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PSYCHOLOGICAL ISSUES RELEVANT TO ASTRONAUT SELECTION FOR LONG-DURATION SPACE FLIGHT: A REVIEW OF THE LITERATURE

By

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Since the inception of the manned spaced program, there has been an emphasis on selecting only those astronauts who would be the most psychologically resistant to problems which could result from the exotic, stressful, and unforgiving environment of space. This paper addresses space-related behavioral problems experienced by the United States and the Soviet Union. Specifically addressed are contentious episodes and impaired judgements that occurred during the Mercury, Apollo, and Skylab missions. Interpersonal dissension has repeatedly occurred among the astronauts and with the authorities on the ground at Houston control. The careful selection procedures which have been used in the past have failed to predict that astronauts would be so adversely affected by the stresses of space flight. Soviet cosmonauts also experienced repetitive episodes of interpersonal tension and poor judgement during their recording-breaking Salyut space missions. The behavioral problems which occur during space flight often do not terminate when the space flight ends, but linger with notable aftereffects. The post-flight problems of ex-astronauts and the implications of isolation and confinement for future long-duration space flights are discussed. Other variables (e.g., compatibility, cohesiveness, crew size, and crew performance) which affect group interaction, and the need for "psychological compatibility" of space crewmembers, are addressed using both American and Soviet literature. Also addressed are

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evolutionary changes in the space mission and the psychological tests that have been used for astronaut selection. Recommendations and the rationale for improving the psychological tests for astronaut selection are included.

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PSYCHOLOGICAL ISSUES RELEVANT TO ASTRONAUT SELECTION FOR LONG-DURATION SPACE FLIGHT: A REVIEW OF THE LITERATURE

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SUMMARY

This technical paper reviews the current literature on psychological issues relevant to astronaut selection for long-duration space flights. Interpersonal problems have been and remain a recurring problem for both short- and long-duration space flights. Even after completion of the space mission, intense psychological aftereffects are reported. The specific behavioral problems experienced during both United States and Soviet Union space flights are reviewed, specifically addressing contentious episodes and impaired judgements that occurred during the Mercury, Apollo, and Skylab missions.

Psychological tests used in the selection process for the space program have focussed primarily on the detection of gross psychopathologies in potential candidates. Although these psychological instruments excluded some people from becoming astronauts, the battery of tests failed to predict which individuals would manifest behavioral aberrations in judgement, cooperative functioning, overt irritability, or destructive interpersonal actions.

As mission length, crew size, and diversity increase, behavioral problems can be expected to persist. Therefore, it is recommended that research and development (R&D) be planned to improve the selection of space crews. Such R&D should include the following topical areas: evaluation of the utility of the Personal Attributes Questionaire (PAQ) masculinity/femininity scale to select androgynous individuals for long-duration space flights; personality and leadership factors important in crew composition, with specific attention to crew compatibility; types of leadership style best suited for short- or long-duration space flights; the determination of that critical point in time during a space flight where the situational factors (such as boredom, crew friction, apathy) become an obstacle to effective leadership; identification of psychological supports or props that can be used to help individuals preserve or restore their emotional stability under conditions of isolation and confinement. Such a comprehensive R&D program is suggested as a possible joint effort between National the Aeronautics and Space Administation and the Air Force Human Resources Laboratory.

PREFACE

This literature review was conducted while the author was assigned to the Air Force Institute of Technology (AFIT) with permanent duty at the Uniformed Services University of the Health Sciences (USUHS) Psychology Department. The research began while the author was temporarily assigned to the National Aeronautics and Space Administration (NASA) Headquarters at Washington D.C. for a summer managerial internship program. Data bases, libraries, and other sources used in the preparation of this document include the National Research Council (NRC), National Technical Information Service (NTIS), Defense Technical Information Center (DTIC), Foreign Technology Division (FTD), and the research centers of NASA. The author wishes to express his appreciation to Dr Mel Montemerlo (NASA/HQ), Dr Jerome E. Singer Professor and Department Chairman of Psychology at the Uniformed Services University of the Health Sciences, and Dr Robert Kennedy (NRC-National Academy of Sciences/Committee on Human Factors) for their invaluable assistance in providing access to many prestigious data bases. Special thanks goes to A1C Jack R. Elvey, Jr. for his invaluable assistance in the typing of this treatise.

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I. INTRODUCTION

There are many challenges inherent in the space program. As the duration of space flights lengthen, concomitant human problems are expected to proliferate. The psychological sequelae of space flight have had not only profoundly positive effects, but also negative aftereffects upon the lives of the astronauts. This literature review examined selected psychological problems associated with space flight. The psychological tests used to select astronauts have been reviewed. Those personal psychological attributes deemed important for space flight are discussed, suggesting that a harmonious space crew for long-duration space flight can be selected when certain individual criteria are met. Recommendations for further research in this area are proposed.

Psychological compatibility has been a recurring problem during the short-duration missions (Kanas & Fedderson, 1971; Kubis & Mclaughlin, 1967). Yet no present attempts are being made to define the desirable personal characteristics of the optimum space crew. Heretofore, psychologists have been hindered from any attempts to address the astronauts' operational problems. Instead, the psychologist has been limited to the role of administering only the initial psychological testing of astronauts (Helmreich, 1980). This procedure continues in spite of the plethora of individual and interpersonal psychological problems that have been documented, during and after space missions. Furthermore, the psychological tests have historically failed to accurately predict individual astronaut's responses to the stresses of space flight.

II. PSYCHOLOGICAL PROBLEMS IN THE SPACE ENVIRONMENT

Reported Problems During the Mission and Post-Mission. Since the inception of the manned space programs, there has been interest in the astronaut's psychological suitability and adaptability for space flight (Brady, 1983; Butler, 1981; Butler & Wolbers, 1981; Christensen, 1962; Helmreich, 1983; Hunter, 1968; Imus, 1961; Mitchell, 1962; Vinograd, 1974). The common factors in all space environments will be isolation (Rawls, McGaffey, Trego & Sells, 1968; Sells, 1966; Sells & Gunderson, 1972), confinement (Brady, 1983; Fraser, 1966; Radloff & Helmreich, 1968; Rawls et al., 1968; Ruff, 1959a; Sells & Berry, 1958), and many opportunities for interpersonal friction (Bluth, 1980; Brady, 1983; Chambers, 1968; Cheston & Winter, 1980; Helmreich, 1980; Petrov, Lomov & Samsonov, 1979; Siminov, 1976). The concern for the astronauts' well-being in the exotic environment of outer space is as salient today as when space travel began. Unfortunately, astronauts and cosmonauts continue to exhibit poor judgement, belligerence, interpersonal dissension, irritability with ground managers, and gross violations of crew discipline, which could have resulted in tragedy. Specific examples of these behavioral anomalies which have resulted in mission impairment are addressed.

U.S. Behavioral Problems in Space. The U.S. space program has experienced several incidents during space flight which are of concern to behavioral scientists. The psychological effects of space flight have included aberrant behaviors and impaired judgement. For example, astronaut Carpenter wasted valuable control fuel, during a Mercury space flight, to obtain unauthorized photographs of scenic sunsets (Cooper, 1976). The resulting unscheduled expenditure of fuel severely restricted the spacecraft's maneuverability. This precariously low fuel state caused consternation among the National Aeronautics and Space Administration (NASA) engineers, since the margin-of-error for a safe re-entry had been reduced to such a meager level (Cooper, 1976; Wolfe, 1979). Why an experienced test pilot, turned astronaut, would exhibit such irrational behavior remains unknown.

Another example of inappropriate astronaut behavior was repeated on the Apollo 9 flight. The Apollo 9 crew exhibited an alarming amount of belligerence (Bluth, 1981). However, they were largely able to overcome their interpersonal dissension so that by the end of the mission, only an awareness of tension remained (Collins, 1974; Cooper, 1976; Cunningham, 1977). Astronaut Schweichart experienced the interpersonal conflict aboard Apollo 9 and correctly predicted that as future missions get longer and the crews larger, more intense interpersonal hostilities would occur.

Another Apollo flight exhibited a similar, but more intense, interpersonal conflict. The crew of Apollo 13 became so irritable with each other and with the ground controllers (i.e., authorities) that the astronauts insisted on taking a day off from in-flight mission duties to sort things out (Bluth, 1981; Cooper, 1976; Wolfe, 1979). This interpersonal dissonance was of such magnitude that NASA personnel strongly considered immediately aborting the Apollo 13 mission and returning it to earth before their interpersonal problems escalated any further (Bluth, 1980; Cooper, 1973, 1976). Although the mission was not aborted, the psychological incompatibility among members of the crew caused the Apollo 13 mission to now be infamously referred to as "the flight that failed" (Cooper, 1973).

Former astronaut Gerald Carr described yet another contentious episode during the flight of Skylab 4. The crew of Skylab 4 became very irritable shortly after occupying the Spacelab. Their irritability escalated into continuous displeasure with each other, their surroundings, and authorities on the ground at Houston Control (Bluth, 1981; Wolfe, 1979). By mid-mission the entire crew insisted on a full day's vacation (i.e., no work) to resolve their interpersonal animosity. This insistence was later labelled as rebellion by high-ranking individuals within NASA (Bluth, 1981). It should be noted that the careful selection procedures failed to predict that the astronauts on this mission, and on a Mercury and two Apollo missions, would be so adversely affected by the stresses of space flight (Bluth, 1981; Cooper, 1973, 1976; Helmreich, 1980; Wolfe, 1979).

Soviet Behavioral Problems in Space. The Soviet Union has also witnessed behavioral aberrations in their cosmonauts (Burnazyan & Yeliseyev, 1978; Gurovskiy & Bryanov, 1974; Leonov, 1972, 1976; Parin, Gorbore & Kosmolinskiy, 1966). The Chief of Crew Training for the Soviet Union, General Beregovoy, reported that on two of the (+/-) 180-day space missions, the crew developed outward signs of hostility (Beregovoy, 1979a, 1979b; Brady, 1983). Although no physical blows resulted, it was an adverse psychological development which demanded careful handling by the Soviet's Group for Psychological Support. This research organization was created specifically to study the psychologically related problems of their cosmonauts and to prevent, when possible, their reoccurrence.

An example of the type of problem which has been researched is an incident which nearly ended in tragedy (Oberg, 1978). On the first 96-day Salyut mission, cosmonaut Romanenko, filled with enthusiasm at being in space, decided to take an unauthorized EVA (extra vehicular activity -- space walk). After donning his space gear, he intended to peek out and observe, first hand, the ambience of earth and space outside the space station. Unfortunately, before he left the space station, he forgot to attach any safety tethers, and found himself floating into the vastness of space. Serendipitously, his cohort, cosmonaut Grechko caught Romanenko's foot as it was exiting the hatch (Bluth, 1981; Lomov, 1979). This incident was not reported until after the mission had safely returned to earth (Bluth, 1981).

This incident, demonstrates that a highly trained and disciplined crew member can become so mesmerized by the outer space milieu that he succumbs to his impulses and ignores all precautions and checklists. What is equally mind-boggling is "Why did his contemporary, cosmonaut Grechko, sit idly by and not intervene, until he realized that a fatal situation was developing, and only then respond"?

Another troublesome incident occurred, "according to reliable sources within NASA," (Montemerlo, 1982) during the 1980 record-breaking 185-day Salyut flight. The cosmonauts became so irked with the ground personnel that they terminated all communications (i.e., radio, television) with the group for a period of two (2) days. Indeed, the behavioral effects of long-duration isolation, confinement, and weightlessness are just beginning to be understood. The implications of these examples are that future astronauts, perhaps not as well-trained or disciplined, may be subject to even more impulsive behaviors. Research needs to be undertaken to understand this reaction, so it will not occur in conceptually analogous situations.

More recently, on December 10, 1982, cosmonauts Anatoly Berezovoy and Valentin Lebedev bade farewell to Salyut 7, the orbiting space ship that had been their home for the previous 211 days. This long-duration space flight broke the previous 185-day record also set by Soviet cosmonauts in 1980 (Schlitz, 1983). Throughout the mission there were occasional hints of what the Soviets diplomatically called "interpersonal tension" aboard the Salyut 7 (Oberg, 1983). It was usually blamed on accumulated crew fatigue and periodic frustrations over equipment problems. After landing, Berezovoy was asked whether he and Lebedev had grown tired of each other. He admitted that they had to "overcome psychological difficulties" and urged that future participants in long-duration space missions should be more prepared psychologically for the experience (Oberg, 1983). In the final months of the flight, the crew's efficiency had also declined markedly. Nevertheless, the Russians continue to insist that time in space will be lengthened during their future space missions.

Post-Mission Problems. Thus far, behavioral problems have been addressed which occurred during space flight. However, as the following section will demonstrate, the behavioral aberrations do not terminate when the space flight ends, but linger, with notable aftereffects. Research on life in space stations may be to behavioral science what the Stanford Linear Accelerator was to physics. Like the physicists who gained immense knowledge from the unique accelerator, psychological knowledge stands to gain from the rare opportunities presented by a space station. On Earth, it is impossible to study atomic structures in their natural environments. There are too many intrusive variables. The same is true for studying human behavior on Earth--there are innumerable influences, recognized and unrecognized. However, the isolation chamber of a space station could be beneficial for identifying certain fundamental social processes that play a key role in understanding and improving human behavior, for future longer-duration space flights.

The space shuttle has opened the universe to men and women from around the world. Space voyagers will no longer come from the ranks of carefully screened test pilots, but will be more diverse, probably less stress-resistant, and less thoroughly prepared for the hardships of space travel (Brady, 1983; Helmreich, 1977, 1980; Rosen, 1976). What effect will the ordeal of a space flight have on space travelers? Some of the astronauts' post-mission behavior indicates severe difficulties in readjusting to their daily lives.

