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LIVING IN CONTAINED ENVIRONMENTS: RESEARCH IMPLICATIONS FROM UNDERSEA HABITATS

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INDIVIDUAL AND GROUP BEHAVIOR IN TOXIC AND CONTAINED ENVIRONMENTS

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We have long been fascinated by man's adaptation to extreme environments. Some of the most gripping accounts of the capacity to endure and adapt have come from participant and survivors. From a greater distance, psychologists and psychiatrists have added to the extensive documentation of reactions to isolated and contained environments includint undersea habitats (see especially Connors, Harrison, & Akins, 1985 for a review). Rather than trying to summarize findings from an often conflicting literature, this discussion will focus on the differences and similarities in behavior in undersea habitats and other closed environments and on gaps in our understanding of the determinants of behavior in contained environments.

The development of saturation diving procedures allows Aquanauts to remain underwater living in and working out of submerged habitats for essentially unlimited periods of time. As habitats are maintained at the ambient pressure of the water outside, divers have to face only a single lengthy decompression on final return to the surface rather than decompression after each working dive. But this also means that divers whose bodies are saturated with high pressure gas mixtures face certain death or serious injury if they do not undergo systematic decompression (decompression periods of up to 10 days may be required from depths below 500 feet). While saturation diving opens up the ocean floor to extended outside work, it also requires that inhabitants exist in a total environment from which escape is difficult, time consuming, and under the control of outside forces. Thus the physical and psychological environment of undersea habitats differs markedly from that in submersibles which are maintained at sea level pressure.

A number of undersea habitats have been constructed and operated for scientific purposes. Miller and Koblick (1984) provide descriptive and operational data on sixty five habitats from seventeen countries, including fourteen from the U.S. Psychologists were quick to note the research potential of habitats as models of highly stressful, total working environments with real isolation but easy accessibility for observational research through video and audio monitoring.

Large scale psychological investigations of Aquanaut behavior were undertaken in the Navy's SEALAB 2 project and in Project Tektite 2 which was jointly sponsored by the Navy, NASA, and the Department of the Interior (Radloff & Helmreich, 1968; Helmreich, 1972; 1973; Bakeman & Helmreich (1973). Sealab 3 was planned as a major habitation project at a depth of 600 feet, but was cancelled following the death of an Aquanaut on the first day of diving. This accident and budgetary constraints of the post-Vietnam years brought underwater exploration to an almost complete standstill.

After years of neglect, interest in psychological research in undersea habitats as representative, confined environments has recently reawakened (Helmreich & Wilhelm, 1985; Connors, Harrison & Akins, 1985). Much of the interest centers on the validity of the habitat environment as an analog of the space station now planned by NASA for the mid-1990s (Foushee, 1986). Discussion of this environment at a conference on psychological effects of chemical and biological warfare further extends the range of interest.

The data from early studies of confined groups conducted in the laboratory (e.g. Altman & Haythorn, 1967; Haythorn, Altman, & Myers, 1966; Haythorn, 1970) would suggest that being cooped up with a peer in a small apartment with adequate food and recreational material is a highly stressful event. A significant percentage of crews aborted such "missions" well short of targeted stays.

Characteristically, inhabitants of confined environments report a variety of minor health complaints such as headaches, sleep disturbances and insomnia (Natani & Shurley, 1974; Weybrew, 1963) and a number of mild psychiatric symptoms (Natani & Shurley, 1974). Social tensions and difficulties in adjustment are also frequent as are decrements in performance over time (Haythorn et. al., 1972; Gunderson & Nelson, 1963; Kubis, 1972; Kanas & Fedderson, 1971).

