Fiscal Year:	FY 2023	**Task Last Updated:**	FY 11/02/2022
PI Name:	Schubert, Michael Ph.D.		
Project Title:	Ground Validation of Self-Administered Incremental Rehabilitation Tool to Mitigate Motion Sickness and Enhance Sensorimotor Recovery		
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:	(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:	mschube1@jhmi.edu	**Fax:**	FY
PI Organization Type:	UNIVERSITY	**Phone:**	410-955-6151
Organization Name:	Johns Hopkins University		
PI Address 1:	Department of Otolaryngology - Head and Neck Surgery		
PI Address 2:	601 N Caroline St, Rm 6245		
PI Web Page:			
City:	Baltimore	**State:**	MD
Zip Code:	21287-6921	**Congressional District:**	7
Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	2019-2020 HERO 80JSC019N0001-HHCBPSR, OMNIBUS2: Human Health Countermeasures, Behavioral Performance, and Space Radiation-Appendix C; Omnibus2-Appendix D
Start Date:	01/01/2021	**End Date:**	09/30/2025
No. of Post Docs:	1	**No. of PhD Degrees:**	3
No. of PhD Candidates:	0	**No. of Master' Degrees:**	3
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	1
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
Contact Monitor:	Brocato, Becky	**Contact Phone:**	
Contact Email:	becky.brocato@nasa.gov		
Flight Program:			
Flight Assignment:	End date changed to 09/30/2025 per NSSC information (Ed., 12/1/22)		
Key Personnel Changes/Previous PI:	We have obtained Institutional Review Board (IRB) approval to change the local site Principal Investigator (Naval Medical Research Unit - Dayton) from Captain Richard Folga to Lieutenant Commander Adam Preston. Captain Folga remains a critical Co-Investigator. No other changes have been made to the Key Personnel.		
COI Name (Institution):	Wood, Scott Ph.D. (NASA Johnson Space Center) Migliaccio, Americo Ph.D. (Neuroscience Research Australia) Adam, Preston (Naval Medical Research Unit in Dayton OH) Folga, Richard (Naval Medical Research Unit in Dayton OH)		
Grant/Contract No.:	80NSSC21M0057		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Astronauts returning from long duration spaceflight suffer from motion sickness, vertigo, and postural imbalance that risk their safety during and after landing. Vestibular patients typically suffer from similar problems that risk their safety during activities of daily living. For both groups, rehabilitation using head motion is the key to recovering from these symptoms, but current methods are uncontrolled and non-quantified. Our team has successfully implemented a self-administered rehabilitation protocol that can be performed by patients at home to improve vestibular function. Our current system measures head and eye movements to improve vestibulo-ocular reflexes. We propose to modify our system to provide additional feedback on head motion to reduce motion sickness for both astronauts and patients as they undergo rehabilitation. We will compare motion sickness and recovery following +3Gx centrifugation (spaceflight vestibular analog) in two groups: a treatment group given feedback to guide their head motion and a control group with no specific head movement strategy. We will also perform similar measurements in patients recovering from acute vestibular loss. We hypothesize this approach will result in a greater ability to tolerate head movements with fewer motion sickness symptoms. In addition to mitigating motion sickness and improving recovery when returning to Earth, our self-administered approach will enable astronauts to be more autonomous without the aid of their reconditioning experts during exploration missions.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This project innovates upon two patented technologies developed from principal investigator Michael Schubert and co-investigator Americo Migliaccio (US20100198104 and US20160242642A1, https:// by refining users' ability to self-treat motion sickness. The device we have built for use in this project guides users to perform sinusoidal head rotations, matched to a metronome, about the yaw, pitch, and roll axes (90 sec epochs, 5 minutes per axis, 15 min total). In addition, the device includes the capacity for subjects to rate their perception of motion sickness using a handheld controller and integrates a heart-rate monitor worn over the subjects arm. Video-oculography captures eye and head velocity, and also tracks the number of blinks and saccades - metrics that can indicate worsening nausea. The benefits of this research to life are similar and critical in both space and Earth environs – validation of an autonomous treatment for motion sickness and balance disorders.
Task Progress:	Recent field tests in astronauts returning from the International Space Station provide direct evidence that long duration spaceflight increases the severity of motion sickness and impairs the crews' ability to balance doing functional tasks after returning to gravity. Our project addresses the "Risk of Impaired Control of Spacecraft, Associated Systems and Immediate Vehicle Egress Due to Vestibular/Sensorimotor Alterations Associated with Spaceflight" by investigating the effectiveness of an automated rehabilitation device to reduce motion sickness and improve balance. This project innovates on the well-established, yet novel, incremental vestibulo-ocular reflex (VOR) rehabilitation training device (StableEyes, Todd et al., 2018; Rinaudo et al., 2021; Rinaudo et al., 2021a) in two primary ways: first, we have developed video-oculography (VOG) and related software that can identify the physiologic mechanisms responsible for the behavior change we intend. We call the rehabilitation training device with VOG capability the StableEyes with Active Neurofeedback (SWAN) device. The SWAN device with rehabilitation method has been validated in a recent publication (Todd et al., 2022). Next, we have innovated on the self-administered rehabilitation method by developing a paradigm that reinforces active head movement at amplitudes above therapeutic thresholds but below aversive thresholds. We have thus modified the incremental VOR rehabilitation method to train gradual increase in head amplitude as an attempt to mitigate gravitation transition (G-transition)-induced motion sickness and optimize crew performance. Our progress over the 2nd year of this award is as follows: I. Development of the SWAN Device (hardware and software): We have built four complete VOG and behavioral testing devices (hardware and software) to a point of operation and have tested the suite of oculomotor tests that include smooth pursuit, saccades, and video head impulse – known to be abnormal during motion sickness. Each of the four units are operational. Part of this development included creating our unique version of eye tracking, which includes a calibration routine, to ensure adjustment of the pupil size and proper fit of the goggles over the face. The rehabilitation module guides and monitors self-generated yaw, pitch, and roll head rotations over three epochs of five minutes each. During rehabilitation, SWAN monitors blinks, heart rate, eye and head velocity, and quality of head motion, while subjects input symptom intensity changes on a hand-held device that can then be used to adjust subsequent head movement amplitude. Visual feedback is provided to guide desired head motion. We have created an operations manual for the SWAN device. II. Development of the Motion Sickness Treatment Protocol and Data Intake Forms: The Motion Sickness Treatment Protocol (incremental head amplitude) has been finalized. We have created a single data intake sheet to be used for both objectives (data collected in civilians undergoing vestibular nerve resection and healthy subjects exposed to centrifugation). III. Development of the Motion Sickness Centrifugation Protocol (including the cabin specifications): To date we have determined our acceleration profile, subject positioning within the centrifuge, and how to monitor spontaneous head and trunk movements during the centrifugation. IV. Augmentation Award: With support from an augmentation award in February of 2022, we will correlate motion sickness with ocular counter roll and perception of visual vertical. To date, we have purchased the necessary VOG equipment to measure ocular counter roll, built the visual perceptual software, and finalized the data collection protocol.
Bibliography Type:	Description: (Last Updated: 12/07/2023)