Fiscal Year:	FY 2010	**Task Last Updated:**	FY 05/11/2011
PI Name:	Dinges, David F. Ph.D.		
Project Title:	Cognitive Performance and Stress in a Simulated Space Environment		
Division Name:	Human Research		
Program/Discipline:	NSBRI		
Program/Discipline--Element/Subdiscipline:	NSBRI--Neurobehavioral and Psychosocial Factors Team		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **BHP**:Behavioral Health & Performance (archival in 2017)		
Human Research Program Risks:	(1) **Sleep**:Risk of Performance Decrements and Adverse Health Outcomes Resulting from Sleep Loss, Circadian Desynchronization, and Work Overload		
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:	GROUND	**Solicitation / Funding Source:**	Directed Research
Start Date:	08/01/2009	**End Date:**	07/31/2010
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	3	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Mollicone, Daniel (Pulsar Informatics Inc.)		
Grant/Contract No.:	NCC 9-58-NBPF00805		
Performance Goal No.:			
Performance Goal Text:			

This project involved neurobehavioral and physiological assessments in two NASA analog environments: N=8 participants in NASA Extreme Environment Mission Operations (NEEMO 14, which was 14 days) in May 2010, and N=6 participants in Desert Research and Technology Study (DRATS, which was 14 days) in August-September 2009. The purpose of this study was twofold: (1) Identify fatigue and stress in relation to performance during analog missions, and (2) further develop normative databases on astronauts in analog environments.
The goals of the study were accomplished by making the following assessments in each analog mission. (1) Cognitive performance was assessed with three brief validated software-based cognitive performance tests (PVT Self Test, Digit Symbol Substitution Test [DSST]) and the Descending Subtraction Test [DST]), which collectively formed the Penn Neurobehavioral Test Battery (PennNTB). (2) Behavioral ratings of fatigue and stress were assessed using visual analog

Task Description:	scale ratings of stress and fatigue (part of the PennNTB). (3) Physiological stress was assessed using salivary cortisol. (4) Feasibility of optical computer recognition (OCR) using facial videos acquired during the cognitive performance testing was assessed with computer webcams that recorded facial videos, which were subsequently evaluated by human scorers for OCR feasibility. (5) Sleep-wake patterns were assessed using wrist actigraphy and sleep logs (in NEEMO 14 only, as comparable data in DRATS was obtained by a different project and principal investigator). Data acquisition in both analogs and for all measurement domains ranged from 84% to 89% (grand average was 86%). Penn NTB cognitive performance tests were completed on 497 test bouts out of 580 planned (86%). Visual analog scale ratings of fatigue and stress were completed for 497 assessments out of 580 planned (86%). Salivary cortisol was assayed on 410 samples out of 476 planned (86%). Facial videos for OCR feasibility were acquired in 414 test bouts out of 476 planned (87%). Days of wrist actigraphy and sleep log data were acquired on 135 out of 150 days (90.0%) in NEEMO 14. The majority of data loss (which was 9%-14%, depending on measure) was associated with operational schedule conflicts (e.g., no time available to complete measure). Less than 2% of data loss was due to technical failure. The data acquired will add to the overall normative performance database on astronauts functioning in space analogs. Thus the data from the project contribute to the further development of norms and performance algorithms for the PVT Self Test (currently being evaluated on the International Space Station as the Reaction Self Test), and to the transition of the other two brief cognitive performance tests (Digit Symbol Substitution Test and Descending Subtraction Test) to space flight. The data also contribute to further development of optical computer recognition (OCR) for monitoring astronauts' expressions of stress, emotions and fatigue (e.g., these data acquired in the analogs provided valuable information of the technical need to ensure adequate facial lighting and screen angle).
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The 3-minute PVT Self Test used in the NEEMO 14 and DRATS analogs is being developed to help people quickly and objectively detect the extent to which fatigue is affecting their alertness and reaction times. As such, the technology has high potential for usefulness in a range of safety-sensitive environments on Earth. Potentially any occupation in which alertness and fatigue management are essential to prevent errors on critical tasks will benefit from adaptations of the PVT Self Test technology (e.g., airport security screeners, physicians on night shifts and prolonged call, etc.). The other two brief cognitive tests evaluated in this project - the Digit Symbol Substitution Test and Descending Subtraction Test - are well validated in the laboratory to be measures of cognitive throughout (DSST) and working memory (DST), and are being used to evaluate the carry-over effects of sleep medications on astronaut performance following abrupt (emergent) awakening (study at JSC Crew Quarters, P.I. S. Johnston). These tests have potential to be useful in a range of Earth-based scenarios in which cognitive capability must be rapidly assessed (e.g., sedation, mild to moderate traumatic brain injury, mild cognitive impairment with aging, etc.). The automated optical computer recognition (OCR) technology being developed for objective monitoring and management of stress, negative emotional states and fatigue in space flight has applications for many Earth-based safety-sensitive occupations, such as transportation workers (e.g., truck drivers, train conductors, airline pilots); operators in safety-sensitive industries (e.g., power plant control rooms); and military personnel.
Task Progress:	This project involved neurobehavioral and physiological assessments in two NASA analog environments: N=8 participants in NASA Extreme Environment Mission Operations (NEEMO 14, which was 14 days) in May 2010, and N=6 participants in Desert Research and Technology Study (DRATS, which was 14 days) in August-September 2009. The purpose of this study was twofold: (1) Identify fatigue and stress in relation to performance during analog missions, and (2) further develop normative databases on astronauts in analog environments. The NEEMO 14 mission was originally scheduled for July-August of 2008, but then postponed by NASA to February-March 2009. It was subsequently postponed a second time to May 2010, when it was successfully completed. Data acquisition in both NEEMO 14 and DRATS analogs involved the following measures: (1) Cognitive performance was assessed with three brief validated software-based cognitive performance tests (PVT Self Test, Digit Symbol Substitution Test [DSST]) and the Descending Subtraction Test [DST]), which collectively formed the Penn Neurobehavioral Test Battery (PennNTB). (2) Behavioral ratings of fatigue and stress were assessed using visual analog scale ratings of stress and fatigue (part of the PennNTB). (3) Physiological stress was assessed using salivary cortisol. (4) Feasibility of optical computer recognition (OCR) using facial videos acquired during the cognitive performance testing was assessed with computer web cams that recorded facial videos, which were subsequently evaluated by human scorers for OCR feasibility. (5) Sleep-wake patterns were assessed using wrist actigraphy and sleep logs (in NEEMO 14 only, as comparable data in DRATS was obtained by a different project and principal investigator). Data acquisition in the two analogs studies was successful, ranging from 84% to 89% (grand average was 86%) for all measurement domains. Penn NTB cognitive performance tests were completed on 497 test bouts out of 580 planned (86%). Visual analog scale ratings of fatigue and stress were completed for 497 assessments out of 580 planned (86%). Salivary cortisol was assayed on 410 samples out of 476 planned (86%). Facial videos for OCR feasibility were acquired in 414 test bouts out of 476 planned (87%). Days of wrist actigraphy and sleep log data were acquired on 135 out of 150 days (90.0%) in NEEMO 14. The majority of data loss (which was 9-14%, depending on measure) was associated with operational schedule conflicts (e.g., no time available to complete measure). Less than 2% of data loss was due to technical failure.
Bibliography Type:	Description: (Last Updated: 03/24/2024)