Fiscal Year:	FY 2015	**Task Last Updated:**	FY 10/14/2014
PI Name:	Bloomberg, Jacob J. Ph.D.		
Project Title:	Developing Predictive Measures of Sensorimotor Adaptability to Produce Customized Countermeasure Prescriptions		
Division Name:	Human Research		
Program/Discipline:	NSBRI		
Program/Discipline--Element/Subdiscipline:	NSBRI--Sensorimotor Adaptation Team		
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **HSIA**:Risk of Adverse Outcomes Due to Inadequate Human Systems Integration Architecture (2) **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		
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City:	Houston	**State:**	TX
Zip Code:	77058-3607	**Congressional District:**	36
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2011 Crew Health NNJ11ZSA002NA
Start Date:	10/01/2012	**End Date:**	05/31/2016
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:	5	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:	NOTE: End date changed to 5/31/2016 per NSBRI (Ed., 11/5/15)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Buccello-Stout, Regina (Wyle Integrated Sciences and Engineering Group) Wood, Scott (Azusa Pacific University) Cohen, Helen (Baylor College of Medicine) Mulavara, Ajitkumar (Universities Space Research Association) Peters, Brian (Wyle Laboratories) Brady, Rachel (Wyle Integrated Sciences and Engineering Group) Seidler, Rachael (University of Michigan)		
Grant/Contract No.:	NCC 9-58-SA02801		
Performance Goal No.:			
Performance Goal Text:			
Task Description:	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 functional tasks during and after these gravitational transitions. Astronauts show significant inter-subject variation in adaptive capability following gravitational transitions. The ability to predict the manner and degree to which each individual astronaut will be affected would improve the effectiveness of a countermeasure comprised of a training program designed to enhance sensorimotor adaptability. Due to this inherent individual variability we need to develop predictive measures of sensorimotor adaptability that will allow us to predict, before actual space flight, which crewmember will experience challenges in adaptive capacity. Thus, obtaining this information will allow us to design and implement better sensorimotor adaptability training countermeasures that will be customized for each crewmember's unique adaptive capabilities. Therefore, the goals of this project are to: 1) develop a set of predictive measures capable of identifying individual differences in sensorimotor adaptability, and 2) use this information to design sensorimotor adaptability training countermeasures that are customized for each crewmember's individual sensory bias and adaptive capacity. To achieve these goals we have the following specific aims: Specific Aim 1: Determine whether behavioral metrics of individual sensory bias predict sensorimotor adaptability. Subjects show individual variation in the degree to which sensory inputs are weighted and reorganized to produce motor output during exposure to discordant sensory conditions. These individual sensory biases may serve as predictors of adaptability. For this aim, subjects will perform tests that will delineate individual sensory biases in tests of visual, vestibular, and proprioceptive function. They will then be tested to determine if these metrics predict how quickly they adapt to a novel discordant sensory environment. Specific Aim 2: Determine if individual capability for strategic and plastic-adaptive responses predicts sensorimotor adaptability. The transition from one sensorimotor state to another consists of two main mechanisms: strategic and plastic-adaptive. Strategic modifications represent immediate and transitory changes in control that are employed to deal with short-term changes in the prevailing environment. If these changes are prolonged then plastic-adaptive changes are evoked that modify central nervous system function to automate new behavioral responses. For this aim, each subject's strategic and plastic-adaptive abilities will be assessed using a test of locomotor function designed specifically to delineate both mechanisms. Subjects will then be tested to determine if these measures predict how quickly they adapt to a novel discordant sensory environment. Specific Aim 3: Develop predictors of sensorimotor adaptability using brain structural and functional metrics. We will measure individual differences in regional brain volumes (structural magnetic resonance imaging, or 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). Subjects will then be tested to determine if these metrics predict how quickly they behaviorally adapt to a novel discordant sensory environment. Specific Aim 4: Determine if individualized training prescriptions based on predictive metrics can be used to optimize sensorimotor adaptability training countermeasures. To determine if predictive adaptability metrics can be used to design individualized training programs we will examine a test case focusing on improving adaptive performance of visually dependent subjects. Subjects who are identified in Experiment 1, as being visually dependent with reduced adaptive capability, will receive individualized training prescriptions designed to reduce their dependence on vision and increase their ability to use vestibular information for control of movement. The training program will have two components. 1) Subjects will walk on a treadmill-motion base system while viewing discordant visual scenes to reduce dependency on vision along with support-surface motion to challenge gait stability. 2) During this training subjects will receive stimuli (vestibular stochastic resonance) to enhance vestibular signal detection. We anticipate that these two components will act in synergy during training to both reduce visual dependency while increasing dependence on vestibular information. Training efficacy will be assessed by comparing the performance of trained and control visually dependent subjects on how quickly they adapt to a novel discordant sensory environment.		