The striking difference between this litany of complaints and observed behavior in the Sealab and Tektite habitats was the high quality of adjustment and sustained performance shown in the undersea environment. Although conditions in habitats were objectively far more severe in terms of danger, demands, and discomfort than in laboratory, simulation studies, psychological problems were notable primarily for their infrequency. Roland Radloff and I have offered an explanation for these divergent finding in terms of a Cost-Reward model of predicted adjustment to environments which is shown in Figure 1 (Radloff & Helmreich,

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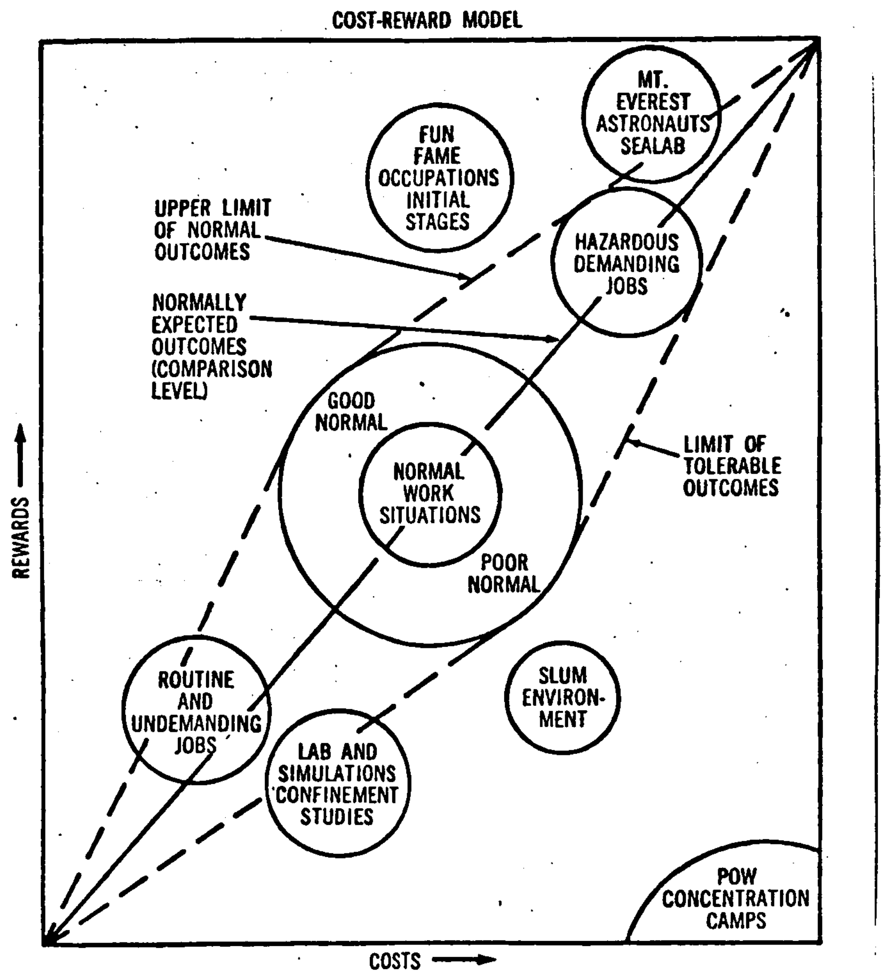

Figure 1. The Cost-Reward Model (from Radloff & Helmreich, 1968).

1968). As the model suggests, exploratory endeavors such as early undersea habitation and spaceflight are notable for the high level of objective costs and rewards. Early Astronauts paid high costs in terms of danger and discomfort, but they received high rewards both subjectively in personal satisfaction from opening new frontiers and demonstrating personal competence and objectively in the form of fame and material rewards. It is not surprising that the personal adjustment and performance of Astronauts and Aquanauts were of a high order. Other environments such as Concentration Camps and hostage situations match extremely high costs with very low rewards and predicted outcomes are highly negative. Of particular interest is the postulated position of laboratory, simulation studies on the Figure. While the "costs" of such environments are not excessive, the rewards are also low and the perceived costs may be unacceptably high, providing a possible explanation for the differential reactions in simulations and much more stressful real world environments. At the least, the model suggests caution in generalizing reactions from one environment to another and especially from simulations to powerful natural settings.

