A Proposed Approach Toward Determining the Psychophysiological Effects of Prolonged Space Flight

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THE PSYCHOPHYSIOLOGICAL effects of prolonged weightlessness and cosmic radiation constitute the major unknowns of future manned space flight. The most recent manned space flights of the Soviet Union have shown that the human organism can function properly for approximately 94 hours of weightlessness. Based on the condition of the Soviet Cosmonauts both during flight and at the time of their return to earth, there is no reason to assume that longer periods of weightlessness would in any way constitute a deterrent to normal sensori-motor and physiological functioning. However, this is only an assumption and is based on two observations. Generalizations to flights of longer duration can not be made with any degree of certainty.

In addition, none of the space flights to date containing living tissue has penetrated either the natural Van Allen radiation belts or the artificial belt resulting from the Pacific atomic tests. Therefore, while some knowledge exists on the psychophysiological effects of prolonged weightlessness, there is none related to cosmic radiation. In view of this informational deficit, it is an imperative prerequisite to the United States lunar program that the psychophysiological effects of prolonged weightlessness and particularly cosmic radiation be determined. The purpose of this paper is to present a proposed approach towards studying these effects.

METHODS

A. *Subjects:*—The subjects in each of these flights should be young chimpanzees in the 40 to 50 pound weight range.

B. *Measurements:*—Both physiological and performance measures should be made. Physiological measurements to be made will be those made possible through the development and perfection of equipment and techniques. Further, measurements made will be those necessary for providing comparative physiological information as well as information concerning the status of the health of the subject. In addition, the ability of the subjects to sleep will be studied. Performance will be measured on an existing set of tasks (Ref. 1) designed to assess simple motor functioning, visual and auditory monitoring, and eating and drinking ability.

C. *Approach:*—A minimum of two orbital flights will be required to evaluate the effects of weightlessness and cosmic radiation for a fourteen day period. The manner in which the evaluation would be made is outlined in Figure 1.

Since the two major variables to be studied are

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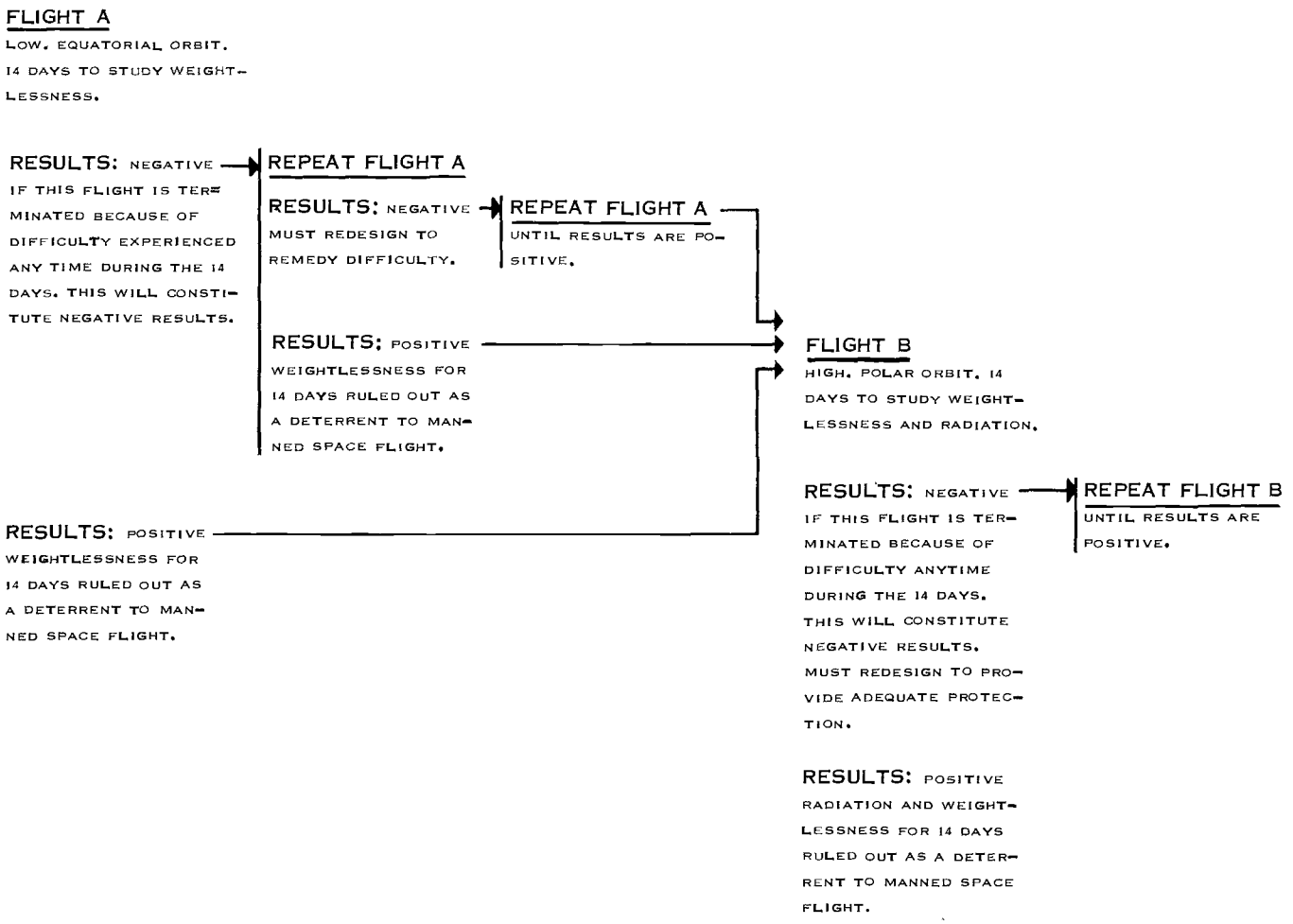

