) Social irritation was caused by:
 - humidity
 - temperature
 - ventilation inadequacies.
- d) The attractiveness of food affected the group tolerance of isolation.
- e) There was a greater amount of sleeping done in isolation.
- f) Diversity for leisure time was required.
- g) Anxiety was relieved through activity.

CONCLUSIONS

The author suggests that initial anxiety could be reduced by subjecting persons to functionally oriented and meaningful tasks, like "do-it-yourself kits." Two-way radio equipment relieves anxiety. Food should be attractive and environmental conditions should be pleasant.

REFERENCES

- ROHRER, H.H. 1960.
 Implications for fallout shelter living from studies of submarine habitability and adjustment to polar isolation.
 In: G.W. Baker, and J.H. Rohrer, eds. Human Problems in the Utilization of Fallout Shelters. National Academy of Sciences, Washington, D.C. pp. 21-30. [Disaster Study No. 12]

PURPOSE

To review each underwater study briefly in an attempt to predict future development in underwater exploration.

CONFINEMENTS REVIEWED

- a) Genesis I, II.
- b) Sealab, I, II.
- c) Conshelf I, II and III.
- d) Man in the Sea I and II.

REVIEW OF STUDIES

GENESIS I

- a) Experiments conducted in 1962 evaluated the effects of three different gas mixtures on animals.
- b) As a result of this series of experiments it was concluded that man could probably be exposed to a breathing mixture of 97% He and 3% O₂ at a pressure equivalent to 200 feet of sea water for prolonged periods of time without developing any deleterious effects.

GENESIS II

- a) In 1962-1963 experiments on men conducted in a recompression chamber at ambient pressure and at a simulated 100 and 200 feet of sea water depth pressure.
- b) One hundred physiological and psychological tests were performed daily on each subject. Only stress indicators were outside normal limits, due to the hazardous situation.

SEALAB I

In this study four men lived and worked at a depth of 192 feet for 11 days.

SEALAB II

Bond performed a field experiment in 1965 in which three groups of 10 men each descended to an underwater lab 205 feet below the ocean surface for consecutive periods of 15 days. Also, one man stayed submerged for the first 30 days.

CONSHELF I

- a) In a 1962 experiment conducted by Cousteau, two men spent 1 week under 33 ft. of water breathing compressed air.
- b) Physically and subjectively the men suffered no harmful effects from their excursions into the sea. No decompression was needed.

CONSHELF II

- a) In a 1963 study directed by Cousteau, five men lived for a month at 36 feet underwater and two additional men lived 1 week at 90 feet before returning to the house at 36 feet. The two additional men breathed a mixture of air plus helium while at the depth of 90 feet.
- b) No harmful effects from exposure were found.

CONSHSELF III

- a) Six men remained at a depth of 370 feet for a period of 3 weeks in a study conducted by Cousteau.
- b) The men did not suffer any injuries or physical damage from the dive.

MAN IN THE SEA, PHASE I

- a) In this study, a man spent about 24 hours at a depth of 200 ft. breathing a mixture of 97% He and 3% O₂.
- b) Link estimated that it should normally require only 16-18 hours decompression from prolonged exposure to the pressure at 200 feet below the surface and 18 to 24 hours at 400 feet.

MAN IN THE SEA II

- a) In a 1964 test conducted by Link, two men lived 2 days at a depth of 432 feet breathing 3.6% oxygen, 5.6% nitrogen, and 90.8% helium.
- b) They did not suffer any apparent harmful effects.

REFERENCES

- SCHULTE, J.H. 1967
Medical aspects of sustained underwater exploration.
Archives of Environmental Health 14:333-336.

PURPOSE

To review the results of various studies on the effects of confinement in a very specific and monotonous sensory environment on an individual alone or with small groups of people.

CONFINEMENTS REVIEWED

- a) Antarctic
- b) Submarine
- c) Fallout shelters
- d) Prison
- e) Lab experiments

REVIEW OF STUDIES

- I. HAYTHORN, ALTMAN and MYERS. (1965)
Study of subjects confined to a small room.
The purpose of this study was to attempt to match the personalities of pairs of men in order to facilitate their adaption to isolation.

Variables: 1. Composition of group
 - a. need dominance
 - b. need achievement
 - c. need affiliation2. Stress

Results: 1. A persisting emotional decrement was noted
2. Two of nine pairs terminated before the end of the period of confinement
3. There were serious outbreaks of hostility toward each other
4. The composition of the isolated pairs was a significant determinant of subjective response to the stress of confinement
- II. TAYLOR. Prison Study. (1961)
The purpose of this study was to determine if personality deterioration is an effect of imprisonment.

Variables: 1. Personality deterioration
2. Cognitive efficiency
3. Motivation

Results: 1. Deterioration was not evident
2. Perhaps deterioration begins with cognitive function and then spreads to a change of attitude, outlook, motivation, and emotional orientation

III. RUFF, LEVY, and THALER. (1959)
Study of subjects confined to a small compartment.

Variables: 1. Behavior
2. Physiological effects
3. Objective and projective tests

Results: 1. A positive attitude toward each other was maintained
2. A trend toward regressive behavior was noted
3. Ego impairment occurred
4. Subjects were capable of more mature and flexible handling of certain conflict areas
5. Hostility was suppressed or denied

IV. GUNDERSON and NELSON. (1963)
Measured emotional reactions of scientists and naval personnel who experienced prolonged social isolation at stations in the Antarctic.

Variables: 1. Somatic symptoms
2. Emotional symptoms
3. Size of group
4. Satisfaction with Antarctic life
5. Affective and work relationships

Results: 1. Sleep disturbances
2. Depression
3. Headaches
4. Irritation
5. Sore muscles
6. An increased incidence over time of symptoms
7. Decline in
 a. work satisfaction
 b. social relationships
 c. group accomplishments
8. Size of groups have no relation to somatic and emotional symptoms

V. MULLIN. (1960)
Study was based on interviews of 85 scientific and Naval personnel, conducted at American Antarctic stations.

Variables: 1. Individual adjustment to the group
2. Sameness of the environment
3. Absence of usual sources of gratification

Results: 1. Headaches
2. Insomnia
3. Horseplay, loud complaining, and swearing
4. Lack of intellectual energy
5. Tension

VI. ROHRER. (1960)
A review of submarine habitability and adjustment to polar isolation.

Variables: 1. Size of group
2. Length of stay

Results: 1. Three phases of adjustment to polar isolation
 a. anxiety
 b. depression
 c. decrease in depression
2. Submarine habitability also revealed an initial anxiety
3. The larger the group, the fewer the disturbances

VII. ALTMAN, SMITH, MYERS, MCKENNA, and BRYSON. Fallout shelters. (1960)

- Variables: 1. Temperature (varied)
2. Presence or absence of a trained leader

- Results: 1. No serious psychological or social stress appeared
2. Trained leaders seemed to be beneficial, but not necessary
3. Emotional agitation and tension were high at start and end of confinement
4. A high degree of group cohesiveness was maintained

VIII. RASMUSSEN. Fallout shelters. (1963)

- Variables: 1. Psychologic discomforts

- Results: 1. Leading source of discomfort was lack of water for washing
2. The winter test revealed complaints about food
3. The summer test revealed numerous complaints about the temperature

CONCLUSIONS

a) The presence of other people in a small isolated group may provide meaningful and varied stimulation for a time, but prolonged confinement can minimize even this source of varied sensory input and result in a monotonous environment.

b) General effects of isolation:

1. Emotional impairment occurs
2. Not all groups show adverse effects to isolation
3. Intellectual functions might be impaired slightly

REFERENCES

- SCHULTZ, D.P. 1965.
Effects of social isolation. Chapter VIII.
In: D.P. Schultz. Sensory Restriction: Effects on Behavior. Academic Press, New York. pp. 147-167.

PURPOSE

A preliminary attempt has been made to compare the social system of the extended duration space ship with other types of social systems in order to obtain background material for further studies. The objective of this study was to define a set of criteria to determine the relevance of data obtained in various situations to the problems of isolation associated with spacecraft.

