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AN OCULAR METRIC STANDARD TO ASSESS THE PERFORMANCE OF OCULAR SYSTEM FOR LONG DURATION IN-FLIGHT USE

Abstract

Human neurophysiological deconditioning, due to spaceflight, has been a challenge to the space program since its inception; challenges that become more acute as extended ISS missions are becoming routine, and a multi-year crewed trip to Mars is being planned. Determining the extent to which these adaptations could adversely impact the performance of operational tasks, assessing how long they persist postflight, and identifying the long-term health consequences, will need to be resolved to enable any autonomous, long-duration, deep-space missions (e.g., Mars Celement 2020). In particular, in humans, vision is the predominant perceptual sense used to control motor action. Thus, it is critical (for the success of any future, long-duration Moon/Mars missions) to understand how microgravity, and other stressors of spaceflight, considering small N subjects, is a challenging task.NASA has long been observing and tracking ophthalmological changes associated with spaceflight driven by the fluid shifts related to microgravity and perhaps other factors. A recent comparison of Optical Coherence Tomography (OCT) measures of retinal thickening pre- vs. postflight indicates that more than two-thirds of US crew members of International Space Station (ISS) show significant changes in the retinal structure after missions lasting 6-months or more (Stringer, 2017). Crew members often experience this Space Associated Neuro-ocular Syndrome (SANS), consisting of visual acuity decrements and ocular structural changes that could become severe enough to adversely impact in-flight performance (particularly as missions become longer). However, the impact of spaceflight on the visual system is not limited to the retina. Recent comparisons of pre-and post-flight brain images have revealed structural changes throughout the brain that implicate visual, visuomotor, and visual-cognitive pathway involvement. Structural alterations in visual/visuomotor/visuocognitive brain areas due to weightlessness are consistent with observed functional impacts: decreased speed and accuracy of fine goal-oriented movements, somatosensory difficulties, and movement-timing impairment (De la Torre, 2014). Current limitations on inflight testing of the crew make it very difficult to determine when and under what conditions SANS, and other disruptions of critical human physiological, neurological, and psychological subsystems, arise. Currently, one cannot predict the visual changes' severity or the recovery's magnitude (or potential further degeneration). This study addresses the need by creating a comprehensive, integrated framework of understanding existing literature in space application and the clinical world to combine structural and performance impacts in standard measures ultimately. To develop a low-profile ocular healthcare diagnostic unit for deep space exploration.