Brain activations for vestibular stimulation and dual tasking change with spaceflight

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Previous studies have documented the effects of spaceflight on human physiology and behavior, including muscle mass, cardiovascular function, gait, balance, manual motor control, and cognitive performance. An understanding of spaceflight-related changes provides important information about human adaptive plasticity and facilitates future space travel. In the current study, we evaluated how brain activations associated with vestibular stimulation and dual tasking change as a function of spaceflight. Five crewmembers were included in this study. The durations of their spaceflight missions ranged from 3 months to 7 months. All of them completed at least two preflight assessments and at least one postflight assessment. The preflight sessions occurred, on average, about 198 days and 51 days before launch; the first postflight sessions were scheduled 5 days after return. Functional MRI was acquired during vestibular stimulation and dual tasking, at each session. Vestibular stimulation was administered via skull taps delivered by a pneumatic tactile pulse system placed over the lateral cheekbones. The magnitude of brain activations for vestibular stimulation increased with spaceflight relative to the preflight levels, in frontal areas and the precuneus. In addition, longer flight duration was associated with greater preflight-to-postflight increases in vestibular activation in frontal regions. Functional MRI for finger tapping was acquired during both single-task (finger tapping only) and dual-task (simultaneously performing finger tapping and a secondary counting task) conditions. Preflight-to-post-spaceflight decreases in brain activations for dual tasking were observed in the right postcentral cortex. An association between flight duration and amplitude of flight-related change in activations for dual tasking was observed in the parietal cortex. The spaceflight-related increase in vestibular brain activations suggests that after a long-term spaceflight, more neural resources are required to process vestibular input.