REVIEW OF THE STUDY

- a) A set of characteristics to be considered in an isolated social system was established. They fell into seven general categories: objectives and goals; value systems; personnel composition; organization; technology; physical environment; and temporal characteristics. A total of 56 variables were classified under these general headings.
- b) Eleven social systems, each involving isolation, confinement, and/or stress to a high degree, were selected for study.
- c) Conditions of the 11 systems were compared to the conditions of an extended duration space mission according to the 56 characteristics referred to above. Similarity was designated by a three-point scale: two (highly similar to extended duration space ship situation), one (moderately similar), and zero (dissimilar).
- d) The order of similarity from highest to lowest was submarines, exploration parties and expeditions, Naval ships, bomber crews, remote stations, POW groups, professional athletic teams, mental hospital wards, prison society, industrial work groups, and shipwrecks.

CONCLUSIONS

- a) Because of the similarity of the social systems on submarines, exploration parties and Naval ships to that of the extended duration space ship, profitable historical studies of literature concerning these areas has been undertaken.
- b) Significant research problems to the study of isolation and confinement in space include: the social system model; research design and methodology; astronaut selection and crew composition; authority; stress; training and preparation; motivation; privacy, personal possessions, personal space, and considerations of territoriality; conflict arousal and resolution; and communication.

REFERENCES

- SELLS, S.B. 1966.
A model for the social system for the multiman extended duration space ship. *Aerospace Medicine* 37(11):1130-1135.
- SELLS, S.B. 1971.
Capsule society - new problems for man in space on long-duration missions. In: *Biotechnology* (Proceedings of a conference held at Blacksburg, Virginia, August 14-18, 1967). National Aeronautics and Space Administration, Washington, D.C. pp. 221-233.

PURPOSE

To review literature dealing with the effects of isolation on man's performance.

CONFINEMENTS REVIEWED

- a) Submarines.
- b) Arctic.
- c) Antarctic.
- d) Penthouse.
- e) Other isolated situations.

REVIEW OF STUDIES

THE NATURE OF ISOLATION

- a) The forms of isolation were generally distinguished as being social isolation, confinement, and sensory restriction.
- b) The circumstances of isolation structure the significance of the situation to the individual. The factors defining these circumstances can be broken down in terms of motivation, goal orientation, preparation, duration, confinement, treatment, social condition, support conditions, and environmental variability.

EFFECTS OF ISOLATION

- a) Social deprivation is a source of stress to the individual to the extent that it calls for modes of personal problem solving that are not available and for which suitable alternatives cannot be found.
- b) The major issues for space mission planners are: 1) to select personnel least vulnerable to stress from social deprivation; 2) to program crew composition and on-board work and living experiences to provide maximal compensatory support for social needs of the crew.
- c) Haythorn has emphasized the importance of compatible personalities in the limited social situation and has made a significant start in the quantitative study of the problem.
- d) Gunderson reported that men with high affectional needs experienced problems with wintering-over situations in the Antarctic confinement.

EFFECT OF CONFINEMENT

- a) 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, presents numerous problems in relation to personal conduct, interpersonal interaction, leadership, organization, and group management.
- b) Haythorn has observed a speeding up of the acquaintance process, marked by an accelerated rate of interpersonal information exchange.
- c) Tendency to withdraw is a reasonable alternative and leads to breakdown of communication.

d) Isolated subjects in the UCLA Penthouse experiment actually staked out areas of exclusion from others and acted with marked hostility toward trespassers.

e) Mullin recorded observations frequently mentioned in the literature:

1) Group and individual tensions and irritations are ever present. The most important lesson a member can learn is he cannot afford to alienate himself from the group support.

2) A mechanism of displacement of hostility frequently observed is the tendency to direct anger, scorn, toward external competitors and superior authorities.

EFFECT OF SENSORY DEPRIVATION

a) The problem appears rather to involve "the same faces, the same surroundings, the same routines" over and over, accompanied by minimal physical mobility and activity.

b) Even a moderate amount of monotony can result in profound psychological effects.

MITIGATION MEASURES

a) Attention must be directed to the requirements of the on-board social system to provide a systematic and internally consistent framework for planning.

b) It appears that whatever produces greater crew competence, compatibility, and cohesiveness would also contribute to greater resistance to isolation effects.

CONCLUSIONS

a) In terms of military applications, until strong scientifically developed arguments for another approach can be offered, the recommendation is to follow the traditional pattern of leadership and social organization.

b) In the areas of crew control and interpersonal behavior, individual beliefs, traditions of service, and idiosyncratic preferences must be respected.

c) Significant contributions can be expected in planning and designing an amazingly comfortable and efficient habitation within which groups of 5-15 men could live and work on long duration space missions.

REFERENCES

- SELLS, S.B., and J.R. RAWLS. 1968.
Effects of isolation on man's performance
In: W.B. Cassidy, ed. American Astronautical Society Science and Technology Series. Volume 20: Bioengineering and Cabin Ecology, American Astronautical Society, Tarzana, California. pp. 89-116.

PURPOSE

To glean useful facts and hypotheses and avoid unsubstantiated over-generalizations and careless conclusions from the literature on small groups in confinement.

CONFINEMENTS

- a) Controlled laboratory isolated group experiments.
- b) Isolated duty stations in the Antarctic and Arctic.
- c) Submarine - service habitability and situation studies.
- d) Experiments in fallout shelter occupancy.
- e) Space-system tests and other aerospace assessments.
- f) Manned space flight.
- g) Experiments in man-in-the-sea.
- h) Various reports of expeditions and explorations.
- i) Accounts of sea voyages and disasters.

REVIEW OF STUDIES

I. Group Behavior

A. Interpersonal Stresses

- 1. Overt or covert interpersonal frictions frequently occur.
- 2. Evidence of pronounced irritability, hostility, and personality conflicts.
- 3. Interpersonal compatibility more important in very confined groups than in groups working in more enriched environments.
- 4. A carefully selected group, well constituted in regard to compatibility, will likely avoid serious personal problems and conflicts.

B. Group Interaction

- 1. Communication and other interactive activities decline with time.
- 2. Territoriality and privacy needs increase with time.

C. Relationship with the Outside World

- 1. Loss in performance feedback and consensual validation from outside sources has been observed.
- 2. Meaningfulness and influences of society will probably diminish during lengthy periods of isolation.
- 3. Displayed aggression and hostility often are directed at people or objects external to the group.
- 4. Functioning of isolated groups was influenced by loss of information about outside events and the lack of important feedback from outside sources.
- 5. Isolation and confinement seemed to foster a resentment for rules and regulations, and an unawareness of any need for legal structure or self-government.

II. Reactions to Confinement and Isolation

A. Boredom and Monotony

- 1. Results in widespread daydreaming and intense desire for a change.
- 2. Particularly noticeable after task program has been learned well enough for it to become routine.

B. Motivation and Morale

- 1. Highly motivated groups appear to endure isolation without serious problems, but this is time dependent.

2. Motivational drops were shown to be caused by poor leadership and conflicts between the subjects and outside agents.
3. There was a significant decline in personal motivation and hence group morale, but accompaniment with any performance decrement has not been reported.
4. The height of morale was shown to be an inverse function of imposed regimentation in one study.

C. Annoyances

1. Limited facilities for personal care
2. Monotonous diet; food annoyances
3. Crowded conditions
4. Behavior of others
5. Boredom
6. Internal friction and relations with staff
7. Resentment over rules
8. Sleeping problems
9. Odors and noise
10. Temperature and humidity

D. Symptomatology

1. An increase in emotional disturbances and symptomatic complaints during prolonged isolation were shown in spite of living condition improvement.
2. Symptomatology usually became apparent after an initial period of confinement and may lessen just before termination.
3. Symptomatic complaints were observed as follows:
 - a. headaches
 - b. nausea
 - c. sleeplessness
 - d. depression
 - e. mood declines
 - f. occasional compulsive behavior
 - g. occasional psychomotor problems

III. Performance Data

A. Intellectual Functioning

1. There was very little evidence of serious shifts over time in intellectual functioning in short and medium term confinement and isolation.
2. There was no test evidence to confirm the decrements that so many persons feel really exist.

