Fiscal Year:	FY 2024	**Task Last Updated:**	FY 03/24/2024
PI Name:	Dinges, David F. Ph.D.		
Project Title:	Standardized Behavioral Measures for Detecting Behavioral Health Risks during Exploration Missions		
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) **Team**:Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	19104-4209	**Congressional District:**	2
Comments:			
Project Type:	FLIGHT,GROUND	**Solicitation / Funding Source:**	2013-14 HERO NNJ13ZSA002N-BMED Behavioral Health & Performance
Start Date:	07/21/2015	**End Date:**	06/30/2023
No. of Post Docs:	2	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	0
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
Contact Monitor:	Whitmire, Alexandra	**Contact Phone:**	
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Flight Program:	ISS		
Flight Assignment:	NOTE: End date changed to 6/30/2023 per NSSC information (Ed., 4/24/23) NOTE: End date changed to 9/30/2022 per L. Barnes-Moten/JSC (Ed., 4/7/21) NOTE: End date changed to 2/28/2021 per PI and NSSC information (Ed., 5/20/2020) NOTE: End date changed to 2/28/2020 per NSSC information (Ed., 5/22/19) NOTE: End date changed to 7/20/2019 per NSSC information (Ed., 8/10/18) NOTE: Element change to Human Factors & Behavioral Performance; previously Behavioral Health & Performance (Ed., 1/18/17)		
Key Personnel Changes/Previous PI:			

COI Name (Institution):	Basner, Mathias M.D. (University of Pennsylvania) Mollicone, Daniel Ph.D. (Pulsar Informatics, Inc.) Stuster, Jack Ph.D. (Anacapa Sciences, Inc.) Strangman, Gary Ph.D. (Harvard Medical School) Stahn, Alexander Ph.D. (University of Pennsylvania) Gur, Ruben Ph.D. (University of Pennsylvania)
Grant/Contract No.:	NNX15AK76A
Performance Goal No.:	
Performance Goal Text:	
Task Description:	The success of long-duration spaceflight missions depends on astronauts' abilities to appropriately respond to and cope with a variety of behavioral and psychosocial stressors throughout the mission, including prolonged confinement, isolation, and threat to life (Slack KJ, Williams TJ, Schneiderman JS, et al. Risk of adverse cognitive or behavioral conditions and psychiatric disorders: Evidence report. 2016.). NASA simulates these stressors in spaceflight analog environments to examine individual behavioral responses with the ultimate goal of predicting, preventing, and mitigating the consequences of these stressors during spaceflight. The space exploration analog missions we and others have studied for NASA have varied in duration (i.e., from 1 month to 14 months) and in the severity of stressors (e.g., magnitude of confinement, social isolation). To evaluate astronaut behavioral health and performance, NASA developed "Standardized Behavioral Measures," (SBM) which is a battery of neurobehavioral assessments that probe astronaut neurocognitive and operational performance, as well as astronaut behavioral health and team cohesion. Upon the completion of the original "Standardized Behavioral Measures for Detecting Behavioral Health Risks during Exploration Missions" project, we initiated two supplemental studies: (1) Data harmonization of the SBM across long duration spaceflight analogs; (2) Continued collection of the Robotic On-Board Trainer for Research (ROBoT-r) from astronauts on the International Space Station (ISS).
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This project will deliver a suite of Standardized Behavioral Measures (SBM) that will be tested for feasibility, flexibility, and acceptability in research studies in both short and long duration space analog environments and on the International Space Station (ISS). With the SBM, it will be possible for NASA's HFBP (Human Factors & Behavioral Performance) program to much better assess and quantify the Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Outcomes for exploration class missions. With the proposed work we will relevantly contribute to Human Research Program's (HRP) goal to provide human health and performance countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive human space exploration. More specifically, the SBM will constitute an important technology to provide mission planners and system developers with strategies for monitoring and mitigating crew health and performance risks. Additionally, Standardized Behavioral Measures could be beneficial for monitoring behavioral health during Earth-based operations, especially those involving isolated, confined, and extreme environments (e.g., Antarctic research expeditions).
