

<b>Fiscal Year:</b>	FY 2006	<b>Task Last Updated:</b>	FY 05/20/2008
<b>PI Name:</b>	Brainard, George C. Ph.D.		
<b>Project Title:</b>	Blue Light for Enhancing Alertness in Space Missions		
<b>Division Name:</b>	Human Research		
<b>Program/Discipline:</b>	NSBRI Teams		
<b>Program/Discipline--Element/Subdiscipline:</b>	NSBRI Teams--Human Performance Factors, Sleep, and Chronobiology Team		
<b>Joint Agency Name:</b>	<b>TechPort:</b>	Yes	
<b>Human Research Program Elements:</b>	(1) <b>BHP</b> :Behavioral Health & Performance (archival in 2017)		
<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>Organization Name:</b>	Thomas Jefferson University		
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<b>City:</b>	Philadelphia	<b>State:</b>	PA
<b>Zip Code:</b>	19107-5083	<b>Congressional District:</b>	1
<b>Comments:</b>			
<b>Project Type:</b>	GROUND	<b>Solicitation / Funding Source:</b>	Directed Research
<b>Start Date:</b>	09/01/2006	<b>End Date:</b>	08/31/2012
<b>No. of Post Docs:</b>	<b>No. of PhD Degrees:</b>		
<b>No. of PhD Candidates:</b>	<b>No. of Master' Degrees:</b>		
<b>No. of Master's Candidates:</b>	<b>No. of Bachelor's Degrees:</b>		
<b>No. of Bachelor's Candidates:</b>	<b>Monitoring Center:</b> NSBRI		
<b>Contact Monitor:</b>	<b>Contact Phone:</b>		
<b>Contact Email:</b>			
<b>Flight Program:</b>			
<b>Flight Assignment:</b>			
<b>Key Personnel Changes/Previous PI:</b>			
<b>COI Name (Institution):</b>			
<b>Grant/Contract No.:</b>	NCC 9-58-HPF00001		
<b>Performance Goal No.:</b>			
<b>Performance Goal Text:</b>	<p>The overall goal of this project is to study the efficacy of blue enriched polychromatic solid-state light for acutely enhancing alertness and cognitive performance in healthy men and women. The purpose of this work is to develop an in-flight lighting countermeasure for enhancing alertness in astronauts as well as NASA ground crew. This is a new, directed research project. To initiate the work, we proposed the following seven aims:</p> <ol style="list-style-type: none"> <li>1) Assemble a team of investigators who will create a set of study designs to be run from 2006 to 2012.</li> <li>2) Establish either collaborative, consultant or subcontract agreements for elements of the work which are best done outside of Thomas Jefferson University (TJU).</li> <li>3) Write and secure Institutional Review Board (IRB) approval of the first study design.</li> </ol>		

