Fiscal Year:	FY 2017	**Task Last Updated:**	FY 02/05/2018
PI Name:	Klerman, Elizabeth B. M.D., Ph.D.		
Project Title:	Ultra-Short Light Pulses as Efficient Countermeasures for Circadian Misalignment and Objective Performance and Subjective Alertness Decrements		
Division Name:	Human Research		
Program/Discipline:	NSBRI		
Program/Discipline--Element/Subdiscipline:	NSBRI--Human Factors and Performance Team		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
Human Research Program Risks:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Boston	**State:**	MA
Zip Code:	02115-5804	**Congressional District:**	8
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	Directed Research
Start Date:	03/01/2016	**End Date:**	05/31/2017
No. of Post Docs:	1	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	1
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:	NOTE: End date changed to 5/31/2017 (original end date was 2/28/2017) per NSBRI (Ed., 3/2/17)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):			
Grant/Contract No.:	NCC 9-58-HFP00006		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	NOTE: Follow-on as a directed research project to Dr. Klerman's National Space Biomedical Research Institute project "Ultra-Short Light Pulses as Efficient Countermeasures for Circadian Misalignment and Objective Performance and Subjective Alertness Decrements"; project NCC 9-58-HFP02802. Both light and exercise are effective countermeasures for space and ground-based crews for circadian phase resetting, and both affect objective performance, subjective alertness, and sleep. Exercise is crucial for space-based crews for cardiovascular and bone health and those who exercise regularly show improved sleep quantity and quality. Exercise increases physiological arousal and can help promote alertness in the short-term. In previous studies, however, it is unclear to what extent exercise alone was responsible for phase shifting the circadian pacemaker or changes in alertness because subjects were exposed to light levels that are known to phase shift the human circadian pacemaker during the exercise. We tested the combined effects of these two countermeasures to determine whether adding exercise to light stimuli will further improve circadian phase resetting, objective performance, subjective alertness, and sleep. The one-year project included an 8-day inpatient protocol with 8 healthy participants. The protocol included a circadian phase delay, as occurs when traveling from Europe/ western Russia to the US. By combining two countermeasures already used by NASA – exercise and lighting – the results of these studies can be easily translated to operations by NASA on the International Space Station (ISS) or for ground based crews. If there are increased positive responses to the addition of exercise to lighting, then such schedules can be implemented on the ISS without additional equipment or devices. The experimental results will have direct Earth-based applications for workers on early-rising, night, or rotating schedules, as well as for people experiencing jet lag. These studies will further our understanding of the physiologic mechanisms that mediate photic stimuli and exercise induced changes in circadian phase and performance. The work directly addresses one of the National Space Biomedical Research Institute (NSBRI) Research Announcement research objectives and two NASA Human Research Program Integrated Research Plan (IRP) Risks. This proposal will also address other NSBRI goals: training of future scientists, collaboration among NSBRI investigators, and a combination of basic science with space-based applications and potential commercial applications.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Light is the major environmental time cue that resets the circadian pacemaker in the mammalian hypothalamus. Light information is captured exclusively by the eyes using specialized cells containing a blue-light sensitive photopigment. Each day the light-dark cycle resets the internal clock, which in turn synchronizes the physiology, psychology, and behavior controlled by the clock. Failure to receive this light-dark information, as experienced for example by totally blind individuals, causes the circadian pacemaker to revert to its endogenous non-24-hour period and possibly become desynchronized from the 24-hour light-dark cycle. Exposure to irregular light-dark cycles, as experienced for example by psychiatric patients with irregular sleep-wake cycles, can also disrupt circadian rhythms. Light also suppresses the hormone melatonin and has a direct arousal effect on the brain, improving alertness and performance. This property of light can be useful as a non-pharmacological treatment in a number of conditions, and if timed appropriately, these direct alerting effects can complement the circadian phase resetting effects of light, for example, in treating shiftwork and jet-lag disorders, to help maintain alertness at the correct time and subsequently improve sleep. Scheduled physical activity such as wheel running in hamsters and mice as well as exercise in humans has also been reported to influence the circadian timing system suggesting that it may facilitate circadian adaptation to shift work. In addition to exercise being used to shift the circadian clock, it can also be used as a countermeasure to improve alertness levels in the short term. Therefore we tested a combination of light exposure and exercise in carefully controlled inpatient conditions for potential additional effects on circadian phase, objective performance, subjective alertness, and sleep.The results of our experiments may be applicable to conditions such as jet lag, and shift-work or night-work. Millions of workers in the safety, security, transportation, healthcare, and industrial sectors are affected by these conditions yearly, with effects on health and safety. For example, the findings could be used to improve performance and alertness and thereby effectiveness and public safety for people who work at night, on rotating schedules, on non-24-hr schedules, or on extended duty schedules (e.g., pilots, train and truck drivers, shift workers, healthcare workers, public safety officers). Attempting to sleep at adverse circadian phases is difficult, resulting in poor sleep efficiency. Similarly, attempting to work at adverse circadian phases, and/or after a long time awake, results in poor worker performance and productivity and leads to an increase in errors. For example, the accidents at the Chernobyl and Three Mile Island nuclear reactors and the Exxon Valdez grounding were all partially attributed to employees working at adverse circadian phases and the Federal Aviation Administration (FAA) reports of air traffic controllers sleeping while scheduled to work at night are related to their work schedule.
Task Progress:	We began our recruitment efforts in May 2016 and we have successfully completed all planned studies. Twenty six participants were consented and screened of whom 9 qualified for the study. Eight participants (4 females) completed the protocol and one male participant was disempanelled due to pre-exisiting medical conditions that were not evident during screening. Ed. note: As this is a follow-on to Dr. Klerman's NSBRI project "Ultra-Short Light Pulses as Efficient Countermeasures for Circadian Misalignment and Objective Performance and Subjective Alertness Decrements"; project NCC 9-58-HFP02802, see that project's reports for publications resulting from this work.
Bibliography Type:	Description: (Last Updated: 10/26/2023)