Task Progress:	The overarching goal of this project was to produce an integrated standardized suite of behavioral health measurement tools that are feasible to implement within the constraints of spaceflight research, ground-based analogs (both short- and long-duration), and prolonged missions in isolated, confined, extreme environments lasting up to 12 months or longer. The project identified a set of objective and subjective measures of behavioral health and performance, termed Standard Behavioral Measures (SBM), developed a research software platform (Standardized Behavioral Measures Tool/SBMT) integrating the identified SBM measures using Apple's iPad, created guidelines for the implementation and administration of the SBMT, and deployed the SBMT in three short- and long-duration research studies in spaceflight analog environments to evaluate its feasibility and acceptability. Data were collected from repeated SBMT administrations across three mission phases (pre-, in-, post-mission) from a total of N=25 astronauts and astronaut-like individuals completing missions in spaceflight analog environments: n=16 crewmembers completing 30-day missions in the Human Exploration Research Analog (HERA) at NASA's Johnson Space Center, n=7 crewmembers completing 14-month winter-over missions at the Neumayer station in Antarctica, and n=2 astronauts completing 6-month missions aboard the International Space Station (ISS). The SBMT was successfully implemented and administered throughout these analog missions, yielding 94.4% of expected SBM data (N=9,136 SBM data points). The implementation of the SBMT into analog missions of varying duration with a high data yield demonstrated that the SBMT is feasible, acceptable, and reliable for the tracking of cognitive and operational performance, behavioral health, sleep-wake behaviors, and team functioning across both short- and long-duration analog isolation missions (1 to 14 months). To expand upon the feasibility testing of the SBMT, a supplement to the original project sought to examine the trajectory of SBM measures across missions in different spaceflight analog environments. The supplement, the Data Harmonization Study, evaluated the neurobehavioral responses of astronauts and astronaut-like individuals across spaceflight analog missions. SBM data from previous spaceflight analog studies were integrated and harmonized to produce a large, harmonized SBM database. In addition to the original cohort of N=25 astronauts and astronaut-like individuals, SBM data were acquired, integrated, and harmonized from an additional n=9 crewmembers completing 14-month winter-over missions at the Neumayer station and n=19 astronauts completing 6-month missions aboard the ISS, which yielded a final total cohort of N=53 astronauts and astronaut-like individuals. The total amount of SBM data available for analysis included: 1) N=421 Robotic On-Board Trainer for Research (ROBoT-r) tests; 2) N=490 Cognition test batteries (N=2,785 Psychomotor Vigilance Tests); 3) N=183 Journal entries for affective analysis; 4) N=3,541 visual analog scales of somatic behavioral states (tiredness, mental fatigue, physical exhaustion, stress, workload, and sleep quality); 5) N=1,789 sleep diaries (e.g., sleep duration and timing); 6) Individual characteristics and personality inventories including N=34 Social Desirability Scale-17 and N=34 IPIP-NEO-120 surveys; 7) N=289 Beck Depression Inventory-II assessments; 8) N=777 Profile of Mood States-Short Form surveys; 9) N=2,328 Team Measures assessments; and 10) N=6,023 wrist actigraphy days for objective measures of sleep-wake behaviors. The trajectory of

	neurobehavioral responses and team functioning across missions were assessed in the total cohort and within each analog environment. This supplemental study further evaluated whether the trajectories of SBM measures differed between analogs and examined the nature of the inter-individual differences both within and between analogs.
Bibliography Type:	Description: (Last Updated: 04/26/2024)
Abstracts for Journals and Proceedings	Jones CW, Kaizi-Lutu M, Stahn AC, Strangman G, Ivkovic V, Bilker WB, Stuster J, Ecker AJ, Dinges DF. "Data harmonization of NASA Behavioral Health and Performance (BHP) Standardized Behavioral Measures to identify behavioral responses across spaceflight analog missions." 2024 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 13-16, 2024. Abstracts. 2024 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 13-16, 2024. , Feb-2024
Abstracts for Journals and Proceedings	Jones CW, Kaizi-Lutu M, Stahn AC, Strangman G, Ivkovic V, Bilker WB, Stuster J, Ecker AJ, Dinges DF. "Data harmonization of NASA Behavioral Health and Performance (BHP) Standardized Behavioral Measures to identify behavioral responses across spaceflight analog missions." 2023 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 6-9, 2023. Abstracts. 2023 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 6-9, 2023. , Feb-2023
Abstracts for Journals and Proceedings	Jones CW, Kaizi-Lutu M, Stahn AC, Roma PG, Strangman G, Ivkovic V, Bilker WB, Stuster J, Ecker AJ, Dinges DF. "Data harmonization of NASA behavioral health and performance (BHP) standardized behavioral measures to identify behavioral responses across spaceflight analog missions." 2022 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 7-10, 2022. Abstracts. 2022 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 7-10, 2022. , Feb-2022
Abstracts for Journals and Proceedings	Dinges DF, Roma PG, Stahn AC, Strangman G, Ivkovic V, Jones CW, Bilker W, Kaizi-Lutu M, Stuster J, Ecker AJ. "Data harmonization of NASA behavioral health and performance (BHP) standardized behavioral measures to identify behavioral responses across spaceflight analog missions." 2021 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 1-4, 2021. Abstracts. 2021 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 1-4, 2021. , Feb-2021
Articles in Peer-reviewed Journals	Boland EM, Rao H, Dinges DF, Smith RV, Goel N, Detre JA, Basner M, Sheline YI, Thase ME, Gehrman PR. "Meta-analysis of the antidepressant effects of acute sleep deprivation." J Clin Psychiatry. 2017 Sep/Oct;78(8):e1020-e1034. https://doi.org/10.4088/JCP.16r11332 ; PubMed PMID: 28937707 , Sep-2017