Fiscal Year:	FY 2011	**Task Last Updated:**	FY 07/31/2010
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:	Goodwin, Thomas	**Contact Phone:**	
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Flight Program:			
Flight Assignment:	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:	August 2010. The rover simulation was Specific Aim 4 of the submitted proposal. Since the original Specific Aims 1-3 of this study were removed from this investigation, the investigator team members on Dr. Wood's proposal assigned to those aims are not participating in the revised integrated study with Dr. Moore.		
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.
This rover simulation study has been incorporated into another post-flight 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 (head stabilization, pitch/roll vestibulo-ocular reflex, tilt motion perception), oculomotor (smooth pursuit, optokinetic nystagmus, dynamic visual acuity), manual dexterity, manual tracking, perspective taking, emergency response, sleepiness and fatigue. According to our hypothesis, we predict that decrements in sensorimotor function will be correlated with performance during the rover simulation.

The rover simulation consists of serial presentation of discrete tasks that the crewmember attempts to complete within a scheduled 10 min block. The tasks are based on navigating around a Martian outpost that consists of a landing area, habitation area, power generator, science area and radio telescope spread over a 970 m2 terrain. Each task is subdivided into three components: (1) presentation of a perspective map detailing the current location of the rover and the location of the task to be performed; (2) navigation of the rover to the desired location as quickly as possible while avoiding obstacles, and (3) fine control of the rover to dock with another object or align a camera view. Metrics will be obtained from each component, e.g., time to orient rover in the desired direction, path deviation and time to move within a target location boundary, and control alignment error in the docking - positioning phase. At the completion of each task, a new perspective map will appear to initiate the next task in the series. Overall operator proficiency will be based on how many tasks the crewmember can complete during the 10 min time block. The order of task presentations will vary across sessions to minimize learning effects.

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 to be used when 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:

During this first project year, the motion base and cabin were assembled to support the rover simulation, and the rover simulation software was developed by Tietronix.
Motion simulator: The motion base is a Stewart type (V7, CKAS, Melbourne, Australia), which has six independently electric actuators legs to position and orient the platform. The V7 has a footprint of 2.1 x 2 m, and carries a payload of up to 650kg. The washout software accepts User Datagram Protocol (UDP) text packets from any simulation software, providing an ‘open-source’ full-motion simulator. A rigid platform (~2.2 m diameter, 57 mm thickness) was bolted to the V7 motion base. A professional racing seat with a 4-point safety harness (Corbeau A4, Sandy, UT) was mounted and can accommodate a detachable custom head restraint. The joystick chosen was based on the current electric rover design and provides the same degrees of freedom for rover motion. A modified polyethylene tank (2.2 m diameter x 1.65 m high x 6 mm thick; Norwesco) is mounted to the plywood base, and three DLP projectors (Benq 515ST) were mounted to roof of the cabin to project images onto lightweight foam core boards mounted to the cabin wall with wooden battens.

Rover simulation: The rover simulation is based on the current electric rover design concepts and early mission scenarios for a Martian outpost. The development of the primary rover simulation was completed in collaboration with Tietronix, with refinements anticipated during science verification testing. The rover simulation consists of serial presentation of discrete tasks that the crewmember attempts to complete within a scheduled 10 min block. The tasks are based on navigating around a Martian outpost that consists of a landing area, habitation area, power generator, science area and radio telescope spread over a 970 m^2 terrain. Each task is subdivided into three components:

(1) Perspective map detailing the current location of the rover and the location of the task to be performed. This map will be replaced by the simulated Martian landscape when the subject moves the joystick to initiate rover motion. The primary metric from this phase will be the time required to orient the rover in the correct direction. This task is intended to be a functional equivalent of the perspective taking test included in Dr. Moore’s test battery.

(2) Navigation of the rover to the desired location as quickly as possible while avoiding obstacles. The main metrics from this phase will be RMS error from the desired path, total pathlength, and the time to move within the target location boundary.

(3) Fine position control of the rover to dock with another object or align a camera view. The primary metric of this phase will be the RMS control alignment error.

At the completion of each task, a new perspective map will appear to initiate the next task in the series. Overall operator proficiency will be based on how many tasks the crewmember can complete during the 10 min time block. The order of task presentations will vary across sessions to minimize learning effects.

Near term plans: The JSC Science Management review and target ISS manifest for informed crew briefings is currently on hold for this study. Following the Test Readiness Review of the motion simulation hardware, a preliminary study is

	planned to examine the effects of variable practice on the rover simulation tasks.
Bibliography Type:	Description: (Last Updated: 08/02/2022)