USING TESTS DESIGNED TO MEASURE INDIVIDUAL SENSORIMOTOR SUBSYSTEM PERFORMANCE TO PREDICT LOCOMOTOR ADAPTABILITY

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Astronauts experience sensorimotor disturbances during the initial exposure to microgravity and during the readapation phase following a return to a gravitational environment. These alterations may lead to disruption in the ability to perform mission critical functions during and after these gravitational transitions. Astronauts show significant inter-subject variation in adaptive capability following gravitational transitions. The way each individual's brain synthesizes the available visual, vestibular and somatosensory information is likely the basis for much of the variation. Identifying the presence of biases in each person's use of information available from these sensorimotor subsystems and relating it to their ability to adapt to a novel locomotor task will allow us to customize a training program designed to enhance sensorimotor adaptability.

Eight tests are being used to measure sensorimotor subsystem performance. Three of these use measures of body sway to characterize balance during varying sensorimotor challenges. The effect of vision is assessed by repeating conditions with eyes open and eyes closed. Standing on foam, or on a support surface that pitches to maintain a constant ankle angle provide somatosensory challenges. Information from the vestibular system is isolated when vision is removed and the support surface is compromised, and it is challenged when the tasks are done while the head is in motion. The integration and dominance of visual information is assessed in three additional tests. The Rod & Frame Test measures the degree to which a subject's perception of the visual vertical is affected by the orientation of a tilted frame in the periphery. Locomotor visual dependence is determined by assessing how much an oscillating virtual visual world affects a treadmill-walking subject. In the third of the visual manipulation tests, subjects walk an obstacle course while wearing up-down reversing prisms. The two remaining tests include direct measures of knee and ankle proprioception and a functional movement assessment that screens for movement restrictions and asymmetries. To assess each subject's locomotor adaptability subjects walk for twenty minutes on a treadmill that oscillates laterally at 0.3 Hz. Throughout the test metabolic cost provides a measure of exertion and step frequency provides a measure of stability. Additionally, at four points during the perturbation period, reaction time tests are used to probe changes in the amount of mental effort being used to perform the task.

As with the adaptive capability observed in astronauts during gravitational transitions, our data shows significant variability between subjects. To aid in the analysis of the results, custom software tools have been developed to enhance in the visualization of the large number of output variables. Preliminary analyses of the data collected to date do not show a strong relationship between adaptability and any single predictor variable. Analysis continues to identify a multi-factorial predictor outcome "signature" that do inform us of locomotor adaptability.

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