Fiscal Year:	FY 2018	**Task Last Updated:**	FY 05/11/2018
PI Name:	Seidler, Rachael D. Ph.D.		
Project Title:	Bed Rest Combined with 0.5% CO2 as a Spaceflight Analog to Study Neurocognitive Changes: Extent, Longevity, and Neural Bases		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Behavior and performance		
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) **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:**	2014-15 HERO NNJ14ZSA001N-MIXEDTOPICS. Appendix E: Behavioral Health & Human Health Countermeasures Topics
Start Date:	06/29/2017	**End Date:**	06/28/2019
No. of Post Docs:	2	**No. of PhD Degrees:**	
No. of PhD Candidates:	2	**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA JSC
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Bloomberg, Jacob Ph.D. (NASA Johnson Space Center) Mulavara, Ajitkumar Ph.D. (Universities Space Research Association) Kuehn, Simone Ph.D. (Max Planck Institute for Human Development) Stahn, Alexander Ph.D. (University of Pennsylvania)		
Grant/Contract No.:	80NSSC17K0021		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	NRA NNJ14ZSA001N-MIXEDTOPICS requests proposals in the area of "Risk Characterization and Monitoring of Behavioral Health and Performance Relevant Outcomes" to determine the effects of 30 days head down tilt bed rest in a 0.5% CO2 environment on neurobehavioral signs and symptoms, neurostructural and neurofunctional alterations, and changes in cognitive function and operational task performance. Our Neuromapping studies measure precisely these metrics in a flight study and a 70 days head down tilt bed rest study under normative conditions. Here, our overarching goal is to quantify neurocognitive changes and associated neural structural and functional alterations occurring as a result of a 30 days head down tilt bed rest plus 0.5% CO2 environment, serving as a spaceflight analog exposure. We will identify the relationship between these neural changes and behavioral function. Our approach utilizes cutting edge neuroimaging techniques and a broad ranging battery of sensory, motor, and cognitive assessments to investigate neuroplastic and maladaptive brain changes occurring in a spaceflight analog environment. Success in this endeavor would 1) result in identification of the underlying neural mechanisms and operational risks of changes in behavior with a spaceflight analog, and 2) identify whether a return to normative behavioral function following bed rest is associated with a restitution of brain structure and function or instead is supported by substitution with compensatory brain processes. Moreover, addition of a CO2 group will enable us to parse out the multiple mechanisms contributing to any spaceflight induced neural structural and behavioral changes that we observe in our ongoing flight projects ((NASA flight project, Seidler Principal Investigator (PI); ILSRA flight study, Stahn PI)), and comparison with our recently completed bed rest projects (Seidler and Stahn, PIs) will allow us to delineate brain and behavioral changes occurring with long term exposure to slightly elevated CO2 levels.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This project uses long duration head down tilt bed rest as a spaceflight environment analog. The intervention mimics several aspects of human spaceflight, including a shift of fluids towards the head and unloading of the body. Thus the results are relevant for clinical populations on Earth, including individuals who are bed ridden for extended periods of time. Moreover, the shifts that occur in how the brain weights sensory information show some similarities with age changes in sensory processing. Thus understanding how the brain and behavior change in response to this environment can also shed insight into the aging process on Earth.
Task Progress:	Data collection for this project was successfully completed at the :enivhab facility in Cologne, Germany, in December 2017 and all data have been transferred. We are currently analyzing these data. To date, we have some preliminary findings for our behavioral measures and for brain changes when processing vestibular stimuli. Interestingly, a couple of the behavioral measures show improvements in performance for subjects in the bed rest plus CO2 environment, particularly in comparison to subjects who were in our previous bed rest study with ambient air measured over similar timepoints. For example, there was a decrease in cognitive processing speed for participants in our previous bed rest study but an improvement here when bed rest was coupled with 0.5% CO2. This finding parallels reports from the SPACECOT experiment, which was a shorter duration pilot study of bed rest plus elevated CO2. These findings may be linked to the increased respiration rate that is seen in elevated CO2 conditions. One of the tests that we use to evaluate brain function in our ongoing studies is a functional MRI session coupled with vestibular stimulation. The latter is achieved using a clinical device which we have modified and validated for use in the MRI environment. Typical stimulation with this device results in activation of the vestibular cortex and deactivation of brainstem, cerebellum, somatosensory, and visual cortices. Our preliminary findings with this dataset reveal that frontal, sensorimotor, temporal, and visual cortices show increasing responses to vestibular stimulation during bed rest plus elevated CO2, which dissipate after subjects leave bed rest and return to ambient air conditions. Regions in the brainstem exhibited the opposite pattern, with decreasing responses during bed rest coupled with CO2 followed by recovery. We also statistically compared the slope of brain changes over time in this group with subjects who previously participated in our bed rest study with ambient air. We found that participants who had elevated CO2 in combination with bed rest exhibited greater changes in frontal, somatosensory, and visual cortices than those that experienced bed rest alone. These findings suggest that bed rest plus elevated CO2 may result in reduced neural efficiency and / or greater sensory reweighting than that seen with bed rest alone. We will continue to analyze these data and evaluate brain-behavior change associations.
Bibliography Type:	Description: (Last Updated: 01/24/2024)