ASSESSING THE RELATIONSHIPS BETWEEN SENSORIMOTOR BIOMARKERS AND POST-LANDING FUNCTIONAL TASK PERFORMANCE

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Spaceflight drives adaptive changes in healthy individuals appropriate for sensorimotor function in a microgravity environment. These changes are maladaptive for return to earth's gravity. The inter-individual variability of sensorimotor decrements is striking, although poorly understood. The goal of this study is to identify a set of behavioral, neuroimaging and genetic measures that can be used to predict early post-flight performance on a set of sensorimotor tasks. Astronauts are recruited who previously participated in sensorimotor field tests and/or posturography soon after long-duration spaceflight. Behavioral tests include assessments of sensory dependency and adaptability. Visual dependency involves treadmill walking while viewing a moving virtual visual scene. Vestibular perceptual thresholds are measured while seated during lateral translations. Proprioception dependency is measured during one-legged stance on a horizontal air-bearing surface. Ground assessment of adaptability is performed (1) during treadmill walking with a virtual linear hallway and a moving walking surface, and (2) during multiple trials of navigating an obstacle course while wearing reversing prisms (adaptive Functional Mobility Test, aFMT). The neuroimaging tests will characterize individual differences in regional brain volumes (using Structural MRI) and white matter microstructure (using Diffusion Tensor Imaging) to serve as potential predictors of adaptive capacity. The genetic tests will utilize saliva samples to examine variations in four genes chosen because of their ability to differentiate sensorimotor adaptation ability in a normative population, including Catechol-O-methyltransferase (COMT), Dopamine Receptor D2 (DRD2), Brain-derived neurotrophic factor (BDNF) and the α2-adrenergic receptor. Twenty-seven ISS crewmembers have been tested to date, including 6 from this past year. This cohort includes 10 first-time fliers, 6F, and mission durations lasting 178.6 ± 30.5 days, mean ± std. We are utilizing a combination of three post-flight functional task outcomes: tandem walk, recovery from fall and dynamic posturography. There is considerable variability among the post-flight performance outcomes for the 27 participants to date. Based on a partial sample using an ordinal scale survey, 70% indicated their ability to perform functional tasks were more impacted postflight relative to inflight with 50% indicating they needed to restrict movements for a longer period postflight relative to inflight. While there is a strong association within tests obtained at different R+0 timepoints, by R+24 hr performance on one post-flight test does not necessarily correlate with performance on other post-flight tests. There are apparent relationships between individual measures and specific post-flight outcome measures, e.g., the cumulative time to complete the aFMT is significantly correlated to pre-to-post-flight changes in tandem walk ($rho = 0.64$, $p = 0.001$). Preliminary statistical analysis indicates combining biomarkers will increase predictive power and this will be explored with future analyses. Our preliminary findings underscore the importance of a comprehensive post-flight test battery including different types of tasks with varying sensory feedback. We expect that understanding the relationships between these sensorimotor biomarkers and post-flight functional task performance will improve both our understanding of the individual variability and our strategy to optimize sensorimotor countermeasures.

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