Fiscal Year:	FY 2011	**Task Last Updated:**	FY 05/04/2011
PI Name:	Dinges, David F. Ph.D.		
Project Title:	Optical Computer Recognition of Stress, Affect and Fatigue during Performance in Spaceflight		
Division Name:	Human Research		
Program/Discipline:	NSBRI		
Program/Discipline--Element/Subdiscipline:	NSBRI--Neurobehavioral and Psychosocial Factors Team		
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **BHP**:Behavioral Health & Performance (archival in 2017)		
Human Research Program Risks:	(1) **BMed**:Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders		
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:**	2007 Crew Health NNJ07ZSA002N
Start Date:	05/01/2008	**End Date:**	04/30/2012
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:**	7
No. of Bachelor's Candidates:	37	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Metaxas, Dimitris (Rutgers University) Goel, Namni (University of Pennsylvania) Basner, Mathias (University of Pennsylvania)		
Grant/Contract No.:	NCC 9-58-NBPF01601		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Astronauts must maintain high-level performance while experiencing demanding workload and work schedules, extreme environmental risks, and psychosocial stressors in space (e.g., isolation, confinement). Stress, negative emotions and fatigue can jeopardize their cognitive performance and neurobehavioral status. The proposed research is developing and validating an objective, unobtrusive, computational model-based tracker of the human face that reliably identifies when astronauts are experiencing stress, emotion and fatigue at levels that compromise performance in space. This optical computer recognition (OCR) system will provide feedback to them for autonomous selection of countermeasures for stress, depression and fatigue. The project is being accomplished through collaborative efforts of Dr. David Dinges (Unit for Experimental Psychiatry) at the University of Pennsylvania School of Medicine, and Dr. Dimitris Metaxas (Computational Biomedicine Imaging and Modeling Center) at Rutgers University. The project has four specific aims: (1) Create an OCR system capable of monitoring facial displays of specific emotions (i.e. angry, happy and sad). (2) Improve our current OCR system's ability to detect facial expressions of high versus low performance-induced stress. (3) Develop OCR algorithms to identify fatigue due to sleep loss based on slow eyelid closures (PERCLOS). (4) Test the technical feasibility of data acquisition and reliability of the advanced OCR system in spaceflight analogs that contain neurobehavioral stressors relevant to spaceflight. The project has primary relevance to strategic goals of the NSBRI Neurobehavioral and Psychosocial Factors (NBPF) Team. Two major laboratory experiments for OCR development and validation are underway. The project is 75% complete. To date, half of the total number of subjects required to complete the two experiments have been studied.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The study focuses on the ability of an unobtrusive, automated optical technology to detect psychological stress, emotion and fatigue during operational performance. The knowledge gained has the potential to identify an objective, unobtrusive, automated method for the recognition, monitoring, and management of the risks of neurobehavioral dysfunction in affect and alertness in space flight and in 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:	In the third year of the current project we have continued to expand the OCR algorithm to recognize facial expressions of emotion and behavioral indicators of excessive sleepiness (through slow eyelid closures). We are also continuing our work to improve the system's ability to correctly identify stress. Preliminary data confirm that the experimental procedures reliably induce stress, emotion and fatigue. During the third year, we have continued collecting data for the two experiments we proposed (one on emotion recognition and one on stress and fatigue detection). 