BEHAVIORAL, BRAIN IMAGING AND GENOMIC MEASURES TO PREDICT FUNCTIONAL OUTCOMES POST - BED REST AND SPACEFLIGHT

A.P. Mulavara[1], B. Peters[1], Y.E. De Dios[1], N.E. Gadd[1], E.E. Caldwell[1], C.D. Batson[2], R. Goel[3], L. Oddsson[4], G. Kreutzberg[1], S. Zanello[5], T.K. Clark[6], C.M. Oman[7], H.S. Cohen[8], S. Wood[9], R.D. Seidler[10], M.F. Reschke[11] and J.J. Bloomberg[11]

[1]KBRWyle, 2400 NASA Parkway, MC: SK/B272, Houston, TX, 77058, ajitkumar.p.mulavara@nasa.gov; [2]MEI Technologies, Houston, TX; [3]University of Houston, Houston, TX; [4]University of Minnesota, Minneapolis, MN; [5]Universities Space Research Association, Houston, TX; [6]University of Colorado Boulder, Boulder, CO; [7]Massachussets Institute of Technology, Cambridge, MA; [8]Baylor College of Medicine, Houston, TX; [9]Azusa Pacific University, Azusa, CA; [10]University of Michigan, Ann Arbor, MI; [11]NASA Johnson Space Center, Houston, TX

Astronauts experience sensorimotor disturbances during their initial exposure to microgravity and during the re-adaptation phase following a return to an Earth-gravitational environment. These alterations may disrupt crewmembers' ability to perform mission critical functional tasks requiring ambulation, manual control and gaze stability. Interestingly, astronauts who return from spaceflight show substantial differences in their abilities to readapt to a gravitational environment. The ability to predict the manner and degree to which individual astronauts are affected will 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 spaceflight, which crewmembers are likely to experience greater challenges to their adaptive capacities. The goals of this project are to identify and characterize this set of predictive measures. Our approach includes: 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; and 3) assessment of genetic polymorphisms in the catechol-O-methyl transferase, dopamine receptor D2, and brain-derived neurotrophic factor genes and genetic polymorphisms of alpha2-adrenergic receptors that play a role in the neural pathways underlying sensorimotor adaptation. We anticipate that these predictive measures will be significantly correlated with individual differences in sensorimotor adaptability after long-duration spaceflight and exposure to an analog bed rest environment.

We will be conducting a retrospective study, leveraging data already collected from relevant ongoing or completed bed rest and spaceflight studies. This data will be combined with predictor metrics that will be collected prospectively (as described for behavioral, brain imaging and genomic measures) from these returning subjects to build models for predicting post spaceflight and bed rest adaptive capability. In this presentation we will discuss the optimized set of tests for predictive metrics to be used for evaluating post mission adaptive capability as manifested in their outcome measures. Comparisons of model performance will allow us to better design and implement sensorimotor adaptability training countermeasures against decrements in post-mission adaptive capability that are customized for each crewmember's sensory biases, adaptive ability, brain structure, brain function, and genetic predispositions. The ability to customize adaptability training will allow more efficient use of crew time during training and will optimize training prescriptions for astronauts to mitigate the deleterious effects of spaceflight.