Another implication of the model is that the levels of costs and rewards may change over time, thus changing expected levels of satisfaction and adjustment. The space program provides a good example of this. While the early Astronauts were national heroes whose every move was front page news and many reaped both financial and political rewards, by the mid eighties, the program was becoming "ordinary" by design and gimmicks such as a Senator and a schoolteacher in space were needed to arouse interest. As we had predicted in 1968, there is evidence that satisfaction and adjustment were flagging in tandem with this shift. It is highly likely that the same phenomenon would have occurred with many Aquanauts had undersea habitation continued to develop. It is possible, of course, that a drop in objective rewards in an environment can be offset if the work activities in the environment provide high levels of intrinsic satisfaction for participants. For example, marine scientists might find such unmatched research opportunities from being able to live on the ocean floor for extended periods that their perceived reward levels would remain extremely high. A similar reaction might be found among scientists given the chance to conduct research in the microgravity environment of the space station.

The critical point for extrapolating reactions from one exotic environment to another is to compare the costs and rewards (both subjectively and objectively) for incumbents. At the least, a conceptual analysis of the costs and rewards in each can be conducted to allow relative placement in a hypothetical matrix of expected adjustment. Such an analysis resulted in the conclusion that ground based simulations of the space station environment could not provide valid data on long-term performance and adjustment while reactions in the analog setting of an undersea habitat should be highly comparable (Helmreich & Wilhelm, 1985).

There are several aspects of behavior in the undersea setting that do occur frequently in other settings regardless of the costs and rewards. Aside from their generality, these findings include especially important areas for future research. Among these were substantial individual differences in both performance and adjustment and significant correlations among individual mood state, attachment to the group, and performance in Sealab (Radloff & Helmreich, 1968) and between group cohesiveness and performance in Tektite (Bakeman & Helmreich, 1973).

Despite highly positive interpersonal relationships in habitats, there were some glimmers of discord. The introduction of a new crewmember through partial rotation reduced both overall group cohesiveness and the performance of unrotated crewmembers in Tektite (Helmreich, 1971). An ancillary finding was that role sharing by crewmembers (i.e. sharing of common tasks such as habitat maintenance and meal preparation and assistance in the scientific investigations of others) increased overall performance and satisfaction (Helmreich, 1971; Helmreich & Radloff, 1973).

Of particular interest were instances of considerable conflict between Aquanauts and "Mission Control" in both Sealab and Tektite (Radloff & Helmreich, 1968; Helmreich, 1971). Many of these centered on how activities should be scheduled and conducted. Similar intergroup conflicts have been noted in many isolated crews including both U.S. and Soviet space missions (Kubis, 1972; Kanas & Fedderson, 1976; Cooper, 1976; Leonov & Lebedev, 1975; Bluth, 1979). The existence of conflict between an isolated group and its support/control facility represents a real threat to mission accomplishment and an important area for further research. While many answers may be found in the more cognitive psychology of intergroup relations (e.g. Stephan, 1985), the most fruitful approach may prove to be through analysis of the structure of the isolated environment in the context of its larger organizational framework. There has been a tendency to examine isolated groups as autonomous entities with insufficient regard for their organizational "shell" (e.g. Hackman, 1986). Issues that are likely to emerge from this approach include the level and type of psychological support required by the isolated group and the optimum level of autonomy that should be provided as well as the most effective internal organization. These issues are especially salient in planning for a manned space station but apply to a considerable degree to most contained environment.

The fact that there are large, unexplained individual differences in reactions to and performance in normal as well as contained environments indicates the need for much additional research on the influence of personality. Individual personalities and the combination of personalities play an especially critical role in determining outcomes in small, contained environments - at least theoretically. However, the body of empirical data on personality effects does not provide a coherent or convincing picture. Few significant and replicated findings regarding personality influences in contained environments have emerged. Similarly, research on military pilot selection has shown few relationships between personality variables and success in flight training. It would appear, however, that the fault is in the measurement and operationalization of personality constructs rather than in the concept itself.

