Fiscal Year:	FY 2024	**Task Last Updated:**	FY 01/25/2024
PI Name:	Seidler, Rachael D. Ph.D.		
Project Title:	Recovery Timeline of Spaceflight-Induced Central Nervous System Changes		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
Human Research Program Risks:	(1) **BMed**:Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders (2) **EVA**:Risk of Injury and Compromised Performance Due to EVA Operations (3) **SANS**:Risk of Spaceflight Associated Neuro-ocular Syndrome (SANS) (4) **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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Zip Code:	32611-8205	**Congressional District:**	3
Comments:	NOTE: PI moved to University of Florida in July 2017; previous affiliation was University of Michigan.		
Project Type:	GROUND	**Solicitation / Funding Source:**	2019-2020 HERO 80JSC019N0001-HHCBPSR, OMNIBUS2: Human Health Countermeasures, Behavioral Performance, and Space Radiation-Appendix C; Omnibus2-Appendix D
Start Date:	03/30/2021	**End Date:**	08/31/2033
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:	1	**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:	Whitmire, Alexandra	**Contact Phone:**	
Contact Email:	alexandra.m.whitmire@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: End date changed to 08/31/2033 per V. Lehman/JSC (Ed., 4/18/23). NOTE: End date changed to 03/31/2029 per L. Juliette/JSC (Ed., 5/3/22).		
Key Personnel Changes/Previous PI:	March 2022 Report: Babette Brumback, Ph.D., CoInvestigator, has retired from the University of Florida and is no longer with the project.		
COI Name (Institution):	Wood, Scott Ph.D. (NASA Johnson Space Center)		
Grant/Contract No.:	80NSSC21K0813		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Our group has reported an upward shift of the brain within the skull following spaceflight, which results in apparent reduced gray matter volume in inferior and frontal brain regions, and apparent increased volume in superior and posterior regions, as measured by magnetic resonance imaging (MRI). Another recent paper that we have published reports free water (fluid in the ventricles and extracellular space) changes in the brain with spaceflight, and degradation of sensory and motor white matter pathways (Pasternak O et al., "Spaceflight-Associated Brain White Matter Microstructural Changes and Intracranial Fluid Redistribution." JAMA Neurol. 2019 Apr 1;76(4):412-419. https:// . PMID: 30673793; PMCID: PMC6459132). Some of these measures show recovery to preflight levels by six months postflight, whereas others do not. For example, in two crewmembers who spent ~12 months in space, free water recovers only 75% by six months postflight. We have also observed increases in ventricular volume with spaceflight, ranging from 5 – 35% across astronauts. These changes exhibit little recovery by six months postflight, raising the possibility that these effects persist for prolonged durations. The brain's glial lymphatic (or 'glymphatic') pathway was identified in humans in just the past few years. It has been suggested that "ocular glymphatic" and cerebral lymphatic dysfunction may contribute to optic disc edema in astronauts, which is one sign of Spaceflight Associated Neuro-ocular Syndrome (SANS). SANS affects up to 50% of long-duration astronauts and poses significant health concerns. Many of these glymphatic vessels are found at the top of the brain and in the human extravascular visual system. Thus, the fluid and brain positional shifts that occur in microgravity may slow the rate of clearance of substances through this system. We are currently testing the impact of elevated CO2 on glymphatic clearance supported by an Office of Naval Research (ONR) grant (awarded to Kernagis and Seidler). The long-term health and functional consequences of these spaceflight-induced brain changes remain unknown, but our preliminary data suggest little recovery of fluid shifts that occur with one year in space when measured six months after return. Thus, we propose the following aims in response to Topic 3 of 80JSC019N0001-HHCBPSR: Aim 1) Determine the recovery timeline of spaceflight-induced ocular changes (e.g., signs of SANS such as optic disc edema) and changes in brain structure, function, and fluid shifts, measuring out to five years postflight. Aim 1a will comprise prospective assessments, while Aim 1b will leverage follow up testing on crewmembers who participated in our Neuromapping flight study and those crewmembers who have existing retrospective pre and postflight MRI scans. Aim 2) Examine longitudinal data for markers of long term health consequences and determine their association with persistent, spaceflight-induced ocular / brain changes. This project will elucidate the persistence of spaceflight-induced ocular and brain changes, as well as quantify their association with long-term health. Determining this is critically important as we extend the duration and distance of human space travel in the near future. Ed. Note (2/29/24): This project has been combined with the work of three other Principal Investigators (PIs) who responded to the same solicitation with independent proposals. The protocols and aims from all four PIs have been integrated into a revised proposal that was delivered to NASA Human Health Countermeasures (HHC) and Human Factors and Behavioral Performance (HFBP) Element Scientists in January 2022. For information on the four related investigations, see: • The Long-Term Consequences of Spaceflight on Brain and Eye Health (PI: Bershad). • Long-Term Brain Structural and Functional Consequences of Spaceflight (PI: Basner). • Investigating Long-term Structural and Functional Changes in the Eye and Brain After Spaceflight (PI: Macias). • Recovery Timeline of Spaceflight-Induced Central Nervous System Changes (PI: Seidler).
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This project has the potential to benefit life on Earth by leading to a greater understanding of central nervous system plasticity.
Task Progress:	The revised integrated "Long-Term Health" (LTH) proposal (Co-PIs: Drs. Macias, Basner, Seidler, and Bershad) was approved by the NASA Human Health Countermeasures (HHC) and Human Factors and Behavioral Performance (HFBP) Elements in January 2023. This LTH Virtual NASA Specialized Center of Research (VNSCOR) has both ground and flight components, and therefore two Research Operations and Integration (ROI) coordination teams. Dr. Macias' Principal Investigator (PI) team is supporting bi-weekly meetings with ROI. In addition, Dr. Macias' PI team is holding bi-weekly meetings with the LTH Co-PI teams to coordinate the overall implementation effort of the ground and flight components of the project. Ed. Note: FY23 report noted that work was conducted to integrate activities across investigators for this VNSCOR. See also: The Long-Term Consequences of Spaceflight on Brain and Eye Health (PI: Bershad). Long-Term Brain Structural and Functional Consequences of Spaceflight (PI: Basner). Investigating Long-term Structural and Functional Changes in the Eye and Brain After Spaceflight (PI: Macias).
Bibliography Type:	Description: (Last Updated: 01/24/2024)