The post-flight behaviors of ex-astronauts Mitchell, Pogue, Irwin, and Worden provide evidence that additional psychological problems can be expected after the flight. Ex-astronaut, retired Navy Captain Edgar Mitchell describes the psychological problems he had after completing his space mission (Rosen, 1976): Something happened to me during the flight that I didn't even recognize at the time. I would say that it was an altered state of consciousness, a peak experience, if you will. I flipped out, or whatever, and the next two years I spent in resettling my entire thought process, because as a result of that experience virtually all of the philosophies, ideas, scientific truth, and so forth, that were dear to me and were a part of my scientific paradigm got tossed right up into the air and fell into a big heap like a bundle of pick-up sticks. Since that time I have been very carefully and slowly picking up those sticks and trying to put them into some sort of order again (p.6). Mitchell adds forebodingly, "I'm afraid we may see a bunch of mental dropouts when people start flying into space by the hundreds, if we don't start now to learn how to prepare them for that experience" (Rosen, 1976).

Many other astronauts have also communicated the impact of their experience in space. Ex-astronaut, retired Air Force Colonel James Irwin felt so spiritually moved by his flight in space that he left the astronaut corps and the military to form his own interdenominational evangelistic organization called, the "High Flight Foundation" (Rosen, 1976). The experiences of Mitchell and Irwin are not isolated occurrences. Ex-astronaut Worden reported that his space flight experience "changed his entire view of reality on earth," and was so spiritually moved that he left the space program to join

Irwin's High Flight Organization (Rosen, 1976). Interestingly, 18 months later astronaut Pogue (the pilot on Skylab 4) resigned from NASA and joined ex-astronauts Irwin and Worden in their spiritual campaign (Pogue, 1974). Many additional astronauts (Bormann, Schweickart etc.) have been profoundly moved by religious sensations after their experiences in space (Rosen, 1976).

Dr Charles Berry, who works for NASA, reports that the astronauts only request to speak with him post-flight. Dr Berry reflects, "No man that I know of has gone into space and not been affected in some way" [by the experience]...." (Rosen, 1976). Dr Berry has strongly urged NASA to fund psychological studies so that future astronauts could be selected for their hardiness, and to develop an effective program to treat, or prevent, the occurrence of post-mission malaise (Rosen, 1976).

Experimental Research on Psychological Problems. Prior to the actual space flights, research was conducted on groups in isolated and confined environments. This research predicted quite accurately which behaviors would become problematic during space flight. The purpose of this section is to examine how people's relationships with one another may affect the psychological functioning and well-being of the astronaut, and the performance and morale of the space crew.

The primary focus is on crews that are small in the sense that each crew member has the opportunity to interact with each and every other crew member on a face-to-face basis. Special attention will be devoted to research findings on groups isolated or confined for relatively long periods of time. Short-duration projects will be included if they demonstrate effects significantly relevant to isolation and confinement experiments (ICE), and are potentially applicable to experiences of long-duration space flight.

During the initial years of the space program, psychological concerns centered around the effects of weightlessness on astronaut performance, and upon man-machine engineering (Chambers, 1968; Engle & Lott, 1979; Gerathewohl, 1959). However, by the mid 1960's, interests had expanded to include certain social psychological variables (National Academy of Sciences, 1972). Over the following decade, a number of theoretical papers and reviews appeared. The most salient of these included those by Berry (1973), Brady, (1983) Haythorn et al. (1972), Helmreich, Wilhelm, and Runge (1980), Kanas and Fedderson (1971), Rawls et al. (1968), Sells (1966), and Sells and Gunderson (1972). These reviews firmly establish that interpersonal and group variables would be important determinants of crew member performance and well-being in both short- and long-duration space flight.

To provide a basis for common understanding, the terms "isolation" and "confinement" are defined. Isolation implies "separation from" one's usual physical and social surroundings. The concept of isolation may be applied to groups, as well as to individuals. Confinement refers to "restriction within." Since confinement always involves some limitations on an individual's freedom of movement, it necessarily entails his/her restriction to only a portion of their environment. Therefore, all astronauts while orbiting the earth maybe thought of as "separated from" the earth, whereas one or more astronauts may perceive themselves as "restricted within" their working arena. This restriction could be physical (such as not being allowed to space walk), or social (experiencing psychological rejection from the group).

Isolation Studies. Typically, studies in which the isolation effect is predominant are those reporting on the extended underwater cruises of nuclear submarines, or on the scientific expeditions of work groups in the Arctic or Antarctic. These studies are particularly valuable because the nuclear submarine and the remote duty station represent social systems closely resembling that of the space ship on an extended mission (Rawls et al., 1968; Sells, 1966; Sells & Gunderson, 1972).

During the historic undersea voyage in which the nuclear submarine Triton circumnavigated the globe, Weybrew (1963) conducted a factor-analytic study of the crew. Two factors which pertained to the psychological status of the crew where identified. The major identifying variables for the first factor, labelled the "Composite Morale Indicator", were low in morale, fed up, irritable, homesick, not feeling like talking, annoyed, disinterested, feeling like giving up, mouth dry, bored stiff, do not feel like doing anything, daydream a lot, headache, uncomfortable, and frustrated. The variables in the second factor consisted of: sleep difficulties, inefficient, jittery, anxious, excited, feeling closed in, joints and limbs tired, uncomfortable, not feeling like eating, and having tight or hot feelings in the stomach. An additional investigation revealed that depression was associated with the variables in the first factor, whereas tension and anxiety were related with the second factor variables.

In an investigation of personal adjustment to the remote Arctic environment, Eilbert and Glaser (1959) worked with a sample of 648 Air Force enlisted personnel who had been assigned to eight Arctic bases and isolated for periods of 2 to 12 months. Attributing the observed decrements in morale and work efficiency to the effects of Arctic isolation, the authors emphasized that the individuals were deprived of their familiar social stimuli, that they had relatively no privacy, and that the incessant sameness of their perceptual environment led to perpetual boredom and behavioral irritability (Eilbert & Glaser, 1959).

The behavioral effects of prolonged isolation in the Arctic were described by Rohrer (1961) in terms of a phase sequence. In the initial period all individuals experienced a sharp increase in anxiety, irritability, and difficulty sleeping. Work activity considerably reduced these unpleasant experiences. During the second and longest phase, anxiety diminished but feelings of depression increased. Finally, just before leaving the third (and last) phase, emotional expression increased and became less inhibited. Interestingly, sleeplessness, a universal symptom associated with Antarctic isolation, was observed in all three phases. As a rationale for the three-phase sequence, Rohrer (1961) suggested that perception of the threat of danger induces anxiety; reduction and loss of customary social roles leads to depression; and anticipation and increase in work activity brings about labile emotional expression. Inhibited during the second phase, hostility and aggression are more overtly and directly expressed in the third phase.

In summarizing three of their studies, Gunderson and Nelson (1963) described the emotional changes in Antarctic groups during a short pre-winter period, followed by a long (3 to 4 months) confining mid-winter, and ending in a short post-winter season which permitted limited outdoor activities. Sleep disturbances, depression, and irritability were, once again, the characteristic symptoms of the mid-winter period. Gunderson and Nelson (1963) suggested that lack of stimulus variety, both cognitive and affective, and restricted physical activity helped to bring about many of the behavioral changes.

Dividing a period of isolation into three 4-month sessions, Rasmussen and Haythorn (1963) discovered changes in conduct and emotions at an Antarctic station. The changes in symptom frequency were not uniform across the various behaviors. All frequencies were lowest in the first 4 months. Sleep difficulties and apathy were maximal in the second period. Restlessness, irritability, suspiciousness, and uncooperativeness increased progressively and became a common syndrome during the last 4-month period.

Smith (1966) reported the effects of monotony and boredom among members of a seven-man group on a 4-month summer journey across the polar plateau of the Antarctic. One finding was that daydreaming increased. Illusory perceptual experiences occurred with some frequency. Outside liaison personnel became the targets of either severe criticism or superlative praise. (As previously mentioned, similar behaviors occurred on Apollo 9, Apollo 13, Skylab 4, and several Soviet flights as well). Rating each other sociometrically, the group members rated those with whom they were in most frequent contact as their least-desired companions for a future trip. All these behaviors may have reflected the desire for change. Some personnel reported a craving for variety so intense that in their fantasies they anticipated and wished for breakdowns in the equipment (Smith, 1966). Relief from complete predictability of experience is a human need, the denial of which has potentially serious consequences. As Smith (1966) comments:

> The need for change, seemingly at a very high cost, raises the question of what point or combination of factors are necessary before individuals will purposively commit destructive acts, or acts not in their best interests, simply as a means of reducing monotony and boredom. (p.490).

Confinement Studies. As previously mentioned, isolation and confinement effects are very often confounded. Most isolation studies involve some degree of confinement; and confinement is often associated with isolation (Chambers, 1968; Fraser, 1966; Radloff & Helmreich, 1968; Rawls, et al., 1968). A relevant example is provided by the extended submerged voyage of a nuclear submarine discussed earlier. In addition to being cut off from shore (i.e., isolated from their accustomed surroundings), the crew finds the submarine itself a constricted, generally unpleasant habitat. Confinement in this instance involves two types of limiting conditions: restriction to the submarine environment and very compact conditions. Both of the conditions are forecast for long-duration space flight (Bluth, 1980; Oberg, 1983).

In an extended space cabin simulation program, four crew men were confined within a submarine for 60 days (Hunter, 1968). One of the men had also participated in a prototype experiment which deserves description. Prior to a 30-day confinement period, an exacting selection process, with an 8-week training program including eight 3-hour sessions of "social sensitivity training," narrowed the initial 25 applicants down to 4 persons. During the course of the simulation, no behavioral degradation was observed. The crew men maintained high motivation and moral, and no serious difficulties in interpersonal relations emerged (Hunter, 1968).

The follow-on 60-day confinement study was equally well planned. The crew men were selected for emotional stability and compatibility, and functioned smoothly as a team (Hunter, 1968). Provocatively, test performance actually improved over the 60-day period. However, as the experiment progressed, subtle changes in the routine were noted in the crew. For example, scheduled events tended to be neglected more frequently. Interpersonal friction was of minor significance and was never overtly expressed. Complaints (also considered to be minimal), concerned sleep difficulties, food (monotonous), and incessant equipment noise (Hunter, 1968). In summation, the four crew men cannot be said to have found their experience particularly stressful.

In contrast, another 30-day simulation study (The Boeing Company, 1964) used a five-man crew for the assessment of a manned environmental system. This study produced less positive, but possibly more instructive results. There was no opportunity for a rigorous selection or training program. (This would be similar to civilians, sponsored by industry, who would work on the shuttle, or inhabit a space station to conduct research paid for by industry -- Bluth, 19[illegible]). Interpersonal problems were associated by an increase of negativity among the crew. A comprehensive testing program during the 30-day simulation added to personal frustration and irritation. The subjects' mood, affect, and behavioral reactions were reduced, whereas hostility and irritability toward each other and outside personnel increased. Nevertheless, intellectual and psychomotor efficiency showed no deterioration. The items that were the most annoying to the group over the 30-day confinement period were food, noise, toilet facilities, behavior of others, crowding, boredom, and lack of privacy (The Boeing Company, 1964).

A human factors analysis of this study revealed that inadequate equipment design contributed substantially to the irritation and vexation of the crew. The primary difficulties centered around water pumps for drinking and food preparation, the complex toilet facility, and inadequate hallway space. The hallway's structural aspect was a continual source of friction as people attempted to pass one another (The Boeing Company, 1964). Interestingly, about 7% of the existing submariner force is released from this kind of duty because they cannot tolerate these conditions in a nuclear submarine (Hunter, 1968). A similar percentage of people could probably be expected to present a problem on future space flights.

Alluisi and his associates described a 30-day confinement study of two five-man crews (Alluisi, Chiles, Hall, & Hawkes, 1963). The individuals were selected from 36 volunteers in an Air Force pilot training class. Astronaut criteria were used. The men were given a short but adequate training program (i.e., according to a criterion). During this time they were familiarized with four individual and two group performance tasks which comprised their workload. The two crews alternated working and resting each 4 hours. The crew-compartment mockup in which they lived was 1100 feet in volume. In the earlier phase (consistent with Rohrer's 1961 findings), all subjects experienced irritability and sleep difficulties. Morale, which was initially high, dropped within a few days but remained steady at the lower level thereafter. The universal and frequent complaint was boredom as the tasks and program became well learned and routine. Despite these minor difficulties, the general picture was one of improvement in work performance over the course of 30 days, even though morale decreased (Alluisi, et al., 1963).

Confinement studies by Soviet scientists (Hicks, 1964) yielded results similar to those obtained by American investigators. Data were reported on subjects confined to test chambers for periods of 10 to 120 days. After adaption to a 10- to 15-day period of confinement, some stabilization of functions developed. This stabilization was followed by a period of relative deterioration wherein sleep was disturbed, fatigue increased, and work capacity was reduced. There was also an increase in irritation and some evidence of depression. Morale was improved, and deterioration lessened, by meaningful activity, responsibility, and knowledge of the purpose and structure of the tasks to be performed (Hicks, 1964). These constructs have potentially important implications for the training scenario of astronauts, particularly for long-duration space flights. Perhaps this is how the Soviets are attempting to increase their time in space -- to even longer than they have already achieved.

Individuals living in groups isolated for relatively long periods of time present a typical pattern of emotional reactivity. This is characterized by anxiety, irritability, depression, and hostility -- the latter frequently suppressed. In addition, pronounced disturbances in the sleep pattern are consistently observed. But despite these seemingly debilitating influences, no serious decrement in work tasks, psychomotor or intellectual performance was reported (Parker &

Evergy, 1972). These constructs also have important implications for the training scenario of astronauts, especially for long-duration space flights.

Isolation and Confinement. NASA has also funded a number of simulation studies relevant to space flight. These have included behavioral research in submersibles, such as the Ben Franklin undersea behavioral experiments (Seitz et al., 1970) and the series of Tektite studies (Deutsch, 1971; Helmreich, 1971; Nowlis, 1972).