Recent research on achievement motivation provides a more reassuring view of personality effects. One of the most intriguing findings is that personality-performance relationships appear to have a delayed onset. Helmreich, Sawin, & Carsrud (1986) found that there were minimal correlations between achievement motives and performance during training and early periods on the job, but that correlations increased and stabilized after some months in the position. Similarly, significant personality-performance relationships were found among jet transport pilots when the criterion was line performance after training (Helmreich, 1986; Chidester, 1986). This delayed onset has been labeled the "Honeymoon Effect" and is postulated to reflect the fact that individuals selected for a position or assignment may exert maximal effort during training and early job experiences, thus masking the influence of personality during the "honeymoon". After continued experience in the same work setting, the underlying dispositions will tend to emerge and to determine performance. If further validated, this phenomenon could explain many instances of the failure of personality factors to explain variance. Quite simply, criteria such as success in training may be inappropriate for isolating personality effects.

Utilizing constellations of personality attributes reflecting instrumental and expressive aspects of the self, considerable success has been achieved in the prediction of both performance and adjustment (Helmreich & Spence, 1978; Spence & Helmreich, 1983). On the instrumental side, achievement motivation has been reformulated as consisting of three dimensions, Mastery Needs or the desire for challenge, Work Orientation or commitment to task completion, and Competitiveness or the desire to best others. It is noteworthy that earlier formulations of achievement motivation considered all three as additive aspects of the motivation to succeed. In contrast, we have found that while Mastery and Work Orientation generally are positive correlates of performance, Competitiveness consistently interferes with task enactment and correlates negatively with performance. The fact that the several components relate differentially to criteria explains why a simple, additive measure was not an effective predictor of performance. In some instances, such as filling mundane, repetitive jobs, Mastery has been found to be unrelated or negatively related to performance whereas in demanding situations it is a central, positive predictor. We have found that a constellation of high mastery, high work orientation and low competitiveness predicts highest attainment on such disparate criteria as scientific achievement, income in MBA graduates, and academic performance as well as piloting jet transports.

The Type A or coronary prone personality syndrome has also been re-examined in terms of performance. Reanalysis of the Jenkins Activity Survey (Jenkins, Zyzanski, & Rosenman, 1971) yielded two factors designated as Achievement Striving and Impatience/Irritability (Helmreich & Spence, 1986; Spence & Helmreich, 1986). The most important findings from this recasting of the construct are the correlations of the two new scales with performance and health symptoms. While Achievement Striving was a significant predictor of performance in pilots, scientists, and student samples, it had no negative health implications. Irritation/Irritability, on the other hand, was related to a variety of health symptoms such as headaches and sleep disturbances and correlated negatively with performance in pilots.

The point of discussing these measures is not to invoke them as the sole or most critical personality influences on performance, but rather to stress the point that our knowledge of personality effects is severely limited and greatly in need of elaboration and refinement.

Another related and essential topic for investigation is the nature and role of leadership in small, isolated groups. As Hollander (1985) has pointed out, the voluminous literature on leadership is replete with conflicting findings. While there is a consensus that leader effectiveness is a joint function of both the leader's personality and characteristics of the situation, research in this paradigm has suffered from a host of methodological and conceptual problems and obtained results are hardly compelling. Nevertheless, the leadership function under isolated and stressful conditions is critical and must be pursued if we are to gain an effective working knowledge of the determinants of performance and adjustment in contained environments.

In conclusion, I would like to stress that while a substantial research literature has accumulated on contained environments, the surface has barely been scratched. We are in roughly the same position as the general who is finally prepared to fight the preceeding war. But perhaps in this case we will be able to bring our new conceptual and methodological armament to bear on an old problem and will be able to develop a more coherent model of behavior in this intriguing set of environments.

References

Altman, I. & Haythorn, W. (1967) The ecology of isolated groups. Behavioral Science, 12, 169-182.

Bakeman, R., & Helmreich, R. (1975) Cohesiveness and performance: Covariation and causality in an undersea environment. Journal of Experimental Social Psychology, 11, 478-489.

Bluth, B. J. (1981) Soviet space stress. Science 81, 2, 30-35.

Chidester, T. R. (1986) Mood, sleep and fatigue effects in flight operations. Unpublished doctoral dissertation, The University of Texas at Austin.

Connors, M., Harrison, A., & Akins, F. (1985) Living aloft: Human requirements for extended spaceflight, Washington, D.C., NASA SP-483.

