Spaceflight Impacts on the Human Brain and Behavior

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Friday, February 18, 2022
3:05 p.m. SCOB 228
https://asu.zoom.us/j/82998527422

Abstract

Studying adaptation to the microgravity environment provides insight into how the central nervous system responds to an environment for which it has not evolved. Microgravity alters vestibular signaling, due to the system’s functional dependence on gravity. Adaptive modifications are reflected in post-spaceflight aftereffects, including declines in gait and balance, until re-adaptation to Earth’s 1G environment occurs. Here we examine how spaceflight affects neural processing of applied vestibular stimulation. We used fMRI to measure brain activity in response to vestibular stimulation in 15 astronauts pre- and post spaceflight. We also measured balance and functional mobility. Data were collected twice pre-flight and four times post-flight (out to six months). We found extensive changes in the brain’s functional response to vestibular stimulation from pre- to postflight in multiple sensory cortices. Further, these pre- to post-flight changes in brain activity correlated with changes in standing balance. These findings provide evidence for sensory reweighting and adaptive cortical neuroplasticity with spaceflight. These results have implications for better understanding compensation and adaptation to vestibular functional disruption, and they provide insights into how humans learn to move in the microgravity environment. Supported by NASA NNX11AR02G.

Bio Sketch

Dr. Seidler’s research focuses on the neural control of movement in health and disease, with a specific focus on motor learning. She uses a range of neuroimaging and neuromodulation techniques coupled with precise measures of movement and cognitive function to determine the neurocognitive underpinnings of motor control. Dr. Seidler has expertise working with a variety of populations including healthy young and older adults, patients with Parkinson’s disease, and NASA astronauts in both basic science and intervention experiments.