B. Perceptual and Motor Skills

1. Members of isolated groups generally seem to be able to maintain their abilities, and only a few instances of skill decrements were reported.
2. Experiments in longer periods of confinement may not hold when participation is more commonplace and routinized.

IV. Physiological and Biochemical Changes

A. In isolated groups, changes can result from:

1. Unresolved conflict and tension
2. Environmental stresses

B. In prolonged durations boredom may contribute to a lowered physiological state.

V. Individual Differences and Selection

A. Individual traits related to successful performance and adjustment are:

1. Work motivation
2. Emotional Stability
3. Social compatibility

B. Well Adjusted

1. Conscientious
2. Responsible
3. Accepts authority

C. Poorly Adjusted

1. Complaining
2. Fearful

3. Marginally concerned about work
4. Greater aggression
5. Less orderliness

D. Screening criteria and predictors which have been reported to be useful:

1. Consideration of past personal effectiveness and adequacy of adjustment to prior duty station.
2. Technical competition of the individual in regard to the nature of the mission.
3. High appropriately directed motivation.
4. Ratings of ego strength and adequacy of defense mechanisms.
5. Detection of personality problems which might be a demoralizing influence or a source of friction.
6. Evaluation of individual in terms of the group to which he will belong.

VI. Other Variables Affecting the Success of Groups in Confinement

A. Group Maintenance

1. Efficient group organization
2. Good leadership
3. Clear definition of objectives and methods
4. Adequate training
5. Effort to maintain good morale

B. Group Size

Must be studied in relationship to severity of isolation and duration of the mission.

C. Work-Rest Cycles

D. Habitat Design

E. Others

1. Privacy
2. Cultural awareness
3. Extent of audio contact from the outside world
4. Expectation as to the duration of confinement

CONCLUSIONS

Fewer problems exist for small groups in isolation than for individuals.

Three major stresses confronting isolated groups are:

Boring sameness of activity and environment as compared to the variability usually available.

Interpersonal dependence necessitating group members to find ways to get along with one another in spite of overcrowding and unfavorable conditions.

Lack of usual sources of emotional gratification and release.

Interpersonal problems are present, particularly in lengthy confinement along with boredom due to unchanging environment.

Interpersonal problems have been shown to be more serious among incompatible groups.

Group members tend to withdraw from one another and from group activities during lengthy confinement and display increased territoriality for areas and possessions.

Aggressive hostility is frequently directed away from the group, perhaps representing useful scapegoating.

Loss of relevant feedback from parent society may be a problem during very long confinement.

Test data are lacking to substantiate many aspects of performance, intellectual effectiveness and perceptual-motor activity did not decline during short-term confinement.

Selection for participation in group confinement must include group considerations in addition to conventional individual criteria.

REFERENCES

- SMITH, S. 1969.
Studies of small groups in confinement.
In: J.P. Zubek, ed. Sensory Deprivation: Fifteen Years of Research.
Appleton-Century-Crofts, New York. pp. 374-485.

PURPOSE

- a) To discuss the role of motivation in the emotional reactions of a space traveler.
- b) To analyze the more dangerous emotional reactions caused by space travel, with a view toward their unconscious derivations.

REVIEW OF STUDIES

MOTIVATIONS

- a) Aggressive - directed toward attaining goals.
- b) Defensive - directed toward avoiding failure; it is here that the chief problems with personnel may be expected.

EMOTIONAL REACTIONS

- a) Psychological reactions to danger involve the intellect and emotions.
- b) Personnel for space travel should choose persons that are likely to employ their intellect consistently in an emergency.
- c) Every man has a breaking point.
- d) Factors that can play an important role are: physical fatigue, sleeplessness, hunger, thirst, discomfort, illness, danger, lack of a strong leader, solitude or poor morale in the group, monotony and boredom, and uncertainty in an emergency.
- e) Individuals need continuous meaningful contact with the outside world.
- f) The presence of another subject causes less serious mental aberrations.
- g) In assessing an individual's ability to withstand the stress of sensory deprivation a person's unconscious reactions should also be studied...a person might have deep seated problems that might not be revealed in psychiatric tests a candidate for space should be put through sensory deprivation experiments... if he can't stand this he should not be able to participate in space travel.
- h) During the course of space travel there should be communication constantly between astronauts and earth monitors and astronauts and family if possible.
- i) Astronauts should be given plenty of work to do.
- j) At least two men should be together to avoid inactivity, monotony and boredom.

REFERENCES

- SOLOMON, P. 1961.
Motivations and emotional reactions in early space flights.
In: B.E. Flaherty, ed. Psychophysiological Aspects of Space Flight (Symposium on Psychophysiological Aspects of Space Flight, Brooks Air Force Base, Texas, 1960). Columbia University Press, New York. pp. 272-277.

PURPOSE

- a) To review the literature on isolation, confinement, and sensory deprivation.
- b) To develop taxonomy and unifying theory relating degree of motivation to performance.

REVIEW OF STUDIES

- a) Long-duration space flight implies a certain amount of monotony, isolation, confinement, and sensory deprivation.
- b) Performance and motivation are related curvilinearly (e.g., high performance at moderate levels of motivation and low performance at both high and low levels of motivation).
- c) Interpersonal relationships in group isolation situations are related to dimensions such as duration, conditions, tasks, authority, and group status.
- d) In view of the existing literature on sensory deprivation, simple, well-learned, behaviors show the highest improvement rate, while complex, unfamiliar tasks show the highest impairment rate.

CONCLUSIONS

The relationship of motivation to both interpersonal relationships and task performance can be applied to the various facets of long-duration space flight.

REFERENCES

- SUEDFELD, P. 1968.
Isolation, confinement, and sensory deprivation.
Journal of the British Interplanetary Society 21:222-231.

PURPOSE

- a) To integrate literature on factors affecting performance of submarine crew-members during prolonged cruises.
- b) To delineate the unique, stress-inducing aspects of the submarine environment which require unique adaptation processes by each submarine crew member.
- c) To describe the psychological and psychophysiological "make-up" of the carefully selected submariner in terms of specific adaptation resources.
- d) To integrate the research findings pertaining to the changes in morbidity patterns and in psychological and physiological stress indicators observed during prolonged submergence - all as they relate to overall submarine crew effectiveness.

CONFINEMENT REVIEWED

Submarines

REVIEW OF STUDIES

STRESS-INDUCING FEATURES

- a) There is growing evidence that headaches, irritability and depression observed during protracted submergence may be the result of restricted muscular activity and stimulus invariance rather than the result of the reduced level of stimulation per se.
- b) Two other perceptual factors may affect submarine effectiveness: lateral esophoria and time perception in the direction of increased positive.
- c) Revitalized ambient atmosphere.
- d) Threat of hyperbaric and reduction exposure.
- e) Interruption of diurnal periodicity.
- f) Sustained effort, sleep deprivation and fatigue.

SUBMARINE CREW CHARACTERISTICS

- a) Input population included 4500-5800 enlisted men (18.5 yrs. average age) and 320-450 officers (22 yrs. average age).
- b) Test score cutoffs for the Arithmetic and Mechanical Aptitude Tests were set at or about 75th percentile for the Navy as a whole.
- c) All men volunteered for submarine service.
- d) Psychiatric screening criteria use was the Personal Inventory Barometer (PIB), which provides an emotional stability score and a depression score.

INDICES OF SUBMARINER EFFECTIVENESS

- a) Vigilance - the significance of the problem appears to have been recognized but the results appear to be equivocal as to the severity of the effects of long exposure to these conditions.

b) Psychological performance:

1)Faucett and Newman 1953 - suggested that the observed decrements in performance may have been due to deteriorating motivation rather than to any direct effect on the experimental conditions upon psychomotor processes.

2)Johnson 1971 - following a brief learning period the curve of mean scores plotted by week submerged reached a plateau, holding consistent or at least showing no decrement, for the duration of the 8-week missions.

3)Wilken 1969 - in a study involving 360 FBM patrols, 192 psychiatric cases were reported, 136 of which were described as anxiety reactions, resulting in 69 sick days, most of which were accrued by one man.

