Fiscal Year:	FY 2022	**Task Last Updated:**	FY 02/13/2023
PI Name:	Seidler, Rachael D. Ph.D.		
Project Title:	Spaceflight Effects on Neurocognitive Performance: Extent, Longevity, and Neural Bases		
Division Name:	Human Research		
Program/Discipline:			
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) **HSIA**:Risk of Adverse Outcomes Due to Inadequate Human Systems Integration Architecture (2) **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		
PI Email:	rachaelseidler@ufl.edu	**Fax:**	FY
PI Organization Type:	UNIVERSITY	**Phone:**	352-294-1722
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PI Web Page:			
City:	Gainesville	**State:**	FL
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:	Flight,Ground	**Solicitation / Funding Source:**	2010 Crew Health NNJ10ZSA003N
Start Date:	07/14/2017	**End Date:**	09/30/2022
No. of Post Docs:	5	**No. of PhD Degrees:**	
No. of PhD Candidates:	3	**No. of Master' Degrees:**	1
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA JSC
Contact Monitor:	Brocato, Becky	**Contact Phone:**	
Contact Email:	becky.brocato@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: End date changed to 9/30/2022 per NSSC information (Ed., 2/5/22) NOTE: End date changed to 9/30/2021 per D. Risin/HRP and NSSC information (Ed., 8/27/20) NOTE: Changed end date to 9/30/2020 per NSSC information (Ed., 10/9/19)		
Key Personnel Changes/Previous PI:	May 2021 report: Scott Wood, Ph.D., is now CoInvestigator on the project for his subject matter expertise.		
COI Name (Institution):	Bloomberg, Jacob Ph.D. (NASA Johnson Space Center) Mulavara, Ajitkumar Ph.D. (Universities Space Research Association) Wood, Scott Ph.D. (NASA Johnson Space Center)		
Grant/Contract No.:	80NSSC17K0461		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	NOTE: Continuation of "Spaceflight Effects on Neurocognitive Performance: Extent, Longevity, and Neural Bases," grant NNX11AR02G, due to Principal Investigator Seidler's move to University of Florida from University of Michigan. NASA Research Announcement (NRA) NNJ10ZSA003N requested proposals to assess changes in elemental neurocognitive functions such as perception, motor control, memory, attention, language, executive function, and emotional processing following long duration spaceflight using both behavioral assessments and monitoring technologies such as fMRI. In response to this call, we propose to perform structural and functional MR brain imaging to identify the relationship between changes in crewmember neurocognitive function and neural structural alterations following a six month International Space Station mission. Our central hypothesis is that measures of brain structure, function, and network integrity will change from pre to post flight in crewmembers (Aim 1). Moreover, we predict that these changes will correlate with indices of cognitive, sensory, and motor function in a neuroanatomically selective fashion (Aim 2). Our interdisciplinary approach utilizes cutting edge neuroimaging techniques and a broad ranging battery of sensory, motor, and cognitive assessments that will be conducted pre flight, during flight, and post flight to investigate neuroplastic and maladaptive brain changes in crewmembers following long duration spaceflight. Success in this endeavor would 1) result in identification of the underlying neural mechanisms and operational risks of spaceflight-induced changes in behavior, and 2) identify whether a return to normative behavioral function following re-adaptation to Earth's gravitational environment is associated with a restitution of brain structure and function or instead is supported by substitution with compensatory brain processes.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The results of this project will have relevance not only to understanding the effects of spaceflight on the human brain and behavior, but also for delineating the capacity of the brain to remodel in response to adaptive stimuli. As such, the results should prove informative for understanding the neural mechanisms associated with adaptive behavioral change and the rehabilitation of these changes during recovery periods.