	<p>4) Design and fabricate the initial solid-state light sources for testing. These sources will serve as the independent variables in the initial study design.</p> <p>5) Have an independent safety analysis completed on the solid-state lighting prototypes.</p> <p>6) Purchase and calibrate equipment for assessing alertness and cognitive performance in the study volunteers.</p> <p>7) Develop a multiyear plan for the development and testing of specific lighting technologies that can be installed in the CEV and other space exploration habitats for acutely enhancing astronaut and ground crew alertness.</p> <p>Towards accomplishing the first two aims, written correspondence, phone calls and direct meetings were used to establish the team of investigators. Over the first year, a total of eight meetings were held: five meetings at TJU in Philadelphia, one in League City during the NASA Human Research Program Investigators Workshop, one at the External Advisory Committee meeting in Houston, and one at Johnson Space Center (JSC). As a result of these meetings, key collaborators who have formally agreed to participate on this project. These include James Maida of JSC's Habitability and Human Factors Branch; Charles Bowen, Ph.D. of Lockheed Martin's Human Factors Design team; David Dinges, Ph.D. and Namni Goel, Ph.D. from the University of Pennsylvania; Stephen Lockley, Ph.D. of Brigham and Womens Hospital and Harvard Medical School; David Sliney, Ph.D. of the U.S. Army Laser/Optical Radiation Program at Aberdeen Proving Ground; and Mark Rollag, Ph.D. of the University of Virginia. These collaborators will work with scientists and staff of TJU's Light Research Program (LRP) towards accomplishing the goals of this project. The collaborators will work on selected aspects of this project as per their expertise.</p> <p>Progress towards the third aim involves the development of two experiments. Subject recruitment for the first experiment will be initiated during this month (the end of the first funding year) and the study will be completed in the second funding year. The second experiment will be initiated and run during the second year. The first experiment is a bench-marking study to characterize the biological potency of the prototype solid-state light source that is described below. A within-subjects, acute light-induced melatonin suppression study will be done with eight healthy men and women. This study will have two important outcomes. First, it will help characterize the biological efficacy of the prototype solid-state light source relative to monochromatic and polychromatic light sources previously studied in our lab. In addition, it will guide the selection of the light intensity that will be tested in the second study, which will focus on alertness. The IRB for the first study has been approved by TJU. The protocol for the second experiment, a two-day study on the alerting effects of blue light, is still being refined. Once the experimental design is completed, a separate IRB covering that work will be written and submitted for review.</p> <p>Progress towards the fourth aim involves our collaboration with Apollo Light Systems, Inc., an industrial partner of NSBRI. Apollo has donated engineering time and materials to develop a large panel of narrowband blue LEDs. This light source will be the independent variable in the first two experiments discussed above. Working closely with an engineer from Apollo, we have modified the original prototype so it can provide a broad range of light intensities with no change to spectral output. Jefferson's LRP staff has thoroughly characterized the prototype radiometry and photometry. This light unit is now completely serviceable for experimental use.</p> <p>Concerning our fifth aim, David Sliney, Ph.D. of Aberdeen Proving Ground has made a series of radiometric measurements of the prototype and has provided an independent safety analysis based on criteria from the American College of Government and Industrial Hygiene (ACGIH) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP). His draft report confirms that the blue solid-state prototype operates "at all wavelengths and emission levels that are far below limits that are recognized as maximal safe exposure values." Once finalized, the report will be distributed to James Maida at JSC and Charles Bowen, Ph.D. of Lockheed Martin for review.</p> <p>For our sixth aim, we have purchased and received polysomnography and psychomotor vigilance task equipment. Setup, testing, and calibration of this equipment has been initiated and will be completed prior to the start of our second experiment. This equipment will not be needed for the first bench-marking experiment.</p> <p>Finally, for the seventh aim, extensive discussions have been held between TJU's LRP and the extramural collaborators concerning a multiyear plan for the development and testing of specific lighting technologies that can be installed in the CEV and other space exploration habitats for acutely enhancing astronaut and ground crew alertness. The specific experiments, experiment sequence, and technology development will be determined once data is available from the first two studies.</p>
<b>Task Description:</b>	
<b>Rationale for HRP Directed Research:</b>	<p>The knowledge we hope to gain from this research, though focused on spaceflight, will also benefit people here on Earth. The sleep deficits experienced by astronauts during space flight can be considered a threat to the success of space missions (Longnecker and Molins, 2005). The resulting physiological and behavioral changes caused by sleep and circadian disruption can lead to diminished alertness, cognitive ability and psychomotor performance (Dijk, et al., 2001). As a measure to counteract sleep disruptions, over 45% of all medications taken in space are sleep aids (Putcha, et al., 1999).</p> <p>Although the studies being considered in this project are focused on developing a non-pharmacological lighting countermeasure for space exploration, it is anticipated that there also will be significant benefits to civilians living on Earth. A significant portion of the global population suffers from chronic sleep loss and/or circadian-related disorders. Evidence for disease or illness occurring due to a disruption of circadian homeostasis has mounted significantly in the past several years. In the United States, 20 million Americans do shift work which interferes with a biologically healthy nocturnal sleep cycle (U.S. Congress OTA, 1991). This group has been shown to be more likely to suffer from a wide variety of ailments, including cardiovascular disease, gastrointestinal distress, cognitive and emotional problems. Furthermore, recent epidemiological studies of female night-shift nurses have shown that they are statistically more likely to suffer from breast cancer and colon cancer compared to day shift workers. Our laboratory is involved in testing the hypothesis that exposure to light at night is a risk factor for cancer (Blask, et al., 2005).</p>
<b>Research Impact/Earth Benefits:</b>	
<b>Task Progress:</b>	New project for FY2006.

Bibliography Type:	Description: (Last Updated: 10/30/2023)
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