In the 30-day Ben Franklin study to determine reactions to confinement and isolation, a crew of six men was towed in a submersible vessel down the East Coast. The desire to participate -- not compatibility -- was the main factor in crew selection. As the mission progressed, the crew showed a trend toward withdrawal and an increased need for privacy. Very little group activity took place. Tension increased gradually, and all volunteers had difficulty sleeping. A major conflict arose between the occupants of the submersible and the surface staff, resulting in failures and misunderstandings in communication. As a result of the communication breakdown, outbursts of anger and frustration were commonplace. Consequently, the topside command became targets for the release of the aquanauts' frustrations. Again, these same trends occurred on the Mercury (Collins, 1974), Apollo 9 and Apollo 13 (Bluth, 1981; Cooper, 1976), and Skylab 4 flights (Bluth & McNeal, 1981) and on several Soviet flights (Bluth, 1981; Brady, 1983; Lomov, 1979) as well. It is notable that indications about these interpersonal difficulties did not show up in interpersonal testing (Ferguson, 1970; Vinograd, 1974).

Interestingly, such conflicts did not develop during the Tektite experiments, 11- to 20-day missions with crew sizes ranging from four to 10 members. Specifically addressed by the Tektite experiments were crew selection, composition, and command structure/leadership. There was a degradation of performance as mission tasks grew more complex. The aquanauts felt very little anxiety or depression during their stay in the habitat. As a result, few conflicts were noted. A possible explanation for this would be that a two-way video link seemed to reduce feelings of isolation and overt hostility toward remote operational personnel. Individual gregariousness was positively associated with performance. The scientists concluded that vehicle design should provide for variability (particularly visual), good food with minimal waste, adequate work aids, individual privacy, adequate garbage disposal, and must avoid "multiple-use" spaces. Once again, the researchers found that "personality measures given prior to the dive failed to predict adjustment" (Vinograd, 1974).

A number of vital questions must be answered before a space crew is launched on a long-duration space flight. Will similar emotional reactions be likely to occur, and if so, what effect will these have on the success of the mission? It should be remembered, as previously stated, that during certain (short-term) Apollo and Skylab space missions, hostilities arose and had a debilitating influence on mission effectiveness. The Soviets discovered that as mission length increased, the severity and frequency of hostility and irritability also increased; whereas judiciousness decreased (Bluth, 1981; Brady, 1983; Oberg, 1983; Stupnitskiy, 1979).

Are there any preventative measures that can be employed to reduce the behavioral adversities associated with long-duration space flight? According to the only group of people who have experienced long-duration space flight (e.g., the USSR), intensive preflight training in psychologically related; as well as changes in their operational procedures, has extended their duration of space flight from 139 days to 211 days ("Two Soviet Cosmonauts", 1982). Unfortunately, their knowledge is not available to us at this time. Therefore, the research literature on group composition seems a logical and necessary area of investigation.

III. VARIABLES AFFECTING GROUP INTERACTION

What sort of human can endure the utter isolation and severe confinement of a long space voyage? What sort of crew can make the voyage a successful one? According to several authors, these are questions of selection and, ultimately, of group composition (Brady, 1983; Helmreich, 1980; Nicholson & Pardoe, 1972; Sells, 1966). Most programs selecting personnel for work in isolated and confined backgrounds (e.g., submarines, Arctic, Antarctic) have emphasized the background, training, personality, interest, and aptitude characteristics of individual applicants or volunteers (Gunderson & Nelson, 1963; Weybrew, 1963). This is the traditional approach, especially where membership in such a group is sizeable (Flinn, Hartman, Powell & McKenzie, 1963). However, in the case of small groups such as astronaut crews, where the interaction and interdependencies demand cooperative functioning and team orientation, another approach might prove to be more beneficial. A selection program directed toward identifying the most effective "crews," rather than merely "qualified individuals," would seem to be a logical approach. In addition, research on team performance and human factors issues are applicable for an effective work force in space. The interested reader is referred to reviews by Singer and Collins (NRC/NAS In Preparation), Steiner (1972, 1976), and Thorndyke (1980) for additional information on these topics.

Compatibility. The identification of effective crews would almost certainly involve the notion of compatibility. Although not always stressed, this concept has been implied as a necessary element in crew selection (Parker & Evergy, 1972; Sells, 1966). American researchers are not alone in this view.

Compatibility, however, is but one aspect of a broader problem which includes leadership and group composition. The effects of these two constructs on group cohesiveness and group performance are also considered to be relevant for the space traveler (Bluth, 1981; Brady, 1983). Some investigators Festinger, 1954; Newcombe, 1953; Zander & Havelin, 1960) claim that similarity among members generates group cohesiveness. Other researchers believe that similarity in member characteristics have no such effect (Seashore, 1954) or that dissimilarity is more likely to increase group cohesiveness (Gross, 1956). Comparable divergence is found with regard to group problem solving and creativity. On the one hand, heterogeneous groups (in attitude, age, personality, etc.) are said to be more creative or more effective in problem solving than are homogeneous groups (Hoffman, 1965). However, this would not always be expected to occur, since heterogeneous groups have historically had greater communication difficulties (Triandis, 1960). It is quite possible that a combination of homogeneity and heterogeneity would be the most effective. Again, the androgynous person concept postulated by Helmreich (1980) supports this view as well. Triandis, Halle & Ewen (1965) found that dyads who were homogeneous in ability but heterogeneous in attitudes were more creative than dyads who were homogeneous in both these respects. McGrath and Altman (1966) came to the conclusion that "there is very little research on group composition, and what little there is gives an unclear picture of the role of composition."

An additional factor to consider in group composition is cohesiveness. Highly cohesive groups exert pressures on their members to act in certain uniform ways (Back, 1951). In industrial settings, high-cohesive work groups maintain more uniform production levels and manifest less anxiety than do low-cohesive groups (Seashore, 1954). Highly cohesive groups also work harder independent of supervision (Berkowitz, 1954; Cohen, 1957). Particularly relevant to future astronauts is Cartwright's (1968) summary of the consequences of group cohesiveness:

> Other things being equal, as cohesiveness increases, there is an increase in a group's capacity to retain its members and in the degree of participation by members in group activities. The greater a group's cohesiveness, the more power it has to bring about conformity to its norm and to gain acceptance of its goals and assignment to tasks and roles. Finally, highly cohesive groups provide a source of security for its members, which serves to reduce anxiety and to heighten self-esteem (p.181).

Cohesiveness. Direct research on the cohesiveness of groups in space settings is relatively sparse. The General Electric (1964) and SEALAB II (Radloff & Helmreich, 1968) experiments attempted to study cohesiveness, with apparently contradictory results. The General Electric study contrasted between an experimental (30-day confinement) group and a control (non-confined) group. Before confinement, both groups were equivalent on the cohesiveness index. After 14 days, the confined group's cohesiveness dropped sharply and continued this downward trend for the remaining 16 days of the experiment. No drop in cohesiveness was noted for the non-confined group. Group performance remained relatively constant, and no overt indication of antagonism or hostility were observed for the confined group. The authors concluded that good personal integration and emotional control persisted, despite a reduction of group and member attractiveness (group cohesiveness) which lasted up to 20 days following the experiment.

SEALAB II used an index of cohesiveness based on sociometric choices obtained pre- and post-submergence. When asked, after the experiment, whom they would choose as team mates in a future SEALAB II experiment, the aquanauts included significantly more members of their present team than they had prior to their submergence. This increased cohesiveness result was consistent across three teams of aquanauts (Radloff & Helmreich, 1968).

These discrepant outcomes could be explained by the relatively boring, non-threatening situation which characterized the General Electric (GE) study versus the dangerous, interdependent existence in a SEALAB environment, where each person's life depends on the supporting activities of another. In the GE experiment, new companions might well have been desired for the sake of variety, whereas in the SEALAB experiment, the proven and trusted competence of previous team mates became the overriding consideration in selecting coworkers for a subsequent submersion mission.

In general, research literature has shown that threat from an external source tends to increase the cohesiveness of the group (Lott & Lott, 1965), a conclusion also supported by Lanzetta (1955). Schacter's (1959) experiments on affiliation provide rationale for this effect. Schacter found that experimentally induced anxiety arouses in an individual a desire to be with others in order to reduce his anxiety and to determine an appropriate course of action. The results, then, of SEALAB II provide another example of the tendency of the group under stress to become more cohesive. Interestingly, Helmreich (1966) extended Schacter's affiliation research (1959) to the SEALAB II experiments and found that first-born and only born children were significantly more frightened and showed significantly poorer performance than later-born men (Helmreich, 1966). Helmreich's research (Doctoral Dissertation) was done in conjunction with Project SEALAB II.

However, in the work of Haythorn (1963; Haythorn & Altman, 1967), the results are not as straightforward. Haythorn and Altman (1967) structured pairs as homogeneous and heterogeneous with regard to four personality dimensions: Dogmatism, Need-Dominance, Need-Achievement, and Need-Affiliation. Nine of these two-man groups were assigned to isolation conditions; an equivalent set of nine groups served as controls. Each isolated two-man crew worked in a confined 12- X 12-foot room in which they worked, rested, and slept, never once leaving it throughout a 10-day period. Control groups worked each day in the same type of room but slept in their own barracks at night. They also left their rooms for meals and for brief rest periods between tasks. After completing the tasks, they were free to go elsewhere and use the remaining time as they wished.

The results were complicated and diverse, and sometimes counterintuitive. Isolation, however, had a pronounced overall effect. Of the nine isolated groups, two were not able to persevere for the 10-day period and were dissolved; and two others developed such serious antagonism (verbal abuse, hostile suggestions, etc.) between members that intervention was deemed necessary. (Interestingly, similar behavioral aberrations, described earlier, occurred on certain Apollo and Skylab missions.) Three of these four "troubled groups" were homogeneously high on need-dominance and two were heterogeneous in regard to Need-Achievement. These four "isolated groups" -- out of the nine total "isolated groups" -- became incompatible after only a week or so in isolation. This failure stemmed from the unique environment of isolation. Of the nine control groups, none aborted, and none showed this degree of difficulty.

Therefore, more research using Need Dominance and Need-Achievement measures as predictor variables in isolation settings needs to be accomplished.

In regard to task performance of the groups, the general hypothesis concerning the effect of isolation was not borne out, for the isolated groups performed more effectively than did the non-isolated groups (Haythorn & Altman, 1967). Also, the personality variables were generally contradictory to expectations. Dyads, incompatible with respect to Dogmatism, Need-Achievement, and Need-Dominance performed better than did dyads compatible in these respects. However, the compatible Need-Affiliation dyad performed better than its incompatible counterpart.

Crew Size and Performance. Since the space program is changing to include more astronauts per mission, a research area that would seem worthy of future exploration would be: What effect will crew size have on the astronauts and the mission? Although the studies are sparse, theoretical comparisons are possible among crew size, performance, and satisfaction.

U.S. space missions thus far have involved primarily two-person groups (dyads) or three-person groups (triads). It is considered feasible to establish orbital bases in the future involving 10 to 20 people (Schlitz, 1983). Subject availability and other practical considerations have discouraged laboratory studies of groups larger than three or four. However, naturalistic studies in underwater and polar environments, in fallout shelters, and in organizational settings provide some basis for forecasting the effects of size variation within the small-group range. Nevertheless, any forecasts must be considered highly tentative, pending the results of experiments which better capture the conditions associated with prolonged space travel.

Steiner (1972, 1976) and Kleinhaus and Taylor (1976), among others, have reviewed the effects of group size on problem solving and other measures of performance. They suggest that increasing group size has three general categories of effects which influence performance. These categories are pooling effects, motivational effects, and organizational effects.

Pooling effects refer to the aggregation of knowledge, abilities, and skills within a group (Steiner, 1972). Adding additional members to a crew increases the potential range of cognitive and manual resources that are available, thereby boosting the crew's performance potential (Steiner, 1976). The incremental benefit of adding new crewmembers will decrease as the crew becomes very large, because of the greater likelihood that some abilities and skills will become over-represented within the subject pool (Kleinhaus & Taylor, 1976). This may occur despite careful selection procedures.

Pooling effects should result in larger crews' having greater performance potential than would smaller crews. However, other consequences of increasing crew size may make it difficult for this potential to be fully realized (Steiner, 1976).

Motivational effects refer to the impact of group membership on individual involvement and commitment to pursue group goals. This is a complex array of effects which, depending on the situation, may undermine or improve individual performance.

Organizational effects refer to the consequences of activities which are intended to coordinate group members and structure or pattern interaction within the group. The larger the group, the more time and effort may be required to attain efficiency, due to extraneous activities. Also, more time and effort may be required for the maintenance of interpersonal coordination (Steiner, 1976). Organizational effects are typically cast with adverse connotations.

A simultaneous consideration of pooling, motivational, and organizational effects leads to the hypothesis that as the size of the space crew increases, there may be a reduction of benefits. The rates at which pooling, motivational, and organizational effects are likely to occur cannot be specified with precision, but the general expectation is that performance will first improve and then deteriorate with increasing crew size. This implies an inverted-U relationship between crew size and individual performance, with maximum performance being associated with crews of intermediate size (minimal redundancy) (Kleinhaus & Taylor, 1976). The exact number of individuals required for optimal group performance during space flight is, of course, contingent on the nature, magnitude, and structure of the task.

<u>Crew Size and Satisfaction</u>. The size of space crews will affect both individual and collective performance. Whether large crews are associated with better or worse overall performance will depend upon many variables. Among the broad array of variables already viewed, another variable of interest is member satisfaction (Bluth, 1980, 1981; Bluth & McNeal, 1981). Increasing crew size increases the number of possible dyadic relationships within the crew according to the formula $(N^2 - N)/2$, where N is the number of people in crew (Sells & Gunderson, 1972). Thus, while a three-per-

son crew could generate three dyadic relationships, a six-person crew could generate 15 dyadic relationships and a 12-person crew could generate 66 dyadic relationships.

