Fiscal Year:	FY 2007	**Task Last Updated:**	FY 10/05/2007
PI Name:	Dinges, David F. Ph.D.		
Project Title:	Countermeasures to neurobehavioral deficits from cumulative sleep deprivation during space flight: Dose-response effects of recovery sleep opportunities		
Division Name:	Human Research		
Program/Discipline:	NSBRI Teams		
Program/Discipline--Element/Subdiscipline:	NSBRI Teams--Human Performance Factors, Sleep, and Chronobiology Team		
Joint Agency Name:		**TechPort:**	Yes
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:**	2003 Biomedical Research & Countermeasures 03-OBPR-04
Start Date:	06/01/2004	**End Date:**	05/31/2008
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	2	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	18
No. of Bachelor's Candidates:	41	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Banks, Siobhan (University of Pennsylvania Health System)		
Grant/Contract No.:	NCC 9-58-HPF00404		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	(1) The overarching goal of this project is to develop sleep schedule countermeasures to ensure optimal neurocognitive performance capability in astronauts during prolonged space flight. The primary aim is to determine the sleep dose-response effects of an acute change in sleep duration that occurs between two periods of chronic sleep restriction, on neurocognitive performance functions, subjective states, and waking and sleep physiology. The optimal performance of astronauts during extended-duration space flight depends heavily on achieving recovery through adequate sleep. There is now extensive evidence that astronaut sleep in space averages 4 to 6.5 hours per day, and when critical operations (e.g., nighttime docking) are scheduled, very little sleep may be obtained during a day prior to the critical event. Ground-based experiments on healthy adults by our laboratory and others have demonstrated that limiting daily sleep duration to less than 7 hours leads to cumulative deficits in neurocognitive performance and alertness. Within 1-2 weeks of sleep restriction at levels experienced by astronauts, performance deficits were serious; impairments on tasks requiring sustained attention, working memory and cognitive throughput reached levels equivalent to those found after 1-2 nights of total sleep loss. The experiment will determine the countermeasure benefits for performance (during critical operations and subsequent days of sleep restriction) from an acute increase in sleep duration (i.e., single night of recovery sleep). In addition, generating sleep dose-response functions will provide critically needed information on the adverse performance consequences of an acute reduction in sleep duration below the chronic sleep-restriction level, which can occur in space flight prior to a day of critical operations. We will establish sleep dose-response curves for the immediate and delayed impact on neurobehavioral functions, of an acute (1 night) change in sleep duration midway in a period of chronic sleep restriction. We will determine if performance recovery is complete after 2 nights of extended sleep, following chronic sleep restriction. In addition to the impact of a single night intervention (specific aim 1), we seek to resolve whether complete neurobehavioral recovery from prolonged chronic sleep restriction is possible within 2 nights. We will investigate the relationship between sleep physiology and performance responses. We will investigate the effects of chronic sleep restriction, acute sleep intervention, and recovery sleep on cardiovascular indices. (2) We are currently in the process of performing preliminary analyses on the data collected. Specifically, we are analyzing the neurobehavioral performance changes across the experimental protocol, and the recovery phase. We are also beginning analysis for the construction of the dose response recovery curves from the chronic sleep restriction. We are in the process of manual scoring and analysis of the polysomnographic data. (3) At the current time we are still collecting and analyzing the data and we have not yet fully constructed the dose response recovery curves. Preliminary analysis however supports the hypothesis that as time in bed for sleep increases on the acute intervention night, following chronic sleep restriction, performance on the next day of simulated critical operations is improved in a sleep duration dose-response manner. (4) We will continue with the data collection across the next two years, to complete a total of 80 subjects. The data collected in the coming year will address the specific aims listed above. Data analysis has commenced, and will continue throughout the data collection process. Neuropsychological, performance, mood and sleep quality data collected thus far will be presented at the 21st Annual meeting of the Associated Professional Sleep Societies conference in Minneapolis next June. We anticipate submitting several manuscripts to peer review journals this year, which will begin to reveal the relationship between the varying durations of time in bed and recovery of waking neurobehavioral and physiological outcomes, following chronic partial sleep deprivation.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The study focuses the effect of different doses of sleep time on performance and cognition. The knowledge gained has the potential to change work scheduling and further understand the effect of sleep loss and recovery on neurobehavioral function in spaceflight 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:	The project is on schedule and the study is progressing well. Fifty-four subjects have completed the 16 day in-laboratory study protocol (for a total of 864 laboratory days) and we expect to recruit another 20 subject in the coming grant year. We are currently in the process of performing analyses on the data collected. Specifically, we are analyzing the neurobehavioral performance changes across the experimental protocol, and the recovery phase. We are in the process of manual scoring and analysis of the polysomnographic and cardiovascular data. Abstracts based on this work have been accepted for presentation at the 21st Annual Meeting of the Associated Professional Sleep Societies, in Minneapolis, examining various aspects of the data. Specifically preliminary construction of a dose response recovery curve from the chronic sleep restriction and investigation of the effect of chronic sleep restriction and recovery on neurobehavioral functions.
Bibliography Type:	Description: (Last Updated: 03/24/2024)
Abstracts for Journals and Proceedings	Banks S, Van Dongen H, Dinges DF. "How much sleep is needed to recover from sleep debt? The impact of sleep dose on recovery." Australasian Sleep Association Meeting, 2006. Intern Med J. 2006;36: A37. , May-2006
Abstracts for Journals and Proceedings	Banks S, Van Dongen H, Dinges DF. "Sleep dose-response study of recovery from sustained sleep restriction." European Sleep Research Society, Innsbruck, Austria, September 12-16, 2006. J Sleep Res. 2006;15:A145. , Sep-2006
Abstracts for Journals and Proceedings	Mc Glinchey EL, Banks S, Minkel JD, Dinges DF. "Effect of chronic sleep restriction on pre-frontal cortex functioning and its relationship to IQ and personality." Australasian Sleep Association Meeting, 2006. Intern Med J. 2006;36: A37. , May-2006
Abstracts for Journals and Proceedings	Mc Glinchey EL, Banks S, Minkel JD, Dinges DF. "Effect of introversion-extroversion on mood during chronic sleep restriction." Associated Professional Sleep Societies 20th Annual Meeting, Salt Lake City, Utah, June 17-20, 2006. Sleep, 2006;29(Suppl):A378. , Jun-2006

Articles in Peer-reviewed Journals	Mollicone DJ, Van Dongen HPA, Dinges DF. "Optimizing sleep/wake schedules in space: Sleep during chronic nocturnal sleep restriction with and without diurnal naps." Acta Astronaut. 2007 Feb-Apr;60(4-7):354-61. http://dx.doi.org/10.1016/j.actaastro.2006.09.022 , Feb-2007
Awards	Dinges DF. "Award for Distinguished Scientific Contributions by Alumnae, Department of Psychology, Saint Louis University, July 2006." Jul-2006