Fiscal Year:	FY 2014	**Task Last Updated:**	FY 08/02/2013
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 on eight ISS astronauts, where each subject will serve as their own control. This past year postflight data collection was completed on the first two subjects. Preflight data was also completed on three additional subjects. Based on the results of the informed crew briefings, additional subjects are targeted for 38S and 39S landings. Based on the direct return of our 39S subject to the European Astronaut Center, this subject will be removed from the experiment. The final subject is targeted for 41S landing in May 2015. Ground control studies 1. Effects of learning across sessions: The data collection for this ground study was completed during FY12 to establish that adequate skill proficiency could be attained within the planned four preflight sessions. Twenty healthy subjects were tested in 5 sessions, with 1-3 days between sessions. This study also served as a normative data set to establish the reliability of the rover analysis methods. During the past year, the analysis methods were refined and results presented at the HRP investigator workshop (Pereira et al., 2013). In particular, new accuracy measures added included cumulative distance to target for both navigation and docking tasks, and misalignment was added for the docking task. In addition, an efficiency metric was added which factors both path length traveled and time. Learning was observed across the 4 sessions, particularly in time to completion for each task. As expected, there was no improvement in perspective taking accuracy due to the absence of visual feedback. Improvements in navigation efficiency were observed as indicated by the reduction in cumulative distance and the increase in calculated efficiency. Docking misalignment improved between the first and second sessions. A slight increase in misalignment during the last 2 sessions may be attributed to subjects placing more emphasis in completing the task faster, as shown by the improved times. Skill acquisition and performance were correlated with self-ratings of previous gaming experience. 2. 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, this past year we measured performance during the rover simulation in 11 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. Each subject performed four different trials with GVS, and the same four trials without GVS, for a total of eight trials each. The presentation order was counterbalanced across subjects. The presence of GVS increased the variability of responses for all three subtasks – perspective taking, navigation and docking. Some subjects were more affected than others. Since the rover simulation provides significant visual feedback, these results suggest that some subjects may be utilizing visual feedback more effectively to compensate for the vestibular disturbance caused by GVS. Therefore, we added a second session in which subjects were asked to perform both subjective vertical tasks and closed-loop nulling

	with and without GVS with both visual feedback and in the dark. The analysis of this second session is ongoing. 3. 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. Our third ground control studies will examine the changes in operator proficiency following a 7-month gap between their 4th and 5th sessions. This data collection will be initiated during this next fiscal year.
Bibliography Type:	Description: (Last Updated: 08/02/2022)
Abstracts for Journals and Proceedings	Pereira MA, Dean SL, MacDougall HG, Moore ST, Wood SJ. "Improvements in performance during multiple sessions in a rover simulation." Presented at the 2013 NASA Human Research Program Investigators' Workshop, Galveston, TX, February 12-14, 2013. 2013 NASA Human Research Program Investigators' Workshop, Galveston, TX, February 12-14, 2013. , Feb-2013