

<b>Fiscal Year:</b>	FY 2022	<b>Task Last Updated:</b>	FY 03/08/2022
<b>PI Name:</b>	Zhang, Quan Ph.D.		
<b>Project Title:</b>	Characterizing the Baselines of Sleep Quality, Cognitive / Operational Performance, Immune Function, and Intracranial Fluids for Deep Space Expeditions		
<b>Division Name:</b>	Human Research		
<b>Program/Discipline:</b>			
<b>Program/Discipline--Element/Subdiscipline:</b>			
<b>Joint Agency Name:</b>		<b>TechPort:</b>	No
<b>Human Research Program Elements:</b>	(1) <b>HFBP</b> : Human Factors & Behavioral Performance (IRP Rev H)		
<b>Human Research Program Risks:</b>	(1) <b>BMed</b> : Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders		
<b>Space Biology Element:</b>	None		
<b>Space Biology Cross-Element Discipline:</b>	None		
<b>Space Biology Special Category:</b>	None		
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<b>City:</b>	Charlestown	<b>State:</b>	MA
<b>Zip Code:</b>	02129-2020	<b>Congressional District:</b>	7
<b>Comments:</b>			
<b>Project Type:</b>	FLIGHT	<b>Solicitation / Funding Source:</b>	2017-2018 HERO 80JSC017N0001-BPBA Topics in Biological, Physiological, and Behavioral Adaptations to Spaceflight. Appendix C
<b>Start Date:</b>	04/22/2019	<b>End Date:</b>	05/31/2026
<b>No. of Post Docs:</b>	0	<b>No. of PhD Degrees:</b>	0
<b>No. of PhD Candidates:</b>	1	<b>No. of Master' Degrees:</b>	0
<b>No. of Master's Candidates:</b>	3	<b>No. of Bachelor's Degrees:</b>	7
<b>No. of Bachelor's Candidates:</b>	10	<b>Monitoring Center:</b>	NASA JSC
<b>Contact Monitor:</b>	Whitmire, Alexandra	<b>Contact Phone:</b>	
<b>Contact Email:</b>	<a href="mailto:alexandra.m.whitmire@nasa.gov">alexandra.m.whitmire@nasa.gov</a>		
<b>Flight Program:</b>			
<b>Flight Assignment:</b>	NOTE: End date changed to 05/31/2026 per NSSC information (Ed., 2/3/2020) NOTE: End date changed to 9/30/2020 per NSSC information (Ed., 2/3/2020)		
<b>Key Personnel Changes/Previous PI:</b>			
<b>COI Name (Institution):</b>	Kimberly, William M.D., Ph.D. ( Massachusetts General Hospital ) Vujovic, Nina Ph.D. ( Brigham And Women's Hospital, Inc. ) Spielmann, Guillaume Ph.D. ( Louisiana State University and A&M College ) Strangman, Gary Ph.D. ( Massachusetts General Hospital ) Ivkovic, Vladimir Ph.D., Sc.D. ( Massachusetts General Hospital )		
<b>Grant/Contract No.:</b>	80NSSC19K0925		
<b>Performance Goal No.:</b>			

