Fiscal Year:	FY 2024	**Task Last Updated:**	FY 10/17/2023
PI Name:	Stahn, Alexander Ph.D.		
Project Title:	Mars Adaptive Training Integrative Knowledge System (MATRIKS) to Improve Operational Performance and Its Neural Basis for Spaceflight		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
Human Research Program Risks:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2020-2021 HERO 80JSC020N0001-HHP, OMNIBUS3 Human Research Program: Human Health & Performance Appendix E; Omnibus3-Appendix F
Start Date:	12/17/2021	**End Date:**	03/31/2026
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 03/31/2026 per NSSC information (Ed., 5/16/22).		
Key Personnel Changes/Previous PI:	Dr. Suzanne Bell (NASA Johnson Space Center) was added as the Institutional PI for the HERA study, replacing Dr. Loerch.		
COI Name (Institution):	Basner, Mathias M.D., Ph.D. (University of Pennsylvania) Dinges, David Ph.D. (University of Pennsylvania) Kuehn, Simone Ph.D. (Max Planck Institute for Human Development, Berlin, Germany) Roalf, David Ph.D. (University of Pennsylvania) Mühl, Christian (German Aerospace Agency (DLR)) Gerlach, Darius (German Aerospace Agency (DLR)) Gur, Ruben (University of Pennsylvania) Johannes, Bernd (German Aerospace Agency (DLR)) Piechowski, Sarah (German Aerospace Agency (DLR))		

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Grant/Contract No.:	80NSSC22K0648
Performance Goal No.:	
Performance Goal Text:	
Task Description:	With prolonged mission durations, spaceflight crews will become increasingly dependent on onboard technologies for knowledge acquisition and maintenance. It is expected that not all skills and knowledge required for these missions can be retained and retrieved based on pre-mission training alone. Limited and delayed communication will significantly constrain support from Mission Control and crews will increasingly rely on autonomous onboard technologies to successfully perform post-landing operations. With the present project we will target NASA's particular interest in developing and assessing an adaptive, just-in-time countermeasure that will consolidate and improve skills that are most relevant to space flight operations. To achieve this aim, NASA established a Virtual NASA Specialized Center of Research (VNSCOR) referred to as "Mars Adaptive Training Integrative Knowledge System (MATRIKS)", comprising the following three projects: (1) "Trinity – Multi-Environment Virtual Training for Long Duration Exploration Missions", PI: A. Anderson (UC Boulder); (2) "Morpheus – A Haptic Sensory Supplement to Optimize In-Flight Adaptive Training for Human Control of Spacecraft Robotic Arms", PI: S. Robinson, UC Davis); and the present project "Neo – Adaptive Training integrative knowledge System to Improve Operational Performance and its Neural Basis for Spaceflight" (UPenn, PI: A.C. Stahn). Neo leverages a validated workstation called 6DF that simulates a rendezvous and docking maneuver using real spacecraft flight dynamics. It is designed to (1) train and improve sensorimotor skills relevant for inflight and post-landing operational tasks; (2) feature an autonomous and adaptive training approach that does not rely on feedback from flight operations on the ground; (3) maximize the transfer of mission-relevant motor skills; (4) allow the assessment of the neural circuitry underlying the task; and (5) deliver the training in a motivating and meaningful way to astronauts. Neo comprises two overarching aims: First, we will identify the neural circuitry underlying spaceflight relevant tasks by performing a subset of the 6DF task during functional magnetic resonance imaging (MRI) in a total of up to N=30 subjects with varying levels of 6DF training experience. Second, as part of the above-mentioned VNSCOR MATRIKS the proposed 6DF autonomous intelligent tutor system will be integrated in an additive manner with a haptic feedback intervention (Morpheus), and a multi-environment virtual trainer (Trinity). It is expected that Neo, Morpheus and Trinity mutually complement each other to facilitate an effective countermeasure tool to acquire and retain operational skills that are critical for exploration class missions. To assess the efficacy of this combined effort, the VNSCOR MATRIKS will collect data in N=16 crew members in one HERA campaign of 45 days duration with N=16 crew members (four missions with N=4 crewmembers each). The primary goal is to identify changes in operational performance as assessed by NASA's simulator of Canadarm2 operations, i.e., Robotic On-board Trainer (ROBoT-r) in response to MATRIKS. As part of Neo we will also identify if, and to what extent MATRIKS will promote transfer to general cognitive performance (Cognition battery), distinctive visuo-spatial tasks critical for telerobotic tasks (Spatial Cognition battery), and affect brain structural changes and the neural circuitry of key brain networks expected to be relevant for spaceflight-related performance.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The expected significance of this 4-year project relates to its relevance for facilitating effective countermeasure tools to acquire and retain operational skills that are critical for exploration class missions. At the conclusion of the research, we will have defined and demonstrated the use of a neuroscience-based, adaptive training integrative knowledge system to potentially mitigate visuo-spatial and sensorimotor brain changes associated with prolonged isolation and confinement to reduce the likelihood or impact of potential decrements in human performance capabilities during long-duration space missions. Together, these data will data will help mission planners to ensure safe and successful space exploration class missions. It is possible that the results from this project also translate to situations on Earth where fine motor skills are essential such as robot-assisted surgery.
Task Progress:	The timeline for the start of the in-lab study at the German Space Agency, Deutsches Zentrum für Luft- und Raumfahrt (DLR) has been delayed by 6 months because of changes regarding the instrument for issuing the subcontract to DLR. Following the signing of the contract by both the University of Pennsylvania (UPenn) and DLR in June 2023, all data were successfully collected between July and September. The delay of the study is not considered a concern for the overall project timeline. In response to the delay of the NASA Human Exploration Research Analog (HERA) campaign C8, which is tentatively scheduled for 01/2025 to 12/2025, NASA requested to propose a supplement, which was submitted in June and revised in October 2023.
Bibliography Type:	Description: (Last Updated: 02/16/2022)