Reports

Approximation to a Gravity-Free Situation for the Human Organism Achievable at Moderate Expense

So far as their effects on the human organism are concerned, the chief peculiarities of weightlessness consist in (i) the cessation of unidirectional stimulation of the vestibular system, together with the sequelae accruing therefrom through reactions of the autonomic and central nervous systems, and (ii) the letting up of the hydrostatic drag on the circulatory system, especially that associated with the erect posture of man. Both of these peculiarities can be approximated to a considerable degree by a combination of relatively simple devices. The use of these would enable data on the effects of this pseudo-weightlessness, maintained for several hours at least, to be obtained long before the still exceedingly costly direct tests of subjecting human beings to prolonged free fall can be carried out by Western scientists.

By far the greater portion of the hydrostatic drag is absent in human beings whose body axis is in a horizontal position, as it is when they are recumbent. Most of the remainder can be evened out and in effect nullified by subjecting them to a moderate spinning motion about their horizontal axis, through the automatic rotation of a cylinder within which they are held. At the same time, little sense of the pressure caused by their body weight would remain if the body, including the limbs, were encased in a skin-tight envelope, and held immersed in a brine having the same specific gravity as the average for the body itself.

Considerable freedom of movement can be allowed for the limbs. The head can be encased in a transparent helmet that is serviced for respiration and oral communication. It is to be held with its axis in alignment with the body axis. That is, the head is not permitted tilting movements that would set its axis at an angle to that of the body; however, it is left free to carry out any desired voluntary movements of rotation on its axis. A field of view, imitative of furnishings and, for example, of a window showing a skyscape, would be arranged that remained in a fixed position with reference to the subject. Thus the field of view would spin together with the subject himself, and the subject would lack the visual stimuli associated with an imposed rotary movement.

The subject, after having been fastened within the cylinder, would at first be at rest but by insensible degrees would be subjected to a rotary movement about his horizontal axis, at a speed that increased until it attained the psychophysiological optimum for disengaging his vestibular apparatus from an effective pull by gravity in any given direction. Thereafter the motion is to be kept smooth and steady. Preliminary experiments have shown that under such circumstances, so long as the subject's head remains with its original relation to the body axis, he soon becomes quite unaware of the rotary movement as such. This is because the fluid in his semicircular canals has come to rest, in relation to their walls (except for any voluntary axial turning movements, which then give rise only to the effects usual for them), and because he has no notification of the imposed rotation through vision and very little through skin or internal bodily pressures.

It is likely that a suitable speed of rotation could be found which was too fast, in relation to the sensitivity of that part of the vestibular apparatus which detects translational (linear) acceleration or gravity in any one direction, to allow such stimuli to accumulate to an appreciable degree. That is, not so rapid a periodicity should be required to transcend "flicker" in the case of the sensation of linear acceleration here in question as in the case of optical flashes. For psychological and physiological purposes, a condition approximating that of weightlessness or free fall would thereby have been achieved. Essentially the same mechanism has long been used for nullifying gravity in studies on plants, but the speed of rotation for this apparatus, called a clinostat, can be much slower because of the much slower reactivity of plant tissues.

Among other questions that would thereby be opened for investigation are those concerned with the effects, on free-fall tolerance, of individual differences (as between persons of differing tendencies to become giddy or motion-sick) and of the effects of differing physiological conditions and of diverse drugs (such as those used against motion sickness). The relatively small cost of the apparatus required for such experiments, and the relatively short time required for its construction, recommend it for pilot studies on the effects of fairly prolonged weightlessness (*1*).

H. J. MULLER

Department of Zoology, Indiana University, Bloomington

Note

1. This report is based upon a paper read at Symposium on Possible Uses of Earth Satellites for Life-Sciences Experiments, Washington, D.C., 17 May 1958; Contribution No. 659 of Zoology Department, Indiana University.

21 May 1958

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper. (Since this requirement has only recently gone into effect, not all reports that are now being published as yet observe it.)

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* 125, 16 (1957)].

Role of Somatotropin in Mammogenesis and Lactogenesis in C3H/He CRGL Mice

In mammary gland growth and differentiation in rodents, mammotropin with ovarian steroids induces lobulo-alveolar development, and if this is followed by treatment with mammotropin and adrenocortical steroids, lactogenesis will result (*1*). Somatotropin (hypophysial growth hormone) synergizes in both these cases to enhance the action of the hormonal combinations (*2, 3*); however, somatotropin has not been reported to act either as a lobulo-alveolar mammogen or as a lactogen in the absence of mammotropin.

Recently it was shown that a purified somatotropin preparation (containing 0.5 to 2 percent mammotropin) acts alone as a duct mammogen in hypophysectomized rats (*1*). Ferguson (*4*) observed that this hormone by itself had no direct mammogenic action in hypophysectomized C3H mice but that the formation of terminal buds and some alveoli was induced by treatment with somatotropin, estradiol, and progesterone. The present report is concerned with the role of somatotropin in mammogenesis and lactogenesis in C3H/He CRGL mice. These experiments are part of a larger study dealing with the endocrine con-