<b>Performance Goal Text:</b>	
<b>Task Description:</b>	<p>Sleep is a central physiological regulator of cognitive / behavioral, neurophysiological, and immune functions. The study of sleep quality and duration on orbit may thus yield important insights into etiology and mechanisms of adverse cognitive/behavioral, Spaceflight Associated Neuro-ocular Syndrome (SANS), and immunological responses during long duration deep space exploration missions. We will investigate these relationships via an integrated approach combining assessments of (1) sleep duration and quality, (2) cognitive performance, and (3) immunological response. We will collect data on crewmembers participating in integrated one-year mission project (CIPHER), including flyers on short-duration (&lt;3 months), nominal-duration (~6 months) and long-duration (~12 months) missions aboard the International Space Station (ISS). We also plan to study demographically matched control subjects in Earth-based analogs (e.g., the Human Exploration Research Analog, or HERA) during missions of similar duration. Our specific aims are: (SA1) Characterize behavioral performance changes during the integrated 1 Year Mission Project (1YMP) on the ISS; (SA2) Characterize changes in brain and systemic physiology as a function of mission duration on the ISS; (SA3) Characterize the relationship between sleep duration and quality on cerebral physiology on the ISS. and (SA4) Characterize the relationship between sleep duration and quality on immune response on the ISS. The outcomes of the study will contribute to quantification of crew health and performance risks associated with human spaceflight, and aid in development of technologies for monitoring and mitigating crew health and performance.</p>
<b>Rationale for HRP Directed Research:</b>	
<b>Research Impact/Earth Benefits:</b>	<p>Successful completion of this project will be a milestone in spaceflight behavioral, neurophysiological, and immune investigation. It will be the largest study of operational performance in space, and would be the first to conduct in-flight resting-state and task-related functional brain imaging. In addition, it will be the first study to probe the relationships and interactions between behavioral, neurophysiological, and immune functioning. The use of three different length missions will further enable us to extrapolate any effects towards longer missions. The findings will be important on Earth as well, by helping to better understand the complex inter-relationships between sleep, brain physiology, immune function, and cognitive performance.</p>
<b>Task Progress:</b>	<p><b>PROJECT OVERVIEW</b></p> <p>Sleep is a central physiological regulator of cognitive / behavioral, neurophysiological, and immune functions. The study of sleep quality and duration on orbit may thus yield important insights into etiology and mechanisms of adverse cognitive/behavioral, Spaceflight Associated Neuro-ocular Syndrome (SANS), and immunological responses during long duration deep space exploration missions. We will investigate these relationships via an integrated approach combining assessments of (1) sleep duration and quality, (2) cognitive performance, and (3) immunological response. We will collect data on crewmembers participating in the integrated one-year mission project (CIPHER), including flyers on short-duration (&lt;3 months), nominal-duration (~6 months) and long-duration (~12 months) missions aboard the International Space Station (ISS). We also plan to study demographically matched control subjects in Earth-based analogs (e.g., the Human Exploration Research Analog/HERA) during missions of similar duration. Our specific aims are: (SA1) Characterize behavioral performance changes during the integrated one-year mission project (CYPHER) on the ISS; (SA2) Characterize changes in brain and systemic physiology as a function of mission duration on the ISS; (SA3) Characterize the relationship between sleep duration and quality on cerebral physiology on the ISS. and (SA4) Characterize the relationship between sleep duration and quality on immune response on the ISS. The outcomes of the study will contribute to quantification of crew health and performance risks associated with human spaceflight, and aid in development of technologies for monitoring and mitigating crew health and performance. [Ed. Note: CIPHER is the short title for a set of 14 studies sponsored by NASA and international partner agencies ( &lt;a target=" blank" href="https://www.nasa.gov/feature/experiments-to-unlock-how-human-bodies-react-to-long-space-journeys"&gt;https://&lt;/a&gt;). CIPHER stands for "Complement of Integrated Protocols for Human Exploration Research".]</p> <p>In addition to the primary project, a Psycho-Neuro-Immunological supplement to this project seeks to investigate the influence of headward fluid shifts on facial expressiveness, ability to convey non-verbal affective cues, and compromised cognitive and immune functioning.</p> <p><b>TASK PROGRESS</b></p> <p>As we approach the end of year 3 of this project, the following milestones have been achieved: • We completed CIPHER integration and timeline revisions. This involved—for all CIPHER investigators—significant reductions in the number of testing days as well as reductions in measurement times to meet the collective flight and crew-time requirements. • Full Institutional Review Board (IRB) approval (from NASA, Massachusetts General Hospital, and partnering space agencies) was obtained. • Subject recruitment was initiated as part of the integrated CIPHER complement informed consent briefing process. • In coordination with NASA Research Operations and Integration (ROI), we completed the design and development of three complete NINscan-ISS (v4) systems. These systems are fully functional, including associated sensor harnesses. • Due to timeline and budgetary issues, we are now initiating a rescop in our project to remove the physiological sleep and functional brain imaging measures from the study. This will have two consequences: (i) the data for sleep quality will become subjective instead of objective, and (ii) the relationship between sleep parameters and cerebral physiology (Aim 3) will need to shift to investigating the relationship between sleep and operationally-relevant behavioral performance. • We completed preparations for the PsychoNeuroImmunological (PNI) supplement data collection process and developed a novel data processing pipeline for analyzing 3D scans of individuals at multiple head-up and head-down tilt angles. • The project provided educational activities for 10 Bachelor's degree and 4 graduate students on both the CIPHER and PNI supplement projects. This included learning how to develop research procedures and protocols, and how to conduct pilot testing and data quality control, as well as writing up and presenting the research at the 2022 NASA Human Research Program Investigators' Workshop.</p>
<b>Bibliography Type:</b>	Description: (Last Updated: 04/12/2022)
<b>Abstracts for Journals and Proceedings</b>	<p>Zhang Q, Ivkovic V, Spielmann G, Kimberly WT, Vujovic N, Strangman GE. "NINSCAN: Characterizing the baselines of sleep quality, cognitive/operational performance, immune function, and intracranial fluids for deep space expeditions." 2022 NASA Human Research Program Investigators' Workshop, Virtual, February 7-10, 2022.</p> <p>Abstracts. 2022 NASA Human Research Program Investigators' Workshop, Virtual, February 7-10, 2022. , Feb-2022</p>

**Abstracts for Journals and  
Proceedings**

Ivkovic V, Peters D, Schenkel M, White BM, Cumani J, Zhang Q, Spielmann G, Strangman GE.  
"CIPHER-NINSCAN-PNI: Quantifying facial deformation in HUT/HDT for assessing psychoneuroimmunological contribution to risks of adverse cognitive/behavioral conditions in spaceflight." 2022 NASA Human Research Program Investigators' Workshop, Virtual, February 7-10, 2022.  
Abstracts. 2022 NASA Human Research Program Investigators' Workshop, Virtual, February 7-10, 2022. , Feb-2022