56 healthy subjects have completed the two experiments (n=28 in Experiment 1 and n=28 in Experiment 2). We are using these data to expand and improve the current OCR algorithm. Together with data acquired in year 1 and year 2, a total of n=56 subjects have been studied to date (i.e., n=28 in each of the 2 experiments). In Experiment 1 (emotion recognition), a total of 31.2 hours of footage for facial emotional analysis has been collected, with 8.5 hours collected during year 3 alone. Subjective emotional questionnaires also were administered to all subjects. The 31.2 hours of footage (n=28, 14 females) has been subjectively scored by humans, who were blinded to the emotion induction tasks. Scorers rated each video based on the durations of emotional states, and which emotion was predominantly expressed. These results will be compared to the scores obtained from the model-based tracker algorithm and will assess and validate the accuracy of the computer-based system. In Experiment 2 (stress and fatigue detection), a total of 166.7 hours of digitally recorded high definition footage was collected capturing the faces of subjects during performance of the Psychomotor Vigilance Task (PVT), with 49.3 hours collected during year 3 alone (In the 2009-2010 report, we incorrectly reported that we had a total of 180 hours of PVT footage). Human scorers manually scored a subset (n=16) of the 20-minute videos collected during the PVT. The state of the eyelid was scored frame-by-frame (4 states: open, closing, closed, opening) and then compared to the algorithm output. Facelab data and PVT reaction times were simultaneously recorded throughout these test bouts, which were administered every 2 hours over the course of two consecutive days. During year 3, 4.5 hours of footage was recorded for facial emotional analysis (14.1 hours total) and 25 hours of footage also was collected for stress analysis (88.7 hours total) during this protocol. In addition, data from neuropsychological tasks, personality questionnaires, and subjective emotional rating scales were obtained from all subjects. With regard to the stress-related hormone analysis in Experiment 2, a total of 140 saliva samples were collected during stress-inducing tasks (5 saliva samples per subject), with 40 samples collected during year 3 alone. EEG/EKG data were also collected during these stress-inducing tasks.
Bibliography Type:	Description: (Last Updated: 03/24/2024)
Abstracts for Journals and Proceedings	Jones CW, Basner M, Goel N, Metaxas D, Dinges DF. "The Validity of Unobtrusive Tracking of Slow Eyelid Closures as a Measure of Space Flight Fatigue." 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. , Apr-2011
Abstracts for Journals and Proceedings	Dinges DF, Metaxas D, Banks S, Goel N, Ecker A, Basner M. "Overview of NSBRI neurobehavioral and psychosocial projects involving detection and mitigation stress, fatigue and conflict in space." NASA Human Research Program Investigators' Workshop, Houston, TX, February 3-5, 2010. NASA Human Research Program Investigators' Workshop, Houston, TX, Abstract Book, February 2010. , Feb-2010
Abstracts for Journals and Proceedings	Yang F, Michael N, Metaxas D, Dinges DF. "Development of Optical Computer Recognition (OCR) for Monitoring Fatigue in Space." 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. , Apr-2011
Abstracts for Journals and Proceedings	Minkel JD, Moreta M, Muto J, Jones C, Goel N, Dinges DF. "Behavioral Risks in Space Flight: Impact of Stressors When Sleep Deprived." 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. , Apr-2011

Abstracts for Journals and Proceedings	Minkel JD, Moreta MC, Muto JA, Jones CW, Goel N, Dinges DF. "Elevated Stress Responses Following Sleep Deprivation in Healthy Adults." 25th Annual Meeting of the Associated Professional Sleep Societies, LLC 2011, Minneapolis, MN, June 11-15, 2011. Sleep 2011;34 Suppl:A104-5. , Apr-2011
Abstracts for Journals and Proceedings	Moreta MC, Muto J, Minkel JD, Di Antonio AR, Htaik O, Metaxas DN, Dinges DF. "Monitoring Emotions in Space by Tracking Facial Expressions." 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. , Apr-2011
Abstracts for Journals and Proceedings	Michael N, Yang F, Metaxas D, Dinges DF. "Development of Optical Computer Recognition (OCR) for Monitoring Stress and Emotions in Space." 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. , Apr-2011
Articles in Peer-reviewed Journals	Minkel J, Htaik O, Banks S, Dinges D. "Emotional expressiveness in sleep-deprived healthy adults." Behav Sleep Med. 2011 Jan;9(1):5-14. http://dx.doi.org/10.1080/15402002.2011.533987 ; PMID: 21218289 , Jan-2011