Thus far, social psychologists have tended to emphasize the adverse effects that increasing group size has on individual satisfaction, motivation and commitment. First, it has been suggested that the larger the group, the less responsible each member may feel for the group's actions. As a result, ego involvement is low (Darley & Latane, 1968). Second, the larger the group, the less visible individual performance, with the result that good performance may go unrecognized and poor performance unpunished (Darley & Latane, 1968). Third, the larger the group, the more thinly distributed are social recognition and other rewards that follow from good performance (Radloff & Helmreich, 1968). Fourth, the larger the group, the less likely that the individual member can deepen commitment by making meaningful inputs to the decision-making processes (Kleinhaus & Taylor, 1976). Finally, it has been suggested that large groups sometimes encourage conditions (such as anonymity) which, in turn, give rise to nonproductive or even destructive behavior (Diener, Dineen, Endressen, Beaman, & Fraser, 1975; Diener, Westford, Diener, & Beaman, 1973; Festinger & Thibaut, 1951; Singer, Brusch, & Lublin, 1965).

Several field studies of isolated and confined groups report somewhat different findings. However, the evidence from studies of isolated and confined groups is a bit sketchy, and is complicated methodologically by the problems that relatively large groups may be stationed at a relatively comfortable main base, while at the same time, small groups may have been located in primitive quarters which offer few of the main base's amenities. Keeping these confounds in mind, a review by Smith (1969) suggests that fewer emotional and interpersonal problems occur in larger groups than in small groups during isolation and confinement. Supporting this view Doll and Gunderson (1969) found that Antarctic parties varying in size form 8 to 10 reported less in the way of compatibility and accomplishment than did parties ranging in size from 20 to 30. In another study, these same authors (1971) found that military personnel stationed at small bases were more hostile than their counterparts at more heavily populated bases. Although cross-study comparisons are difficult, it is interesting to not that Georgia Fallout Shelter Studies (Hammes, Ahearn, & Keith, 1965; Hammes & Osborne, 1965; Hammes & Watson, 1965), which imposed very spartan conditions on large groups, had very few interpersonal problems and very low defection rates.

However, the crew size-interpersonal compatibility relationship is not well understood. Because few studies have involved varying group size while holding other variables constant, the necessary knowledge for making a confident prediction is lacking. A basic research question concerns identifying the function of the relationship between crew size (particularly over the range from about 2 to 30 crewmembers) and social satisfaction. Any attempt to rate the experimental studies on group size, performance, or satisfaction is difficult due to the questionable comparability of these groups. Additionally, the relatively short intervals of time studied in some experimental and field studies impose yet another confounding factor.

IV. ASSESSMENT PROCEDURES

Assessment Needs. Crews of astronauts and scientists represent an area of mixed backgrounds, discipline, training, language, and goals. Past experience has shown that interactions between scientists and non-scientists in the Arctic and Antarctic and on oceanographic research vessels has been an area of tension and authority conflict (Bernard & Killworth, 1974; Bluth & McNeal, 1981; Kanas & Fedderson, 1971; Vinograd, 1974, 1976). In the early days of the American space program, status distinctions between scientists and pilots were also present and were not always happily remembered (Wolfe, 1979). There were misunderstandings over mission priorities and scientific objectives. The scientific aspects of a mission were not always considered to be of major importance (Cunningtham, 1977; Wolfe, 1979).

Cultural and background differences have been identified as disturbances that affect intercrew tranquility on oceanographic vessels. Also, crew demands sometimes interfered with the research objectives for which the cruise was funded; and at times, one scientist's work interfered with that of another, causing friction and stress (Helmreich, 1977). In one extreme case, the crew threw overboard all the collected specimens in an expensive expedition because of a misunderstanding over the use of the ship's freezers (Benard & Killworth, 1974). These interpersonal, professional misunderstandings could continue to occur between scientists of eclectic backgrounds and the astronaut commander. Some type of educational intervention appears to be necessary to rectify the problem of interpersonal conflict, between scientist and non-scientist (Bluth, 1980).

It could be argued, however, that the Skylab Program had a professionally mixed (e.g., scientists and non-scientists/pilot) astronaut crew. Nevertheless, except for skylab 4, no major conflicts developed. However, in the Skylab situation the crews trained together for many years, and each scientist was considered a full-time astronaut. This will not be the case in shuttle missions with payload specialists (i.e., individuals with special skills to accomplish the goals of a particular space flight) who are to fly for one time only and are oriented toward the successful, stressful, and ego-involving accomplishment of their assigned experiments.

The evolutionary changes in space missions, objectives, training, crews, and leadership paradigms can be seen in Figure 1. The flight crews from Mercury up through Skylab were small, homogeneous units (Brady, 1983). All crewmembers had trained together over a long period of time, in countless situations. Consequently, a coherent team developed, with little actual professional or status differentiation (Bluth, 1981). Experiments and objectives were carefully worked out, and outcomes were predictable for the most part. Since mission objectives had been clarified, from the initial Mercury program through the Apollo missions, little emphasis was placed on leadership styles. However, considering the interpersonal hostility aboard Apollo 9, Apollo 13, and Skylab 4, perhaps more attention should have been paid to leadership skills.

During Skylab, some experiments were more open-ended, but that was the exception, not the rule. However, with the coming of a Spacelab, important changes will emerge (Helmreich, 1983). The crew will no longer be homogeneous. There are important differences between astronauts, mission specialists, and payload specialists. Training is not the same for these different professionals. The commander and pilot are all trained, with full astronaut status. The mission specialist has astronaut status, but is not trained as a pilot. Payload specialists have only 1 year of training in space safety (Montemerlo, 1982). These latter crewmembers are not astronauts in the traditional sense of the term. These individuals are not spacesuit qualified and are not pilots (Montemerlo, 1982). With the separation of training and the significant professional distinctions, an important status differentiation emerges. It is felt that these differences could hinder or jeopardize the success of long-duration space flight. To minimize interpersonal friction, formal training in leadership theory, small-group behaviors, and the careful selection of crews for optimum capability needs to be addressed. Each of these constructs will be discussed in turn, following a historical description of psychology's role in selecting astronaut candidates.

SPACE STATION OBJECTIVES

MISSIONS	OBJECTIVES	TRAINING	CREW	PARADIGM
MERCURY TO APOLLO	PREDICTABLE	EXTENSIVE HOMOGENEOUS	1-3 ASTRONAUTS	FORMAL
SKYLAB	PREDICTABLE	EXTENSIVE HOMOGENEOUS	3 ASTRONAUTS	FORMAL
SHUTTLE-SPACELAB	MAINLY PREDICTABLE	DIFFERENTIATED	3-10+ ASTRONAUTS + PAYLOAD CREW WITH MIXED GENDER	FORMAL
FUTURE SPACE STATIONS	MAINLY PREDICTABLE/ VERY MODIFIABLE	DIVERSE	10-30+ MIXED GENDER ASTRONAUTS AND SCIENTISTS	FORMAL TO SEMI-FORMAL

FIGURE 1

Current Assessment Procedures. Since the inception of the manned space program, there has been an emphasis on selecting only those astronauts who would be the most psychologically resistant to those problems that could result from the exotic, stressful, and unforgiving environment of space (Brady, Bigelow, Emurian, & Williams, 1974; Fine & Jennings, 1966; Grether, 1962; Hartman & Flinn, 1964; Kanas & Fedderson, 1971; Ruff, 1959a). The selection procedure of the initial 31 military test pilots to the astronaut corps included comprehensive medical and physiological tests. Fifteen psychological tests were also administered (Grimwood, 1964; Lamb, 1963; Wilson, 1959). The 15 tests used for astronaut selection primarily examined the neuropsychological and personality traits of the applicants. A multi-modal approach, using self-report, projective techniques and biochemical assays, was employed to obtain only the most qualified astronauts and to eliminate individuals having psychopathologies (Flinn et al., 1963).

Regarding the psychological selection requirements for potential astronauts, the emphasis was to select an individual who possessed certain desirable traits or characteristics, and would be unlikely to have any problems. An individual was sought who had a high degree of intelligence, preferably characterized by mathematical and spatial aptitudes (Flinn et al., 1963). The Wechsler Adult Intelligence Scale (WAIS), the Doppelt Math Reasoning Test, and the Minnesota Engineering Analysis test were selected for measuring the presence of these intelligence traits in the Mercury and Apollo space programs. For the selection of the space shuttle astronauts, the Shipley Institute of Living Scale replaced the WAIS, and the Miller Analogies Test was used for measurement of general intelligence and verbal achievement (Patterson & Jones, 1982).

In addition to a minimum IQ of 132, the astronauts for the Mercury, Apollo, and space shuttle flights needed to be well adjusted (Flinn, et al., 1963; Lamb, 1963; Patterson & Jones, 1982). Along with the ability to work closely with others (which was evaluated daily), astronauts were also expected to tolerate extreme isolation without undue anxiety. This aspect was measured by using sensory deprivation experiments (Imus, 1961; Sells & Berry, 1958). The astronaut candidate was also expected to possess the necessary flexibility and adaptability to meet any emergency without psychological disintegration (Kubis & McLaughlin, 1967; Novosti, 1977; Wilson, 1959). However, this characteristic was subjectively evaluated by nonpsychological "experts". Psychologists were not allowed to provide input into these so-called "operational" matters (Brady, 1983; Helmreich, 1983).

Behavior indicative of a deliberate, rather than an impulsive person was also deemed critical (Ambler, Berkshire, & O' Connor, 1961; Bair & Gallagher, 1958). Additionally, the candidates' motivation for volunteering in the space program was to be mission-oriented rather than based on a personal need for achievement (Beyer & Sells, 957; Wilson, 1959). The presence of these traits was subjectively determined by observations of the astronauts' behavior during their rigorous daily activities. A post-hoc analysis of the astronaut volunteers showed that volunteers were superior to non-volunteers on aptitudes, preflight performance, flight grades and motivation (Ambler, et al., 1961; Wilson, 1959).

Thus, the existence of desirable traits in the astronauts was evaluated by psychological tests, interviews, and daily observations of behavior and performance under stressful test conditions (Flinn, et al., 1963). It should be noted that 4 of the 31 astronaut finalists (out of 500 hopefuls) were eventually eliminated for potential psychological inadequacies (Ambler, et al., 1961; Flinn, et al., 1963; Hartman & Flinn, 1964).

The projective tests used in the initial screening procedure included: the Rorschach Inkblot, Thematic Apperception Test (TAT), Draw-a-Person Test, and the Bender Visual Motor Gestalt test. These tests were used to tap into the persons' pre/subconsciousness (Trego & Sells, 1970). The theory behind using the projective approach was to ascertain if repressed material existed (Beck, 1950; Brockaway, 1954; Rapaport, 1979) which could cause problems for the prospective astronaut (Patterson & Jones, 1982; Trego & Sells, 1970).

For the selection of astronaut candidates to the space shuttle program, additional psychological tests were used. These tests included the Schedule of Recent Life Events (SRE), the Rotter I-E Scale, and the Jenkins Activity Survey (JAS) (Patterson & Jones, 1982).

The underlying assumption of the SRE is that life changes per se are stressful and that behavioral aberrations are more apt to occur as the number of major life stressors increases above a certain critical level. However, the SRE fails to discriminate between positive and negative stressors. After reviewing other major life change scales, the SRE was considered most appropriate since all that was sought was an indication of each candidate's recent life stress (Patterson & Jones, 1982).

Another psychological instrument used for the selection of astronauts was the Rotter Internal-External (I-E) Scale. The Rotter I-E Scale is concerned with measuring differences between individuals' perceptions of the degree to which events are controlled by means available to them (Rotter, 1966). This perspective suggests that some persons believe in their capacity to manipulate events to facilitate accomplishment of personal goals (internal perspective). Other persons feel that goal achievement is dependent on decisions, forces, or circumstances over which they have no control, or upon means to which they have no access (Rotter, 1966). Rotter's I-E scale provides a means for measurement of this orientation. An internal perspective was deemed as a more desirable trait for the astronaut candidate than an external perspective (Patterson & Jones, 1982).

The Jenkins Activity Survey (JAS) was chosen as a suitable psychological instrument to classify each astronaut candidate's personality as either Type A or Type B (Patterson & Jones, 1982). The JAS was used, instead of the more lengthy structured interview, because of the time allotted for the psychological screening tests. The JAS is a paper-and-pencil test which is objectively scored and interpreted. This test is content-oriented, with classification based upon the astronaut candidates' descriptions of their own behavior. The JAS asks questions relative to how fast subjects perform tasks, how they respond to waiting, and how involved they are with their work (Jenkins, Rosenman & Friedman, 1967).

In addition to the psychological tests, interviews, and observations of performance under stressful conditions, the physiological measures of the astronaut candidates' catecholamine and 3-methoxy-4-hydroxymandelic acid excretion levels were provided by the physicians (Gold. 1959). Thus, a multi-modal research approach (self-report, behavioral observation, and biochemical measures) was used, and still is being used, for the initial selection of astronauts (Patterson & Jones, 1982).

Additional Psychological Variables that Need to be Assessed. A number of factors have been mentioned, thus far, regarding the selection of astronauts. These include psychological adjustment, extensive flight experience (the original Mercury Astronauts were all test pilots), and scientific training (in the case of the later Scientist-astronauts). Thus far, the primary psychological and psychiatric emphasis has been on detecting psychological pathologies, with little emphasis placed on selecting those astronauts who would be the most "psychologically compatible" (Brady, 1983; Flinn, et al., 1963; Helmreich, 1983; Patterson & Jones, 1982; Wilson, 1959).