Task Progress:	NASA Research Announcement (NRA) NNJ10ZSA003N requested proposals to assess changes in elemental neurocognitive functions such as perception, motor control, memory, attention, language, executive function, and emotional processing following long duration spaceflight, using both behavioral assessments and monitoring technologies such as functional magnetic resonance imaging (fMRI). In response to this call, we proposed to perform structural and functional MR brain imaging to identify the relationship between changes in crewmember neurocognitive function and neural structural alterations following a six month International Space Station mission. Our central hypothesis was that measures of brain structure, function, and network integrity would change from pre to post flight in crewmembers (Aim 1). Moreover, we predicted that these changes would correlate with indices of cognitive, sensory, and motor function in a neuroanatomically selective fashion (Aim 2). Our interdisciplinary approach utilizes cutting edge neuroimaging techniques and a broad range of sensory, motor, and cognitive assessments that were conducted pre flight, during flight, and post flight to investigate neuroplastic and maladaptive brain changes in crewmembers following long duration spaceflight. Success in this endeavor would 1) result in identification of the underlying neural mechanisms and operational risks of spaceflight-induced changes in behavior, and 2) identify whether a return to normative behavioral function following re-adaptation to Earth's gravitational environment is associated with a restitution of brain structure and function or, instead, is supported by substitution with compensatory brain processes.. Over the past year, we have continued to make progress with our data analyses and dissemination of results. For example, we published our findings showing that mobility and balance decline from pre to postflight, suggesting possible disruption and/or down-weighting of vestibular inputs; these behaviors recovered to baseline levels within 30 days postflight. We also identified bimanual coordination declines pre to postflight; recovery to baseline levels was also evident within 30 days postflight. There were no performance changes in dual task cost during or following long duration spaceflight, although it may be that our secondary task was not sufficiently difficult to elicit effects. This work has been recently published (Tays et al. 2021, Frontiers in Neural Circuits). [Ed. Note: See Cumulative Bibliography.] We also published a case study describing brain changes in a Crewmember who experienced an Aborted Launch ("CAL"). CAL's launch and landing experience was dissociated from prolonged microgravity exposure. Using MRI, we found that hypergravity exposure during the aborted launch did not induce lasting ventricular enlargement or intracranial fluid shifts resembling those previously reported with spaceflight. This case study therefore rules out hypergravity during launch and landing as a contributing factor to previously reported long-lasting intracranial fluid changes following spaceflight. This work was published in McGregor et al. 2021, Frontiers in Neurology. We also reported our findings illustrating brain and behavioral evidence for sensory reweighting from pre to postflight. We used functional MRI to measure brain activity in response to vestibular stimulation pre and post-spaceflight. We also measured vestibularly-mediated behaviors, including balance, mobility, and rod-and-frame test performance. As expected, vestibular stimulation at the preflight sessions elicited activation of the parietal opercular area ("vestibular cortex") and deactivation of somatosensory and visual cortices. Pre to postflight, we found widespread reductions in this somatosensory and visual cortical deactivation, supporting sensory compensation and reweighting with spaceflight. These pre to postflight changes in brain activity correlated with changes in eyes closed standing balance, and greater pre to postflight reductions in deactivation of the visual cortices associated with less postflight balance decline. The observed brain changes recovered to baseline values by three months postflight. Together, these findings provide evidence for sensory reweighting and adaptive cortical neuroplasticity with spaceflight. These results have implications for better understanding compensation and adaptation to vestibular functional disruption. These findings were published in Hupfeld et al. 2022, Cerebral Cortex.
Bibliography Type:	Description: (Last Updated: 03/18/2025)
Articles in Peer-reviewed Journals	Tays GD, Hupfeld KE, McGregor HR, Salazar AP, De Dios YE, Beltran NE, Reuter-Lorenz PA, Kofman IS, Wood SJ, Bloomberg JJ, Mulavara AP, Seidler RD. "The effects of long duration spaceflight on sensorimotor control and cognition." Front. Neural Circuits. 2021 October 26;15:723504. https://doi.org/10.3389/fncir.2021.723504 ; PMID: 34764856; PMCID: PMC8577506 , Oct-2021

Articles in Peer-reviewed Journals	McGregor HR, Hupfeld KE, Pasternak O, Wood SJ, Mulavara AP, Bloomberg JJ, Hague TN, Seidler RD. "Case report: No evidence of intracranial fluid shifts in an astronaut following an aborted launch." Front. Neurol. 2021 Dec 9;12:774805. https://doi.org/10.3389/fneur.2021.774805 ; PMID: 34956056; PMCID: PMC8695608 , Dec-2021
Articles in Peer-reviewed Journals	Hupfeld KE, McGregor HR, Koppelmans V, Beltran NE, Kofman IS, De Dios YE, Riascos RF, Reuter-Lorenz PA, Wood SJ, Bloomberg JJ, Mulavara AP, Seidler RD. "Brain and behavioral evidence for reweighting of vestibular inputs with long-duration spaceflight." Cereb Cortex. 2022 Feb 8;32(4):755-69. https://doi.org/10.1093/cercor/bhab239 ; PMID: 34416764; PMCID: PMC8841601 , Feb-2022
Articles in Peer-reviewed Journals	Hupfeld KE, Richmond SB, McGregor HR, Schwartz DL, Luther MN, Beltran NE, Kofman IS, De Dios YE, Riascos RF, Wood SJ, Bloomberg JJ, Mulavara AP, Silbert LC, Iliff JJ, Seidler RD, Piantino J. "Longitudinal [magnetic resonance imaging] MRI-visible perivascular space (PVS) changes with long-duration spaceflight." Sci Rep. 2022 May 5;12:7238. https://doi.org/10.1038/s41598-022-11593-y ; PMID: 35513698; PMCID: PMC9072425 , May-2022
Articles in Peer-reviewed Journals	Mahadevan AD, Hupfeld KE, Lee JK, De Dios YE, Kofman IS, Beltran NE, Mulder E, Bloomberg JJ, Mulavara AP, Seidler RD. "Head-down-tilt bed rest with elevated CO2: Effects of a pilot spaceflight analog on neural function and performance during a cognitive-motor dual task." Front Physiol. 2021 Aug 25;12:654906. https://doi.org/10.3389/fphys.2021.654906 ; PMID: 34512371; PMCID: PMC8424013 , Aug-2021