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

Foushee, H. C. (1986) Research plan for human factors in space. NASA Ames Research Center.

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

Hackman, J.R. (1986) Group level issues in the design and training of cockpit crews. In H. Orlady & H.C. Foushee (Eds.) Cockpit resource management training. Proceedings of the NASA/MAC Workshop. NASA CP-xxxx.

Haythorn, W. (1970) Interpersonal stress in isolated groups. In J. McGrath (Ed.) Social and psychological factors in stress. New York: Holt, Rinehart, & Winston.

Haythorn, W., Altman, I. & Myers, T. (1966) Emotional symptomatology and subjective stress in isolated pairs of men. Journal of Experimental Research in Personality, 1, 290-305.

Helmreich, R. (1971) The Tektite II human behavior program. In Miller, J.W., Vanderwalker, J., & Waller, R. (Eds.), The Tektite II Project. Washington, DC: Government Printing Office.

Helmreich, R.L. (1986) Pilot selection and performance evaluation: A new look at an old problem. In G.E. Lee (Ed.) Proceedings of the Tenth Symposium: Psychology in the Department of Defence. Colorado Spgs: U.S. Air Force Academy.

Helmreich, R., & Radloff, R. (1973) Environmental stress and the maintenance of self esteem. In Aronson, E., & Helmreich,R. (Eds.), Social psychology. New York: Van Nostrand.

Helmreich, R.L., Sawin, L.L. & Carsrud, A.L. (1986) The honeymoon effect in job performance: Delayed predictive power of achievement motivation. Journal of Applied Psychology. 71, 185-188.

Helmreich, R.L., & Spence, J.T. (1978) The Work and Family Orientation Questionnaire: An Objective Instrument to Assess Components of Achievement Motivation and Attitudes Toward Family and Career. JSAS Catalog of Selected Documents in Psychology, 8.

Helmreich, R.L., Spence, J.T., & Pred, R.S. (1986) Making it without losing it: Type A, achievement motivation, and scientific attainment revisited. (submitted for publication)

Helmreich, R.L. & Wilhelm, J.A. (1985) The undersea habitat as a space station analog: Evaluation of research and training potential. Austin: NASA/UT Technical Report 85-7.

Hollander, E. (1985) Leadership and power. In G. Lindzey & E.Aronson (Eds.) Handbook of social psychology. Vol. 2. New York: Random House.

Jenkins, C.D., Zyzanski, S.J., & Rosenman, R.H. (1971) Progress toward validation of a computer scored test for the Type A coronary prone behavior pattern. Psychosomatic Medicine, 33, 193-202.

Kanas, N.A. & Fedderson, W.E. (1971) Behavioral, psychiatric, and sociological problems of long duration missions. NASA TM X-58067.

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

Leonov, A.A. & Lebedev, V.I. (1975) Psychological compatibility in interplanetary flight. Voprosy Filosofii, 9, 14-27.

Miller, J. & Koblick, I. (1985) Living and working in the sea.. New York: Van Nostrand, Reinhold.

Natani, K. & Shurley, J.T. (1974) Sociopsychological aspects of a winter vigil at a South Pole station. Human adaptability to Antarctic conditions. E.K.E. Gunderson (Ed.) Antarctic Research Series, Washinton: American Geophysical Union, 89-114.

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

Spence, J.T., & Helmreich, R.L. (1983) Achievement-related motives and behavior. In J.T. Spence, (Ed.), Achievement and achievement motives: Psychological and sociological approaches (pp. 10-74). San Francisco: W.H. Freeman & Co.

Spence, J.T., Helmreich, R.L., & Fred, R.S. (1986) Impatience versus achievement strivings in the Type A pattern: Differential effects on students' health and academic achievement. (submitted for publication)

Stephan, W. (1985) Intergroup relations. In G. Lindzey & E. Aronson (Eds.) Handbook of social psychology. Vol. 2. New York: Random House.

Weybrew, B. (1963) Psychological problems of prolonged submarine submergence. N. Burns, R. Chambers, & E. Hendler (Eds.) Unusual environments and humans behavior: Physiological and psychological problems of man in space. London: Free Press.