Fiscal Year:	FY 2024	**Task Last Updated:**	FY 01/11/2024
PI Name:	Strangman, Gary E Ph.D.		
Project Title:	Personalized Performance Optimization Platform (P-POP)		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
Human Research Program Risks:	(1) **BMed**:Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders (2) **Team**:Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	strang@nmr.mgh.harvard.edu	**Fax:**	FY
PI Organization Type:	NON-PROFIT	**Phone:**	617-724-0662
Organization Name:	Massachusetts General Hospital		
PI Address 1:	Department of Psychiatry		
PI Address 2:	149 13th Street, Suite 2651		
PI Web Page:			
City:	Charlestown	**State:**	MA
Zip Code:	02129-2020	**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:	02/23/2021	**End Date:**	02/22/2025
No. of Post Docs:	2	**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
Contact Monitor:	Whitmire, Alexandra	**Contact Phone:**	
Contact Email:	alexandra.m.whitmire@nasa.gov		
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Ivkovic, Vladimir Ph.D. (Massachusetts General Hospital) Stankovic, Aleksandra Ph.D. (Massachusetts General Hospital) Zhang, Quan Ph.D. (Massachusetts General Hospital) Maes, Patricia Ph.D. (Massachusetts Institute of Technology) Kosmyna, Nataliya (Massachusetts Institute of Technology)		
Grant/Contract No.:	80NSSC21K0669		
Performance Goal No.:			

Performance Goal Text:	
Task Description:	BACKGROUND: The environmental conditions of prolonged spaceflight pose significant psychological risks for astronauts. In particular, long duration exposure to an isolated and confined environment can contribute to adverse cognitive or behavioral events and compromise mission safety and/or success. In order to mitigate against mission-related disruptions arising from decrements in behavioral health and performance, NASA needs a set of validated strategies on-board to both maintain and restore psychological well-being and operational effectiveness. This proposal aims to refine and empirically assess a platform technology designed to monitor and guide crewmembers towards optimal physiological and mental states for current or future tasks via personalized manipulation of the surrounding work environment. Our closed-loop, feedback-based intervention approach will not only enable the maintenance of individual behavioral functioning, but will promote improved team operations as well. Our four specific aims are as follows: AIM 1: Perform a detailed risk assessment of factors that contribute to personal (and team) dysfunction, particularly in isolated, confined, and extreme environments. AIM 2: Develop a personalized performance-optimization platform (P-POP) based on closed-loop/feedback that integrates physiological sensing with augmentation of the astronaut's local working environment (e.g., audio, haptics, light). AIM 3: Characterize the ability of P-POP to improve key performance capabilities including attention, response time, memory, cognitive control, and operationally-relevant performance. AIM 4: Assess the feasibility, acceptability, and efficacy of our proposed platform for use in individuals and teams via empirical testing during long-duration spaceflight analogs. HYPOTHESES: (Hyp1) The novel P-POP will provide real-time physiological monitoring to enable the personalized manipulation of the local work environment—both in the lab and in Human Exploration Research Analog (HERA). (Hyp2) Our targeted work environment modulations (e.g., sound, haptics, light) will generate significant improvements in individuals' cognitive and operational performance. DELIVERABLES: Our project will generate the following deliverables: (1) a characterization of those factors that contribute to poor individual and team performance in isolated, confined, and extreme (ICE) settings; (2) a novel platform technology capable of real-time tracking of psychological and behavioral health markers and providing targeted augmentation of the local work environment to manipulate those markers; (3) an evaluation of the feasibility, acceptability, and efficacy of the proposed platform technology, on both individual and team metrics, including testing in a spaceflight analog. Based on our findings, we will develop specific protocols and guidelines for optimal deployment of our platform, as well as providing standards recommendations. SIGNIFICANCE: This work will provide NASA with a novel and scalable platform technology for on-board behavioral health management—adapting the local working environment via biosensing and feedback. The approach is personalized and closed-loop, guiding individuals away from less-optimal states (as assessed by physiological measurements) and towards more-optimal states. We expect the approach to help maintain and improve individual performance as well as team performance. The system does not require video displays or graphics. Importantly, however, the platform will be designed for future augmentation via other countermeasure approaches (e.g., visual, olfactory), depending on the needs and capabilities of any particular exploration mission. On Earth, such a platform could have considerable utility for optimizing human performance in a wide range of workplaces.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The goal of P-POP is to develop a personalized/wearable system that can help enhance user cognitive and spaceflight operations performance. The system will incorporate relatively low-tech "countermeasures"--haptic stimuli, auditory stimuli and lighting stimuli--to help optimize the user's alertness, attention and motivation and/or relaxation depending on the requirements of the task. The optimization will be based on a "closed loop" concept whereby physiological sensing will help identify the user's present state, optimization via one or more countermeasures (CMs) will be deployed, and physiological sensing will determine the consequences of the CMs, allowing for real-time, adaptive feedback-based optimization. Such an approach--being based on feedback from the individual--is inherently personalized: each individual crewmember, by using their own system, can achieve different simulation/relaxation goals simultaneously. On Earth, such a platform could have similar utility for optimizing human performance in a wide range of office or remote workplace settings.