CONCLUSIONS

The optimal quality of the submariners' adjustment results from first, the comprehensiveness of the medical and psychiatric screening procedures designed to identify poor adjustment risks for the service. Secondly, motivation patterns must be tied to the selection procedure.

REFERENCES

- WEYBREW, B.B. 1971.
Submarine crew effectiveness during submerged missions of sixty or more days' duration.
U.S. Naval Submarine Medical Center, Submarine Base, Groton, Connecticut.
22 pages.
[Report No. 686]

PURPOSE

To identify and delineate the most important areas of submarine psychology which will formulate a theoretical model for future research in applied psychology.

REVIEW OF STUDIES

TIME PERCEPTION IN SUBMARINES

- a) Underestimation of task-filled intervals.
- b) Overestimation of void intervals. Individual differences in time estimation may be predictive of adjustment to submergence.

SOCIAL MOTIVATION

- a) Behavior directed toward satisfying needs for status, affiliation and prestige.
- b) Slightly motivated by desire to be with "good fellows", "better class of men", etc.

CONFORMITY MOTIVATION

Willingness to take orders from superiors is a trait of most officers and enlisted men.

ROLE BEHAVIOR AND GROUP STRUCTURE

- a) Group cohesiveness is a function of role behavior ascribed to the group.
- b) Crew members whose roles are clearly delineated maintain more favorable attitudes during submergence.
- c) Low discrepancy between self-perceived roles and ascribed roles correlate highly with high group morale and leadership.

LEADERSHIP

- a) Crew morale is related to leader's ability to delegate authority and the number of personal contacts with other officers and men.
- b) Successful leadership is characterized by factors relating to:
 - 1) Drive.
 - 2) Aptitude for submarine service.
 - 3) Stable career orientation.
- c) Leader's preference for members of group is transparent to group members themselves.

VIGILANCE

- a) Tendencies toward the following were noted:
 - 1) Reduced alertness.
 - 2) Inability to concentrate.
 - 3) Reduction in excitation level as cruise progressed.

- b) Daily measures of critical flicker frequency thresholds indicated no significant change in visual sensitivity.
- c) Perceptual spans for numbers and letters showed no decrement.
- d) Monotony was coincident with reduced excitement level and consequently lowered vigilance.

PSYCHOMOTOR PERFORMANCE

- a) Any decline is probably due to deteriorating motivation rather than any direct effect on psychomotor processes.
- b) Trend toward increased muscular tension during cruise has not been shown to be related to performance.

SUBJECTIVE INDICES

- a) As subjective tension increased, subjects had more difficulty sleeping.
- b) Interpersonal irritability increased.
- c) Headaches increased both in frequency and severity.
- d) Good adjustment was observed on days when land falls are approached.
- e) Adjustment was most favorable on Sundays and least favorable on clean-up days.

ASSESSMENT OF ADJUSTMENT POTENTIAL

- a) Assessment of abilities.
- b) Assessment of personality traits.
- c) Aptitude assessment.
- d) Motivation assessment.
- e) Assessment of over-all adjustment status.
- f) Psychophysiological assessment.

CONCLUSIONS

Suggestions for research focus resulting from review are as follows:

- a) Selection methodology is needed that will emphasize positive factors contributory to resilient psychological health as well as negative factors related to behavioral disorders.
- b) Development of new multivariate techniques of collecting predictor data are needed.
- c) Assessment of initial motivation and the problems of maintaining optimal motivation during extended missions should be investigated.
- d) Development of operational criteria is needed which will reliably indicate individual differences in the changes in the quality of adjustment as a function of time for prolonged missions.

REFERENCES

- WEYBREW, B.B. 1963.
 Psychological problems of prolonged marine submergence.
 In: N.M. Burns, R.M. Chambers, and E. Hendler, eds. Unusual Environments and Human Behavior - Physiological and Psychological Problems of Man in Space. Macmillan Company, New York. pp. 87-125.

PURPOSE

- a) To discover the requirements for getting shelters built in our contemporary society.
- b) To identify and analyze the wide range of human problems that would be encountered in general adoption and use of fallout shelters.

PRESENTATIONS AT SYMPOSIUM

The following studies from the symposium that were concerned with the social and psychological effects of isolated groups.

- Study I: Rohrer, J.H. Implications for Fallout Shelter Living from Studies of Submarine Habitability and Adjustment to Polar Isolation.
- Rohrer suggests that the size of the group and duration of the stay affect a person's adjustment in an isolated group. He has applied the findings from submarine habitability and polar isolation to suggest some speculations concerning the results of the initial anxiety to be expected in shelters:
1. Persons who are predisposed to psychiatric symptoms will exhibit them and create management problems.
 2. Increased anxiety will result in increased aggression which will be displaced.
 3. Increased anxiety will result in headaches and sleeplessness.

- Study II: Biderman, A.D. The Relevance of Studies of Internment for the Problems of Shelter Habitability.
- Biderman attempts to relate information regarding internment of military, civilian, and political war prisoners to the problems of fallout shelter living. He suggests some physiological and psychological results of isolation that might pertain to shelter habitability.
1. A possible threat from depressive reactions and disinvolvements.
 2. Organic and other effects of deprivation (hunger and other deprivational conditions) included:
 - a. short temper
 - b. infantilism
 - c. projection
 - d. failing memory
 - e. shortened attention span
 3. Distress and discomfort caused by:
 - a. inactivity
 - b. boredom
 - c. monotony
 4. Sexual deprivation is rarely reported as a major source of distress.
 5. Some individuals adapt to an isolated environment by being:
 - a. active
 - b. aggressive
 - c. adaptive
 Others adapt by being:
 - a. passive
 - b. withdrawn
 - c. maladaptive
 6. A great many individuals lose the ability to cope with the physical environment.

Study III: Miler, D.C. Some Implications for Shelter Living Based on a Study of Isolated Radar Bases.
Miller's study examined the impact of isolation on morale and human relations problems. Some findings are:

1. Leisure problems will emerge.
2. Apathy and lassitude will increase unless there is a vigorous work and recreational program.
3. The more isolated the shelter, the greater the extent of personal problems.
4. Inclement weather which limits out-of-door activity is detrimental to mental outlook.
5. There is much restlessness.

Study IV: Vernon, J.A. Generalizations from Sensory Deprivation to Fallout Shelters.
Vernon's generalizations from studies of sensory deprivation to fallout shelters are:

1. Hallucinations may occur.
2. Persons may become sensitive to pain.
3. There may be a loss of some motor performance while in the shelters.
4. Shelterees might tend to sleep a lot.
5. Fallout shelters are likely to produce stress in individuals.

Study V: Murray, E. J. Adjustment to Environmental Stress in Fallout Shelters.

A number of psychological adjustment problems might arise from individuals being confined to fallout shelters:

1. Physiological deprivations (lack of food and water, poor air circulation, and overcrowding) can produce:
 - a. irritable feelings
 - b. poor social and emotional adjustment
 - c. a deterioration in moral standards
2. Overcrowding may cause:
 - a. decreased efficiency
 - b. depression
 - c. irritability
3. Depression and fatigue can result from physiological deprivations.
4. Noise in confinement may cause:
 - a. irritability
 - b. fatigue
 - c. aggression
5. Overall stress will be produced by the conditions.
6. A great deal of frustration is produced. Common reactions to frustration might be:
 - a. aggression
 - b. depression
 - c. regression
 - d. withdrawal

REFERENCES

BAKER, G.W., and J.H. ROHRER, eds. 1960.
Symposium on human problems in the utilization of fallout shelters.
National Academy of Sciences, Washington, D.C.
[Disaster Study #12]

PURPOSE

To provide a summary of present knowledge of how man adjusts, individually or in groups, to situations of isolation, whether physical or social, purposeful or accidental.

