Fiscal Year:	FY 2017	**Task Last Updated:**	FY 01/24/2018
PI Name:	Mulavara, Ajitkumar P. Ph.D.		
Project Title:	Developing Personalized Countermeasures for Sensorimotor Adaptability: A Bedrest Study		
Division Name:	Human Research		
Program/Discipline:	NSBRI		
Program/Discipline--Element/Subdiscipline:	NSBRI--Sensorimotor Adaptation Team		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **Sensorimotor (SM)**:Risk of Impaired Control of Spacecraft, Associated Systems and Immediate Vehicle Egress Due to Vestibular/Sensorimotor Alterations Associated with Space Flight		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	77058	**Congressional District:**	36
Comments:	NOTE: Formerly at Universities Space Research Association		
Project Type:	GROUND	**Solicitation:**	2013 HERO NNJ13ZSA002N-Crew Health (FLAGSHIP & NSBRI)
Start Date:	06/01/2014	**End Date:**	05/31/2017
No. of Post Docs:	1	**No. of PhD Degrees:**	1
No. of PhD Candidates:	2	**No. of Master' Degrees:**	0
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
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Performance Goal No.:			
Performance Goal Text:			

Task Description:	A targeted research area described in the NNJ13ZSA002N National Space Biomedical Research Institute (NSBRI) Research Announcement is to: Employing a bed rest study, identify and characterize sensorimotor mal-adaptations that may impact performance during a series of g-transitions following long periods in microgravity. Integrate physiological observations and –omics data to develop personalized countermeasures to any observed sensorimotor mal-adaptations. The goals of this project were to identify and characterize a set of predictive measures that include: 1) behavioral tests to assess sensory bias and adaptability; 2) imaging to determine individual brain morphological and functional features; 3) genotype markers for genetic polymorphisms that play a role in the neural pathways underlying sensorimotor adaptation. Information from this study will help in the design of sensorimotor adaptability training countermeasures that may be customized for each crewmember's individual characteristics. The study is almost completely retrospective, in that no new bed rest or flight studies are required. To achieve these goals the following Aims will be pursued: 1) Aim 1: Determine whether baseline individual sensory biases and capabilities for strategic and plastic-adaptive responses predict both change and also the ability to re-adapt sensorimotor and functional performance after 70 days bed rest or short/long duration spaceflight. We will determine if participants' individual sensory biases in use of vision, vestibular, and proprioception as well as tests of strategic and long-term adaption predict the change from pre to post-tests after bed rest or spaceflight and determine if those biases predict rates of re-adaptation in sensorimotor performance. 2) Aim 2: Determine if baseline brain morphological and functional metrics predict both change and also the ability to re-adapt sensorimotor and functional performance after 70 days bed rest or short/long duration spaceflight. We will determine if individual differences in regional brain volumes (structural MRI), white matter integrity (diffusion tensor imaging, or DTI), functional network integrity (resting state functional connectivity MRI), and sensorimotor adaptation task-related functional brain activation (functional MRI) predict pre to post levels of decrements and their rates of re-adaptation in sensorimotor performance. 3) Aim 3: Determine if genetic markers predict both change and also the ability to re-adapt sensorimotor and functional performance after 70 days bed rest or short/long duration spaceflight. We will determine whether genetic polymorphisms in COMT, DRD2, BDNF, and genetic polymorphism of alpha2-adrenergic receptor are associated with pre to post levels of decrements in sensorimotor performance and rates of re-adaptation. Developing predictive measures of sensorimotor adaptability 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. We will be conducting a retrospective study leveraging data already collected from relevant ongoing/completed bed rest and spaceflight studies. This data will be combined with predictor metrics -- behavioral, brain imaging, and genomic measures collected from these returning subjects to build models for predicting post-mission (bed rest or spaceflight) adaptive capability as manifested in their outcome measures. Comparisons of model performance for various groups of predictors will provide insight into how to design subject-specific countermeasures 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. This funding year multiple levels of approvals were obtained including Authority to Proceed from the Science Management Panel, Lifetime Surveillance of Astronaut Health (LSAH), and International Space Station Medical Projects (ISSMP) element in order to be able