Fiscal Year:	FY 2022	**Task Last Updated:**	FY 07/07/2022
PI Name:	Strangman, Gary E Ph.D.		
Project Title:	Operational Performance Effects and Neurophysiology in Partial Gravity (OPEN-PG)		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	Yes
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:	02129-2020	**Congressional District:**	7
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2019 HERO 80JSC019N0001-FLAGSHIP & OMNIBUS: Human Research Program Crew Health. Appendix A&B
Start Date:	09/01/2020	**End Date:**	08/31/2024
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
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Flight Program:			
Flight Assignment:	NOTE: End date changed to 08/31/2024 per NSSC information (Ed., 11/25/22)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Ivkovic, Vladimir Ph.D. (Massachusetts General Hospital) Zhang, Quan Ph.D. (Massachusetts General Hospital)		
Grant/Contract No.:	80NSSC20K1500		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Background: Understanding human performance under various partial-gravity loadings is critical to NASA's crewed mission strategies. For example, current vehicle and mission designs for Mars landings require the crew to use robotic teleoperation within 24 hours of landing—unaided from Earth—to connect landing craft power systems with pre-positioned power generators. This design requires the crew to perform complex sensorimotor operations to maintain life support, as soon as possible after a gravitational transition, and in an unfamiliar partial-gravity setting. Unfortunately, there remains limited knowledge about how the sensorimotor system is affected by exposure to both partial gravity and gravity transitions. Addressing these gaps will in part require integrated assessment of operational and sensorimotor performance alongside neurovestibular and neurophysiological responses during exposure to various gravitational loads. Aim 1: Characterize and quantify changes in operationally-relevant sensorimotor and vestibular performance as a function of gravitational load. Aim 2: Characterize and quantify changes in physiology—particularly in brain function and autonomic activation during behavioral performance—as a function of gravitational load. Aim 3: Develop a model to predict behavioral performance and neurophysiological responses under different gravitational loads based on preflight ground testing data. Hypotheses: (Hyp1) We predict a monotonic but non-linear relationship between Robotics On-Board Trainer-r (ROBoT-r) performance and gravitational load, with larger departures from 1g leading to more impaired performance. (Hyp2) Behavioral alterations will be paralleled by physiological changes at different gravity loads, including activation of prefrontal and vestibular cortex, and autonomic nervous system activation. (Hyp3) Ground-based challenges to the vestibular system will induce detectable neurophysiological responses, and the amplitude of these responses (i.e., an indicator of individual "sensitivity" to these provocations) will help (3a) predict neurophysiological responses in-flight, and (3b) predict behavioral performance in flight. Deliverables: Overall, our project will characterize (1) operationally-relevant performance and (2) neurophysiological responses as a function of gravity load, as well as (3) providing models to predict performance and neurophysiological impacts of partial gravity based on preflight-data. This work has the potential to identify individuals who are particularly resilient to altered gravity, and will be key for planning future exploration-class missions where survival will depend on the operational capabilities of astronauts in partial-gravity environments.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The proposed parabolic flights will help fill critical knowledge gaps regarding human exposure to fractional-gravity conditions. Specifically, our project will address gaps regarding operational performance, neurophysiological status, individual sensitivity to different gravitational loads between 0-1g, as well as prediction of behavioral performance and physiological responses to partial gravity. In addition to filling key gaps surrounding human performance of operationally-relevant tasks in partial gravity, this work may provide a method to help identify crewmembers who are particularly resilient for performing particular tasks under novel gravity loadings. The results have the further benefit of providing a better understanding of the role of disorientation in Earth-based operational performance. This is relevant not only to fighter pilots, but to task performance by individuals with neurological or medical conditions that adversely affect the vestibular system (e.g., stroke, infections).
Task Progress:	The past year included a major delay due to the parabolic flight's being rescheduled to 2023 plus substantially slowed obligations. However, to-date, the main activities we have completed are as follows: • Flight plans confirmed: Novespace was officially contracted by NASA to conduct the parabolic flight campaign in June 2023. All partial-g parabolas will be conducted together (10 at each partial-g level) for each subject. All zero-g parabolas will be conducted on a second flight for each subject. As of this writing, the exact number of flights and ordering has yet to be confirmed. • New Hand Controllers; Dr. Strangman worked closely with the NASA Human Research Program (HRP) and the NASA Dynamic Skills Trainer (DST) lab to finalize the design and performance characteristics of new hand controllers. Four sets of controllers were fabricated over the prior year, and Dr. Strangman conducted one site-visit to personally test the controllers, as well as participating in various communications with NASA Human Factors and Behavioral Performance (HFBP) and DST. Challenges continue with achieving smooth (i.e., non-sticky) translation of the controllers. Various approaches have been tried, including external lubricants, polishing the metal components, embedded lubricants (i.e., Teflon) and related approaches. As of the writing, the controllers are much improved but still have occasional "stickiness", as judged both by Dr. Strangman and HFBP personnel, that was not present in prior controllers. Work is ongoing. • Initiation of Novespace interactions: In May 2022, we initiated discussions with our liaison at Novespace to describe our study, how we propose to implement it, and to begin to determine what, if any, challenges may be present. This was formalized in our submission of our Experiment Safety Data Package (ESDP), which was delivered in June 2022 and provided in writing our experimental plans, needs in terms of hardware, software, electrical and space resources, and risk mitigation plans. • IRB Approval: Institutional Review Board (IRB) Protocols are well underway. These will be finalized and submitted once the experimental design/logistics details (described above) are fully settled. • ROBoT-r Task Truncation - Revised Initial Conditions: In order to conduct meaningful testing on the Robotic On-Board Trainer for Research (ROBoT-r) during the ~20 sec of altered gravity during each parabola, we need to shorten the individual ROBoT-r runs from the current maximum of 99 sec down to ~15 sec. This requires moving the starting-point of each run substantially closer to the grappling target than normal (a bit over 2 meters). We used our existing datasets to identify the mean translational and angular offsets obtained by prior users as of 15 sec prior to the completion of a run (or by 80 sec if completion is not achieved). These offsets were then used to generate a cloud-distribution of 100 starting points per difficulty level, similar to the "standard" set of initial conditions used for the standard/nominal ROBoT-r runs, but closer to the capture target.
Bibliography Type:	Description: (Last Updated: 04/26/2024)
Abstracts for Journals and Proceedings	Ivkovic V, Shelhamer M, Kelly A, Reilly G, Zhang Q, Strangman GE. "Operational Performance Effects and Neurophysiology in Partial Gravity (OPEN-PG)." 2022 NASA Human Research Program Investigators' Workshop, Virtual, February 7-10, 2022. Abstracts. 2022 NASA Human Research Program Investigators' Workshop, Virtual, February 7-10, 2022. , Feb-2022