FORMAL PRESENTATIONS

- a) John P. Zubek and Paolo Bonaiuto - provided reviews of the measured effects of sensory and perceptual deprivation in behavior.
- b) Ernest Haggard - reported on the adjustment of isolated Norwegian farmers.
- c) Eric Gunderson - Discussed the adaptation of scientists and sailors in the wintering-over groups at Amundsen-Scott Station at the South Pole, Byrd Station and the other Antarctic posts.
- d) Paul D. Nelson - considered the phenomenological features of isolation, emphasizing that the natural course of human life involves man in a diversity of group contexts under a wide variety of environmental conditions.
- e) R.W. Radloff - discussed the usefulness as well as the reliability of such measures as: effects of underwater isolation, as in the cases of Tektite and Sealab.
- f) Paul Fraisse - reported results of experiments in caves with particular emphasis on how perception of time is distorted and sleep affected by a long period of monitored life in a cave.
- g) W.W. Haythorn - reported on the studies of dyads at NMRI involving interactions of two-man groups under conditions of great restriction of personal space. He pointed out that, although there were unrewarding features of isolation, like tedium stress and unreality stress up to a reaction of claustrophobia, there were possible rewarding features as well, such as a positive sort of contemplation and satisfaction following a period of self-appraisal on which explorers and monks have reported.
- h) Dr. Irving Altman - presented ecological aspects of the experience of isolation and a consideration of the dynamics of social penetration.
- i) S.B. Sells - considered the taxonomy of man.
- j) Walter Wilkins - determined implications of the study of man in isolation for understanding behavior.

REFERENCES

- FORGAYS, D.G., and J.M. LEVIN. 1969.
Man in isolation and/or enclosed space: Report of activities of NATO Symposium in Rome, Italy, October 20-24, 1969.
University of Vermont, Burlington, Vermont. 14 pages.
- WILKINS, W.L. 1970.
NATO symposium on man in isolation and/or enclosed spaces.
European Science Notes 24(3):88-89.

PURPOSE

To review what effects the factor of confinement will play in manned space flights of long duration.

PRESENTATIONS AT SYMPOSIUM

Contents and Findings

- I. An overview of confinement as a factor in manned space flight (*T.M. Fraser. Lovelace Foundation for Medical Education Research, Albuquerque, New Mexico).
 - A. The behavioral response to confinement may take the form of hostility or frustration toward the environment, experimenters, or the other subjects.
 - B. With multi-man groups, cliques can form.
 - C. Although the group appears to function well, covert hostilities may emerge later.
 - D. A number of studies and findings are briefly reviewed.
- II. Social emotional considerations in confined groups (*W.W. Haythorn. Naval Medical Research Institute, National Naval Medical Center, Bethesda, Maryland).
 - A. Isolation and confinement are stressful to small groups of men, even when the confinement situation is physically comfortable and safe.
 - B. Dyad research has revealed a high rate of mission aborts when the variety of tasks required of subjects is reduced and when their expectations of the duration of confinement are increased.
 - C. The stresses of stimulus reduction, isolation, and confinement can be alleviated through a process of stimulus enrichment.
- III. Crew station design and volume requirements (*W.E. Federsen. Crew Systems Division Manned Spacecraft Center, Houston, Texas).
 - A. Review of aspects of space station design known to impair performance.
 - B. Recommendations for additions and improvements.
- IV. Work-rest schedules under conditions of long-term performance (*W.D. Chiles. Training Research Division Behavioral Sciences Laboratory, 6570th Aerospace Medical Research Laboratories).
 - A. Adjustment to circadian rhythms should be a factor in long-term scheduling or work-sleep periods.
- V. Preventive and remedial measures related to crew activities and performance (*R.M. Patton. Human Performance Branch, Ames Research Center, Moffett Field, California).
 - A. Review of problem areas and suggested approaches to solving problems related to crew activities and performance.
 - B. The problem areas covered are: selection; training; and inflight measures.
- VI. Operational evaluations of the confinement problem (*M.A. Grodsky. Man-Machine Engineering Department, The Martin Company, Baltimore, Maryland).
 - A. Discussion of possible effects of long duration confinement on space crews and means of evaluation concerning mission - and system-oriented tasks.
- VII. Human factors in a confined operational environment - Sealab (*J.W. Miller. Engineering Psychology Branch, Office of Naval Research, Washington, D.C.).
 - A. Divers underwater were significantly more fearful and aroused than on the surface prior to submersion.
 - B. Age and maturity were the only characteristics associated with being chosen as a leader. Performance, fear, arousal, gregariousness, and choice as a peer were not related to leader choice.
 - C. There was no increase in the homogeneity of emotional responses over time.
 - D. Self-reported fear and arousal were significantly correlated with performance criteria. The more frightened and aroused divers showed inferior performance.

- E. First-born and only children were more frightened and had poorer performance than later-borns.
- F. Failure of an individual to share group activities and social behavior was associated with higher levels of reported stress and inferior performance.

CONCLUSIONS

Mission conditions affecting responses to confinement:

1. Physical Environment
 - a. Gravity
 - b. Environmental pressure
 - c. Environmental composition
 - d. Temperature-humidity
 - e. Sanitation
 - f. Food-water
 - g. Medical treatment
 - h. Environmental stability
 - i. Environmental pollution
 - j. Sound levels
 - k. Radiation effects
2. Sensory-Motor Limitations
 - a. Reduced depth perception
 - b. Reduced kinesthetic and vestibular stimulation
 - c. Monotonous stimulus environment
 - e. Reduced functional area
3. Psychological environment
 - a. Personal danger
 - b. Command structure
 - c. Interpersonal relations
 - d. Privacy
 - e. Flexibility of mission
 - f. Communication problems
4. Crew tasks
 - a. Active as opposed to passive vigilance tasks
 - b. Variety of tasks
 - c. Extent and capability of ground support
 - d. Sensory equipment
 - e. Guidance and control requirements
5. Crew size
 - a. One man
 - b. Two to four
 - c. Five or more
6. Diurnal work cycles
 - a. Work-rest cycle
 - b. Sleep-wakefulness
 - c. Amount of pre-flight training and adaptation
7. Individual differences
 - a. Adequacy of selection procedures

REFERENCES

- NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. 1966.
The effects of confinement on long duration manned space flights (Proceedings of the NASA Symposium, November 17, 1966).
Office of Manned Space Flight, NASA, Washington, D.C. 53 pages.

PURPOSE

To review problems relating to the performance of isolated military groups in stressful environments. To study situations similar to those in Arctic isolated groups.

VARIABLES STUDIED

- a) The three general areas investigated were:
 - 1. ecological factors and stress
 - 2. group structure and group dynamics
 - 3. personnel aspects of group performance
- b) The most important variables considered were:
 - 1. performance
 - 2. depression
 - 3. perception
 - 4. adjustment
 - 5. morale
 - 6. boredom
 - 7. interaction

RESULTS

- a) Inactivity, boredom, and monotony increase distress and discomfort. This is more relevant for well-fed persons, who have surplus energy beyond that required for existence, than for starved, exhausted persons.
- b) In the 7-day confinement experiment performance efficiency on psychomotor tasks decreased; on tests of judgment and learning reasoning it did not decrease.
- c) People who have trouble with authority were more prone to trouble in confinement.
- d) In confinement for 36 hours in tank-type respirator experiment - all subjects showed impaired ability to concentrate, distortions in time judgment, and degrees of anxiety. Half had delusions, illusions, and hallucinations.
- e) Decreased activity enhances depression.
- f) Separation from valued stimuli - wives, friends, home - causes worry and depression.
- g) Perceptual distortions and hallucinations seem most related to lack of patterning or absence of order or meaning.
- h) When men function as a team, instead of a disorganized mob, they have more strength, skill, stress tolerance and stamina.
- i) Most maladjustment in confinement in Alaska related to dissatisfaction with military provision for family, lack of interesting things to do, inadequate social outlets. This led to low morale.
- j) Good leadership positively correlated with high morale.
- k) Though initial Attitude and Group Behavior Scales indicated adjustment in a group isolated for 12 months at South Pole Station, further study revealed resentment and dislike among group members.

- l) Youngest men received lowest adjustment station and performance ratings.
- m) Lack of communication concerning purpose of mission, role designations, importance of work, correlates highly with low morale.
- n) Individual job satisfaction and morale positively affects group integration and cohesiveness.
- o) Small groups with good integration are potentially effective groups.

REFERENCES

- SELLS, S.B. 1961.
 Tri-service conference on research relevant to behavior problems of small military groups under isolation and stress.
 Texas Christian University, Fort Worth, Texas 273 pages.

