Fiscal Year:	FY 2022	**Task Last Updated:**	FY 11/29/2021
PI Name:	Reschke, Millard F Ph.D.		
Project Title:	Neuro-Vestibular Examination During and After Spaceflight (Vestibular Health)		
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) **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:**	281-483-7210
Organization Name:	NASA Johnson Space Center		
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PI Address 2:	Neuroscience Laboratories		
PI Web Page:			
City:	Houston	**State:**	TX
Zip Code:	77058-3607	**Congressional District:**	36
Comments:			
Project Type:	FLIGHT	**Solicitation / Funding Source:**	2017-2018 HERO 80JSC017N0001-BPBA Topics in Biological, Physiological, and Behavioral Adaptations to Spaceflight. Appendix C
Start Date:	01/30/2019	**End Date:**	12/01/2027
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:	Stenger, Michael	**Contact Phone:**	281-483-1311
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Flight Program:			
Flight Assignment:	NOTE: End date is now 12/01/2027 per implementation phase extension, per L. Taylor/JSC (Ed., 7/29/2020)		
Key Personnel Changes/Previous PI:	August 2022: Dr. Reschke has retired from NASA. The new Principal Investigator is Gilles Clement, Ph.D. For information on the continued investigation, see "Neuro-Vestibular Examination During and After Spaceflight (Vestibular Health) (PI: Clement)". November 2021 report: None		
COI Name (Institution):	Clement, Gilles Ph.D. (NASA Johnson Space Center) Dervay, Joseph M.D. (NASA Johnson Space Center) Makishima, Tomoko M.D., Ph.D. (University of Texas Medical Branch at Galveston) Wood, Scott Ph.D. (NASA Johnson Space Center)		
Grant/Contract No.:	Internal Project		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Adaptation to the absence of Earth's gravitational environment during spaceflight causes neurological disturbances that are either directly or indirectly mediated by the vestibular system. These disturbances include space motion sickness, spatial disorientation, and cognitive impairment, as well as changes in head-eye coordination, vestibulo-ocular reflex, and interactions with support surfaces. After return to Earth, astronauts experience other vestibular-driven behavioral changes, including re-entry motion sickness, motion illusions, gaze-induced nystagmus, and balance and locomotion deficits. Otolith-mediated reflex gain changes are striking shortly after g-transitions. However, animal studies have shown that structural modifications of the vestibular sensory apparatus may occur throughout an extended spaceflight exposure. To date, no long-duration flight studies have directly investigated potential changes in the vestibular organs of astronauts. As a part of the Complement of Integrated Protocols for Human Research (CIPHER), this study will address this gap by performing a systematic neuro-vestibular examination of crewmembers in orbit at regular intervals, as well as immediately after landing. Crewmembers from short-duration, six-month, and one-year missions will be recruited to investigate temporal changes, and to identify trends in adaptation to vestibular health and performance. In orbit, subjects will perform active movements and be exposed to various passive maneuvers executed by the operator. Observations and recordings of eye, head, and body movements, as well as subjective perception of motion and verbal reports, will be used for evaluating the presence of abnormal eye movements, dysmetria, motion sickness symptoms, and illusions of motion during head or body movements. Tests will be performed both early in the mission and once every one or two months thereafter. The post-flight examination will be performed on R+0 and several times thereafter.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The tests proposed in this study are well established and validated protocols that are able to detect acute or chronic vestibular syndromes. Repeated measurements during adaptation to g-transitions will provide insight into the vestibular compensation process. If the observed physiological changes in the crewmembers are more deleterious after the year-long International Space Station (ISS) expeditions than those documented after standard-duration ISS expeditions, then relevant countermeasures will be required to enable longer duration missions. Depending on the etiology of the vestibular disorders revealed by our tests, monitoring for long-term health outcomes and vestibular rehabilitation countermeasures can be tailored to the deficits observed.
Task Progress:	Ed. Note, August 2022: Dr. Reschke has retired from NASA. The new Principal Investigator is Gilles Clement, Ph.D. For information on the continued investigation, see "Neuro-Vestibular Examination During and After Spaceflight (Vestibular Health) (PI: Clement)". November 2021 Report: This past reporting period, the commercial binocular video eye tracking system (DX Falcon, Neurolign Technologies Inc, Toronto, CN) was the first new flight CIPHER hardware certified for ISS. A Science Verification Test of the flight hardware and procedures was performed in the Columbus mockup on June 30, 2021, as part of the certification process, and the inflight data management processing flow was confirmed. The inflight protocol has been further refined on this platform to sequence the operator and subject through the experiment protocol using recorded instructions and audio prompts. The preflight vestibular evaluation was also implemented on the rotatory test system (Dx Neurotologic Test Center, Neurolign Technologies Inc, Toronto, CN) in the Neuroscience Laboratory. Both vestibular evaluation (rotatory) and exam (goggles) protocols include skew deviation measures that will be shared with the Ocular Alignment investigation (Principal Investigator Mark Shelhamer). A Test Readiness Review was completed for the ground test system prior to the normative data collection. An Informed Crew Briefing (ICB) was presented to the crews of SpaceX Crew-3 in December 2020 and SpaceX Crew-4 in April 2021. Informed Crew Briefing for Crew-5 was conducted during November and December 2021 for potentially the first CIPHER participant. The Falcon Goggles Operator Training program was developed to train inflight operators how to set up test sessions, complete a hardware checkout, and guide a subject through the experiment protocol using the Falcon Goggles hardware and software. Two crewmembers on SpaceX Crew-3 and one crewmember on SpaceX Crew-4 were trained as inflight operators. Initial functional checkout of this system is planned during the SpaceX Crew-3 mission by the first inflight operator. A ground-based study was performed from August 2021 to October 2021 to collect normative responses. Thirty-one subjects were tested in the laboratory using the same equipment and procedures as the crew inflight and ground protocols. Data analysis of this normative study is ongoing. The results of this control study will be presented at the Human Research Program (HRP) Investigators' Workshop in February 2022.
Bibliography Type:	Description: (Last Updated: 06/28/2023)
Abstracts for Journals and Proceedings	Clément GR, Macaulay TR, De Dios Y, Wood SJ, Dervay JP, Makishima T, Reschke MF. "Neuro-vestibular examination during and after a year on the International Space Station." 2021 NASA Human Research Program Investigators' Workshop, Virtual meeting, February 1-4, 2021. Abstracts. 2021 NASA Human Research Program Investigators' Workshop, Virtual meeting, February 1-4, 2021. , Feb-2021
Articles in Peer-reviewed Journals	Clément G, Beaton KH, Reschke MF, Wood SJ. "Effects of motion paradigm on human perception of tilt and translation." Sci Rep. 2022 Jan 26;12(1):1430. https://doi.org/10.1038/s41598-022-05483-6 ; PMID: 35082357; PMCID: PMC8792002 , Jan-2022