PHYSIOLOGICAL OBSERVATIONS AND OMICS TO DEVELOP PERSONALIZED SENSORIMOTOR ADAPTABILITY COUNTERMEASURES USING BED REST AND SPACE FLIGHT DATA

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Astronauts experience sensorimotor disturbances during the initial exposure to microgravity and during the re-adapation phase following a return to an earth-gravitational environment. These alterations may disrupt the ability to perform mission critical functional tasks requiring ambulation, manual control and gaze stability. Interestingly, astronauts who return from space flight show substantial differences in their abilities to readapt to a gravitational environment. The ability to predict the manner and degree to which individual astronauts would be affected would improve the effectiveness of countermeasure training programs designed to enhance sensorimotor adaptability. For such an approach to succeed, we must develop predictive measures of sensorimotor adaptability that will allow us to foresee, before actual space flight, which crewmembers are likely to experience the greatest challenges to their adaptive capacities. The goals of this project are to identify and characterize this set of predictive measures that include: 1) behavioral tests to assess sensory bias and adaptability quantified using both strategic and plastic-adaptive responses; 2) imaging to determine individual brain morphological and functional features using structural magnetic resonance imaging (MRI), diffusion tensor imaging, resting state functional connectivity MRI, and sensorimotor adaptation task-related functional brain activation; 3) genotype markers for genetic polymorphisms in Catechol-O-Methyl Transferase, Dopamine Receptor D2, Brain-derived neurotrophic factor and genetic polymorphism of alpha2-adrenergic receptor that play a role in the neural pathways underlying sensorimotor adaptation. We anticipate these predictive measures will be significantly correlated with individual differences in sensorimotor adaptability after long-duration space flight and an analog bed rest environment. We will be conducting a retrospective study leveraging data already collected from relevant ongoing/completed bed rest and space flight studies. These data will be combined with predictor metrics that will be collected prospectively - behavioral, brain imaging and genomic measures; from these returning subjects to build models for predicting post-mission (bed rest - non-astronauts or space flight - astronauts) adaptive capability as manifested in their outcome measures. Comparisons of model performance will allow us to better design and implement sensorimotor adaptability training countermeasures that are customized for each crewmember's sensory biases, adaptive capacity, brain structure and functional capacities, and genetic predispositions against decrements in post-mission adaptive capability. This ability will allow more efficient use of crew time during training and will optimize training prescriptions for astronauts to ensure expected outcomes.