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| **Fiscal Year:** | FY 2019 | **Task Last Updated:** | FY 04/29/2020 |
| **PI Name:** | Bloomberg, Jacob J. Ph.D. | | |
| **Project Title:** | Sensorimotor Predictors of Postlanding Functional Task Performance | | |
| **Division Name:** | Human Research | | |
| **Program/Discipline:** | | | |
| **Program/Discipline--Element/Subdiscipline:** | | | |
| **Joint Agency Name:** | | **TechPort:** | No |
| **Human Research Program Elements:** | (1) **HHC**:Human Health Countermeasures | | |
| **Human Research Program Risks:** | None | | |
| **Space Biology Element:** | None | | |
| **Space Biology Cross-Element Discipline:** | None | | |
| **Space Biology Special Category:** | None | | |
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| **Zip Code:** | 77058-3607 | **Congressional District:** | 36 |
| **Comments:** | | | |
| **Project Type:** | Ground | **Solicitation / Funding Source:** | Directed Research |
| **Start Date:** | 01/01/2019 | **End Date:** | 09/30/2019 |
| **No. of Post Docs:** | | **No. of PhD Degrees:** | |
| **No. of PhD Candidates:** | | **No. of Master' Degrees:** | |
| **No. of Master's Candidates:** | | **No. of Bachelor's Degrees:** | |
| **No. of Bachelor's Candidates:** | | **Monitoring Center:** | NASA JSC |
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| **Flight Program:** | | | |
| **Flight Assignment:** | NOTE: End date changed to 9/30/2019 (original end date 8/31/2020) due to Principal Investigator Bloomberg retiring; project continues with Scott Wood as PI (Ed., 4/24/2020) | | |
| **Key Personnel Changes/Previous PI:** | | | |
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| **Grant/Contract No.:** | Directed Research | | |
| **Performance Goal No.:** | | | |
| **Performance Goal Text:** | | | |

