Fiscal Year:	FY 2018	**Task Last Updated:**	FY 11/20/2018
PI Name:	Holden, Kritina Ph.D.		
Project Title:	Effects of Long-duration Microgravity on Fine Motor Control Skills		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
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) **BMed**:Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders (2) **HSIA**:Risk of Adverse Outcomes Due to Inadequate Human Systems Integration Architecture (3) **Sensorimotor**:Risk of Altered Sensorimotor/Vestibular Function Impacting Critical Mission Tasks		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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PI Organization Type:	NASA CENTER	**Phone:**	281-483-8829
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PI Address 2:	Mail Code: C46		
PI Web Page:			
City:	Houston	**State:**	TX
Zip Code:	77058-3607	**Congressional District:**	22
Comments:			
Project Type:	FLIGHT	**Solicitation / Funding Source:**	Directed Research
Start Date:	10/01/2013	**End Date:**	09/30/2018
No. of Post Docs:	0	**No. of PhD Degrees:**	1
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:	ISS		
Flight Assignment:	ISS NOTE: End date changed to 9/30/2018 per E. Connell (JSC HRP)--Ed., 6/25/18 NOTE: Element change to Human Factors & Behavioral Performance; previously Space Human Factors & Habitability (Ed., 1/19/17) NOTE: End date changed to 6/29/2018 per E. Connell/M. Whitmore (JSC HRP)--Ed., 1/21/16 NOTE: Change in title to "Effects of Long-duration Microgravity on Fine Motor Control Skills" from "Effects of Long-duration Microgravity on Fine Motor Skills: 1-year ISS Investigation" per E. Connell/SHFH HRP (Ed., 8/19/15) NOTE: Risk/Gaps per E. Connell/HRP (Ed., 3/20/14) NOTE: Start date changed to 10/1/13 (from 6/25/13) per M. Whitmore/JSC (Ed., 2/24/14)		
Key Personnel Changes/Previous PI:	November 2018 report: Dr. Alan Feiveson was added as a co-investigator for the last year of the project to assist with statistical analyses. December 2016: Aniko Sandor, Ph.D., is no longer CoInvestigator on the project. December 2015: Shelby Thompson, Ph.D. removed from the project. Ernest Vince Cross, Ph.D. and Maya Greene, Ph.D. added to the project.		

COI Name (Institution):	Cross, Ernest Ph.D. (Leidos Corporation/NASA Johnson Space Center) Greene, Maya Ph.D. (Wyle Laboratories/NASA Johnson Space Center) Feiveson, Alan Ph.D. (NASA Johnson Space Center)
Grant/Contract No.:	Directed Research
Performance Goal No.:	
Performance Goal Text:	
Task Description:	Fine motor skills will be critical during long-duration space missions, particularly those skills needed to interact with new technologies required for autonomous operations in next-generation space vehicles, spacesuits, and habitats. Few, arguably no, studies have been completed to investigate this type of functional fine motor performance in microgravity. There has also not been a complete, systematic study of fine motor performance to include different phases of microgravity adaptation, long-term microgravity, and the sensorimotor recovery period after transition to Earth gravity (post landing). In addition, the studies conducted to date have not been conclusive regarding the effects of microgravity on fine motor control. The opportunity to systematically collect fine motor performance data throughout a long-duration mission is of great value. It will add to our knowledge base and provide a vastly improved capability to judge the risk of performance decrements due to long-duration microgravity. The proposed investigation will also provide an additional measure of functional performance post-flight, and a new functional test in-flight. These data will contribute to closure of several research gaps and may drive in-flight mitigations and/or design decisions for future vehicles/habitats. Specific Aims: Aim 1: Determine the effects of long-duration microgravity on fine motor performance. • How does fine motor performance in microgravity trend/vary over the duration of a six-month, and year-long space mission? • How does fine motor performance on orbit compare with that of a closely matched subject on Earth? Aim 2: Determine the effects of different gravitational transitions on fine motor performance. • How does performance trend/vary before and after gravitational transitions, including the periods of early flight adaptation, and very early/near immediate post-flight periods?
Rationale for HRP Directed Research:	This research is directed due to a time constraint. This proposal focuses on the research opportunity afforded by the 2015 year-long mission of two crewmembers aboard the International Space Station (ISS).
Research Impact/Earth Benefits:	The Fine Motor Skills test battery software was released for public use through the NASA Technical Reporting process, and the app will soon be available on the Apple app store. The test battery can be used to measure fine motor decrements in elderly or diseased populations. The software may also prove beneficial in rehabilitation of fine motor skills in elderly patients, people with motor disorders, and patients with brain injuries.
Task Progress:	Space travelers will endure many challenges as they embark on future long-duration missions beyond low Earth orbit. They will face isolation, confinement, a closed environment, space radiation, and long-duration microgravity. We know that the human body is impacted by these deleterious effects of spaceflight, and International Space Station (ISS) research over the last fifteen years has led to a basic understanding of these effects, as well as the efficacy of mitigations. One less studied area of spaceflight performance is fine motor skills. These skills involve the integration of visual information and coordination of muscles, bones, and nerves to produce small, precise movements of the small muscle groups of the hands and fingers. Fine motor skills will be critical for interacting with hardware and software-based controls to perform a variety of tasks such as information access, just-in-time training, subsystem maintenance, and medical treatment, among others. Fine motor skills are also critical for tasks involving hand controllers – flying a space vehicle, or teleoperating a robotic arm. In the Effects of Long-duration Microgravity on Fine Motor Control Skills flight study, subjects completed a set of fine motor tasks on an iPad computer, with a stylus and finger. The tasks included: Pointing, Dragging, Shape Tracing, and Pinch-Rotate. Response times and errors for each task were captured and sent to the International Space Station (ISS) server for downlink once a week. Subjects performed the task approximately once a week for the first 3 months of the flight, and every 14 days for the remainder of the flight. Due to postflight crew time constraints, a short version of the Fine Motor Skills test battery (5 minutes) was used for the early postflight data sessions. The short sessions were completed on landing day (Return +0), R+1, and R+3, and regular-length sessions (15 min) were completed on R+5, R+15, and R+30. The study included two one-year subjects and seven standard duration (six-month) astronauts. Eight ground-matched subjects completed the study with the same schedule as the flight crew, lagged by a few weeks. The Fine Motor Skills flight study was completed in 2018. Due to some technical issues with the data from the one-year mission, formal analyses have been focused on data from the seven standard duration subjects. Statistical analyses were performed to identify effects of long-duration microgravity on inflight fine motor performance, and effects of gravity-related transitions on fine motor performance. Results have implications for crew activities that must be completed with accuracy soon after landing on a planetary surface. Results are currently being prepared for submittal to a technical journal.
Bibliography Type:	Description: (Last Updated: 10/29/2023)
Articles in Peer-reviewed Journals	Holden K, Greene M, Vincent E, Sándor A, Thompson S, Feiveson A, Munson B. "Effects of long-duration microgravity and gravitational transitions on fine motor skills." Hum Factors. 2023 Sep;65(6):1046-1058. https://doi.org/10.1177/00187208221084486 ; PMID: 35609944 , Sep-2023