Fiscal Year:	FY 2024	**Task Last Updated:**	FY 11/02/2023
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:	0	**No. of PhD Degrees:**	4
No. of PhD Candidates:	0	**No. of Master' Degrees:**	3
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:	2	**Monitoring Center:**	NASA JSC
Contact Monitor:	Stenger, Michael	**Contact Phone:**	281-483-1311
Contact Email:	michael.b.stenger@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 submitted an amendment to the Johns Hopkins University (JHU) Institutional Review Board (IRB) for approval to change the local site principal investigator (Naval Medical Research Unit Dayton) back to Richard Folga from Lieutenant Commander Adam Preston. Lieutenant Commander Preston will remain a co-investigator. Colin Grove, Ph.D. (Assistant Professor, Emory University) has also been added as a 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) Grove, Colin R Ph.D. (Emory University)		
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:	December 2023 - minor updates to Earth Benefits (Ed., 12/13/23) This project innovates upon two patented technologies developed from principal investigator (PI) 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 a subject to rate his/her/their perception of motion sickness using a handheld controller and integrates a heart-rate monitor worn over the subject's arm. Video-oculography captures eye and head velocity, and also tracks the number of blinks and heart rate variability – 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:	At Johns Hopkins University (JHU), we have collected data from n=10 (n=24 planned) patients with unilateral vestibular hypofunction due to having the balance nerve (vestibular nerve) cut to remove a benign tumor. Each patient has been measured at 3 separate time points (pre-operative, inpatient stay day 2-5, 14-day follow-up). The domains of the outcome measures include subjective experience, oculomotor (vestibulo-ocular reflex) function, perception of oculomotor alignment in vertical and roll position, posture, and gait. At the Naval Medical Research Unit Dayton (NAMRU-D), we are using the Disorientation Research Device (DRD) and have conducted two "dry-runs" for 1 hour each, exposing subjects to 60 minutes of rotation at 2.5Gx. The dry-runs have been critical to ensure the safety and comfort of the subjects, ensuring the DRD motion profile is effectively generating motion sickness similar to what crew members experience on long-duration space travel, delivery of equipment, and training of the NAMRU-D personnel in proper use of the equipment for independent data collection. A final dry-run is scheduled for January 2024. In addition to the same outcome measures listed for the JHU site, we will also collect video ocular counter roll (vOCR) data. The vOCR data collection is enabled from a NASA Human Research Program (HRP) augmentation grant award (Colin Grove) to the PI (Schubert). The vOCR measures degrees of ocular roll that will be compared between groups and correlated with our outcome measures. Of interest will be to compare vOCR data with subject perception of motion sickness, which prior literature has suggested may predict those crewmembers warranting a rehabilitative countermeasure as intervention. Each site will randomize a total of n=24 subjects to participate in either the traditional means for treating motion sickness (rest at NAMRU-D; vestibular rehabilitation at JHU) or the StableEyes With Active Neurofeedback (SWAN) self-administered rehabilitation method. Preliminary Results suggest: 1. Pre-operative asymmetry exists in the perception of oculomotor alignment. 2. Asymmetries of vertical misalignment improve, but asymmetry in torsional alignment persists. 3. Both traditional and SWAN rehabilitation appear to similarly mitigate the significant decrease in accuracy as patients recover over 2 weeks. 4. Compared to traditional rehabilitation, subjects who participated in the SWAN rehab (the self-administered rehabilitation) completed the "Timed Up and Go" Test more quickly at 2 weeks post-op and with a larger improvement. 5. Compared to traditional rehabilitation, subjects who participated in the SWAN rehab had larger improvements in duration to stand on firm or foam surfaces with eyes open or closed. 6. Compared to traditional rehabilitation, subjects who participated in the SWAN rehab had larger improvements in duration to stand on firm or foam surfaces with eyes open or closed on foam with their heads extended. We delivered two poster presentations at the 2023 NASA Human Research Program Investigators' Workshop (IWS). For the 2024 IWS, we have submitted three abstracts for presentation. One paper establishing the video-oculographic functionality used in the SWAN device has been published.
Bibliography Type:	Description: (Last Updated: 12/07/2023)
Articles in Peer-reviewed Journals	Todd CJ, Schubert MC, Rinaudo CN, Migliaccio AA. "Unidirectional vertical vestibuloocular reflex adaptation in humans using 1D and 2D scenes." Otol Neurotol. 2022 Oct 1;43(9):e1039-e1044. https://doi.org/10.1097/MAO.0000000000003684 ; PMID: 36075099 , Oct-2022

Significant Media Coverage	Cranford, N. (Schubert M interview). "NASA harnesses US Navy spinning device to simulate spaceflight." Dr. Schubert interviewed for a NASA.gov web feature. Houston, TX, May 17, 2023. Also posted on social media (X, Instagram, and Facebook). https://www.nasa.gov/humans-in-space/nasa-harnesses-us-navy-spinning-device-to-simulate-spaceflight/ , May-2023