Fiscal Year:	FY 2017	**Task Last Updated:**	FY 05/30/2017
PI Name:	Strangman, Gary E Ph.D.		
Project Title:	Quantifying and Predicting Operationally-Relevant Performance in a Long-Duration Spaceflight Analog		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Behavior and performance		
Joint Agency Name:		**TechPort:**	No
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) **Sleep**:Risk of Performance Decrements and Adverse Health Outcomes Resulting from Sleep Loss, Circadian Desynchronization, and Work Overload		
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:**	2015-16 HERO NNJ15ZSA001N-ILSRA. Appendix F: International Life Sciences Research Announcement
Start Date:	08/01/2016	**End Date:**	07/31/2019
No. of Post Docs:	2	**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
Contact Monitor:	Williams, Thomas	**Contact Phone:**	281-483-8773
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Flight Program:			
Flight Assignment:	NOTE: Element change to Human Factors & Behavioral Performance; previously Behavioral Health & Performance (Ed., 1/18/17)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Zhang, Quan Ph.D. (Massachusetts General Hospital)		
Grant/Contract No.:	NNX16AO30G		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Exploration spaceflight missions will expose crewmembers to many risks that could affect their performance and mission success. Minimizing such risks will require identifying and validating objective indicators of behavioral health and performance (BMed2 Gap), understanding the contribution of sleep loss on individual behavioral health (Sleep2 Gap), and identifying countermeasures that can reduce these risks (BMed1, BMed6, and Sleep9 Gaps). Currently the Robotic On-Board Trainer (ROBoT) is used operationally by astronauts both on the ground and on the International Space Station (ISS) to practice Canada Arm activities. Our group is helping adapt ROBoT for research use and for quantitative performance assessment. In addition, our group is developing and testing NINscan-SE: a multi-use system for measuring brain and physiological function. Both ROBoT and NINscan-SE are being characterized and validated in our laboratory over the next several months, and will undergo analog feasibility testing during the Human Exploration Research Analog (HERA) 2016 campaign. We propose to deploy both in this project to: Aim 1: Characterize operational task performance changes during 45-day HERA missions, including the roles of time-in-mission, workload, sleep debt, and operational emergencies. Aim 2: Characterize brain and systemic physiology changes during 45-day HERA missions, including the roles of time-in-mission, workload, sleep debt, and operational emergencies. Aim 3: Identify physiological or behavioral variables that predict operational performance. Aim 4: Quantify the influence of behavioral health countermeasures on both operational performance and (neuro)physiological measures. To achieve these aims, we will recruit up to 32 crewmembers from eight 45-day missions in the HERA facility during Campaigns 4 and 5, plus 32 control subjects. HERA and control participants will all perform ROBoT tasks plus undergo physiological monitoring 2x/week, on matching schedules, thus enabling us to differentiate changes in operational performance due to practice over time from any changes due to HERA sequestration. In addition, two “unexpected operational emergency” events will be introduced in the first and last weeks of each HERA mission. These will consist of an acute need to capture a wayward satellite traveling near the limits of Canada Arm capabilities. We will also work with the Behavioral Health and Performance (BHP) Element and other HERA investigators to coordinate ROBoT and physiological data collection before, during, and after one or more countermeasure (CM) deployments during the HERA missions. CM(s) may include a lighting intervention, a Virtual Space Station-based behavioral intervention, diet, exercise or some other intervention. The experimental design will depend on the nature of the CM. We will test hypotheses that the CM(s) generate detectable changes in ROBoT performance and rest/task (neuro)physiology recordings. We will also compare ROBoT performance to the standardized Behavioral Core Measures (BCM), if available. The knowledge-deliverables of this project will describe: (i) changes in operationally-relevant (ROBoT) performance during the HERA mission in a well-controlled analog study of substantial size; (ii) changes in cerebral and systemic physiology associated with HERA mission parameters as well as operational performance; (iii) identification of potential predictors of future ROBoT performance; and (iv) the influence of the investigated countermeasure(s) on operational performance and physiology.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The ROBoT system—and the HERA isolation protocol—are quite specific to NASA spaceflight operations and hence have relatively few direct Earth applications. However, the ROBoT spacecraft-capture simulations represent a highly skilled, complex operational performance task. It could thus be used as a comparison task in concert with detailed cognitive testing to help dissect the cognitive components complex tasks as well as the influence of other physiological stressors (e.g., sleep deprivation, alcohol consumption, medical radiation) on the performance of such tasks. Use of different complex tasks in with the same approach could be useful in assessing and predicting performance in a wide range of other operational environments (diving, pilots, military, surgeons, etc.). Regarding NINscan-SE, no current NIRS, EEG, or polysomnography device has both the portability and the multi-use features of the system we will be deploying. This system could thus have substantial novel Earth applications. Hospital monitoring applications could include long-duration, non-invasive brain monitoring in the NeuroICU following stroke or traumatic injury, for which no similar technology exists. Real-time, in-office brain activation assessment could also be enabled, for assessment of psychiatric states, for monitoring the neural effects of cardiovascular or psychoactive drugs or other therapies, or for brain monitoring during rehabilitation. Mobile monitoring could perhaps have an even larger impact outside the hospital setting. A wearable monitor would enable ambulatory syncope monitoring, or multi-parameter ambulatory epilepsy monitoring. If deployed in emergency settings, NINscan-SE could potentially be used to detect cerebral or abdominal hemorrhage, ischemia, and/or cortical spreading depression by first responders. Home monitoring uses include various sleep disorders, as well as any of the various commercial possibilities indicated below.