Fig. 1. A proposed approach towards determining the psychophysiological effects of prolonged manned space flight.

weightlessness and radiation, it is necessary to make a minimum of two flights if the effects of the two variables are to be separated at all. Flight A provides for a 14-day study of weightlessness without the influence of the radiation variable. A flight of this duration now seems most appropriate in view of the apparent lack of ill effects resulting from the flights of the Soviet Cosmonauts for an extended period. In a 14-day equatorial orbit the weightlessness phenomenon can be adequately studied and if this flight indicates no ill effects, then Flight B may take place. Flight B, a 14-day polar orbital flight, will involve both weightlessness and exposure to cosmic radiation. Should psychophysiological difficulties be encountered during this flight, it would be unwise to attribute such difficulty solely to radiation exposure. This is so because it is possible that although weightlessness alone is inadequate to bring about significant psychophysiological changes, it might interact with radiation sufficiently for the two variables to produce a combined effect. If it is considered imperative to isolate the individual effects of the two variables, then an artificial gravity state during a polar orbital flight would permit the study of the radiation variable, uninfluenced by weightlessness.

If either Flight A or B initially produces negative results, then repeated flights must be made as changes are incorporated into the space vehicle. Flight B will not be undertaken until Flight A proves successful, and Flight B will be repeated, if necessary, until danger to the biological entity is negligible.

It should be evident that flights of longer duration would be in order following the program suggested in this paper, and that the approach could very well follow the design outlined here in assessing the effects of these key variables.

SUMMARY

An approach is presented which will afford study of the biological effects of prolonged weightlessness and cosmic radiation. It is recognized that this approach certainly does not encompass all areas of space research and should not be interpreted as implying all-inclusiveness, nor an oversight or a disregard for more basic research in exobiology or environmental, behavioral, and physical biology. Instead, it is believed that along with a program such as outlined in this paper, research in these general areas should be accelerated.

REFERENCE

1. ROHLES, F. H., REYNOLDS, H. H., GRUNZKE, M. E., and FARRER, D. N.: A Performance Schedule for Extended Space Flight with the Chimpanzee. Technical Documentary Report No. 62-14, July 1962.