IAA meeting: 310 words

Visual Performance Challenges to Low-Frequency Perturbations after Long-Duration Space Flight, and Countermeasure Development

Ajitkumar Mulavara,[1] Scott Wood,[1] Matthew Fiedler,[2] Igor Kofman,[2] Walter B. Kulecz,[2] Chris Miller,[2] Brian Peters,[2] Jorge Serrador,[3] Helen Cohen,[4] Millard Reschke,[5] and Jacob Bloomberg[5]

[1]Universities Space Research Association, Houston, TX, USA, [2]Wyle Integrated Science and Engineering Group, Houston, TX, USA, [3]Dept of Veterans Affairs NJ Healthcare System, East Orange, NJ, USA, [4]Baylor College of Medicine, Houston, TX, USA, and [5]NASA Johnson Space Center, Houston, TX, USA.

Astronauts experience sensorimotor disturbances after long-duration space flight. After a water landing, crewmembers may need to egress the vehicle within a few minutes for safety and operational reasons in various sea state conditions. Exposure to even low-frequency motions induced by sea conditions surrounding a vessel can cause significant motor control problems affecting critical functions. The first objective of this study was to document human visual performance during simulated wave motion below 2.0 Hz. We examined the changes in accuracy and reaction time when subjects performed a visual target acquisition task in which the location of the target was offset vertically during horizontal rotation at an oscillating frequency of 0.8 Hz. The main finding was that both accuracy and reaction time varied as a function of target location, with greater performance decrements occurring when vertical targets were acquired at perturbing frequencies of 0.8 Hz in the horizontal plane.

A second objective was to develop a countermeasure, based on stochastic resonance (SR), to enhance sensorimotor capabilities with the aim of facilitating rapid adaptation to gravitational transitions after long-duration space flight. SR is a mechanism by which noise can enhance the response of neural systems to relevant sensory signals. Recent studies have shown that applying imperceptible stochastic electrical stimulation to the vestibular system (SVS) significantly improved balance and oculomotor responses. This study examined the effectiveness of SVS on improving balance performance. Subjects performed a standard balance task while bipolar SVS was applied to the vestibular system using constant current stimulation through electrodes placed over the mastoid process. The main finding of this study was that balance performance with the application of SR showed significant improvement in the range of 10%-25%. Ultimately an SR-based countermeasure might be fielded either as preflight training to enhance adaptability, or as a miniature patch-type stimulator worn post flight.