

SPACE LIFE SCIENCES SYMPOSIUM (A1)
Human Physiology in Space (2)

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FUNCTIONAL SENSORY-MOTOR PERFORMANCE FOLLOWING LONG TERM SPACE FLIGHT:
THE FIRST RESULTS OF “FIELD TEST” EXPERIMENT

Abstract

The effect that extended-duration space flights may have on human space travelers, including exploration missions, is widely discussed at the present time. Specifically, there is an increasing amount of evidence showing that the physical capacity of cosmonauts is significantly reduced after long-duration space flights. It is evident that the most impaired functions are those that rely on gravity, particularly up right posture and gait. Because of the sensorimotor disturbances manifested in the neurology of the posture and gait space flight and postflight changes may also be observed in debilitating motion sickness. While the severity of particular symptoms varies, disturbances in spatial orientation and alterations in the accuracy of voluntary movements are persistently observed after long-duration space flights.

At this time most of the currently available data are primarily descriptive and not yet suitable for predicting operational impacts of most sensorimotor decrements observed upon landing on planetary surfaces or asteroids. In particular there are no existing data on the recovery dynamics or functionality of neurological, cardiovascular or muscle performance making it difficult to model or simulate the cosmonauts' activity after landing that will allow us and develop the appropriate countermeasure that will ensure the rapid and safe recovery of crewmembers immediately after landing in what could be hostile environments. However and as a starting position, the videos we have acquired during recent data collection following the long duration flights of cosmonauts and astronauts walking and performing other tasks shortly after return from space flight speak volumes about their level of deconditioning.

A joint Russian-American team has developed a new study specifically to address the changes in crewmembers performance and the recovery of performance with the intent of filling the missing data gaps. The first (pilot) phase of this study includes recording body kinematics and quantifying the coordination and timing of relatively simple basic movements – transition from seated and prone positions to standing, walking, stepping over obstacles, tandem walking, muscle stiffness, as well as characteristics of postural sway and orthostatic tolerance. Testing for changes in these parameters have been initiated in the medical tent at the landing site.

The first set of experiments showed that during the first hour after landing, cosmonauts and astronauts were able to execute (although slower and with more effort than preflight) simple movements such as egress from a seated or prone position and also to remain standing for 3.5 minutes without exhibiting pronounced cardiovascular changes. More challenging tests, however, demonstrated a prominent reduction in coordination – the obstacle task, for example, was performed at much slower speed and with a marked overestimation of the obstacle height and tandem walking was greatly degraded suggesting significant changes in proprioception, brainstem and vestibular function. There is some speculation that the neural changes, either from the bottom-up or top down may be long lasting; requiring compensatory responses that will modify or mask the adverse responses we have observed. Furthermore, these compensatory responses may actually be beneficial, helping achieve a more rapid adaptation to both weightlessness and a return to earth.