	In an effort to increase efficiency and maximize the predictive power of our measures we are currently completing the data collection for Specific Aims 1, 2, and 3 simultaneously on the same subjects (n=15). This involves behavioral testing in our labs at NASA/Johnson Space Center and neuroimaging at the University of Texas Medical Branch Victory Lakes Facility, which is located offsite. This approach had a number of benefits including increased data capture. By having the same subject perform all three specific aims we can enhance our ability to detect how wider range factors and their grouping can predict adaptability in a specific individual. This provides a much richer data base and potentially a better understanding of the predictive power of the selected factors.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Sensorimotor adaptability training programs have Earthbound application in rehabilitation of patients with balance disorders, and for fall prevention training among seniors. We have previously shown that training using variation in visual flow during treadmill exercise improves functional mobility in healthy older adults who were experiencing age-related postural instabilities (Buccello-Stout et al. 2008; 2013). This project will provide measures that will allow individualized training programs that serve to enhance the efficacy of ground-based rehabilitation and training programs. Buccello-Stout, RR, Bloomberg, JJ, Cohen, HS, Whorton, EB, Weaver, GD, & Cromwell, RL. Effects of sensorimotor adaptation training on functional mobility in older adults. J Gerontol B Psychol Sci Soc Sci. 63(5): 295-300. 2008. Buccello-Stout RR, Cromwell RL, Bloomberg JJ, Whorton EB. Effects of sensorimotor adaptation training on head stability movement control in response to a lateral perturbation in older adults. The Journal of Aging and Physical Activity. 21: 272-289. 2013.
Task Progress:	In an effort to increase efficiency and maximize the predictive power of our measures we are currently completing the data collection for Specific Aims 1, 2, and 3 simultaneously on the same subjects (n=15). This involves behavioral testing in our labs at NASA/Johnson Space Center and neuroimaging at the University of Texas Medical Branch Victory Lakes Facility, which is located offsite. This approach has a number of benefits including increased data capture. By having the same subject perform all three specific aims we can enhance our ability to detect how wider range factors and their grouping can predict adaptability in a specific individual. This provides a much richer data base and potentially a better understanding of the predictive power of the selected factors. Data collection for Specific Aims 1, 2, and 3 will be completed by December 2014. Significant improvements were made to our data-collection process for the Treadmill Visual Dependency and Novel Sensory Discordance tests. These tests require simultaneous data collection of video-based motion capture and analog data. We consolidated the data collection from three to two computers while still assuring that the video-based motion capture data and the analog data were synchronized. This allowed us to eliminate several post-processing steps to synchronize the data, saving up to an hour of analysis time per data collection session. We have received approval from the NASA Institutional Review Board (IRB) and completed a NASA Test Readiness Review (TRR) to conduct the study supporting Specific Aim 4. We are currently conducting pilot testing and plan to begin data collection for Specific Aim 4 in Sept. 2014. Data Collection at Azusa Pacific University (APU): The focus of the data collection at Dr. Wood's APU laboratory is to expand the set of predictive measures capable of identifying individual differences in the ability to adapt to novel discordant sensory environments. As with the primary data collection at NASA Johnson Space Center (JSC), three sets of predictor tests have been implemented to delineate individual sensory biases or asymmetries in tests of visual, vestibular, and proprioceptive function. The ability to adapt to discordant sensory cues will be assessed by improvements in time-to-completion of an obstacle course over a foam surface while wearing visual distortion lenses. This past year five undergraduate students assisted Dr. Wood in implementing the tests (described in the Main Findings section). During the next phase, thirty students will be recruited to perform each of the following tests. We expect both the overlapping measures in another research setting as well as the unique features of the tests implemented at APU will enhance our ability to generalize results towards a comprehensive set of predictive tests to determine individual capability for rapid sensorimotor adaptation.
Bibliography Type:	Description: (Last Updated: 05/21/2021)
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Awards	Bloomberg J. "Received an award for top research achievements on the ISS at the 3rd Annual ISS Research and Development Conference in Chicago, Ill, June 2014." Jun-2014