PURPOSE

To bring together the relevant features from several studies on confinement and isolation with particular emphasis on the application of this data for further research.

METHOD

Literature dealing with the following subjects was surveyed:

- a) Pertinent animal experiments.
- b) Controlled studies in which humans were confined and/or isolated.
- c) Personal reports on the effects of confinement, isolation, and extreme hazard.

REVIEW OF STUDIES

- a) Early explorers coped with their aloneness and the monotony of their surroundings by making a conscious effort to control their own thought processes, to rigidly structure their work day, and to draw into themselves for added stimulation and interest.
- b) Early explorers experienced: fear, monotony resulting in reduced overall mental efficiency, feelings of depersonalization, and hallucinations.
- c) The degree of hazard present and the way in which the isolates perceive the hazard affect the response to the situation.
- d) Both very high and very low amounts of sensory input result in disorganization on a central level. A lack of sensory input not only results in a lack of specific sensory data reaching the cortex, but also deprives the cortex of the influence it normally receives from the brain stem.
- e) When personal concepts of temporal congruity and logical analysis are disrupted (as by sleep loss), the frequency of misperceptions increases.
- f) Monotony and a lack of patterning do not provide adequate cues to the individual and also fail to provide the essential nonspecific input on which the cortex depends for normal functioning.
- g) Early sensory deprivation and restriction interfere with the emergence of normal patterns of perception and response.
- h) Studies suggest a tentative relationship between stimulus change and sensory deprivation. Organisms attempt to maintain a given level of arousal. Level of arousal varies within and between species and is dependent upon: 1) the total of the organism's prior experience and 2) the strength of momentary stimulus events that preceded exposure to the present stimulus configuration.
- i) An organism's behavior in confinement or isolation can be interpreted as an attempt to maintain some level of arousal.
- j) Isolation - confinement environments remove the consensual validation to which we are accustomed and on which we are dependent in a normal unrestricted environment.

CONCLUSIONS

- a) An adequate theoretical framework for handling the concepts involved in the areas of isolation and confinement will depend on the utilization of data that have already been accumulated in a number of ancillary areas, including: childhood separations, critical age studies, effects of early environment, psychopharmacology and the behavioral effects of hallucinogenic agents, biological rhythms, and time estimation.
- b) A thorough engineering study must be conducted of pilots' sensory and motor capabilities under changing conditions of acceleration, and equipment must be designed accordingly.
- c) Emphasis must be placed on the selection and training of crews.
- d) Group cohesiveness and team effectiveness under stress will assume new importance in future space missions.

REFERENCES

- BURNS, N.M., and D. KIMURA. 1963.
Isolation and sensory deprivation.
In: N.M. Burns, R.M. Chambers, and E. Hendler, eds. Unusual Environments and Human Behavior. Physiological and Psychological Problems of Man in Space. Macmillan Company, New York. pp. 167-192.

PURPOSE

To survey the following behavioral, psychological, physiological, and medical factors of manned space missions of 1 to 2-year duration in order to assess whether man's participation is possible and feasible and to make recommendations for future research.

- a) Physiological and Medical Factors.
- b) Physical Factors.
- c) Sensory, Perceptual, and Motor Factors.
- d) Motivation, Cognition, and Sleep-Work Factors; Central- and Autonomic-Nervous-System Indices.
- e) Skilled Performance.
- f) Subjective States.
- g) Group Processes and Interpersonal Interaction.
- h) A Social System Approach to Long-Duration Missions.
- i) Human Factors and Operational Requirements.

METHOD

At NASA's request, the Space Science Board undertook a study of the behavioral, psychological, physiological and medical factors of manned space missions.

- a) A Steering Committee was organized to survey the above factors and to identify specialists to write about these factors.
- b) The papers written were incorporated into this report by the Steering Committee.
- c) Since spaceflight biomedical and behavioral measurements have been few (as of the preparation of this report, 1970-1971), analogies were sought in the literature. Investigations of confinement and isolation were drawn on, these included studies of social isolation (laboratory experiments), underwater habitats, submarines, Antarctic and Arctic stations, simulated fallout shelters, and space studies.

MAJOR RECOMMENDATIONS MADE AFTER SURVEYING FACTORS

- I. Ground-based research and subsequent inflight research with men and animals should cover the full range of physiologically deconditioning factors:
 - a) Understanding of course of deconditioning over two years.

- b) Deconditioning mechanisms and consequences.
 - c) Validation of effective countermeasures.
 - d) Inflight research to include only definitive experiments that cannot be performed on ground.
 - e) Cautious, conservative incremental approach with man.
 - f) Possible use of human surrogates, especially primates, which will remain in space for long-duration studies in man-tended orbital stations.
 - g) Unmanned animal flights to investigate discrete problems.
- II. Long-duration ground-based investigations of immediate and cumulative effects of high Z particles should be undertaken:
- a) As soon as facilities are available.
 - b) Provided that interim studies support the present hypothesis concerning the nature and severity of this hazard.
 - c) In order to develop proper protection against the effects of high Z particles.
- III. Research concerning the long-term effects on man of isolation, confinement and sensory restriction in conjunction with other stresses is critically needed.
- a) Research should emphasize the following:
 - 1) Cognitive functioning including EEG changes.
 - 2) Maintenance of performance and retention of skills.
 - 3) Sleep and work/rest cycles.
 - 4) Group processes.
 - 5) Allocation of tasks.
 - 6) Perceptual and motor skills.
 - b) The following methodological approach is recommended - observation and measurement from shorter operational missions must be analyzed for relevance to longer-term missions, such as:
 - 1) Training exercises in simulators should be utilized as sources of data bearing on crew performance over long periods of time.
 - 2) Long-term simulator studies and other field studies should provide useful sources of data.
 - 3) Laboratory studies are essential to clarify relationships among variables.
 - 4) Computer and mathematical modeling efforts seem warranted and necessary in order to synthesize information obtained through empirical research.
 - c) Forms and systems of measurement to be used:
 - 1) Four system levels important to research on microsocieties are:

Physiological
 Psychological
 Task performance
 Interpersonal

2) On each system level measurement may take four forms:

Subjective report
 Observations
 Trace measurements
 Archival measures

d) Substantive research questions:

- 1) Sources of CNS changes noticed in prolonged periods of comparative monotony.
- 2) Effect of training and conditioning on long-term physical adaptation and maintenance of performance.
- 3) The role of interpersonal compatibility in mitigating social withdrawal and encapsulation.
- 4) The role of leadership in maintaining adjustive interpersonal relationships.
- 5) The effect of expectations or "set" on experimental results.

IV. Techniques must be available to measure physiological, psychological and performance status inflight and to provide early indications of potentially serious situations:

- a) Precise measurement of higher level performance.
- b) Tests for psychological and/or psychiatric problems.
- c) Emphasis on principles of noninterference, automotive and monitoring for critical deviations in biological parameters that best predict reductions in well-being.

V. Requirements for life support and safety, optimal habitability and comfort, and operational efficiency should be incorporated early into spacecraft engineering. Man's physical, psychological, behavioral, and interpersonal requirements must be considered in the design of the spacecraft and the mission.

- a) Habitability must be improved regarding capsule volume, configuration and noise as they relate to work, mobility, recreation and sleep.
- b) Broad research programs and close coordination among engineers, life scientists and human factors experts will be necessary.

VI. Elements of the long-duration mission should be viewed as portions of a totally integrated and mutually reinforcing system. Systems analyses approval should be advantageous in providing a common frame of reference for interdisciplinary planning and implementation. Elements of long-duration mission include:

- a) Temporal factors - preflight, inflight, postflight.
- b) Engineering factors - spacecraft and its internal environment, new technology.
- c) Operational factors - ground support, mission control, space mission.

d)Scientific factors - inflight experiments, preparation and completion, medical care, ground-based resources.

e)Human factors - ground crew and flight crew and their relationships.

VII. Crew composition and selection criteria should be considered matters of first importance.

REFERENCES

NATIONAL ACADEMY OF SCIENCES. 1972.
Human factors in long-duration spaceflight.
Space Science Board, National Research Council, National Academy of Sciences,
Washington, D.C. 272 pages.

