Fiscal Year:	FY 2022	**Task Last Updated:**	FY 12/07/2022
PI Name:	Wood, Scott J. Ph.D.		
Project Title:	Manual Crew Override of Vehicle Landings Following G-Transitions		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **HSIA**:Risk of Adverse Outcome Due to Inadequate Human Systems Integration Architecture (IRP Rev L) (2) **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		
PI Email:	scott.j.wood@nasa.gov	**Fax:**	FY
PI Organization Type:	NASA CENTER	**Phone:**	(281) 483-6329
Organization Name:	NASA Johnson Space Center		
PI Address 1:	2101 NASA Parkway		
PI Address 2:	Mail code SD2		
PI Web Page:			
City:	Houston	**State:**	TX
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:**	Directed Research
Start Date:	04/04/2022	**End Date:**	09/30/2032
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA JSC
Contact Monitor:	Stenger, Michael	**Contact Phone:**	281-483-1311
Contact Email:	michael.b.stenger@nasa.gov		
Flight Program:	ISS		
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Barratt, Michael M.D. (NASA Johnson Space Center) Duda, Kevin Ph.D. (Draper Laboratory) Heineman, Raymond M.S. (NASA Johnson Space Center) Moore, Steven Ph.D. (Central Queensland University, Rockhampton, Australia) Reschke, Millard Ph.D. (NASA Johnson Space Center) Wheelock, Douglas M.S. (NASA Johnson Space Center) Young, Millennia Ph.D. (NASA Johnson Space Center) Bishop, Michael M.S. (NASA Johnson Space Center)		
Grant/Contract No.:	Directed Research		
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Task Description:	Manual control during exploration spaceflight consists of both planned automated supervisory control and unplanned crew override. This crew override capability is critical to enable overall mission success during landing contingencies. However, the introduction of manual override capabilities must be implemented to enable crews to mitigate risks introduced by human error. Adaptive changes in the sensorimotor system can manifest during G-transitions as spatial disorientation. While training and landing aids enable successful landing through disorientation, these adaptive changes may increase cognitive demand that need to be accounted for in the manual control strategy. It is important to characterize these effects as soon as possible following the G-transition. Therefore, during this study, we will examine two types of piloting tasks following International Space Station (ISS) missions: an actual T-38 flight performed at the rally airport and a simulated lunar landing using a six degree-of-freedom (6DOF) motion-base. The motion base simulation will be implemented both in the laboratory at the NASA Johnson Space Center (JSC) and at the NASA Kennedy Space Center (KSC) and will be available within hours following return from commercial crew landings. The primary goals of this study are (1) to understand the impact of spaceflight on crew ability to perform manual crew override tasks, (2) to examine how adaptive changes in vestibular and cognitive function relate to changes in manual crew override proficiency, and (3) compare performance during late in-flight "just-in-time" training with early post-flight crew performance. The impact of spaceflight on piloting capability will be assessed from pre- versus post-flight changes in crewmembers assigned to either short duration (< 30 day) or long duration (~6-month) missions to the ISS. Individual differences in post-flight vestibular and cognitive changes include motion sickness reports, measures of tilt motion perception accuracy and precision, and dual task tracking. During the T-38 flights, pilots will be tasked to take over controls and set up the final approach for landing through "minimums" (i.e., short of touchdown). During the 6DOF lunar simulation, the crew will manually take over attitude and rate-of-descent to the nominal or re-designated landing aimpoint during the approach phase. The outcome measures for both T-38 and lunar crew override tasks will include the percent time maintaining actual vehicle states, e.g., attitude and rate-of-descent, within recommended guidance during the landing approach, number and maximum deviation outside limits and root mean square error (RMSE). Given that 'just-in-time' (JIT) training is an operational expectation for the Human Landing System (HLS) program, all participants will perform late inflight JIT training for each manual crew override task they will participate in. Crew proficiency will be captured inflight during JIT training that will be implemented on a laptop with hand controllers to allow the crewmember to practice the landing task procedures, like the approach implemented for JIT training with Shuttle landing and ISS telerobotic tasks. This project will deliver an operational demonstration of crew override capability following spaceflight and identify potential deficits that may require remediation. Comparison of individual vestibular and cognitive changes with crew override performance will help better characterize the manual control risks associated with sensorimotor alterations. Comparing performance parameters from the JIT training to post-flight performance will help demonstrate transfer of inflight JIT training to post-flight manual crew override performance. The inclusion of "just-in-time" training will ensure we are characterizing changes in override proficiency with this expected countermeasure in place.
Rationale for HRP Directed Research:	This research is directed because it contains highly constrained research. This flight study addresses the sensorimotor research emphasis stated in the Human Research Program (HRP) Integrated Research Plan titled "Risk of Altered Sensorimotor/Vestibular Function Impacting Critical Mission Tasks". One gap associated with this risk (SM-102) is to "characterize the effects of short and long-duration weightlessness on manual control after G-transitions." This research gap led to the solicitation of a manual control study conducted before and after long duration flights on the ISS to map changes in sensorimotor function to manual control decrements. Unfortunately, these results (Moore et al., 2019) were limited due to testing delays related to time required for direct returns from Kazakhstan, with the initial measurements conducted more than 20 hr following landing. The approach of this investigation is to leverage the commercial crew landings in the US to obtain measurements as early as possible. While the Moore study used a T-38 X-plane simulation, we will obtain measures during actual T-38 flights. We will also add a lunar landing simulation based on the current concept of operations for the HLS. Further refinements are also proposed in the sensorimotor and cognitive test battery based on the previous study.
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2022.
Bibliography Type:	Description: (Last Updated: 01/25/2023)