PSYCHOPHYSIOLOGICAL ASPECTS OF SPACE FLIGHT

Edited by Bernard E. Flaherty

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Edited by BERNARD E. FLAHERTY, LT.COL., USAF (MC)

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Preface

OTIS O. BENSON, JR.

One can say with confidence that we now possess all the basic knowledge required to keep man alive in space for a limited, yet significant, period of time. Although there is room for refinement and simplification, and although the development of equipment continues to pose difficult problems, all the essential knowledge is at hand.

By contrast, our position with respect to man's behavioral capabilities in space is not nearly so well established. Human history provides no example of what would seem to be such an unfavorable combination of psychic stressors. Isolation, confinement, weightlessness, unusual and distasteful methods of coping with personal problems, anxiety over the reliability of equipment—all these factors, individually as well as collectively, would seem to jeopardize human capability in ways which we have only begun to assess.

The foregoing circumstances clearly called for a conference of informed physicians and scientists for the purpose of surveying our present knowledge and recommending the directions which future research must take in order to provide the required technology within desirable time periods. Such a conference, believed to be the first of its kind, was sponsored at Brooks Air Force Base on May 26 and 27, 1960, by the School of Aviation Medicine, in keeping with its long tradition of leadership in the solution of aeromedical problems. We are pleased to acknowledge here the administrative assistance provided by Southwest Research Institute, and the editorial efforts of the Columbia University Press in making the proceedings available to an interested public.

The reader will note that the conference agenda embraced an unusual variety of topics ranging from the psychosocial problems of

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small groups, through the medical and psychological problems of selection, training, and maintenance, to the bedrock problems of neurophysiology and endocrinology. Correspondingly, the reader will note that the speakers represented a variety of professional and scientific persuasions—a variety that was no less evident among those who were invited to attend. It was no accident that we took this approach to the central theme of the symposium. Rather, it was a deliberate approach, calculated to lend substance to our perspective that man's behavior is a joint function of many kinds of influences arising both inside and outside the body, and that the understanding and control of this behavior can be achieved only through the joint efforts of all the life sciences. This is the frame of reference within which we pursue behavioral research at the School of Aviation Medicine, and it is typical of much of the research throughout the remainder of the United States Air Force.

It will be evident to even the most casual reader that the symposium has not provided an exhaustive treatment of the central theme, either in breadth or depth. Nevertheless, he will find provoking discussions of those topics which have the most critical relevance for manned space flight, and it is sincerely hoped that these will generate further thought, imagination, and active research planning for our future needs. If we can but realize this consequence alone, the symposium will have served a vital purpose.

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Introduction

BERNARD E. FLAHERTY

In the man-machine system essential to space flight, man's limitations are the baseline which determine the degree of efficiency of the total system (1). Man's psychophysiological limitations are less well-defined than the limitations of any other part of the man-machine system; his total behavior is most meaningful only when we are able to integrate the psychosocial facets of his performance into a framework of genetics, anatomy, physiology, and chemistry.

It is possible to predict some of the stresses which will be encountered by the astronaut in space travel; we know that they will arise from forces outside the capsule, within the capsule, and within man himself (2). Stresses may be exclusively external—e.g., engineering failure, radiation, forces of gravity; or, they may be entirely internal—in the sense of psychophysiological malfunction. It will be virtually impossible to isolate a single stress and the immediately resulting psychophysiologic response, because man, as a complex, constantly interacting psychophysiologic unit, is demonstrated most classically in the man-machine system. Furthermore, man is an integral part of the total machine; the contributions of the machine to the final system output cannot be differentiated from the contributions of man. A stress of any type or quantity will initiate a series of interlocked physical and psychophysiological reactions in the total system. Within a matter of seconds (or fractions of a second) it will be necessary for the human operator to isolate from this series of interactions a basic *gestalt* problem and the major components intrinsic in this problem. He must immediately select the best available finite solution; the accuracy of this solution

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will depend on appropriate past experience in a framework of his potential, current psychophysiologic efficiency, and the availability of reliable data from the machine.

The over-all purpose of this symposium is the definition and suggested resolution of the psychophysiological problems implicit in space flight. To achieve this goal it is necessary to answer these questions:

1. *Where are we now?* It is imperative that we assess realistically our current basic achievements in science as they apply to these problems. Our urgent need for resolution of these problems may force us to apply our knowledge prematurely. On the other hand, unnecessary repetition and reduplication of basic science effort, a pleasant but expensive academic luxury, frequently delays immediately available "application."

2. *Where do we go from here?* An appraisal of our current status must force us to determine how psychophysiologic research and application in the problems of space flight can proceed most expeditiously. We must utilize the appropriate efforts of physiologists, anatomists, and chemists—as well as those of researchers engaged in the various "pure" behavioral disciplines.

If these interdisciplinary efforts are to succeed, we must establish a common language. There is increasing evidence that psychologists and psychiatrists must become more substantially grounded in anatomy, chemistry, and physiology; "organicists," in turn, must learn functional psychological principles.