to recruit from all available crewmembers who had participated in prior studies to record their functional performance after spaceflight to participate in the study. A total of six crewmembers who had participated in prior spaceflight studies and three subjects who had participated in bed rest studies to quantify their functional performance before and after these missions agreed to participate in this study. Preliminary results indicate a correlation between the subjects' pre mission ability to utilize somatosensory information from their feet and ankles to the change in performance abilities of dynamic balance performance as well as the change in recovery from fall functional test performance after spaceflight and bedrest. Another highlight was the findings from various studies across investigators' laboratories, using data from control subjects, that have shown individual sensory preferences, adaptation ability to surrogate sensorimotor environments, subjects' brain structure and functional connectivity as well subjects' single nucleotide polymorphisms in genetic markers can be used to predict subjects' ability to adapt to novel sensorimotor environments.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This project will produce a set of predictive measures to determine individual capability for rapid sensorimotor adaptation. This will allow the implementation of sensorimotor adaptability rehabilitation and re-conditioning training programs that may be customized for vestibulopathic or elderly patients' sensory bias, motor learning modes and individual adaptive capability, brain structural and functional characteristics, or targeted single nucleotide polymorphisms. This will optimize training prescriptions to enable efficient use of patient time during rehabilitation and re-conditioning training programs to ensure expected outcomes.
	1. We recruited and tested six crewmembers and three bed rest subjects for whom we collected prospectively data across sensory utilization tests; adaptive capabilities in locomotor and manual control; single nucleotide polymorphisms (SNPs) for DRD2, COMT, BDNF, and DRAI (Alpha 2 adrenergic receptor (DraI)). We also shared retrospectively collected functional performance data on two tasks before and immediately after spaceflight and bed rest. Preliminary results show subjects' ability to utilize somatosensory information may predict the change in dynamic postural control after exposure to both spaceflight and bed rest analog environments. 2. A control subject database was augmented to 45 subjects that have the same test of performance. Using information from these tests, data show that subjects' utilization of somatosensory information at the bottom of the feet and at the ankle joints were predictive of the ability to adapt to novel sensorimotor disturbance during walking. Further, the SNP in BDNF and DRD2 showed the ability to delineate subjects' ability to adapt to visuomotor disturbance during walking.

Task Progress:	3. A control-subject group study (n=58) conducted at the University of Houston explored the link between adaptation in manual control and the classical split-belt treadmill locomotor adaptation task. Data showed a significant linear relationship between the number of attempts required to achieve adaptation in the two tasks. These data confirm the notion that a common central adaptive mechanism is employed across sensorimotor sub-systems. 4. A control subject study (n=34) at the University of Michigan investigated whether individual variability in the rate of visuomotor manual adaptation is associated with differences in regional gray matter volume and resting state functional connectivity. Resting state functional connectivity strength between sensorimotor, dorsal cingulate, and temporoparietal regions of the brain was found to predict the rate of learning during the early phase of the adaptation task. As for structural predictors, greater gray matter volume in temporoparietal and occipital regions predicted faster early learning, whereas greater gray matter volume in superior posterior regions of the cerebellum predicted faster late learning. These findings confirm that neural predictors of early and late adaptation may facilitate different aspects of sensorimotor adaptation that may be targeted by countermeasures. 5. A study conducted on people with benign paroxysmal positional vertigo (BPPV) explored the interaction between visual dependence and balance control. Control subjects with poor balance scores had significantly greater visual dependence, indicating reliance on visual cues can affect balance control. The side of impairment was strongly related to the side of perceived bias in the Earth vertical determined by BPPV subjects, indicating a relationship between the effect of BPPV with spatial orientation perception.
Bibliography Type:	Description: (Last Updated: 10/09/2019)
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