Gerathewohl SJ. ***Comparative studies on animals and human subjects in the gravity-free state.*** **J Aviat Med 1954; 25:412–9.**

Early consideration of human spaceflight was pessimistic concerning human ability to function in weightlessness. In 1947, Gauer and Haber predicted that the consequences of spaceflight weightlessness would be a very severe impairment of muscular coordination resulting in an absolute incapacity to act (8). In 1949, the author of this Classic and Haber suggested that during transition into sub-gravity, a sensation of falling would occur due to the effect of weightlessness on the otoliths and it was plausible to expect that the information provided to the brain would be contradictory and confusing (12). In this Classic, the author reviewed recent experimental work on disorientation and other effects of "zero-G" and drew more hopeful conclusions, while pointing out that many areas needed further investigation.

He described observations of animals on sub-orbital flights and humans in parabolas which had produced more relevant evidence: whereas normal mice in zero-G showed violent movements and symptoms of disorientation, labyrinthectomized mice were less susceptible (13). Test pilots told the author that when they flew a series of parabolas, their sensations of falling and disorientation at the onset of zero-G gradually disappeared. They had reported over-reaching with hand movements, which was controlled by visual fixation of the target. Von Beck had also found visual and motor incoordination on aiming tests in humans during parabolic flights. He described disorientation of turtles in parabolic flight which diminished after 20 to 30 parabolas or with labyrinthectomy (15).

Gerathewohl cited evidence that although all normal animal and human subjects had shown disorientation and loss of motor coordination during short periods of weightlessness, performance improved when more visual and tactile clues were provided (2). He concluded that it might be possible to adapt to short episodes of zero-G, although "We still do not know what would happen if the subject had to stay in the gravity free state for a long period of time."

Background

Siegfried Gerathewohl, Ph.D., was a German psychophysiologist who came to the United States following World War II as part of Operation Paperclip. He worked at the Department of Space Medicine at Randolph AFB, San Antonio, TX, and later in the Life Sciences Directorate at NASA.

At the time of this paper, the effects of short-duration weightlessness on human physiology were completely unknown and subject to much speculation (1). Gerathewohl later undertook numerous studies of human factors during parabolic flight, the only method then available for exposing subjects to what we now call "microgravity." His studies of cats showed that the righting reflex, which depends on an intact otolith system, ceased to function in zero-G (9). He documented in humans an illusion where objects appeared to move upward at the onset of zero-G due to stimulation of the otoliths (11). He also showed that disturbances in hand-eye coordination occurred in zero-G that resolved after a short period of adaptation (10). His analysis of animal data from suborbital rocket flights showed that the cardiovascular system adapted well to weightlessness (5).

Medical concerns over possible adverse effects of zero-G in humans continued during preparation for Project Mercury and became an area of contention between investigators and flight surgeons involved in operational space medicine, reaching resolution only with the success of early astronaut flights (14,16), as described in other Classic papers (6,7).

Comment by Stanley R. Mohler, M.D.

In 1966 when I became Chief of the new FAA Aeromedical Applications Division in Washington, I enticed Dr. Gerathewohl, who was then with NASA, to join us as Chief of our Research Planning Branch. Our relationship was highly synergistic and his intellectual contributions were invaluable to the FAA.

This Classic paper was one of the first to discuss how humans would react to weightlessness. At that time, a number of highly respected professionals were concerned that persons entering a protracted gravity-free state might encounter physiological and psychological problems that would preclude any meaningful role for humans in space. Two famed test pilots had been quoted as stating that the transition to zero gravity produced "befuddlement" (Crossfield, 1951) and "certain orientational disturbances" (Yeager, 1952). We now realize that some of those symptoms may have been related to the "push-pull" effect associated with a sudden shift from −Gz to +Gz (3,4).

This 1954 paper identified some potential problems for persons encountering microgravity upon insertion to orbit and focused on the important role of the vestibular system and the need to study it further. The last sentence of the paper provided future guidance for investigations: "Not only because of its scientific value, but also because of its practical application for space flight, the exploration of human behavior under gravity-free conditions should be considered as an important goal."

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