The effects of long duration bed rest as a spaceflight analogue on resting state sensorimotor network functional connectivity and neurocognitive performance

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Long duration spaceflight has been associated with detrimental alterations in human sensorimotor systems and neurocognitive performance. Prolonged exposure to a head-down tilt position during long duration bed rest can resemble several effects of the microgravity environment such as reduced sensory inputs, body unloading and increased cephalic fluid distribution. The question of whether microgravity affects other central nervous system functions such as brain functional connectivity and its relationship with neurocognitive performance is largely unknown, but of potential importance to the health and performance of astronauts both during and post-flight. The aims of the present study are 1) to identify changes in sensorimotor resting state functional connectivity that occur with extended bed rest exposure, and to characterize their recovery time course; 2) to evaluate how these neural changes correlate with neurocognitive performance. Resting-state functional magnetic resonance imaging (rsfMRI) data were collected from 17 male participants. The data were acquired through the NASA bed rest facility, located at the University of Texas Medical Branch (Galveston, TX). Participants remained in bed with their heads tilted down six degrees below their feet for 70 consecutive days. RsfMRI data were obtained at seven time points: 7 and 12 days before bed rest; 7, 50, and 65 days during bed rest; and 7 and 12 days after bed rest. Functional connectivity magnetic resonance imaging (fcMRI) analysis was performed to measure the connectivity of sensorimotor networks in the brain before, during, and post-bed rest. We found a decrease in left putamen connectivity with the pre- and post-central gyri from pre bed rest to the last day in bed rest. In addition, vestibular cortex connectivity with the posterior cingulate cortex decreased from pre to post bed rest. Furthermore, connectivity between cerebellar right superior posterior fissure and other cerebellar regions decreased from pre bed rest to the last day in bed rest. In contrast, connectivity within the default mode network remained stable over the course of bed rest. We also utilized a battery of behavioral measures including spatial working memory tasks and measures of functional mobility and balance. These behavioral measurements were collected before, during, and after bed rest. We will report the preliminary findings of correlations observed between brain functional connectivity and behavioral performance changes. Our results suggest that sensorimotor brain networks exhibit decoupling with extended periods of reduced usage. The findings from this study could aid in the understanding and future design of targeted countermeasures to alleviate the detrimental health and neurocognitive effects of long-duration spaceflight.

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