

BEHAVIORAL ASSESMENT OF SPACEFLIGHT EFFECTS ON NEUROCOGNITIVE PERFORMANCE - EXTENT AND LONGEVITY

Y.E. De Dios¹, I.S. Kofman¹, N.E. Gadd¹, G.A. Kreutzberg¹, B.T. Peters¹, L.C. Taylor¹, D.J. Campbell¹, S.J. Wood⁴,
J.J. Bloomberg³, R.D. Seidler², A.P. Mulavara¹

¹ KBRwyle, Houston, TX; ²University of Michigan, Ann Arbor MI; ³NASA Johnson Space Center, Houston, TX;
⁴Azusa Pacific University, Azusa CA

Exposure to the microgravity environment during spaceflight missions impacts crewmembers' sensorimotor function. Bock et al. [1] studied the cognitive demands of human sensorimotor performance and dual tasking during long duration missions and concluded that both stress and scarcity of cognitive resources required for sensorimotor adaptation may be responsible for these deficits during spaceflight. Therefore, in consideration of the health and performance of crewmembers in- and post-flight, we are conducting this study to investigate the effects of spaceflight on the extent, longevity and neural bases of sensorimotor, cognitive, and neural changes. The data presented will focus on the behavioral measures that were collected pre-, in- and post-flight including spatial cognition, processing speed, bimanual coordination, functional mobility, computerized dynamic posturography (CDP), and vibrotactile induced vestibular evoked myogenic potential (VEMP).

To date, data were collected over the course of two pre-flight sessions and four post-flight sessions on five crewmembers (n=13) using the protocol described in Koppelmans et al. [2]. Balance control was assessed using CDP, with eyes closed and a sway-referenced base of support (Sensory Organization Test 5), with and without head movements in the pitch plane. Spatial working memory was assessed using Thurston's Card Rotation Test and a Mental Rotation Test. The Rod and Frame Test was performed to test visual dependence. The Digit Symbol Substitution Test was performed to evaluate processing speed, and the Purdue Pegboard Task was performed to test bimanual coordination. Vestibular function was assessed by eliciting ocular VEMP via a hand held striker on the side of the head as subjects lay supine on a gurney. Subjects also performed the Functional Mobility Test of walking through an obstacle course to assess rate of early motor learning. Data were also collected on the same crewmembers during three in-flight sessions on the International Space Station (ISS). In-flight, spatial working memory was assessed using the Mental Rotation Test, adaptation to visuo-motor transformation in manual control was assessed using the Sensorimotor Adaptation Test, and multi-tasking ability was assessed using the Dual Task Test. These three tests were performed in a strapped-in configuration mimicking a seated position – waist bungees pulled the crewmember toward the “floor” with feet secured in foot loops. The Mental Rotation Test was also performed in a free-floating configuration while the crewmember floated while holding on to the gamepad controller used to provide input that was secured to the equipment rack on the ISS.

Preliminary findings from data collected to date, will be included in the presentation. Eventual comparison to results from supporting bed rest and longitudinal studies will enable the parsing out of the multiple mechanisms contributing to any observed spaceflight-induced sensorimotor and cognitive behavioral changes.

This work is funded by NASA NNX11AR02G (PI: RDS)

REFERENCE

- [1] Bock O, Weigelt C, Bloomberg JJ. *Cognitive demand of human sensorimotor performance during an extended space mission: a dual-task study*. Aviation, Space, and Environmental Medicine, 2010. **81**(9): p. 1-6.
- [2] Koppelmans V, Erdeniz B, De Dios YE, Wood SJ, Reuter-Lorenz PA, Kofman I, Bloomberg JJ, Mulavara AP, Seidler RD. *Study protocol to examine the effects of spaceflight and a spaceflight analog on neurocognitive performance: extent, longevity, and neural bases*. BMC Neurol. 2013 Dec 18;13:205. doi: 10.1186/1471-2377-13-205.