Fiscal Year:	FY 2022	**Task Last Updated:**	FY 09/16/2021
PI Name:	Wood, Scott J. Ph.D.		
Project Title:	Non-Pharmaceutical Motion Sickness Mitigation		
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		
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Zip Code:	77058	**Congressional District:**	36
Comments:	NOTE: PI returned to NASA JSC in January 2017. PI was at Azusa Pacific University from August 2013 – January 2017; prior to August 2013, PI was at NASA JSC.		
Project Type:	Ground	**Solicitation / Funding Source:**	2019 HERO 80JSC019N0001-FLAGSHIP & OMNIBUS: Human Research Program Crew Health. Appendix A&B
Start Date:	10/01/2020	**End Date:**	09/30/2022
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**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:**	NASA JSC
Contact Monitor:	Brocato, Becky	**Contact Phone:**	
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Flight Program:			
Flight Assignment:	NOTE: End date changed to 9/30/2022 per PI (Ed., 7/7/21)		
Key Personnel Changes/Previous PI:	September 2021 report: None		
COI Name (Institution):	Pradhan, Gaurav Ph.D. (Mayo Clinic Arizona) Reschke, Millard Ph.D. (NASA Johnson Space Center) Stepanek, Jan M.D. (Mayo Clinic Arizona) Cevette, Michael Ph.D. (Mayo Clinic Arizona)		
Grant/Contract No.:	Internal Project		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Motion sickness represents one of the greatest clinical challenges impacting crew activities following G-transitions. Our project seeks to validate a non-pharmaceutical tool using galvanic vestibular reduction (GVR) by transcutaneously delivering bilateral inhibitory signals to suppress vestibular sensitivity and reduce post-landing motion sickness. Our first specific aim is to evaluate the effect of timing and magnitude on the administration of our non-pharmaceutical treatment to motion sickness. While we have previously demonstrated that our approach can mitigate motion sickness if introduced prior to provocative stimuli, one of the goals of this study is to determine the efficacy if we administer the treatment following the onset of symptoms. Validating the efficacy following symptom onset would greatly enhance flexibility to implement this treatment during recovery operations. Using a repeated measures counter-balanced design exposing subjects to provocative Coriolis cross-coupling stimuli on a rotating chair, we will compare motion sickness severity across three treatment interventions: prior to stimulus (symptom) onset, following symptom onset, and placebo control. Symptom severity will be assessed using both subjective reports and objective autonomic measures (e.g., electrogastrography). We expect that the most effective administration will be GVR delivered prior to the onset of symptoms, but that it will continue to be more effective relative to placebo control even if delivered following symptom onset. In order to leverage our non-pharmaceutical technique that allows continuous adjustments in “dosage” level throughout recovery, we must map changes in GVR level with functional performance. Our second specific aim is to characterize the dose response of GVR amplitude to functional fitness task performance. We will measure performance on a sensorimotor and cognitive test battery in steps ranging from 0mA (control) to the level of GVR thought to provide maximal motion sickness protection. The advantages of our non-pharmaceutical countermeasure approach will be to provide rapid therapeutic effect while allowing continuous titration of GVR amplitude during recovery to minimize side effects while enhancing performance.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Our project will deliver a non-pharmaceutical countermeasure approach using galvanic vestibular reduction (GVR) that can be customized to mitigate G-transitional induced motion sickness while optimizing sensorimotor and cognitive performance. The ability to treat motion sickness with non-pharmaceutical approaches has the benefit to not only avoid sedative side effects of the medication but also allow for flexibility to turn the treatment on and off without residual effects associated with drug metabolism. Understanding the operational impacts of each device will provide a more informed evidence base for implementing this tool into crew recovery operations.
Task Progress:	We have tested 15 out of 30 total subjects to date, 12 of which have completed all four sessions required. The initial session is utilized to establish galvanic vestibular sensitivity measures to customize the GVR level, and to characterize performance on a sensorimotor-cognitive test battery as a function of GVR stimulus level. The next three sessions involve head movements during constant rotation as a motion sickness stressor. The efficacy of GVR to mitigate motion sickness is tested across three separate counterbalanced sessions: administration from the onset of testing, at a midpoint of testing, and placebo control. The rotation direction is alternated, and test sessions are separated by at least four days to minimize habituation effects. Motion sickness stressor: During the three rotating chair sessions, subjects are accelerated (10 deg/s/s) to a constant velocity. Subjects then perform up to 10 sets of head movements. For each set, a head movement is cued every 10 seconds, alternating between pitch forward (chin resting to chest) and pitch backward (head upright). During each head movement subjects are asked to use a joystick to record the amplitude of their rotation sensation (yaw, pitch and/or roll). There were total of 7 forward and 7 backward movements per set lasting 2.5 mins. During the 2 min pause between head movement sets, symptom scoring is obtained using the Pensacola Diagnostic Index and a subject discomfort (0-20) ratings. If GVR effectively suppresses vestibular sensitivity, subjects should experience low symptom scores, be able to perform more head movements before reaching the endpoint, and have reduced motion illusions as quantified by the joystick. There have been no adverse effects or dermal discomfort due to GVR stimulation. The rotation speed was 30 deg/s for the first 9 subjects. Subjects are tested until they reach the motion sickness endpoint of 8 symptom points or a maximum set of 10 head movements. Since several subjects did not reach a motion sickness endpoint, the rotation speed was increased to 60 deg/s to increase motion sickness stressor for the remaining 21 subjects. Given the repeated measures design, we do not plan to recruit replacement subjects for those reaching motion sickness endpoints at the lower speed. Sensorimotor cognitive test battery: The purpose of this test battery is to assess how GVR may impair performance over the range of stimulus amplitudes used to treat motion sickness. This test battery utilizes both dynamic posturography as well as a modified timed up and go (TUG) locomotion task. The dynamic posturography is known as the modified Clinical Test of Sensory Integration on Balance (mCTSIB) measuring sway velocity during two 10-second trials for each of the following conditions: Standard -- eyes open on firm surface (EO-FI), Proprioception -- eyes closed on firm surface (EC-FI), vision -- eyes open on foam surface (EO-FO), and vestibular -- eye closed on foam surface (EC-FO). The modified TUG involved standing up upon on command, walking 4 meters, turning around, walking back to the chair, and sitting down. The subject is required to step over an obstacle (30 cm high, 10 cm wide) positioned midway between the chair and the turning point, once on the way toward the turning point and again on the return back. The time stops when the patient is seated. We also conducted flight simulator performance in Virtual Reality (VR) and cognitive tasks in the form of the Oculo-Cognitive Addition Test (OCAT), which requires participants to look for numbers on a screen and add these numbers together. OCAT includes eye-tracking, and currently, we are analyzing cognitive and oculomotor performance measures. VR Flight performance provides simulator immersion and visuomotor function during flight. Data collection and analysis is still ongoing through the remainder of the calendar year.
Bibliography Type:	Description: (Last Updated: 06/03/2025)
Abstracts for Journals and Proceedings	Pradhan GN, Cevette MJ, Stepanek J, Reschke MF, Wood SJ. "Non-pharmaceutical motion sickness mitigation using galvanic vestibular reduction." 2021 NASA Human Research Program Investigators’ Workshop, Virtual, February 1-4, 2021. Abstracts. 2021 NASA Human Research Program Investigators’ Workshop, Virtual, February 1-4, 2021. , Feb-2021