

Operational implications from Field Test results: Sensorimotor guidelines for exploration missions

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Two key sensorimotor objectives of the joint NASA-Russian Field Test (FT) study were (1) to quantify functional performance on long duration crewmembers as close to landing as possible, and (2) to develop a recovery timeline back to preflight baseline. The purpose of this presentation is to provide an overview of the FT results and discuss the operational implications for future exploration missions. The NASA and Russian teams conducted a total of 48 Field Tests, including 18 using a reduced Pilot FT (PFT) protocol. The combined PFT/FT cohort included 14 first-time fliers, 4F, and nine cosmonauts who repeated FT during a second mission. The mission durations were 185 ± 42 days, mean $\pm$ std. Nominally, the initial postflight session was performed in the medical test at the Soyuz landing site or at the nearby airport ($R+2.2 \pm 1.3$ hrs, mean $\pm$ std), and then repeated multiple times throughout the postflight recovery. The common tasks performed across PFT and full FT protocols included sit-to-stand, recovery from fall (prone to stand) and tandem walk, performed in that order of increasing difficulty. The full FT protocol also included seated tasks (eccentric gaze, dysmetria finger to nose, eye-hand coordination on a tablet, grip force discrimination), a standing posture test with an upper body perturbation, a timed up and go mobility test with obstacles, and a dynamic visual acuity task during vertical oscillations. While there was considerable variability in the postflight outcome measures across crewmembers, the level of vestibular/cerebellar and sensorimotor impairment was greater than previously observed during shorter spaceflight missions. Most striking was the higher incidence of motion sickness even without constraining the standard medical interventions. Motion sensitivity prevented some crewmembers from attempting and/or completing the early testing. The recovery timeline varied with task complexity, generally taking longer when either the basis of support was limited (e.g., tandem walk) or visual cues were deprived (eyes closed). Based on this evidence, mission planners need to expect a range of response across individuals and tasks following G-transitions. Individual health assessments are recommended along with development of pre-worked, prioritized content and timelines, with the ability to change roles depending on crew readiness. Handholds and balance aids are recommended to help stabilize the crewmembers to perform specific tasks (e.g., touch screen selection) or to allow the crewmember the ability to rest with onset of symptoms. Based on anecdotal reports and performance on computerized dynamic posturography, multiple testing on landing day appeared to be beneficial for some participants, while others may have pushed beyond their motion tolerance limit in an effort to complete more FT objectives. Instead of delaying planetary surface operations to allow for recovery, our results suggest that early mobility may be important. Early active self-administered retraining, individualized based on the level of initial impairment and motion sensitivity, will enable a more efficient motor learning and enhance crew performance.