Task Progress:	The objective of this project is to develop a personalized performance optimization platform, which functions by sensing various physiological parameters from the user, including brain activity, interpreting that data to identify the user's state (e.g., under- vs. over-stressed), and delivering one or more countermeasures via haptic, auditory, or lighting-based stimulation to optimize that state. We ultimately hope to do this in a continuous, real-time fashion for ongoing performance optimization. P-POP development is being conducted in phases. Phase 1 (conducted during the first year of the project) involved development and integration of the auditory CM into the hardware platform, specifically using music to optimize behavioral performance. This effort was completed at the end of Phase 1, and was immediately followed by testing of that CM in n=24 human volunteers. In parallel with this testing, we initiated Phase 2 development, which added the somatosensory/haptics CM to the P-POP platform. This step has been completed, and testing this year will assess whether this somatosensory/haptics CM can aid operationally-relevant behavioral performance. We are also starting Phase 3 development, to add a lighting CM to the P-POP platform, followed by similar human performance testing. Finally, in Phase 4, the completed, three-CM P-POP platform will be tested at the NASA Johnson Space Center (JSC) Human Exploration Research Analog (HERA) facility as a CM to isolation in confinement during a HERA analog campaign. By the end of the 3rd year of this project, we will have completed the following major tasks: Reviews: For project Aim 1, we conducted a detailed literature review to identify risk factors that contribute to personal (and team) dysfunction in isolated, confined, and extreme (ICE) environments, along with potential sensory CM

	approaches. A manuscript is being finalized on this topic. In addition, we conducted a detailed review on the role of music in the modulation of mental states and performance. A complete manuscript will be published on the NASA Technical Reports Server, and an abridged version is currently under review. Platform Development & Testing: We completed Phase 1 development and Phase 1 (Aim 3) of the music CM. We have completed Phase 2 development of the somatosensory/haptics CM (Aim 2) and are about to start the associated testing (Aim 3). We have initiated Phase 3 development of the personalized lighting CM (Aim 2). We have also begun discussions with JSC Research Operations and Integration (ROI) and other investigators regarding the future planned HERA campaign testing of P-POP.
Bibliography Type:	Description: (Last Updated: 02/05/2025)
Abstracts for Journals and Proceedings	Kosmyna N, Stankovic A, White B, Thoolen S, Ivkovic V, Maes P, Strangman G. "P-POP: A Personalized Performance Optimization Platform for long duration spaceflight – 2023 update." 2023 NASA Human Research Program Investigators' Workshop, "To the Moon: The Next Golden Age of Human Spaceflight", Galveston, TX, February 7-9, 2023. Abstracts. 2023 NASA Human Research Program Investigators' Workshop, "To the Moon: The Next Golden Age of Human Spaceflight", Galveston, TX, February 7-9, 2023. , Feb-2023