PURPOSE

To review studies on the dynamics of groups isolated and confined for periods up to 1 year.

CONFINEMENTS REVIEWED

- 1)Arctic
- 2)Antarctic
- 3)Submarines
- 4)Spaceflight Simulation
- 5)Underwater Habitats

REACTIONS OF INDIVIDUALS TO ISOLATION AND CONFINEMENT

Arctic

Individuals confined for 2-12 months showed decrements in performance and morale due to lack of privacy and social stimuli.

Antarctic

1)Individuals confined for 4-12 months developed symptoms of some or all of the following:

- a)Anxiety
- b)Boredom
- c)Daydreaming
- d)Depression
- e)Hostility
- f)Irritability

2)In one case, an increase in work activity helped alleviate the symptoms.

Submarine

1)Individuals confined for up to 60 days exhibited some or all of the following traits:

- a)Boredom
- b)Daydreaming
- c)Desocialization
- d)Headaches
- e)Insomnia
- f)Irritability

- 2) These symptoms were on occasion caused or increased by a lack of space and a high carbon dioxide atmosphere.

Spaceflight Simulation

- 1) In studies which followed both extensive selection procedures (physical, intellectual and emotional) and intensive training in "social sensitivity", subjects:

- a) Maintained high motivation and morale
- b) Improved performance
- c) Established good interpersonal relations
- d) Evidenced no decrements in psychomotor or cognitive functions.

- 2) In a 30-day simulation study carried out after random selection and no training, interpersonal stress was evident and although cognitive and psychomotor functions were not impaired subjects were:

- a) Hostile
- b) Irritable
- c) Dissatisfied by the food
- d) Unhappy about lack of privacy

- 3) In another 30-day simulation confinement which only included technical training, two 5-man crews alternated work/rest schedules of 4 hours on/4 hours off. Although subjects achieved high performance levels, they were:

- a) Fatigued
- b) Bored
- c) Irritable

Underwater Habitats

The dangerous environment of the Sealab II experiment led each person to depend more on others and fostered cohesion.

Group Dynamics

- 1) As confinement continues, an informal or functional group structure will develop from the formal structure.
- 2) Members will easily perceive where teammates stand regarding popularity and power and may choose an emotional leader, ("father figure") in addition to the formally designated leader.
- 3) The effective leader must perform well and support the emotional and social needs of his crew in order to achieve correspondingly high levels of performance and cohesion.
- 4) A mild degree of stress produces optimal performance; too little stress produces little or no motivation.
- 5) In a monotonous boring environment, cohesion will decline; in a dangerous interdependent environment, it will increase.

RECOMMENDATIONS

- 1) To counteract boredom, change and rotation of work assignments, work companions, and project responsibilities should be programmed into the flight schedule.
- 2) Some leadership functions should be delegated to and rotated among crew members.
- 3) Selection of astronaut teams should focus on identifying effective crews rather than individuals.
- 4) More research needs to be done to match homogeneous vs. heterogeneous characteristics that lead to optimal compatibility and performance.
- 5) Broad understanding of oneself and others must be included as an essential part of the training process.
- 6) Isolation and confinement impose a strain on group structure, induce severe pressures on leadership, and threaten group integrity.

REFERENCES

- KUBIS, J.F. 1972.
Isolation, confinement, and group dynamics in long duration spaceflight.
Astronautica Acta 17:45-72.

R-39

REVIEW/PSYCHOLOGICAL ASPECTS
OF SPACEFLIGHT

Kubis, J.F., and McLaughlin, E.J.

PURPOSE

To examine the involvement of psychological considerations in selection of astronauts, in their training, and in their behavior during actual space flight.

SUBJECTS

Thirty-two candidates selected from a pool of 500 names. All were:

- a) Qualified jet pilots with over 1500 hours of flying time.
- b) Graduates of test pilot school and under 40 years of age.
- c) Highly intelligent and in excellent physical condition.

PROCEDURES

- a) Upon completion of all physiological, psychological and biochemical tests at the Aerospace Medical Research Laboratory, the primary group of astronauts was selected by the Candidate Evaluation Committee.
- b) Each received technical and psychological training to develop his confidence and regulate his anxiety.
- c) During flight, effects of weightlessness and other stresses were assessed, physiologically and psychologically.

RESULTS

- a) Stresses associated with short-term space flight produced no significant deterioration of visual acuity or spatial orientation.
- b) Most astronauts maintained good emotional reactions, though some irritability was experienced on one 14-day mission.
- c) Performance was maintained at a high level and adaptability and decision making processes were in evidence.

CONCLUSIONS

- a) Psychological stability is the most important consideration in evaluating a candidate. His intelligence, maturity and motivation must be assessed.
- b) Excellent physiological performance is a secondary consideration.
- c) Although the impact of short-term space flight on man's body and brain have been assessed, it is now necessary to plan confinement experiments for future space flights which may last one year or more.
- d) It is expected, from reviewing long-term confinement studies in the Antarctic and on submarines, that anxiety, irritability, sleep disturbances, depression and hostility will develop among crew members in prolonged

spaceflight unless determinations of compatibility are carefully established.

e) Behavioral and performance norms, gathered under comfortable, gravity-oriented conditions, will not be applicable in the weightless state and can only be measured by observations of crew members in actual space flight. For experimental purposes an orbiting space laboratory should be put into operation as soon as possible.

REFERENCES

- KUBIS, J.F., and E.J. MCLAUGHLIN. 1967.
Psychological aspects of space flight.
Transactions of the New York Academy of Sciences, Ser. II, 30(2):320-330.

PURPOSE

To review insights into human behavior in isolation and/or confinement as demonstrated by material developed since the last NATO Symposium on Man in Isolation and/or Enclosed Space held in Italy in 1969.

REVIEWS STUDIED

- a) ZUBEK, J.P. Behavioral and physiological effects of prolonged sensory and perceptual deprivation: A review.

Zubek reports on sensory deprivation and its resulting perceptual aberrations. Lack of sensory stimuli also increases an individual's susceptibility to propaganda, impairs his cognitive functioning and slows occipital alpha frequencies. Measures to counteract effects of sensory deprivation include physical and mental exercises and special training for isolation conditions.

- b) FRAISSE, P. Temporal isolation, activity rhythms, and time estimation.

Fraisse reports on temporal isolation, biorhythmicity, and time estimation. Circadian rhythms tend to remain stable but subjects consistently underestimate time intervals.

- c) HAGGARD, E.A. Some effects of geographic and social isolation in natural settings.

Haggard studies the behavior of children raised in Norway's remote mountain farms. Children thus reared show greater interfamily heterogeneity and display different behavioral characteristics than urban children.

- d) GUNDERSON, E.K.E. Individual behavior in confined or isolated groups.

Gunderson writes of adverse effects of confinement/isolation on emotional equilibrium, motivation and effectiveness based on studies carried out in the Antarctic.

- e) NELSON, P.D. The indirect observation of groups under confinement and/or isolation.

Nelson analyzes confined and/or isolated groups, their structures, behavior, goal patterns, cultures, and effectiveness.

- f) RADLOFF, R.W. Naturalistic observations of isolated experimental groups in field settings.

Radloff has conducted 6 years of research on saturation diving groups. Since divers regard continuous observation as a safety factor, psychologists can study their behavior unobtrusively and without negative reactions.

- g) HAYTHORN, W.H. The miniworld of isolation: Laboratory studies.

Haythorn reviews laboratory studies of social isolation. He concludes that the major stresses of isolation and confinement are stimulus reduction, limited space, privacy, and mobility, non-gratification of needs, and interpersonal incompatibility. He recommends further investigations into the cognitive and aesthetic needs of small isolated groups.

- h)ALTMAN, I. An ecological approach to the functioning of socially isolated groups.

Altman studies group adaptation, management of conflict and facilitation of positive interpersonal exchange. He finds that time and physical scales become telescoped, events proceed rapidly, and interpersonal tolerance is low. Early and effective group structure formation is critical for the later cohesiveness of the group.

- i)DE MONTMOLLIN, G. Concepts and strategies of research on groups in isolation: Comments on Altman's approach.