As previously noted, inter-crew friction had developed which impinged on mission performance, causing cancellation of certain experiments (Bluth, 1980; Cooper, 1976; Oberg, 1981, 1983). To avoid the reoccurrence of this problem, perhaps a better approach for the manned space program, in addition to screening for psychological problems, would be to select for advantageous (i.e., crew-oriented) psychological characteristics. These characteristics would be general enough to be applicable to all space missions, and include cooperativeness, need-achievement, masculine-feminine traits, and leadership skills.

Cooperativeness. Space voyagers will perform highly interdependent ventures which require cooperation for success. According to McClintock (1972; McClintock, Moskowitz & McClintock, 1977), people vary in terms of their interests in coordinating their efforts for mutual gains. He postulates three potential types of motivation.

"Own gain motivation" refers to a preference for doing as well as one can for oneself, regardless of how one's choices affect other people. If it is personally beneficial to choose a course which happens to benefit someone else, knowledge of the likely harm has little deterrent effect (McClintock et al., 1977).

"Relative Gain motivation" prompts one to receive a higher level of rewards than the other people in the relationship. The important consideration for the person governed by relative gain motivation is to "best" other people by always "coming out on top" (McClintock et al., 1977).

"Joint gain motivation" refers to preferences for courses of action which produce benefits for other people, as well as for oneself. Joint gain motivation includes both a sensitivity to other peoples' needs and a concern for their welfare (McClintock et al., 1977).

McClintock and his associates hypothesize that each person is more or less consistently governed by one of these three motives (Maki, Thorngate, & McClintock, 1979; McClintock, 1972). Each motive is believed to stem from early childhood socialization and reflects both familial and cultural values. A better understanding of these motives may prove beneficial for selecting the most compatible astronaut crew for long-duration space flight. A means of measuring cooperativeness in potential astronauts could be through the use of a confederate (i.e., another astronaut in a training situation).

Need-achievement. Relevant to cooperativeness is Helmreich's work on need-achievement (Helmreich et al, 1980). Classically, need-achievement has been defined as a persistent preference for engaging in success-related activities (Atkinson, 1958; Atkinson & Birch, 1978). People with high need-achievement have many admirable qualities, but problems may arise onboard a space vehicle if attaining standards of excellence involves "prima donna" behaviors or a put-down of other members of the crew. According to Helmreich, need-achievement can be reconceptualized as the involvement of three independent factors. "Work orientation" refers to motivation to work hard because work is valuable activity in and of itself. "Mastery orientation" refers to a desire to continually improve one's own best performance. "Competition" refers to an attempt to do better than other people. Helmreich et al. (1980) hypothesized that the combined interests of task accomplishment and social compatibility will be best served if crewmembers show a strong work and mastery orientation but relatively little competitiveness. The rationale is that competitive individuals are likely to create interpersonal stress and hostility. The tension that results could adversely affect collaborative performance and further undermine the quality of a challenging social environment, the quality of which has already been sapped by the conditions of life in space (Helmreich et al., 1980).

The need-achievement hypothesis is intriguing, given the competitive orientation of the early astronauts (Cunningham, 1977; Wolfe, 1979). The available evidence suggests that work orientation and mastery orientation positively correlate with performance, and competition negatively correlates with performance (Helmreich et al., 1980). Additional research is required to test this hypothesis under conditions analogous to extended-duration space flight. In addition, it might be of interest to explore the possibility that the extent of the frictions generated by one crewmember's competitiveness may vary as a function of the orientations of the other members of the crew.

Masculine and Feminine Traits. Research by Helmreich, and others, has focused on the study of masculine-instrumental traits and feminine-expressive traits as measured by the Personal Attributes Questionnaire (PAQ) (Helmreich & Spence, 1976; Helmreich, Spence, & Holahan, 1979; Spence & Helmreich, 1978). Masculinity and femininity were long considered to be the end points of a psychological continuum, with all individuals falling somewhere along this continuum (Helmreich, et al., 1979). This formulation bore the additional assumption that the possession of one attribute (i.e., masculinity) necessarily implied the lack of the other. A number of investigators have questioned the validity of this historic assumption and considerable research has supported a redefinition of the psychological natures of men and women (Ickes & Barnes, 1978; Helmreich et al., 1980; Klein & Willerman, 1979; Spence & Helmreich, 1978).

Psychological masculinity has recently come to be defined "as a constellation of attributes denoting an instrumental, goal-seeking orientation", whereas femininity has been defined "as a set of characteristics reflecting psychological expressivity and sensitivity to the feelings and needs of others" (Spence & Helmreich, 1978). Research by Helmreich and Spence; Helmreich et al., 1980; Spence & Helmreich, 1978; Spence, Helmreich, & Holahan, 1979) suggests that some individuals of both sexes, who score high in masculinity and femininity (i.e., labeled as psychologically androgynous) appear to have a number of important advantages. For instance, they have the capacity for both goal-seeking instrumental behavior and for interpersonal sensitivity. The extent to which these capacities are exercised depends largely upon situational demands. These androgynous people appear to have positive self-concepts, as well as rewarding interpersonal relationships. (Helmreich and his associates carefully separate the capacity for instrumental and expressive behaviors from other sex-linked behaviors and from gender/role preference).

Furthermore, other laboratory research suggests that strong instrumentality, combined with interpersonal sensitivity, is associated with enhanced task fulfillment and more rewarding social interactions (Ickes & Barnes, 1978). These concepts would appear to represent highly desirable traits for astronauts selected for prolonged-duration space missions. Additionally, the measurement of these traits are made very simple by using the PAQ. The inclusion of the PAQ into NASA's operational inventory would seem promising for reducing the interpersonal conflict historically associated with long-duration space flight.

Leadership Traits. In this section some social processes that are likely to occur among space crewmembers will be addressed. The specific topics to be considered include leadership, cohesiveness, and changes that can be expected over time.

The increasingly important role that leadership will have to play in long-duration space flight is a critical factor for future successful space missions (Hauty, 1958; Haythorn, McGrath, Hollander, Latane, Helmreich & Radloff, 1972; Jacobs, 1971). As space travel becomes more routine, public interest is expected to wane (Brady, 1983; Helmreich & Spence, 1976). The effect of diminished public interest could result in a lessening of the astronaut's personal inhibitions and thereby cause more frequent interpersonal conflicts during the space mission (Leonov & Lebedev, 1975). Also, with the cadre of civilian scientists -- turned space travelers -- steadily increasing, the challenge for effective leadership will expand as well (Bluth, 1981). Unfortunately, one of the most valuable of all human commodities, the leadership ability of people, still remains an elusive, complex entity, which is best quantified during or after a mission (Brady, 1983; Helmreich, 1980). However, since astronauts have not yet experienced any truly long-duration space flights (as have the Soviet cosmonauts), direct observations and post-hoc debriefings are not available to assist us in discussing leadership.

Leadership involves the application of a flexible, continuous process by which the leader uses institutionally designated power and personal charismatic authority to persuasively influence individuals (Fiedler, 1971; Havron & McGrath. 1961). According to Hollander (1978), leaders exercise their influence for the following purposes: to meet challenges posed from without, to set goals, to maintain group harmony, and to interpret conditions which are threatening to the group. For the leader to be effective, the power to exert influence must have been conferred through appointment by a higher authority, or from the group itself (Cooper, 1966; Ivancevich & Donnelly, 1970). Authority is concerned with influence which is generated from occupying a specific place in the organizational hierarchy (Ivancevich & Donnelly, 1970). Power suggests that one individual has something that another individual, or group, wants or needs, and that influences the latter's actions (French & Raven, 1958).

Drawing from these definitions, the effective astronaut leader would be expected to judiciously exert power, in a cooperative manner, to facilitate the interpersonal processes involved in establishing, planning for, accomplishing, and evaluating mutually desired professional objectives. Therefore, the commander of the space vehicle must possess the discernment required to transform power and authority into influence in order that appropriate sharing, learning, or change can occur within subordinate individuals or groups.

Although one group member may be elected or appointed leader and assigned distinguishing tokens of status and rank, the leader/followership distinction is oftentimes blurred (Fleischman, Harris, & Burtt, 1955; Fiedler, 1971; Fiedler, Chemere & Mahar, 1978). Leadership is a relational concept, with the result that the person who is leader from an initial perspective is a follower when viewed from another outlook (Hollander, 1978). In any multi-level, hierarchical structure, most people will fill both leader and follower roles. This process necessitates that the leader voluntarily, albeit temporarily, relinquish the leadership role in a particular group, and assume that role of follower (Fiedler, et al., 1971, 1976). Such instances are easily imaginable when one considers the technological complexity that comprises a space vehicle and the resulting shifts in responsibility that necessarily accompany technical demands in-flight. Therefore, the space leader's desire to assist the group in accomplishing its objectives should take precedence over a temporary status change (Maloney, 1979).

Other leadership variables include autocratic and participative leadership styles. Leaders who make decisions without soliciting subordinates' inputs are said to use autocratic procedures. Leaders who solicit subordinates' inputs are said to use participative or consultative decision making -- where the leader seeks opinions of the rank and file.

Early "leadership climate" research undertaken on the eve of World War II suggested many advantages to the democratic approach (Lewin, Lippitt, & White, 1939). Most reviewers seem to believe that modal group members can offer very useful information and conclude that more often than not the quality of a decision will be enhanced by membership participation (Steiner, 1972, 1976; Kleinhaus & Taylor, 1976). In addition, it has been found that organizational members are more likely to feel more personal commitment to decisions which they have helped to make, than to decisions which have been imposed from above (Coch & French, 1948; Hollander, 1978; Kleinhaus & Taylor, 1976). The element of interpersonal dynamics incorporated into these observations has emerged from years of research on group processes and the role of leadership (Bales, 1950; Bass, 1960; Burke, 1972; Cartwright, 1968; Fiedler, 1971; Fleischman, et al., 1955; French, 1949). However, the overall picture contains many complexities. The optimum point along the autocratic-democratic continuum depends on such variables as the personalities of the group members, the distribution of knowledge and skill within the group, the group's size and organization, and the degree of structure that the problem requires (Hollander, 1978; Vroom, 1976; Vroom & Yetton, 1973).

Likewise, the Soviets have discovered during their extended-duration space flights that the satisfaction crewmembers have with their leaders, peers, and environmental milieu contributes meaningfully towards mission success (Bluth, 1981; Borrowman, 1982; Oberg, 1983). Conversely, a lack of satisfaction can interact negatively with other annoyances and produce problems, as happened during the Apollo 13 and Skylab 4 flights (Cooper, 1976; Wolfe, 1979). Therefore, the space commander who aspires to leadership should possess the resiliency characteristics of a leader who emerges from, and always returns to, the wants and needs of those on which mission success depends. For example, the Russians have reported success with procedures whereby mission decisions were made by the commander while crew issues were decided by democratic votes (Leonov & Lebedev, 1975). However, the ultimate success of a long-duration space flight may well be decided by the interactional leadership skills that the commander/leader has acquired through education, training, and experience (Berry, 1973).

Additional leadership variables include task and socio-emotional leadership activities. Task activities are those actions which assist the group in accomplishing or moving toward its goal. Socio-emotional activities promote harmonious relations within the group (Katz & Kahn, 1978). Socio-emotional leadership is at least as important as task leadership, and judging by some of the literature (Leonov & Lebedev, 1975), perhaps even more so.

It is not clear how frequently the same individual can fill both task and socio-emotional leadership roles. A review of the leadership styles used by Arctic expeditionary leaders showed few individuals were capable of both task and socio-emotional leadership skills (Leonov & Lebedev, 1975). Leonov and Lebedev's findings are supported by the pioneering research of Bales (1950, 1953, 1958, 1970). This research found that some people engaged in more task and socio-emotional activities than did others, and as a result, were offered leadership status (Bales, 1950, 1953). However, according to Bales (1958), the person who primarily engages in the most task activities is not the same person who performs the most socio-emotional activities. In effect, two leaders emerged. The task leader was rated as having the best ideas, being the most influential, and offering the most guidance (Bales, 1958, 1970), whereas the socio-emotional leader was the most liked individual (Bales, 1958, 1970). A possible explanation for the second leader's emergence is that the task leader's purposeful urgings (e.g., unpopular decisions, criticism) hurt people's feelings. To soften the impact of the first leader's task-oriented actions, the second leader emerges by showing concern both for the individual's feelings, and for the group's goal.

Based on the literature, one could anticipate the emergence of a second (e.g., socio-emotional) leader during a prolonged space flight (assuming a crew greater than a dyad). However, this might not be the case. Interestingly, when a leader is designated by a higher authority and is hence perceived as "legitimate", group members are more accepting of heavy-handed task acts, and the need for the second leader diminishes (Katz & Kahn, 1978). Earlier research by Jacobs (1971) has demonstrated that the leader can afford to be firm when accepted by the group, pursuing clear goals, and invested with power to reward and punish (Jacobs, 1971). However, when goals are unclear, the leader's authority or power can often appear diminished. Consequently, difficulties are bound to arise, and the leader will probably have to resort to other sources of power to maintain a modicum of tranquility, while still accomplishing the tasks at hand.

Through a consideration of power as influence, and influence as affecting desired psychological change, French and Raven (1958) expanded the understanding of power through formulation of a classic typology. The resultant categorization provides five bases for power. The first is reward power. This form of power exerts its potential influence by creating in the follower an awareness that the leader has the capability to provide followers with some desired substantial incentive, in exchange for conformity to a designated request.

In contrast to reward power, is coercive power. This second form of power has its roots in the follower's perception that the leader has the capacity to impose sanctions on the follower's non-compliant behavior.

Legitimate power, which forms a third basis of power, is operationalized in the leadership situation, in a complex manner. The major thrust of legitimate power is achieved within the psyche of the individual one wishes to influence. The degree to which a person will ascribe legitimate powers to the leader is based on how well the person has internalized values regarding who has a "right" or "ought" to lead him/her. If followers perceive these qualities as being present in an individual leader, they will acquiesce to what they view as the leader's legitimate power (French & Raven, 1958).

