

Fiscal Year:	FY 2024	Task Last Updated:	FY 02/15/2024
PI Name:	Fanchiang, Christine Ph.D.		
Project Title:	HCAAM VNSCOR: Using a Human Capabilities Framework to Quantify Crew Task Performance in Human-Robotic Systems		
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:	(1) HSIA :Risk of Adverse Outcomes Due to Inadequate Human Systems Integration Architecture		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	80122-1801	Congressional District:	6
Comments:			
Project Type:	Ground	Solicitation / Funding Source:	2017-2018 HERO 80JSC017N0001-BPBA Topics in Biological, Physiological, and Behavioral Adaptations to Spaceflight. Appendix C
Start Date:	04/15/2019	End Date:	08/31/2024
No. of Post Docs:	0	No. of PhD Degrees:	
No. of PhD Candidates:	2	No. of Master' Degrees:	1
No. of Master's Candidates:	1	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:	NOTE: End date changed to 8/31/2024 per NSSC information (Ed., 3/10/24) NOTE: End date changed to 4/14/2024 per A. Beitman/JSC (Ed., 2/20/23) NOTE: Start date changed to 4/15/2019 per NSSC information (Ed., 5/18/21) NOTE: End date changed to 4/14/2023 per NSSC information (Ed., 1/22/2020)		
Key Personnel Changes/Previous PI:	March 2020 report: Change to PhD graduate student for upcoming semester. August 2021 report: Added a MS graduate student (Kaitlyn Hauber) for the 2021-2022 academic year to help deploy subject testing July 2021 report: Added a Postdoc Dr. Katya Arquilla (volunteer) to help with data analysis May 2022 report: Removed a MS student (Kaitlyn Hauber) because she graduated July 2022 report: Postdoc upgraded to Professor (Dr. Katya Arquilla) at MIT Sept 2022 report: Added a PhD student (Amelia Gagnon) at MIT to help with HERA fNIRS data analysis because of her background in brain biosignals (EEG)		
COI Name (Institution):	Klaus, David Ph.D. (University of Colorado, Boulder) Shelhamer, Mark Sc.D. (Johns Hopkins University)		

Grant/Contract No.:	80NSSC19K0655
Performance Goal No.:	
Performance Goal Text:	
Task Description:	<p>This task is part of the Human Capabilities Assessments for Autonomous Missions (HCAAM) Virtual NASA Specialized Center of Research (VNSCOR).</p> <p>Effective space exploration will require proper task coordination between humans and robotic systems. These systems can be characterized in a variety of ways, from level of autonomy to the number of functions provided. At the most basic level a robotic system can be considered a hand tool while something more complex could be a humanoid companion. To ensure the robotic system is effective, the crew must trust that the system performs its intended function(s), or retain enough Situation Awareness (SA) and capability to find another way to execute the required task.</p> <p>Currently, there are no comprehensive standards for measuring, monitoring, and evaluating task performance with regard to crewmember capabilities, the design of the task, and the dynamic spacecraft environment. This work seeks to address this missing performance infrastructure by providing a conceptual framework for measuring task design quality and developing a path for validation using a task performance metric through experimentation both in university labs and using NASA's analog missions.</p>
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	<p>Leveraging wearable technologies for monitoring human health and performance is beneficial for a range of people here on Earth whether it is for elite athletes to rehabilitation patients in the hospital. Currently, there are limitations to the use and integration of data from various wearable sensors. The work done for this project will help to provide some guidance regarding wearable data integration and effectiveness of the data for predicting performance degradation. The ability to predict changes in performance can be useful for a number of scenarios here on Earth.</p>
Task Progress:	<p>The objective of this investigation is to provide a method for validating a previously defined Capabilities Framework, which describes the relationship between human capabilities and performance. The approach is to have human subjects perform representative spaceflight-like task scenarios while being monitored by a suite of non-invasive biometric measures. The data collected will be analyzed to determine whether these non-invasive biometric measures can be used as proxy indicators to performance changes. The work performed this year focused on final data collection for our Block 2 testing, and supporting NASA's Human Exploration Research Analog (HERA) Campaign #6 Mission 4; and doing the analysis on the remaining data, while putting together documentation for publication of the findings.</p> <p>The focus for this grant year was to continue collecting data for our Block 2 testing, which investigates whether biomeasures can be used to classify different task types. For this grant year, we were able to run 22 more subjects under this Block 2 testing regime. Initial data analysis for classification of the tasks indicates that the best accuracies that we could reasonably achieve ranges from 20-40% using the Random Forest Classifier, Support Vector Machine, Linear Discriminant Analysis, and K-Nearest Neighbor classifiers. This classification accuracy is only just above guessing (25% for four categories of workload). There are a number of possible interpretations as to why the accuracy performs poorly, including potential ordering effects of the protocol, fatigue induced from the test session, learning or habituation effects, or environmental or demographic impacts. These will continue to be investigated using other analysis techniques, including Linear Mixed Models.</p> <p>And continued analysis on the missions of the HERA Campaign #6 has indicated that the fNIRS measures collected over a 20-minute task may provide a different perspective of task performance than our in-lab five-minute cognitive tasks, in that there may be indicators of mental fatigue present. Additionally, the functional near-infrared spectroscopy (fNIRS) data from HERA indicates that it can clearly identify when the subject is switching from one cognitive task to the next. More thorough analysis will be done with advanced modeling techniques to again capture mixed effects modeling.</p>
Bibliography Type:	Description: (Last Updated: 02/26/2025)