Fiscal Year:	FY 2016	**Task Last Updated:**	FY 06/10/2016
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**:Risk of Altered Sensorimotor/Vestibular Function Impacting Critical Mission Tasks		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	ajitkumar.p.mulavara@nasa.gov	**Fax:**	FY 281-244-5734
PI Organization Type:	NASA CENTER	**Phone:**	281-483-8994
Organization Name:	KBRwyle/NASA Johnson Space Center		
PI Address 1:	2101 Nasa Parkway, NASA/JSC		
PI Address 2:	MC: SK2/B21		
PI Web Page:			
City:	Houston	**State:**	TX
Zip Code:	77058	**Congressional District:**	36
Comments:	NOTE: Formerly at Universities Space Research Association		
Project Type:	Ground	**Solicitation / Funding Source:**	2013 HERO NNJ13ZSA002N-Crew Health (FLAGSHIP & NSBRI)
Start Date:	06/01/2014	**End Date:**	05/31/2017
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	1	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**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:			
COI Name (Institution):	Peters, Brian Ph.D. (Wyle Laboratories) Feiveson, Alan (NASA Johnson Space Center) Bloomberg, Jacob (NASA Johnson Space Center) Ploutz-Snyder, Lori (Universities Space Research Association) Seidler, Rachael Ph.D. (University of Michigan) Reschke, Millard (NASA Johnson Space Center) Cohen, Helen Ed.D. (Baylor College of Medicine) Wood, Scott Ph.D. (Azusa Pacific University) Zanello, Susana (Universities Space Research Association)		
Grant/Contract No.:	NCC 9-58-SA03801		
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: 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. In response to this call this project will 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 adaptation 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.
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.
Task Progress:	During the last funded year: 1. NASA International Space Station Medical Project (ISSMP) element approved implementation of study for 51 subjects. 2. CFT 70 bed rest analog study Functional Task Test Control Group of subjects are being recruited by the NASA Test Subject Facility. 3. NASA Science Management Panel reviewed this study and have formulated a plan for implementation of the study: a) Use NSBRI funding until 31 May 2017. b) Proceed with easiest populations, presumably bed rest, retired astronauts, management astronaut, presumably in that order. c) Defer active astronauts until after data are acquired and approach is validated, then initiate HRP-funded study involving active astronauts, presumably after 31 May 2017. 4. One paper was published in the Frontiers of Systems Neuroscience by Dr. Rachael Seidler (Co-Investigator in this project) [Ed. note: See FY2015 report Bibliography] and a second paper is in review; two abstracts were published in proceedings of the Association for Research in Otolaryngology Annual Mid-Winter meeting and 5 other abstracts were presented at the Human Research Program Investigators' Workshop. 5. Retrospective Spaceflight and Bedrest data analysis -- lower limb joint strength and computerized dynamic posturography data that were collected as part of their medical requirement for subjects who participated in the CFT 70 bed rest and spaceflight campaigns to use with their corresponding data from functional tests were requested and obtained after approval from the NASA - AOHMG. Bed rest-induced calf strength losses account for 6-14% of concomitant changes in balance control, dynamic postural stability, and functional performance. Additional work to evaluate the influence of calf strength loss on the performance of longer and more plantarflexor-intensive tasks (e.g., ladder climb and uphill ambulation) is needed. 6. Dr. Bloomberg's project on developing predictors for sensorimotor adaptability program is being leveraged by increasing its scope beyond the original proposal. Additional tests (Proprioceptive contribution to balance control; sensory organization tests 1-6; Vestibular threshold; Spatial orientation under otolith canal mismatch and four targeted single nucleotide polymorphisms using saliva

	samples) were performed on the same 16 subjects from whom data were collected. This contributed significantly towards a group of predictor test protocols for identifying adaptability to novel sensorimotor environments. This also meets one of the goals recommended by the NASA Sensorimotor Review Panels to reduce the number of tests to overcome redundancies and find efficiencies to streamline testing paradigms in post flight and post bed rest participants. The result of this endeavor was a reduced set of 14 tests were identified and reduced the time for testing session from around 6 hours of testing to a total of 3.45 hours including travel time to the MRI testing center (40 minutes of travel time). The following publication is in process: Rahul Goel, Yiri De Dios, Nichole Gadd, Erin Caldwell, Brian Peters, Millard Reschke, Jacob Bloomberg, Lars Oddsson, Ajitkumar Mulavara. "Measuring the contributions of somatosensory information during unipedal postural control."
Bibliography Type:	Description: (Last Updated: 08/25/2020)
Abstracts for Journals and Proceedings	Mulavara A, Seidler R, Peters B, Cohen H, Wood S, Bloomberg J. "Developing Personalized Sensorimotor Adaptability Countermeasures for Spaceflight." 39th Annual MidWinter Meeting of the Association for Research in Otolaryngology, San Diego, CA, February 20-24, 2016. Abstracts of the 39th Annual MidWinter Meeting of the Association for Research in Otolaryngology, San Diego, CA, February 20-24, 2016. Vol. 39, p. 281. , Feb-2016
Abstracts for Journals and Proceedings	Nair M, Mulavara A, Bloomberg J, Sangi-Haghpeykar H, Cohen H. "Relationship Among Visual Dependence, Balance, and Spatial Orientation and Abnormal Loading of the Labyrinth in BPPV." 39th Annual MidWinter Meeting of the Association for Research in Otolaryngology, San Diego, CA, February 20-24, 2016. Abstracts of the 39th Annual MidWinter Meeting of the Association for Research in Otolaryngology, San Diego, CA, February 20-24, 2016. Vol. 39, p. 574. , Feb-2016