The remaining two categories of power might well be considered as largely pertaining to qualities and resources within the leader. Referent power may be likened to charisma, in its most grandiose interpretation. The basis for referent power lies in the potential for personal identification with qualities admired in the leader. To the extent that this positive transference is sustained, the follower will have incentive to adhere to behaviors, perceptions, and beliefs similar to those of the leader. Comparatively, expert power is a more circumscribed base of power. This category of power is bestowed on a leader, when the followers have observed in the leader some knowledge, training, experience or ability which they believe to be lacking in themselves. The leader is then ascribed a power that results from this imagined expertise in an area of which the follower has limited knowledge. Occasionally, a "halo" effect may occur, whereby this power base extends into other areas of knowledge.

A person who can lead competently under one set of conditions may prove ineffective under other conditions (Fiedler, 1967, 1971, 1978; Hollander, 1978; Katz & Kahn, 1978; Mann, 1959). Perhaps one of the most promising theories which simultaneously considers both situational and personality factors is Fiedler's (1967, 1971, 1978) Contingency Theory of leadership. Concerned with predicting "performance" rather than satisfaction or morale, Contingency Theory has been tested successfully in many military and civilian settings and deserves close attention for use in the space program. The independent variables are situational favorableness and leadership style, with the dependent variable being leadership effectiveness.

Situational favorableness refers to structural and social climate variables which make a group "easy" or "difficult" to lead. These include the extent to which the leader is accepted or rejected by the group, the extent to which the group's goals are clear and structured, and the extent to which the leader has been invested with the power to reward and punish group members. Leadership style refers to the leader's orientation towards task and people (Fiedler, et al., 1976). The dependent variable, leadership effectiveness, is operationalized by any objective measure of task accomplishment.

According to Contingency Theory, different degrees of situational favorableness require different leadership styles. This theory contends that leadership style is fairly well ingrained within the person (Fiedler, et al., 1976). This implies that training programs designed to change the styles of leaders -- selected for missions of varying degrees of situational favorableness -- should be relatively ineffective. However, Fiedler and his associates have developed a self-instructional program called "LEADER MATCH", which helps leaders self-select and gain control over variables that determine situational favorableness (Fiedler, et al., 1976; Fiedler, 1978). "Leader Match" has thus far been supported by the results of eight validation studies (Fiedler, 1978). Fiedler's program may prove useful for future space leaders, either in its present form or with some modifications. These modifications could include efforts to extend beyond assessing the situational favorableness of a given mission. Selection of an astronaut with the particular style or leadership deemed most appropriate for the anticipated circumstances of a mission deserves further study.

Another leadership model that examines the advantages and the disadvantages associated with autocratic and democratic decision-making procedure has been described in the literature (Vroom & Yetton, 1973; Vroom, 1976). The Vroom-Yetton model of participative decision making, analyzes situations, personnel, and likely scenarios where effective leadership may be required (Vroom, 1976). In essence, this model is applied by first answering seven questions (regarding such issues as the availability of information, degree of conflict among subordinates, and the need for subordinate acceptance of decisions). On the basis of the pattern of answers, one of five decision-making procedures is prescribed. The Vroom-Yetton model of leadership has promise for use in selecting the most qualified astronauts for space travel.

In summation, future research on leadership for long-duration space flight might include an expanded range of leadership alternatives and options. Particularly pressing problems include identifying the optimal distribution of task and socio-emotional activities and achieving the "best fit" between structural characteristics and leader characteristics. In addition, more needs to be known about the consequences of various autocratic and participative decision-making procedures under conditions of isolation, confinement, and risk.

V. SUMMARY AND CONCLUSIONS

Interpersonal problems have been and remain a recurring problem for both short- and long-duration space flights. Even after the astronauts have successfully completed their space voyage, intense psychological aftereffects are reported. These aftereffects include intense religious experiences, a total reordering of scientific and personal priorities, and an overwhelming preoccupation with the space flight. Interestingly, all these space-related problems occurred among a hardy group of test pilots, presumed to have been carefully selected. As the astronaut population changes to include civilians from industry, payload specialists, scientists and pilot astronauts, the potential for additional space-related problems increases as well.

Past psychological tests were used only for detecting gross psychopathologies among candidates. Although these psychological instruments excluded some persons from becoming astronauts, the battery of psychological tests failed to predict which individuals would manifest behavioral abberrations in judgement, cooperative functioning, overt irritability, or destructive interpersonal actions.

What sort of human being or crew can endure the isolation and severe confinement of a long space voyage and make the space voyage a success. This is a question of selection and ultimately, of group composition. Most programs for selecting personnel to work in exotic environments (i.e., isolation and confinement) have emphasized the background, training, personality, and aptitude characteristics of individuals. Unfortunately, this traditional approach, in spite of careful screening and selection procedures, has revealed no reliable predictive measures for selecting those individuals that are most resistant to problems under conditions of isolation and confinement.

For a long time to come, the stresses of isolation and confinement will be inevitable accompaniments of long-duration space flight. The effects of these stresses on an individual will be partially determined by interactions with other crew members, attitude towards the group, or the quality and type of leadership practiced by each member. How these stresses will be endured or resisted will depend, at least partially, on the interactional dynamics of the group.

Strong demands will be placed on crew members who occupy leadership roles. The penalties for weak or incompetent leadership will be high. Case histories have shown that very few people can perform both task and socio-emotional leadership roles. Research has demonstrated that most often these two leadership roles are differentiated.

Contemporary leadership theory focuses on the interaction of structural and personality variables rather than upon either variable alone. The most relevant of these theories is Contingency Theory. This theory implies that situational favorableness and leadership style combine to determine leadership effectiveness. It further suggests that socio-emotionally oriented leaders are maximally effective under conditions of intermediate favorableness. However, task-oriented leaders are most effective under conditions of intermediate favorableness. However, task-oriented leaders are most effective under conditions of extremely high or extremely low situational favorableness. Future space missions are likely to vary by degree in terms of situational favorableness, and situational favorableness may decline as the length of the mission increases.

Isolation and confinement impose a strain on group structure, induce intense challenges for leadership, and threaten group integrity. The desire for change, as a reaction to boredom, may endanger the group's status quo, as well as the success of the space mission. The cohesiveness of the group will also be affected by interpersonal difficulties among its members. Clique formation could endanger cohesiveness, group integrity, and ultimately the space mission.

Under conditions of isolation, as experienced on a long-duration space mission, crew members will be deprived of normal familial ties, separated from their natural environment, and prevented from exercising a variety of social roles. Historically, the characteristic effects of such isolation, are anxiety, depression, irritability, and hostility.

As confinement increases, physical and social interaction become more intense, and the crew person operates at a higher level of emotional arousal. In turn, such feelings as discomfort, fatigue, frustration, hostility, or apathy tend to arise.

The optimal planning of future manned space flights requires a better understanding of the effects that increasing group size will have on interpersonal dynamics. Substantially larger crews than dyads and triads have been forecast for future space flights. A thorough understanding of the effects that crew size will have on crew member performance and satisfaction awaits the results of carefully controlled studies of different sized groups operating under space flight-like conditions.

VI. RECOMMENDATIONS

Behavioral problems have historically been associated with the space program. As mission length, crew size and diversity increase, these problems are expected to worsen. The following recommendations are an attempt to improve the selection procedures presently in use. These suggestions are based on the scientific research findings reviewed in this paper.

Until enhanced selection measures are achieved, behavioral problems during space flight are predicted to persist. The author recommends that research attention be focused on the PAQ masculinity/femininity scale, to select only those candidates who possess androgynous traits. Since the literature has been very consistent regarding their complementary mix of goal-oriented and socially oriented behaviors, it seems logical to select androgynous individuals for long-duration space flight. Additionally, a possibly fruitful area of future research would be to collect data on the astronauts' birth order, as well as their scores on the PAQ masculinity/femininity scale. The combination of this information would be used for identifying and selecting the most compatible crews --rather than merely effective individuals -- for long-duration space flight. Thus, the fundamental emphasis of future astronaut selection programs should be on crew composition, with specific attention focused on crew compatibility.

Another area subsumed under the category of crew composition would include McClintock's three types of motivation or motives: own gain, relative gain, and joint gain motivation. By creating situations in the astronauts' training environment to test for their dominant orientation, astronauts who were higher than their peers on joint gain motivation could be preferentially selected over others rated lower on this trait.

A provocative future research question must address which type of leadership, such as task-oriented or socio-emotionally oriented leadership, is the best for short- or long-duration space flights. The management of a space crew might be served by having daily, housekeeping (non-mission) decisions decided in a democratic manner. By contrast, mission decisions would ultimately be decided by the commanding authority, after soliciting alternatives from the crew in a participatory manner. Furthermore, as the demands of a particular mission change, so also could the needed leadership styles be expected change.

Contingency theory has recognized that both leadership effectiveness and situational effectiveness are inextricably intertwined. Another focus for future space-related research is to determine at what point during the space flight the situational factor (e.g., boredom, crew friction, apathy) become an obstacle to effective leadership. A similar related issue would be: What are the situational factors that are most likely to impinge on leadership effectiveness? Additional research is required to achieve a good match between situational favorableness and leadership style throughout the course of future flights. Also more is needed to be known about the consequences of various autocratic and participatory decision-making procedures under conditions of isolation, confinement, and risk. Future research must also examine the procedures which astronauts can use to diagnose and contain onboard frictions when they arise. One possibility would be to give the astronauts training in how to best handle conflicts that might arise between members of their crew. A means of dealing with these potential problems in advance could be achieved via use of role-playing during training.

Unfortunately, much more is known about how to exclude people who are liable to react badly than how to choose people of exceptional psychological health. Whatever the ultimate selection procedures, there is no avoiding the fact that as more and more people are chosen for space missions, a few "high risk" individuals will inadvertently be chosen. Mission planners and managers need to know more about the kinds of psychological support or props that can be used to help people preserve or restore their emotional stability under conditions of isolation and confinement. These psychological supports might include the use of video games to be played on a video display terminal; individualized music (i.e., with earphones); a surprise to be opened daily or weekly (depending on total mission length), or on special occasions (i.e., on birthdays or anniversaries); and opportunities for private conversations with a member's family.

Finally, it is felt that psychological researchers should be more involved in researching "operational" aspects of the space program, especially in light of all the behavioral problems that have occurred during and after the space missions. An excellent arena in which this research could be conducted would be to initiate a joint testing effort between NASA and the United States Air Force using the most sophisticated testing equipment available, which is located at the AFHRL Lackland AFB testing facility. If psychological research remains excluded from operational issues, then more frequent and severe problems can be expedited from the eclectic astronaut corps of the 1980's and beyond. Indeed, continued use of basically mid-1950's selection procedures seems to be neither prudent nor in the best interest of the astronauts and the nation.

BIBLIOGRAPHY

Alluisi, E.A. (1976). Summary report of the task force on training technology. Washington DC: Defense Science Board Task Force on Training Technology.

Alluisi, E.A., Chiles, W.D., Hall, T.J., & Hawkes, G.R. (1963). Human group performance during confinement. (Technical Documentary Report No. AMRL-TDR-63-87). Wright-Patterson AFB, OH 6570th Aerospace Medical Research Laboratories.

Ambler, R.K., Berkshire, J.R., & O'Connor, W.F. (1961). The Identification of Potential Astronauts. (Research Report No. 33). Pensacola, FL: U.S. Naval Aviation Medical Center.

Atkinson, J.W., & Birch, D. (1978). Introduction to motivation. (2nd ed.). New York: D. Van Nostrand.

Atkinson, J.W., (1958). Motives in fantasy, action and society. Princeton, NJ: Van Nostrand.

Back, K.W. Influence through social communication (1951). Journal of Abnormal Social Psychology, 46, 9-23.

Bair, J.T., & Gallager, T.J. (1958, November 12-14). Volunteering for extra-hazardous duty. Research Review.

Bales, R.F. (1970). Personality and interpersonal behavior. New York: Holt, Rinehard & Winston.

Bales, R.F. (1958). Task roles and social roles in problem solving groups. In E. Maccoby, T.M. Newcomb, & E. Hartley (Eds.), Readings in social psychology. New York: Holt, Rinehart & Winston.

Bales, R.F. (1953). The equilibrium problem in small groups. In T. Parsons, R.F. Bales, & E.A. Shields (Eds.), Working papers in the theory of action. New York: Free Press.

Bales, R.F. (1950). Interaction process analysis: A method for the study of small groups. Reading, MA: Addison-Wesley.

Bass, B. (1960). Leadership, psychology, and organizational behavior. New York: Harper.

Bavelas, A. (1950). Communication patterns in task-oriented groups. Journal of the Acoustical Society of America, 22, 725-730.

Bavelas, A. (1946). Group decision in setting production goals. In N.R.F. Maier (Ed.), Psychology in Industry. Boston: Houghton-Mifflin.

Beck, S.J. (1950). The normal personality as projected on the Rorschach test. Journal of Psychology, 30, 241-298.

Beregovoy, G.T. September (1979)a. Chief of cosmonaut crew training: Interview. Munich, West Germany.

Beregovoy, G.T. (1979)b. Role of human factors in space flights. In B.N. Petrov, B.P. Lomov, & N.D. Samsonov (Eds.). Psychological problems of space flight. Moscow: Nauka Press, pp. 152-157.

Berkowitz, L., & Howard, R. (1959). Reactions to opinion deviates as affected by affiliation need and group member interdependence. Sociometry, 22, 81-91.

Berkowitz, L. (1954). Group standards, cohesiveness, and productivity. Human Relations, 7, 509, 519.

Bernard, L.C. (1980). Multivariate analysis of new sex role formations and personality. Journal of Personality and social Psychology, 38, 323-336.

