Fiscal Year:	FY 2013	**Task Last Updated:**	FY 08/05/2012
PI Name:	Wood, Scott J. Ph.D.		
Project Title:	Effect of Sensorimotor Adaptation Following Long-Duration Spaceflight on Perception and Control of Vehicular Motion		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Biomedical countermeasures		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **Sensorimotor**:Risk of Altered Sensorimotor/Vestibular Function Impacting Critical Mission Tasks (Revised as of IRP Rev M)		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	77058	**Congressional District:**	36
Comments:	NOTE: PI returned to NASA JSC in January 2017. PI was at Azusa Pacific University from August 2013 – January 2017; prior to August 2013, PI was at NASA JSC.		
Project Type:	FLIGHT	**Solicitation / Funding Source:**	2008 Crew Health NNJ08ZSA002N
Start Date:	10/01/2009	**End Date:**	02/29/2016
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
Contact Monitor:	Loerch, Linda	**Contact Phone:**	
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Flight Program:	ISS		
Flight Assignment:	ISS Increments 33-34, 35-36, and 37-38 (pending in September 2012)--per PI (Ed., 8/7/2012) NOTE: End date is now 2/29/2016 per HRP Master Task List dated 7/12/2011 (Ed., 8/4/2011)		
Key Personnel Changes/Previous PI:	None		
COI Name (Institution):			
Grant/Contract No.:	Internal Project		
Performance Goal No.:			
Performance Goal Text:			

Task Description:

The central nervous system must resolve new patterns of sensory cues during movement in a novel gravitoinertial environment in order to maintain accurate spatial orientation awareness. We hypothesize that adaptive change in how inertial cues from the vestibular system are integrated with other sensory information leads to perceptual disturbances and impaired manual control during transition to a new gravity environment. The primary goals of this investigation are to quantify post-flight decrements in manual control performance during a rover simulation (both acute and recovery), and to examine the relationship between manual control errors and adaptive changes in sensorimotor function and motion perception. Eight crewmembers returning from 6 month stays onboard the International Space Station (ISS) will be tested on a six degree-of-freedom motion simulator during four pre-flight and three post-flight sessions on R+1, 4 and 8 days following landing. Ground control studies on non-astronauts will assess effects associated with learning across multiple sessions, changes in proficiency as a function of time between pre- and post-flight sessions and changes in performance during galvanic vestibular stimulation.

This rover simulation study has been incorporated within the manual control study titled “Assessment of operator proficiency following long-duration spaceflight” under the direction of principal investigator Dr. Steven Moore. Dr. Moore’s project includes a test battery to assess sensorimotor and cognitive function, including vestibular (pitch/roll tilt motion perception), visual acuity, manual dexterity, manual tracking with and without dual tasking, reaction time, sleepiness scale, perspective taking and spatial memory (match-to-sample). Dr. Moore’s experiment also includes driving and flying simulations. According to our hypothesis, we predict that decrements in sensorimotor and cognitive function will correlate with performance metrics during the operator simulations. The simulator utilizes a Stewart-type motion base (CKAS, Australia), single-seat cabin with triple scene projection covering 150° horizontal by 50° vertical, and joystick controller. The rover simulation consists of serial presentation of discrete docking tasks that the crewmember attempts to complete within a scheduled 10 min block. Each task consists of 1) perspective-taking, using a map that defines the rover orientation and location relative to the docking target, 2) navigation toward the target around a Martian outpost as efficiently as possible, and 3) docking a side hatch of the rover to another rover or habitat hatch using a visually guided targeting system. The primary dependent variables obtained from each component include time to completion and accuracy. At the completion of each task, a new perspective map will appear to initiate the next task in the series. The number of tasks the crewmember can complete during the 10 min time block will determine the overall operator proficiency.