De Montmollin agrees with Altman and emphasizes the necessity of managing, rather than just understanding, the psychological life environment of isolated groups. Programs should be developed and tested to provide training in interpersonal relationships, in individual and collective adaptation to confinement, and in common goal sharing among subjects who already have strong individual motivation.

- j)SELLS, S.B. The taxonomy of man in enclosed space.

Sells presents the thesis that a taxonomy of man in isolation and/or confinement requires the analysis of these situations in terms of a social system model. Effects of social isolation, confinement and sensory restriction cannot be disentangled from the highly interdependent social system contexts in which they occur, and indications are that these vary significantly among classes of social systems.

- k)WILKINS, W.L. Isolation research: The methodological context..

Wilkins provides an overview of research presented at the 1969 NATO Symposium. (See R-33 in this report)

REFERENCES

- RASMUSSEN, J.E. 1973.
Man in isolation and confinement.
Aldine Publishing Company, Chicago, Illinois. 330 pages.

R-41

REVIEW/SYMPOSIUM - TEAM PERFORMANCE
IN ISOLATED ENVIRONMENTS

Sells, S.B.

PURPOSE

To investigate the effects of conditions of isolation on team performance.

CONFINEMENTS REVIEWED

- Study I - Mount Everest climbing expedition of 18 men
- Study II - Scientific stations in Antarctica with 8 to 26 men
- Study III - Comparison of Sealab II findings with reports of adjustment in similarly stressful environments.

PRESENTATIONS AT SYMPOSIUM

Study I

EMERSON, R.M., and J.T. LESTER. Reflections on Mt. Everest.

Discussed ideas related to the subject of team performance in isolated environments utilizing data collected in the 18-man Mount Everest Expedition of 1963 of which both authors were members.

EMERSON, R.M. Group performance in remote environments.

- a) Discussed some of the effects of the level of group autonomy on the group's structure.
- b) If an autonomous group was not overstaffed, it tended to assume an equalitarian structure, both in reward distribution and in the decision making process.
- c) A non-autonomous, initially equalitarian group, with outside resource or reward inputs, will soon evolve into a power hierarchy. (Power derives from outside the group, while authority stems from performance within the group.)

- d) An autonomous group has problems of authority to deal with, but one which is non-autonomous has power and authority problems to deal with.

LESTER, J.T. Accommodation and expression in remote environments.

- a) Described interpersonal relationships from the dialectic between the necessity to accommodate oneself to another and the apparent necessity to express or assert oneself in relation to another.
- b) Normative forces lead to a sense of community; self-expressive forces lead toward a sense of individuality. In any enduring interpersonal relationship, a balance must be reached between the affirmation of shared norms and the affirmation of individuality in relation to those norms.
- c) Infractions of shared norms may be viewed as examples of correcting imbalances between accommodation to norms and individual self-direction.
- d) Many balancing maneuvers will be unavailable on prolonged space flights, which may be set off by establishing more flexible norms and allowing for more freedom of self-expression.

Study II

GUNDERSON, E.K.E. Group compatibility in restricted environments.

a) Investigated the antecedents and correlates of group compatibility to improve understanding of the determinants of group effectiveness. Summarized studies of group compatibility conducted at scientific stations in Antarctica.

b) Social attractiveness, while difficult to assess, may be an important concept in the prediction of group compatibility.

c) Wide variation in attitudes and personality needs were detrimental to group harmony and cooperation.

d) Both formal and informal group structures were positively related to group compatibility, but an intermediate level of formality in group structure was associated with group incompatibility.

Study III

RADLOFF, R. Costs and rewards in exotic environments.

a) Introduced a conceptual model useful in considering performance in and adjustment to exotic environments.

b) The model consists of a cost-reward matrix, where the desirability of a situation depends on having rewards (whether subjective or objective) greater than costs.

c) Implications of model:

1) Later groups in exotic environments will experience poorer outcomes than pioneering groups, since rewards may be expected to decline faster than costs as more groups enter exotic environments.

2) Costs will be relatively stable and rewards will be relatively unstable for groups in exotic environments.

d) For a maturing system, the analysis implies that:

1) In a maturing system more attention should be devoted to substituting for rewards which have disappeared and maximizing potential available rewards rather than on minimizing costs, because costs are relatively stable and rewards are labile.

2) Rewards available to later groups in exotic environments will differ from the rewards available to pioneering groups.

3) Caution should be exercised against overly optimistic expectations of performance in later groups derived from an analysis of the behavior of earlier groups.

4) Rewards for later groups will be derived from personal and peer group relations rather than from recognition received from society at large and from the sub-culture.

5) Since rewards will depend on the peer group, it emphasizes the role of leadership in creating an atmosphere in which rewards can be maximized from qualities intrinsic to the situation as discussed by Sells.

6) Attention should be derived toward selection of men who are able to maximize the rewards of the situation as it exists.

REMARKS ON SYMPOSIUM

VINACKE, W.E.

a) Laboratory research is valuable in establishing theoretical tenets and empirical techniques in social psychology and in shaping field research.

b) There should be a two-way interchange between field and laboratory studies.

SAUCER, R.T.

The greatest challenge today facing the behavioral scientist involved in manned spaceflight is to be able to select crew members with outstanding emotional health and selected mental attributes.

REFERENCES

- SELLS, S.B. (Chairman) 1968.
 APA symposium on factors affecting team performance in isolated environments.
 Institute of Behavioral Research, Texas Christian University, Fort Worth, Texas.
 48 pages.

PURPOSE

To search and review all literature which relates individual characteristics to successful adjustment to isolation and confinement.

CONFINEMENTS REVIEWED

POLAR ENVIRONMENTS

- a) Psychiatric screening can predict performance effectiveness as well as prevent selection of subjects prone to mental disorders.
- b) Emphasis was placed on the adequacy of the individual's defense mechanisms.
- c) Friction in a group is created by people who are inflexible, demanding, overly sensitive or narcissistic.
- d) A positive correlation exists between a man's job effectiveness and his level of compatibility with others in the group.
- e) "Control (or lack of control) of hostile and aggressive impulses has special significance in the small, closed group setting."
- f) The Rorschach technique is not useful as an adjustment predictor.
- g) Biographical and demographic data are not accurate predictors of successful adaptation.
- h) Positive correlations exist between age and emotional composure while negative correlations exist between age and measure of motivation.

SUBMERSIBLE ENVIRONMENTS

- a) Few background variables were related to attitude changes during and following submergence.
- b) Age and maturity were the only criteria for choice of leader.
- c) Tests defining Verbal Comprehension and Speed-in-Spatial Orientation Factors "may have considerable value in predicting the quality of a person's adjustment to the confinement, frustration and other stresses of submarine living."

LABORATORY AND SIMULATOR ENVIRONMENTS

- a) Individual differences in stimulus demand should be investigated as part of the selection process.
- b) "Good adjustment is associated with flexibility, low sociopathy and ability to be aggressive and angry, yet not hostile."
- c) Relationships between pain endurance tests and personality scales yield no significant coefficients.

CONCLUSIONS

- a) Good adjustment can be related to:
 - 1) Age and level of maturity
 - 2) Absence of history of delinquency or infraction of established regulations
 - 3) Low level of need for avocational activity

- 4)Low in impulsiveness.
- 5)Having feminine interests.
- 6)Well-organized in thought and performance.
- 7)Accepting of a dependency situation.

b)Poor adjustment can be related to:

- 1)Rural background.
- 2)Frequent sick calls.
- 3)Single status.
- 4)Low frequency of worship.
- 5)High scores on Psychopathic Deviate and Hypomania but a low on Ego Strength.

c)Individuals who have performed successfully in prior isolation and confinement tests will most likely perform well in space flight.

d)To appraise and predict performance, multiple predictor tests and criteria have become standard in selection; predictions, however, are not always accurate, best results being obtained by examiners using a flexible interview technique to receive maximum information.

e)Self-selection data have proven useful in determining a subject's motivation.

f)Previous research on selection has concentrated too much on isolating negative factors rather than on identifying positive factors contributing to resilient psychological adjustment to prolonged hazardous duty.

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