Fiscal Year:	FY 2023	**Task Last Updated:**	FY 12/20/2022
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		
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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:**	
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:	Per the Principal Investigator: Nataliya Kosmyna, Ph.D. has been added to the project as a CoInvestigator (Ed., 3/2/23).		
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 seek to do this in a continuous, real-time fashion for ongoing performance optimization. Personalized performance optimization platform (P-POP) development is being conducted incrementally, in approximately year-long phases. Phase 1 (conducted during this first year of the project) involved development and integration of the auditory countermeasure (CM) into the hardware platform, specifically using music to optimize behavioral performance. This effort was completed early in year 2 and was immediately followed by testing of that CM in n=24 human volunteers. In parallel with this testing, we have initiated Phase 2 development, adding the somatosensory/haptics CM to the P-POP platform. This will be followed by testing whether this somatosensory/haptics CM can aid operationally relevant behavioral performance. In Phase 3, we will add the lighting CM to the P-POP platform. Finally, in Phase 4, the completed three-CM P-POP platform will be tested at the JSC HERA facility as a CM to isolation in confinement during a HERA analog campaign. By the end of the 2nd 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 prepared of 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: For project Aim 2, we completed Phase 1 development and Phase 1 testing of the music CM and have initiated Phase 2 development and preparation for testing (the somatosensory/haptics CM). We have also initiated the planning of the Phase 3 development (personalized lighting CM).
Bibliography Type:	Description: (Last Updated: 04/26/2024)
Abstracts for Journals and Proceedings	N. Kosmyna, A. Stankovic, B. White, S. Thoolen, V. Ivkovic, P. Maes, and G. Strangman "P-POP: A PERSONALIZED PERFORMANCE OPTIMIZATION PLATFORM FOR LONG DURATION SPACEFLIGHT – 2023 UPDATE" 2023 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 7-9, 2023 Abstracts. 2023 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 7-9, 2023 , Jan-2023