Rationale for HRP Directed Research:

Research Impact/Earth Benefits:

Sensorimotor function is critical for spatial orientation, gaze stabilization, and postural stability. This project examines how adaptive changes in sensorimotor and cognitive function may increase the risk of impaired ability to maintain control of vehicles and other complex systems. The goal is to map changes in physiological function with functional measures of manual control. Establishing these relationships will be relevant to how pathophysiological impairments in sensorimotor processing may affect other vehicular control tasks, such as driving with vestibular patients. Vehicle driving is one of the most complex tasks required of humans. A majority of vestibular-impaired patients report that driving is difficult or dangerous. Successful completion of this project will contribute to the development of assessment techniques for determining fitness for driving duty. Specifically, the rover simulation utilizes a multiple degree-of-freedom motion base simulator to address aspects of vehicular control performance, including perspective taking, navigating a course safely, and fine positioning control. This approach can be easily adapted to a wide variety of simulated vehicle designs to provide similar assessments in other operational and civilian populations.

Task Progress:

ISS Flight Study
Our flight study utilizes repeated measures pre- versus post-flight design, where each subject will serve as their own control. The flight manual control study was presented during this reporting year to Increments 33-34, 35-36, and 37-38 (pending in September). Four ISS crewmembers to date have agreed to participate in the study. Preflight data collection for the first two crewmembers was completed, with the first postflight data collection planned for Expedition 34 in the late March 2013 timeframe.

Ground control studies

1. Effects of learning across sessions

Postflight performance will be influenced in part by the level of skill proficiency crewmembers attain during preflight baseline testing. Given the novel nature of the rover simulation task, it was important to establish that adequate skill proficiency could be attained within the planned 4 preflight sessions. Another objective of this study was designed to investigate the effects of varying the simulation scenarios across sessions.

Twenty healthy subjects were tested in 5 sessions, with 1-3 days between sessions. Each session consisted of a serial presentation of 8 discrete rover tasks to be completed as quickly and accurately as possible. Each task consisted of 1) perspective-taking, using a map that defined a docking target, 2) navigation toward the target around a Martian outpost, and 3) docking a side hatch of the rover to a visually guided target. Subjects were randomly assigned to either a control group (tasks identical in the first 4 sessions) or a varied-practice group. The dependent variables for each task included accuracy toward the target and time to completion.

The greatest change in time to completion occurred during the docking phase. There was no significant difference between 4th and 5th sessions, suggesting that learning effects would be complete by the end of the preflight baseline period. There were no significant differences between the control and variable practice groups.

Both perspective-taking accuracy and navigation path length varied most by specific task selection. There was a consistent difference in all time measures across sessions between those with at least moderate prior gaming experience and those without. Based on this control study, the same four rover tasks will be used throughout the flight study.

2. Changes in operator proficiency as a function of session recency

For the flight study, some changes in proficiency would be expected as a function of time (6 months) between pre- and post-flight sessions. For example, T38 pilots are required to be recertified by a flight instructor when they have not flown for a period of 45 days. One of our ground control studies will examine the changes in operator proficiency following a 6 month gap in their 4th and 5th sessions. This data collection will be initiated during this next fiscal year.

3. Changes in operator proficiency during galvanic vestibular stimulation (GVS)

	Our main hypothesis is that adaptive change in how inertial cues from the vestibular system are integrated with other sensory information leads to perceptual disturbances and impaired manual control during transition to a new gravity environment. As a factor of influence study, we propose to measure performance during the rover simulation in 10 subjects with and without GVS. GVS has been utilized extensively by Dr. Moore's laboratory as a sensorimotor spaceflight analog to assess the effects of disrupting vestibular function on posturography, locomotion, manual control and cognitive function. The rover GVS study will be initiated during this reporting period and completed in early FY13.
Bibliography Type:	Description: (Last Updated: 08/02/2022)
Abstracts for Journals and Proceedings	Wood SJ, Dean SL, De Dios YE, MacDougall HG, Moore ST. "Assessment of proficiency during simulated rover operations following long-duration spaceflight." 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, February 14-16, 2012. 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, February 14-16, 2012. , Feb-2012
Abstracts for Journals and Proceedings	Dean SL, De Dios YE, Moore ST, MacDougall HG, Wood SJ. "Acquisition of skill proficiency over multiple sessions of a novel rover simulation." Presented at the 83rd Annual Scientific Meeting, Aerospace Medical Association, Atlanta, GA, May 13-17, 2012. Aviation, Space, and Environmental Medicine, 2012 Mar;83(3):229. http://www.ingentaconnect.com/ , Mar-2012