Compartmentalized thinking, occasionally noted in scientific thought, is probably seen most frequently in the various behavioral disciplines. Two problems of this type are most evident: First, there is understandable loyalty on the part of adherents to a particular discipline toward the codes, hypotheses, and systems of interpretation peculiar to that discipline; occasionally this loyalty assumes an emotionally burdened, cult-like fervor that can lead to rejection of all clinical and basic science evidence which would contradict its beliefs.

It is evident the several behavioral groups (including the biochemist and neurophysiologist with a primary interest in behavior) need each other if they are to make a meaningful whole of many separate parts. Both semantics and working concepts must reflect an emotional insight that behavior occurs in an *organism*, the fabric of which limits behavior and is changed by behavior. This is a truism, accepted intellectually, but denied too often in emotionally charged interpretations.

A second problem area, related to the first, is common to all behavioral disciplines. I refer here to the principle of causality, as it relates to psychic determinism. With few exceptions up to the present time, all behavioral phenomena have been evaluated and interpreted essentially in terms of simple "cause and effect." There is increasing evidence that behavior may be based, in part at least, on random, variable factors. Eccles (3) considers the manner in which the brain achieves liaison with the "mind" as the essence of this problem. Livingston's recent work (9) suggests one possible neurophysiological mechanism of hallucination is associated with space and time distortion, emphasizing central control of peripheral sensory receptors. This is of immediate interest to workers attempting to explain hallucinatory phenomena seen frequently in isolation and sensory deprivation experiments.

Increasing experimental evidence, and the fact that causality has long ago been discarded as a fundamental axiom of the advanced physical sciences (4, 5), suggests that we may wish to revise basic tenets in the interpretation of behavior (6). In attempting to establish "mind" into these current concepts of the physical sciences, we might consider seriously the edict of Philip Morrison (7):

> In the end, . . . no view of the world can remain unchallenged by the physicists' findings; the future of every philosophy can be measured by the degree to which it can admit to the world of the mind the physical map of the atomic universe.

A sense of urgency pervades our study of the psychophysiological aspects of space flight. Already the United States and Allied Nations have sent over three hundred mammalian creatures into flight within, or approaching, the boundaries of space. Data obtained from these flights and from simulated flights have helped us to anticipate the reactions of space flight on the various body systems in the human being. The void that remains, the human element, cannot be determined until a significant number of astronauts have returned from flight through space. However, we can anticipate, from what we know already of space flight and its environment, many of the problem areas; and we can predict with some degree of accuracy the psychophysiological reactions of man to this environment.

Realization that the critical problem areas which threaten man's effective conquest of space are largely psychophysiological in nature results in an appreciation of the urgent responsibilities of this symposium. The definition of neurophysiologic effects of stress, with particular emphasis on endocrine and endogenous rhythm factors, is essential. The requirement that physiologic data from the human operator be constantly available to earthbound observers must be resolved. We must establish allowable quantitative and qualitative deviations in sensory input—and the manner in which these deviations effect psychophysiologic response. We must evaluate all possible techniques—such as chemotherapy, hypnosis, conditioning, or thermal variations—by which the pioneer human operator might be assisted in withstanding his many stresses.

These are but a few of the critical problems we discussed during this symposium. The product of our work must establish our current achievements and blatant deficiencies; it must serve as a stimulus for rapid resolution of the psychophysiologic impasse which delays man's entry into space. "Man is a sea-level, low-speed, one-g, 12-hour animal" (8), representing the weakest link in our aerospace development to date.

This symposium was organized to strengthen this "weakest link," and to force an exchange of ideas between disciplines which communicate rarely and poorly—despite a mutual, urgent need to share research efforts in approaching a common goal. One facet of this common goal is an evaluation of the psychophysiological aspects of space flight.

REFERENCES

1. Gantz, K. F., ed., Man in Space. New York, Duell, Sloan & Pearce, 1959.
2. Flaherty, B. E., Psychiatry in space flight, in *Proceedings*, Detroit Regional Meeting of APA, October, 1959.
3. Eccles, J. C., Neurophysiological Basis of Mind. Oxford, The Clarendon Press, 1953.
4. Russell, B., On the notion of cause, in *Mysticism and Logic and Other Essays*, pp. 180, 194, 199. London, Allen and Unwin, 1951.
5. Tarski, A., Introduction of Logic and Methodology of Deductive Sciences, p. 98. New York, Oxford University Press, 1941.
6. Angel, Ronald W., The concept of determinism, Am. J. Psychiat., 116:405, 1959.

7. Morrison, Philip, Cause, chance, and creation ("Adventures of the Mind, 51"), Saturday Evening Post, 232:No. 44:32, 110, 111, 112, 114, April 30, 1960.
8. White, General Thomas D. (Chief of Staff, USAF), The inevitable climb to space, Air Univ. Quart. Rev., X:No. 4, Winter, 1958–59.
9. Livingston, R., Reticular Formation of the Brain, An International Symposium. Detroit, Mich., Henry Ford Hospital, 1958.

PART 1

Technical Background and Experience