	Since project initiation on 8/1/2016, the following tasks have been completed. ROBoT v6.2 Software: A new version of ROBoT was generated and deployed to HERA for Campaign 4. This version of ROBoT added (1) support for the newly-fabricated hand-controllers, (2) a new setup tab and associated action buttons so that the operations and research versions of ROBoT can coexist within the same code-base, (3) a post-session comments box, (4) revised feedback for crewmembers that is in better alignment with NASA operations (10=best score, 0=worst), (5) a custom set of emergency trials specific to our C4 protocol, plus (6) various bits of code cleanup and bug fixes. The tab and action buttons were key to enable seamless transition between the “ops” version of ROBoT (which does not save data and displays different feedback) and ROBoT (which does save data). Support for the new controllers is supplemental, meaning the ROBoT system can now be configured to use either legacy or new-style hand controllers as needed. The post-session comments box allows subjects to type in immediately following a set of 12 runs any issues that were encountered (problems with system setup, interruptions during performance, unexpected software glitches encountered, and so on). NINscan-SE Hardware: Our NINscan-SE prototype was also reconfigured for use in HERA C4. This involved two hardware changes. The first involved developing a new auxiliary sensor component module. The previous NINscan-SE auxiliary sensors were designed specifically for polysomnography, whereas the new module incorporates sensor leads

Task Progress:	for 3-channel EEG and 2-channel EOG (to minimize wiring that users need to manage). As with the prior module, it simply needs to plug into the base recorder box for use. In addition, we modified the internal electronics of the recorder box to incorporate a second reference channel. This was done so that our F3/F4 EEG channels could be referenced to the contralateral mastoid for more robust and noise-resistant measurements. Training Materials: New training materials were also developed for HERA C4. While the ROBoT familiarization video from HERA C3 could still be used, we needed to revise the user instructions to reflect a change in login and setup procedure screens, interpreting the new evaluation screens, what to enter in the post-session survey/comments box, and description of the pre-task resting baseline recording period for assessing the default mode network activity. The NINscan-SE instructions needed to be revised to reflect the new sensor module and electrode positioning scheme relative to its deployment in HERA C3. HERA C4M1 Data Collection: The new version of the ROBoT software was delivered to HERA in February 2017. Dr. Ivkovic traveled to Houston to confirm appropriate setup of the system and conducted all Mission 1 crew familiarization (with both ROBoT and NINscan-SE), training, and all baseline data collection. ROBoT and NINscan-SE data was also validated (to confirm the appropriate data was being collected) prior to hatch-closing, which occurred on 5/6/2017. In the remaining 2 months of the grant year we anticipate completing the following activities: HERA C4M1 Completion: Mission 1 is ongoing and scheduled for hatch opening on 6/19/2017, followed by a 1-week period of post-mission data collection. Thus, we expect to complete Mission 1 (n=4) before the end of June. Upon completion of this phase, we will collect all ROBoT data and NINscan-SE data and begin the quality control and the initial data analysis phase. HERA C4 M2: The HERA Mission 2 crew (n=4) is scheduled to begin training on 7/20/2017 with hatch closing on 8/5/2017. Dr. Ivkovic will again travel to Houston for the training-to-hatch-closing phase of M2, completing the same tasks as for Mission 1. The remainder of M2 will be completed during year 2 of this project. Controls: We are currently running controls for our HERA C3 mission. Immediately following those controls we will begin running controls for HERA C4. These subjects will be performing ROBoT sessions on the same schedule as the individuals in HERA C4, including the same NINscan-SE recording protocols. These subjects will continue to be run through most of year 2 of the project.
Bibliography Type:	Description: (Last Updated: 02/05/2025)