Fiscal Year:	FY 2020	**Task Last Updated:**	FY 03/07/2020
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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City:	Centennial	**State:**	CO
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:	03/06/2019	**End Date:**	04/14/2023
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:	1	**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:	Williams, Thomas	**Contact Phone:**	281-483-8773
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Flight Program:			
Flight Assignment:	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 graduate student for upcoming semester.		
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:	This task is part of the Human Capabilities Assessments for Autonomous Missions (HCAAM) Virtual NASA Specialized Center of Research (VNSCOR). 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. 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.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	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.
Task Progress:	The objective of this investigation is to provide a method for validating a previously defined Task Design Framework, which describes the relationship between human capabilities and performance. The approach of this project is to have human subjects perform representative spaceflight-like task scenarios while being monitored by a suite of non-invasive biometric measures. The research aim is to determine whether these non-invasive biometric measures can be used as proxy indicators of performance changes. To identify any bridge between biometrics to human performance, several phases of this project are outlined (definition phase, data collection phase, analysis phase). The first phase is the definition phase, which started on April 15, 2019 and ends on January 14, 2020. During this phase, the research team focused on the initialization of the project including detailed coordination with the other HCAAM VNSCOR teams, and NASA's Flight Analogs Program to ensure seamless integration for the Human Exploration Research Analog (HERA) Campaign #6. Specific accomplishments by the research team include the first two major objectives outlined by the study proposal: 1) Evaluate Quantitative Framework for Measuring Crew Capabilities and Task Interaction. As part of this objective, a detailed review of the Task Design Framework was done to map the task types to the specific biometric outputs of interest. This mapping required two stages: 1) mapping specific task types to specific human capabilities needed to perform the task, and 2) mapping of the human capabilities to possible biometric outputs such as heart rate acceleration/deceleration, increased electrodermal activity, etc. Leveraging the Task Design Framework updates, the research team focused on identifying appropriate non-invasive wearable sensors and monitors that would be best used for the HERA operational setting. Several factors were taken into consideration when down selecting the sensor suite to ensure the sensors were suitable for 45-day mission including aspects of usability, subject comfort, onboard memory capacity, ease of use by the crew, etc. 2) Establish Protocols for Measuring Human Capabilities. The outcome of this objective was the submission and full approval of the IRB (Institutional Review Board) protocol required to run the human test subjects in NASA's HERA Campaign #6. The research team approached this objective with a systematic process and accomplished the tasks in a somewhat chronological order: a) Candidate Task Identification: Identified over 50 representative tasks done by astronauts and provided detailed characteristics and protocols for each task. b) Sensor Operation: Developed a basic checklist on how to use the sensors and what other components are needed (i.e., laptop, charging device, stopwatch, paper, pencil, etc.) for data acquisition. c) Calibrate (Verify) Sensor Data: Compared sensors to standard measure (accuracy) BioPac and normalized the output data and plots. This step ensured the data we measured could be seen across higher accuracy sensors such as the BioPac. d) Validate Sensors: Compared data to expected task output (example: heart rate goes up during a high physical activity). e) Task Down Selection: Chose tasks that will have the largest differences in biometric changes that can be observed in the data. Also identified tasks that are representative of astronaut activities and can be implemented in HERA. f) IRB Protocol Submission and Approval: Protocol was written, edited, and submitted to the IRB panels at both the University of Colorado and NASA Johnson Space Center (JSC). Both required a few modifications and edits and were fully approved. Summary of Accomplishments • Reviewed and Updated Task Design Framework • Identified and Down selected Appropriate Sensor Suite • Identified Candidate Tasks for Experiment Protocol • Operated, Calibrated, and Validated Sensor Application • Down selected Tasks for Experiment Protocol • Submitted and Received Approval for IRB Protocol (Approved by NASA and University of Colorado Boulder IRB) • Submitted Data Sharing Agreement with NASA LSDA (Life Sciences Data Archive) • Coordinated with HERA Experiment Support Scientist (ESS) for delivery of Science Requirement Document (SRD)

	for HERA Campaign #6.
Bibliography Type:	Description: (Last Updated: 02/26/2025)