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| **Task Description:** | [Ed. note July 2019: Continuation of "Sensorimotor Predictors of Postlanding Functional Task Performance," with Principal Investigator (PI) Ajitkumar P. Mulavara, Ph.D., due to PI Mulavara becoming CBS Portfolio Scientist. New PI is Jacob Bloomberg, Ph.D.]<br>[Ed. note UPDATE April 2020: Principal Investigator Bloomberg retired September 2019; project continues with Scott Wood as PI--"Sensorimotor Predictors of Postlanding Functional Task Performance (PI=Wood)]<br><br>Microgravity exposure results in an adaptive central reinterpretation of information from multiple sensory sources to produce a sensorimotor state appropriate for motor actions in this unique environment, but this new adaptive state is no longer appropriate for the 1G gravitational environment on Earth. These alterations may disrupt the ability to perform mission critical functional tasks requiring ambulation, manual control, and gaze stability. Astronauts who return from spaceflight show significant inter-subject variations in their abilities to readapt to a gravitational environment. The ability to predict the manner and degree to which each individual astronaut will 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 determine, before actual spaceflight, which crewmembers will experience the largest challenges in adaptive capacity. 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.<br><br>The goal of this project is to characterize a set of predictive measures that include:<br><br>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.<br><br>Deliverables: This study will target recruitment of up to n=30 with no less than 15 subjects for this study including completing data collection for n=15 subjects and analysis (x 1 test session). Risk Characterization, quantification, and evidence will be provided in final report and publication. This project will produce a set of predictive measures to determine individual capability for rapid sensorimotor adaptation allowing the determination of volume and type of sensorimotor adaptability training countermeasures targeted for individual sensory integration profiles. This will also additionally inform the program on the ability to predict individual sensorimotor risk profile associated with spaceflight. |
| **Rationale for HRP Directed Research:** | The proposed works qualifies for directed research under the "Highly Constrained Research" category in the Human Research Program (HRP) Unique Processes, Criteria, and Guidelines. This project will utilize the findings from two previous studies (SM Predictors-Ground, SM Predictors-Retrospective) that were funded by the NASA Human Research Program (HRP) through a National Space Biomedical Research Institute (NSBRI) cooperative agreement. These studies have validated, in a non-astronaut ground population, a unique set of measures that were predictive of adaptation in response to exposure to novel sensorimotor environments. Predictors were evaluated in three categories, including: 1) behavioral tests to assess sensory bias and adaptability; 2) imaging to determine individual brain morphological and functional features; and 3) genotype markers for genetic polymorphisms that play a role in the neural pathways underlying sensorimotor adaptation. These two studies were conducted to help characterize the sensorimotor risk profile and design sensorimotor adaptability training countermeasures that may be customized for each crewmember's individual characteristics. In addition to collecting data from ground subjects, the SM Predictors-Retrospective study gathered data from six crewmembers, and from three subjects who participated in a bed rest campaign in the past. While these data supported the validity of the tested measures, the small number of subjects in this part of the study limited the interpretation of the collected data, and logistical challenges (namely, the end of the NSBRI cooperative agreement) precluded recruiting additional astronaut subjects until now. Meeting HRP's goal of addressing gap SM 24 requires collection of data from additional crewmembers who fit the recruitment criteria for this study (crewmembers for whom functional task performance data sets exists after previous spaceflight missions). This proposed effort will thus build-upon the findings from the previous studies, with the full data set (from both the prior study and the proposed one) used to build predictive models of postflight functional task performance capabilities. Since this study directly builds upon the two prior studies and data needs to be collected seamlessly, it requires the specific expertise that has been developed within the NASA Johnson Space Center Neurosciences Laboratory. Therefore, the work reflects "focused and constrained data gathering and analysis that is more appropriately obtained through a non-competitive proposal." |
| **Research Impact/Earth Benefits:** | The goal of this study is to identify a set of behavioral, neuroimaging, and genetic measures that can be used to predict early post-flight performance on a set of sensorimotor tasks. We expect that understanding the relationships between these biomarkers and post-flight functional task performance will improve both our understanding of the individual variability and our strategy to optimize sensorimotor countermeasures. These same biomarkers may also be useful for understanding individual variability in balance function in the general population, and predicting sensory compensation associated with aging and/or the onset of vestibular disease. |
| **Task Progress:** | [Ed. note July 2019: Continuation of "Sensorimotor Predictors of Postlanding Functional Task Performance," with Principal Investigator (PI) Ajitkumar P. Mulavara, Ph.D., due to PI Mulavara becoming CBS Portfolio Scientist. New PI is Dr. Jacob Bloomberg]<br>During this task period, the laboratory test protocols were successfully implemented in the Johnson Space Center (JSC) Neuroscience Laboratory. Testing with the initial 6 subjects (PI Mulavara, National Space Biomedical Research Institute (NSBRI) grant)) had been conducted in the previous lab location (Building 266) prior to the laboratory move to the current location in Building 21. Some changes were required to accommodate the available equipment (vestibular thresholds performed on the 6DOF Moog device instead of the Tilt-Translation Sled). This also required modifications to the 6DOF Moog platform to facilitate reconfiguration (seat to treadmill) within the same session. Finally, the protocol was streamlined to fit within 95 min window to make the desired International Space Station (ISS) subject enrollment more feasible. The enrollment criteria was also modified to include prior participation in Functional Task Test (FTT), Pilot Field Test (PFT), Field Test (FT), targeting 14 astronauts that previously did not respond + 6 new, and expanding the available subject pool to include 8 other astronauts that participated in dynamic posturography (specifically SOT-5 with head movements, MedB1.5) within R+1 days. This includes a total pool of 28 new possible subjects.<br><br>The final laboratory protocol includes three tests of sensory dependency (treadmill walking with moving visual scene, |

vestibular translation thresholds, proprioception by standing on horizontal air bearing surface), two adaptation tests (treadmill walking on 6DOF with moving visual scene, and obstacle course with reversing prisms), and genetic (saliva) sample. Neuroimaging test data collected prior to the subject's previous ISS missions will be obtained through data sharing requests.

Following the completion of the test configuration and Institutional Review Board (IRB) approval, the safety Test Readiness Review was conducted in March 2019, and testing restarted in May. As of the end of September 2019, an additional four subjects were completed. No preliminary results were available as preliminary analysis was on hold pending further subject participation.

[Ed. note UPDATE April 2020: End date changed to 9/30/2019 (original end date 8/31/2020) due to Principal Investigator Bloomberg retiring; project continues with Scott Wood as PI--see that project for subsequent reporting--"Sensorimotor Predictors of Postlanding Functional Task Performance (PI=Wood)]

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