Bernard, H.R., & Killworth, P.D. (April 1974). Scientists and crew: A case study in communications at sea. Springfield, VA: Office of Naval Research.

Berry, C.A. (1973). A view of human problems to be addressed for long-duration space flights. Aerospace Medicine, 44, 1136-1146.

Beyer, D.H. & Sells, S.B. (1957). Selection and training of personnel for space flight. The Journal of Aviation Medicine, 28, 1-12.

Bluth, B.J., & McNeal, S.R. (1981). Update on space, Vol I. Grandada Hills, CA: National Behavior Systems.

Bluth, B.J. (1981). Soviet space stress. Science, 2, 30-35.

Bluth, B.J. (May 1980). Social and psychological problems of extended space missions. Paper presented at the AIAA Global Technology 2000 Meeting, Baltimore, MD, 6-8.

Borrowman, G.L. (1982). Training for space. Spaceflight, 24, 129-132.

Brady, J.V. (1983). Human behavior in space environments: A research agenda. Baltimore, MD: The Johns Hopkins University School of Medicine.

Brady, J.V., Bieglow, G., Emurian, H., & Williams, (1974). D.M. Design of a programmed environment for the experimental analysis of social behavior. In D.H. Carson (Ed.), Man-Environment interactions: Evaluations and applications, 7. Milwaukee, WI: Social Ecology, Environmental Design Research Association.

Brockway, A.L., (1954). Rorschach concepts of normalcy. Journal of Consulting Psychology, 18, 259-265.

Burke, P.J. (1972). Leadership role differentiation. In C.G. McClintock (Ed.), Experimental Social Psychology. New York: Holt, Rinehart & Winston.

Burnazyan, A., & Yeliseyev, A. (9 AUG 78). Psychological support in space. Pravda, p3, Col 1-2.

Butler, G.V. (1981). Working in space. New York: American Institute of Aeronautics and Astronautics.

Butler, G.V., & Wolbers, H.L. (1981). Working in space. AIAA Student Journal, Fall 2-9.

Cartwright, D. (1968). The nature of group cohesiveness. In D. Cartwright & A. Zander (Eds.), Group Dynamics: Research and theory (3rd ed.). New York: Harper & Row.

Chambers, R.M. (1968). Isolation and confinement. In J.D. Hardy (Ed.), Physiological problems in space exploration. Springfield, IL: Charles C. Thomas Publishers.

Cheston, T.S., & Winter, D.L. (1980). Human factors of outer space production. Westview Press. AAAS Selected Symposium No. 50.

Christeensen, J.M. (August 1962). Engineering psychological research for space flight. Paper presented to American Psychological Association Symposium, Man in Space, St Louis, MO.

Coch, L., & French, J.R.P, Jr. (1948). Overcoming resistance to change. Human Relations, 1, 512-532.

Cohen, S. (1980). Aftereffects of stress on human performance and social behavior: A review of research and theory, Psychology Bulletin, 88, 82-108.

Cohen, E. (1957). Stimulus conditions as factors in social change. Sociometry, 20, 135-144.

Collins, M. (1974). Carrying the fire. New York: Ballentine.

Cooper, H.S.F. (1976). A house in space. New York: Bantam Books.

Cooper, H.S.F. (1973). Apollo Thirteen: The flight that failed. New York: Dial.

Cooper, R. (1966). Leaders task relevance and subordinate behavior in industrial work groups. Human Relations, 19, 57-84.

Cunningham, W. (1977). The all American boys. New York: MacMillan.

Darley, J., & Latane, B. (1968). Bystander intervention in emergencies: Diffusion of responsibility. Journal of Personality and Social Psychology, 8, 377-383.

Deutsch, S. (1971). A man-systems integration study of the behavior of crews and habitability in small spaces. In J.W. Miller (Ed.), Tektite 2: Scientists in the sea. Washington, DC: US Dept of the Interior, pp. VIII-1 -VIII-14.

Diener, E., Dineen, J., Endresen, K., Beaman, A.L., & Fraser, S.C. (1975). Effects of altered responsibility, cognitive set, and modeling on physical agression and deindividuation. Journal of Personality and Social Psychology, 31, 328-337.

Diener, E., Westford, K.L., Diener, C., & Beaman, A.L. (1973). Deindividuation effects of group presence and arousal on stealing by halloween trick-or-treeters. Proceedings of the 81st Annual Convention of the American Psychological Association, 8, 219-220.

Doll, R.E., & Gunderson, E.K.E. (1971). Group size, occupational status, and psychological in an extreme environment. Journal of Clinical Psychology, 27, 196-198.

Doll, R.E., & Gunderson, E.K.E. (1969). Hobby, interest and leisure activity behavior among station members in Antarctica, US MNMRU Rep NO. 69-31.

Ebersole, J.H. (1960). The new dimensions of submarine medicine. New England Journal of Medicine, 599-610.

Eilbert, L.R., & Glaser, R. (1959). Differences between well and poorly adjusted groups in an isolated environment. Journal of Applied Psychology, 43, 171-174.

Emurian, H.H., Brady, J.V., Meyerhoff, J.L., & Mougey, M.S. (1981). Behavioral and biological interactions with confined microsocieties in a programmed environment. In J. Gerry & L.A. handman (Eds.), Space Manufacturing. New York: AIAA, 407-421.

Engle, E., & Lott, A. (1979). Man in flight, Leeward Enterprises, 254-264.

Ferguson, J.M. (1970). Use of the Ben Franklin submersible as a space station analog, Vol 1, Summary Technical Report OSR-70-4, NAS-8-30172.

Festinger, L. (1954). A Theory of social comparison processes. Human Relations, 7, 117-140.

Festinger & Thibaut, J. (1951). Interpersonal communication in small groups. Journal of Abnormal and Social Psychology, 46, 92-99.

Fiedler, F.E. (1978). Recent developments in research on the contingency model. In Berkowitz (Ed.), Group processes. New York: Academic Press.

Fiedler, F.E., Chemers, M.M., & Mahar, L. (1976). Improving leadership effectiveness: The leader match concept. New York: John Wiley & Sons.

Fiedler, F.E. (1971). Validation and extension of the contingency model of leadership effectiveness: A review of empirical findings. Psychology Bulletin, 76, 128-148.

Fiedler, F.E. (1967). A theory of leadership effectiveness. New York: McGraw-Hill.

Fine, P.F., & Jennings, C.F. (1966). Personality development: Applications of theory to problems of aerospace selection. Aerospace Medicine, 697-701.

Fleishman, E., Harris, E., & Burtt, H. (1955). Leadership and supervision in industry: An evaluation of a supervisory training program. Columbus: Ohio State Bureau of Education Research.

Flinn, D.E., Hartmen, B.O., Powell, D.H., & McKenzie, R.E. (1963). Psychiatric and psychological evaluation. Brooks AFB, TX: USAF/School of Aerospace Medicine.

Fraser, T.M. (1966). The effects of confinement as a factor in manned space flight. NASA CR-511, Lovelace Foundation for Medical Education and Research.

French, J., & Raven, B. (1958). Legitimate power, coercive power, and observability in social influence. Sociometry, 21, 83-97.

French, R.L. (1949). Morale and leadership: Human factors in undersea warfare. Washington DC: National Research Council.

Gatchell, R.J., & Baum, A. (1983). Health psychology. Addison Wesley.

General Electric manned space operation, (1964). Results of a four-man 30-day mission simulation program (GE Doc 64sd679).

Gerathewohl, S.J. (8-12 JUN 1959). Psychological problems of selection, holding, and care of space fliers. Paper presented at the American Rocket Society, San Diego, CA.

Glass, D.C., & Singer, J.E. (1972). Urban stress: Experiments on noise and social stressors. New York: Academic Press.

Gold, J. Heat tests. (1959). In Project Mercury candidate evaluation program (Tech Rpt No. WADC-TR 59-505).

Goodenough, D.R., & Karp, S.A. (1961). Field dependence and intellectual functioning. Journal of Abnormal and Social Psychology, 63, 241-246.

Grether, W.F. Psychology and the space frontier. (1962). American Psychologist, 28, 92-101.

Grimwood, J.M. (1964). Project Mercury: A chronology (NASA SP-4001, 1963). New York: McGraw-Hill, 31-32.

Gross, M.L. (1962). The brain watchers. New York: Random House.

Gross, E. Symbiosis and consensus in small groups. (1956). American Sociology review, 21, 174-179.

Gunderson, E.D., & Nelson, P.D. (1963). Adaptation of small groups to extreme environments. Aerospace Medicine, 34, 1111-1115.

Gurovskiy, N.N., & Bryanov, I.I. (1974). Selection of astronauts and cosmonauts. In NASA-Washington, DC, Foundations of Space Biology and Medicine, 3, 419-437.

Halstead, W.C. (1947). Brain and intelligence. Chicago: University of Chicago Press.

Hammes, J.A., Ahearn, T.R., & Keith, J.F., Jr. (1965). A chronology of two weeks fallout shelter confinement. Journal of Clinical Psychology, 21, 452-356.

Hammes, J.A., & Osborne, R.T. (1965). Survival research in group isolation studies. Journal of Applied Psychology, 49, 418-421.

Hammes, J.A., & Watson, J.A. (1965). Behavior patterns of groups experimentally confined. Perceptual and Motor Skills, 209, 1269-1272.

Hartman, B.O,. & Flinn, D.E. (1964). Crew structure in future space missions. In Lectures in Aerospace Medicine. Brooks AFB, TX: USAF School of Aerospace Medicine, February, p.50.

Hathaway, S.R., & McKinley, J.C. (1943). Manual for the Minnesota multiphasic personality inventory. New York: Psychological Corporation.

Hauty, G.T. (1958). Human performance in the space environment. Air University Quarterly Review, Vol X.

Havron, M.D., & McGrath, J.E. (1961). The contribution of the leader to the effectiveness of small military groups. In L. Petrullo & Bass (Eds.), Leadership and interpersonal behavior. New York: Holt, Rinehart & Winston.

Havron, M.D. (1952). The effectiveness of small military units (Personnel Research Section Report No. 980). Washington DC: Adjutant Generals Office.

Haythorn, W.W., McGrath, J.J., Hollander, E.P., Latane, B., Haythorn, W.W. (1972). Interpersonal stress in isolated groups. In J.E. McGrath (Ed.), Social and psychological factors in stress. New York: Holt, Rinehart & Winston.

Haythorn, W.W., & Altman, I. (1967). Personality factors in isolated environments. In M.H. Appley & R. Trumball (Eds.), Psychological stress. New York: Appleton-Century-Crofts.

Haythorn, W.W. (1963). Selection and training considerations for a manned space laboratory. Paper presented at AIAA/ASMA Manned Space Laboratory Conference, California.

Helmreich, R.L. (1983). Applying psychology in outer space: Unfulfilled promises revisited. American Psychologist, 38, 445-450.

Helmreich, R.L., Wilhelm, J.A., & Runge, T.E. (1980). Psychological considerations in future space missions. In S. Cheston & D. Winters (Eds.), The human factors in outer space production. Washington, DC: American Association for the Advancement of Science.

Helmreich, R.L. (1980). Psychological considerations in future space missions. In T.S. Cheston & D.L. Winter (Eds.), Human factors of outer space production. Boulder, Colorado.

Helmreich, R.L., Beane, W., Lucker, W., & Spence, J.T. (1978). Achievement motivation and scientific attainment. Personality and Social Psychology Bulletin, 4, 223-226.

Helmreich, R.L. (1977). Psychological considerations in undersea habitation and space colonization. Industrialization Forum, 8, 9-12.

Helmreich, R.L., & Spence, J.T. (1976). Sex roles and achievement. In R.W. Christina & D.M. Landers (Eds.), Psychology of motor behavior and sport.

Helmreich, R., & Radloff, R. (1972). Group processes and interpersonal interaction. In Space Science Board-NASA, Human factors in long-duration space flight. Washington DC: National Academy of Sciences.

Helmreich, R.L. (1971). The TEXTITE II human behavior program (ONR Tech Rpt No. 14). Austin TX: University of Texas.

Helmreich, R.L. (1966). Prolonged stress in SEALAB II: A field study of individual and group reactions. Unpublished Doctoral Dissertation, Yale University.

Hicks, S.A. (1964). The effects of confinement on the performance of combat relevant skills: Summary report (Tech Mem 16-64, AMCMS Code 5014.11.84). Aberdeen Proving Ground, MD: US Army Human Engineering laboratories.

Hoffman L.R., (1965). Group problem solving. In L. Berkowitz (Ed.), Advances in experimental social psychology (Vol II). New York: Academic Press, 99-132.

Hoffman, B. (1962). The tyranny of testing. New York: Crowell-Collier.

Hollander, E.P. (1978). Leadership dynamics: A practical guide to effective relationships. Glencoe, IL: Free Press.

Holmes T.H., & Rahe, R.H. (1967). The social readjustment rating scale. Journal of Psychosomatic Research, 11, 213-218.

Hunter, G.S. (1968). Test supports space survival concept. Aviation Week & Space Technology, 80-87.

Ickes, W, & Barnes, R.D. (1978). Boys and girls together--and alienated: On enacting stereotyped sex roles in mixed dyads. Journal of Personality and Social Psychology, 36, 669.

Imus, H.A. (1961). Psychological factors in space travel (Rpt No. 61-4). Pensacola, FL: US School of Aviation Medicine, US Naval Aviation Medical Center.

Ivancevich, J., & Donnelly, J (1970). Leader influence and performance. Journal of Personnel Psychology, 33, 539-549.

Jacobs, T.O. (1971). Leadership and exchange in formal organizations. Alexandria, VA: HUMRRO.

Jenkins, C.D., Rosenman, R.H., & Friedman, M. (1967). Development of an objective psychological test for the determination of the coronary-prone behavior pattern in employed men. Journal of Chronic Diseases, 20, 371-379.

