FUNCTIONAL TASK TESTS IN PARTIAL GRAVITY DURING PARABOLIC FLIGHT

T. R. Macaulay[1], A. Bollinger[1], S. J. Wood[2], M. F. Reschke[2], G. R. Clément[1]

[1] KBR, Houston, TX, [2] NASA Johnson Space Center, Houston, TX

BACKGROUND

Critical mission tasks required by crews immediately after landing on a planetary surface include walking, jumping, and egressing from a seat. Understanding how these functional tasks are performed in partial gravity such as on the moon or Mars is necessary to define effective and comprehensive countermeasure strategies for preserving crew performance during exploration-class missions. We propose to study the performance of these tasks during the partial gravity phases of parabolic flight. These tasks will be performed using the same equipment and procedures as those used with astronauts returning from spaceflight and with ground-based subjects after prolonged axial body unloading during bed rest (sensorimotor standard measures).

HYPOTHESIS

We hypothesize that partial gravity during parabolic flight will cause acute changes in vestibular, proprioceptive, and sensorimotor functions, and these changes will impact the performance of mission critical tasks such as standing, walking, and jumping. The largest changes in performance are expected at the lowest gravity level (0.25g) because subjects will no longer be able to use the gravitational reference for the perception of upright. Ultimately, this information could be used to assess performance risks and inform the design of countermeasures for NASA exploration-class human missions.

METHODS

Twelve subjects will be tested during three flights of 30 parabolas, including 10 parabolas at 0.25g, 10 parabolas at 0.5g, and 10 parabolas at 0.75g. Subjects also will perform tests in 1*g* between parabolas. The tasks will be the same as those tested on astronauts returning from spaceflight: sit-to-stand with obstacle walk, tandem rail balance, jump down, and recovery from fall. Measurements will include: (a) time to test completion (sit-to-stand with obstacle walk, recovery from fall); (b) time elapsed between the start of motion and the stabilization of upright posture (recovery from fall, jump down); (c) mean sway speed during quiet standing (recovery from fall, jump down); (d) changes in heart rate and blood pressure (recovery from fall); (e) balance time and torso accelerations (tandem rail balance); (f) cone of stability (jump down); and (g) severity of motion sickness symptoms.

RELEVANCE

Although gravitational dose-response curves have been obtained for some biochemical systems in animals, these dose-responses are unknown for most human physiologic systems. Our study will compare the outcomes of four functional task tests in 0.25g, 0.5g, 0.75g, and 1*g* with those previously obtained in ground-based subjects after prolonged axial body unloading and in astronauts immediately after spaceflight. These comparisons will help us understand the true extent of functional task performance deficits in partial gravity. The dose-response relationship between gravity level and task performance decrement also will help determining the gravity threshold for these functional tasks.

ACKNOWLEDGEMENT

This work is supported by the NASA's Human Research Program Human Health Countermeasures Element.