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NEUROVESTIBULAR ADAPTATION IN VERTEBRATE AND INVERTEBRATE GRAVI-SENSING ORGANS FOLLOWING MICRO- AND HYPER-GRAVITY EXPOSURE AND RE-ADAPTATION TO 1G.

Abstract

The gravi-sensing organs, the utricle in vertebrates and statocysts in invertebrates, sense the sum of inertial force due to head translation and head orientation relative to gravity. Under normal conditions gravity is constant. However when this force changes, such as in spaceflight, the nervous system responds to the new gravity state. The peripheral receptors, brain or both might be involved. When the organism is exposed to transients in gravity, do the utricle and statocyst respond by regulating their output? Our data and those of others suggest that these responses are common among the different species. First, we will examine the response of utricular afferents following exposure to G on two US Shuttle missions (STS-90 and –95). Within the first day after landing, the magnitude of neural response to an applied acceleration was on average three-times greater than controls. Reduced gravitational load in orbit apparently resulted in an up-regulation of the sensitivity of utricular afferents. By 30 hours post-landing, responses were statistically similar to control. Time course of return to normal approximately parallels the decrease in vestibular disorientation in astronauts following return from space. Next, we will examine the responses of statocyst receptors in the land snail following exposure to G on two unmanned Russian missions (Foton M-2 and -3). Similar to the findings in vertebrates an increased sensitivity of response to adequate motion stimuli was observed: a significantly larger response in statocyst neurons to body position changes at all tested speeds in postflight snails. Lastly, we will use well-controlled hypergravity (HG) experiments in the vertebrate model to address the following questions. If the influence of G leads to adaptation and subsequent re-adaptation processes in otolith function upon return to 1G, then does the transfer from 1G to HG impart the opposite effects? Do the effects accompanying transfer from HG to 1G conditions resemble in part (as an analog) the transfer from 1G to G? Results show a biphasic pattern in reaction to 3G exposures: an initial sensitivity up-regulation (3- and 4-day) followed by a significant decrease after 16-, 24- and 32-day exposure. Return to control values following 16-day exposure is on the order of 8 days. Utricular sensitivity is strongly regulated by altered gravity exposure, and transition from hypergravity to normal gravity seem to resemble the transfer from 1G to microgravity, and might be used as an analog ground-based model. Support Contributed In Part By: NASA 03-OBPR-04