Kanas, N.A., & Fedderson, W.E. (1971). Behavioral, paychiatric, and sociological problems of long-duration space missions. Houston, TX: Manned Spacecraft Center.

Katz, D.L., & Kahn, R.L. (1978). The social psychology of organizations (2nd ed.). New York: Wiley.

Klein, H., & Willerman, L. (1979). Psychological masculinity and femininity, and typical and maximal dominance expression in women. Journal of Personality and Social Psychology, 37, 2059-2070.

Kleinhaus, B., & Taylor, D.A. (1976). Group process, productivity, and leadership. In B. Sedenberg & A. Snadowski (Eds.), Social psychology: An introduction. New York: Free Press.

Kubis, J.F., & McLaughlin, E.J. (1967). Psychological aspects of space flight. Transactions of the New York Academy of Sciences, Ser II, 30(2), 320-330.

Lamb, L.E. (1963). Aeromedical evaluation for space pilots. Brooks AFB, TX: USAF School of Aerospace Medicine (AFSC).

Lanzetta, J.T. (1955). Group behavior under stress. Human Relations, 8, 29-51.

Latane, B. (1980). Social impact theory and group influence: A social engineering perspective. In P.B. Paulus (Ed.), Psychology of group influence. Lawrence Erlbaum Associates.

Leonov, A.A. (April 1976). The problem of crew interrelationships in international space flights. Woodland Hills, CA: Tech-Tran, Inc..

Leonov, A.A., & Lebedev, V.I. (1975). Psychological problems in interplanetary flight. Washington, DC: NASA.

Leonov, A.A. (1972). Selection, training, and compatibility of spaceship crews. Washington, DC: Joint Publications Research Service, February.

Lewin, K., Lippitt, R., & White, R. (1939). Patterns of aggressive behavior in experimentally created "social climates." Journal of Social Psychology, 10, 271-297.

Lomov, B.F. (1979). General characterizations of problems of space psychology. In B.N. Petrov, B.F. Lomov, & D. Samsonov (Eds.), Psychological problems of space flight. Moskow: Novki Press, 4-23.

Lorge, I., Tuckman, J., Aikman, L., Spiegel, J., & Moss, G. (1955). Problem-solving by teams and by individuals in a field setting. Journal of Education Psychology, 46, 160-166.

Lott, A., & Lott, B. (1965). Group cohesiveness and interpersonal attraction: A review of the relationships with antecedent and consequent variables. Psychological Bulletin, 64, 259-305.

Maki, J.E., Thorngate, W.B., & McClintock, C.G. (1979). Prediction and perception of social motives. Journal of personality and Social Psychology, 37, 203-220.

Maloney, M. (1979). Leadership in nursing: Theory, strategies action. St Louis, MO: C.V. Mosby Company.

Mann, R.D. (1959). A review of the relationship between personality and performance in small groups. Psychology Review, 56, 241-270.

McClintock, C.G., (1972). Game behavior and social motivation in interpersonal settings. In C.G. McClintock (Ed.), Experimantal Social Psychology. New York: Holt, Rinehart, & Winston.

McClintock, C.G., Moskowitz, J.M., & McClintock, E. (1977). Variations in preferences for individualistic, competitive, and cooperative outcomes as a function of age, game, class, and task in nursery school children. Developmental Psychology, 48, 1080 - 1085.

McGrath, J.E., & Altman, I. (1966). Small group research. New York: Holt, Rinehart & Winston.

Mitchell, M.B. (August 1962). Selection of the astronauts. Presented to the American Psychological Association on Man in Space.

Montemerlo, M. (1982). Personal communmication. Washington DC: NASA/HQ, Director of Human Factors.

National Academy of Sciences. (1972). Human factors in long-duration space flight. Washington DC: Space Science Board, National Research Council, National Academic of Sciences.

Newcombe, T.M. (1953). An approach to the study of communicative acts. Psychology Review, 60, 393-404.

Nicholson, T., & Pardoe, G. (1972). The reliability of man in space. New Scientist, 54, 271.

Novosti. (1977). Barrier of weightlessness. Spaceflight, 19(5).

Nowlis, D.P. (30 OCT 72). Comprehensive habitability testing program (Report No. 72-8834). Airesearch Manufacturing corporation.

Oberg, J. (1983). Comrades in orbit. Science Digest, 91(6), 52-59.

Oberg, J. (1981). Red star in orbit. New York: Random House.

Oberg, J. (1978). Close encounter, Soviet style. L-5 News, 3(8), 10.

Parin, V.V., Gorbov, F.D. & Kosmolinskiy, F.F. (1966). Space psychology. Priroda-Nature No. 12, 3-12.

Parker, J.F., & Evergy; M.G. (1972). Habitability issues in long-duration undersea and space missions (ONR 196-113).

Patterson, J., & Jones, B. (December 1982). Personal communication at the US Air Force School of Aerospace Medicine.

Perry, C.J. (1967). A psychiatric "back-up system" for the selection of space crews. American Journal of Psychiatry, 123(7), 821-825.

Perry, C.J. (1967). Psychiatric support for man in space. International Psychiatry Clinics, 4, 197-221.

Perry, C.J. (1965). Psychiatric selection of candidates for space missions. The Journal of the American Medical Association, 194(8), 99-102.

Petrov, B.N., Lomov, B.P., & Samsonov, N.D. (1979). Psychological problems of space flight. Moscow: Nauka Press, 130-135.

Pogue, W.R. (1974). Three months in space. Society of Experimental Test Pilots, 12, 203-217.

Race to take the high ground in space. U.S. News & World Report, (22 NOV 1982). 40-41.

Radloff, R., & Helmreich, R.L. (1968). Groups under stress: Psychological research in SEALAB II. New York: Appleton-Century-Crofts.

Rapaport, D., Gill, M.M., & Schafer, R. (1979). Diagnostic psychological testing. New York: International University Press.

Rasmussen, J.E., & Haythorn, W.W. (1963). Selection and effectiveness considerations arising from enforced confinement of small groups. Proceedings of the Second Manned Space Flight Meeting, American Institute of Aeronautics and Astronautics, Texas.

Rawls, J.R., McGaffey, C.N., Trego, R., & Sells, S.B. (1968). Some determiners of interpersonal climate in relation to long distance space missions. Ft Worth, TX: Texas Christian University Institute of Behavioral Research.

Rich, V. (1978). Foreward with programme. Nature, 1978, 262, 575.

Rohrer, J.H. (1961). International relationships in isolated small groups. In B.E. Flaughtery (Ed.), Psychophysiological Aspects of Space Flight, 263-271.

Rorschach, J. (1942). Psychodiagnostics. Berne, Switzerland: Huber.

Rosen, S.G. (1967). Mind in space. Medical Service Digest, USAF, 27, 4-17.

Rotter, J.B. (1966). Generalized expectancies for internal vs external control of reinforcement. Psychological Monographs, No. 609.

Ruff, G.E. (1959). Isolation. Aeronautics, 4(2), 22-23, 110-111.

Ruff, G.E. (December 1959). Psychological tests. In C.L. Wilson (Ed.), Project Mercury Candidate Evaluation Program (WADC Tech Rpt 59-505). Wright-Patterson AFB, OH: 81.

Sanford, R.N. (1942). Thematic apperception test: Directions for administering and scoring. Cambridge, MA: Harvard Psychological Clinic.

Schacter, S. (1951). Deviation, rejection, and communication. Journal of Abnormal and Social Psychology, 46, 190-207.

Schacter, S. (1959). The psychology of affiliation. Stanford, CA: Stanford University Press.

Schacter, S. (1954). Cross-cultural experiments on threat and rejection. Human Relations, 7, 403-439.

Schlitz, W.P. (1983). Aerospace world: News, views and comments. Air Force Magazine, 66,(2), 29.

Seashore, S.E. (1954). Group cohesiveness in the industrial work group. Ann Arbor, MI: Institute for Social Research.

Seitz, C.P., Goldman, D.A., Del Vacchio, R.J., Phillips, C.J., Jessop, R.P., & Fagin, R. (1970). Use of the Ben Franklin submersible as a space station analog: Volume 1. Psychology and Physiology. Bethpage, NY: Grumman Aerospace Corporation.

Sells, S.B., & Gunderson, E.K.E. (1972). A social system approach to long-duration missions. In Space Science Board-NASA, Human factors in long-duration space flight. Washington, DC: National Academy of Science.

Sells, S.B. (1966). A model for the social system for the multiman extended duration spaceship. Aerospace Medicine, 37, 1130-1135.

Sells, S.B., & Berry, C.H. (1958). Human requirements for space travel. Air University Quarterly Review, 10(2).

Seeman, J.S., & McFarlance, T.G. (1972). Results of post-test psychological examinations of the crew man for the 90-day manned test of an Advanced Regenerative Life Support system (NASA CR-112019). Huntington Beach, CA: McDonnell Douglas Astronautics.

Sexner, J.L. (1968). An experience in submarine psychiatry. American Journal of Psychiatry, 1, 25-30.

Silverman, A.J., Cohen, S.I., & Shmavonian, B.M. (1959). Selection techniques for space crews. American Journal of Psychiatry, 115,(12), 1110-1112.

Siminov, P.V. (1976). Psychophysiological stress of spaceflight. In Foundations of space biology and medicine, Volume II, Book II, 558-564.

Singer, J.E., Brusch, C., & Lublin, S.D. (1965). Some aspects of deindividuation: Identification and conformity. Journal of Experimental Social Psychology, 1, 356-378.

Singer, J.E., & Collins, D.L. Team performance relevant to human factors and design. In preparation for NAS-NRC, Committee on Human Factors.

Smith, S., & Haythorn, W.W. (1972). Effects of compatibility, group size, and leadership seniority on stress, anxiety, hostility, and annoyance in isolated groups. Journal of Personality and Social Psychology, 22, 67-97.

Smith, S. (1969). Studies of small groups in confinement. In J.P. Zubeck (Ed.), Sensory deprivation: Fifteen years of research. New York: Appleton-Century-Crofts.

Smith, W.M. (1966). Observations over the lifetime of a small isolated group: Structure, danger, boredom, and vision. Psychological Reports, 19, 475-514.

Spence, J.T., Helmreich, R.L., & Holahan, C.K. (1979). Negative and positive components of psychological masculinity and femininity and their relationships to self-reports of neurotic and acting out behaviors. Journal of Personality and Social Psychology, 37, 1673-1682.

Spence, J.T., & Helmreich, R.L. (1978). Masculinity and femininity: Their psychological dimensions, correlates and antecedents. Austin, TX: University of Texas Press.

Spence, J.T., & Helmreich, R.L. Comparison of masculine and feminine personality attributes and sex-role attitudes across age groups. In Press.

Steiner, I.D. (1976). Task performing groups. In J.W. Thibaut, J.T. Spence, & R.C. Carson (Eds.), Contemporary topics in social psychology. Morristown, NJ: General Learning Press.

Steiner, I.D. (1972). Group process and productivity. New York: academic Press.

Stupnitskiy, V.P. (1979). Methodological and organizational principles of the psychological training of cosmonauts. In B.N. Petrov, B.P. Lomov & Samsonov, N.D. (Eds.), Psychological problems of space flight. Moscow: Nauka Press, 152-159.

The Boeing Company. (1964). Manned environmental system assessment (NASA CR-134). Seattle, WA: Boeing.

Thorndyke, P.W. (August 1980). Improving training and performance of Navy teams (R-2607-ONR). Rand Corporation.

Torrence, E.P. (1954). Some consequences of power differences on decision making in permanent and temporary three-man groups. In Hare, Borgatta, Bales (Eds.), Small groups: Studies in social ineraction. New York: Knopf.

Trego, R.E., & Sells, S.B. (1970). Toward selection for long-duration isolated missions. Fort Worth, TX: Institute of Behavioral Research, Texas Christian University.

Triandis, H.C., Halle, E.R., & Ewen, R.B. (1965). Member heterogeneity and dyadic creativity. Human Relations, 18, 33-55.

Triandis, H.C. (1960). Cognitive similarity and communication in a dyad. Human Relations, 13, 175-183.

Two Soviet cosmonauts land after record 139 days in orbit. (3 NOV 82). The Washington Post, p. A-14.

Ulsamer, E. (1983). The finite limits of affordability. Air Force Magazine, 66, (1), 77-83.

Vanier, D.J., & Hardison, N.M. (1978). Age as a determinant of sex-role sterotyping. Psychological Reports, 42, 35-38.

Vinograd, S.P. (1976). An appraisal of future space biomedical research. In Foundations of space biology and mecidine (Volume III). Washington, DC: NASA, 467-470.

Vinograd, S.P. (December 1974). Studies of social group dynamics under isolated conditions (NASA CR-2496). Washington, DC: 23-30, 135-140, 146.

Vroom, V.H. (1976). In M. Dunnette (Ed.), Handbook of industrial and organizational psychology. Chicago: Rand McNally, 527-1551.

Vroom, V.H., & Yetton, P. (1973). Leadership and decision making. Pittsburg, PA: University of Pittsburg Press.

Weybrew, B.B. (1963). Psychological problems of prolonged marine submergence. In N.M. Burns, R.M. Chambers, & E. Hendler (Eds.), Unusual environments and human behavior. New York: Free Press, 87-126.

Wilson, C.L. (1959). Project Mercury candidate evaluation program (WADC-TR-59-505). Wright-Patterson AFB, OH: Wright Air Development Center.

Watkin, H.A. (1965). Psychological differentiation and forms of pathology. Journal of Abnormal Psychology, 70, 317-336.

Wolfe, T. (1979). The right stuff. New York: Farrar, Straus, Giroux.

Zander, A., & Havelin, A. (1960). Social comparison and interpersonal attraction. Human Relations, 13, 21-32.

Zajonc, R.B. (1965). The requirements and design of a standard group task. Journal of Experimental Social Psychology, 1, 71-88.