

## 0227

### THE EFFECT OF LIGHT ON CIRCADIAN ENTRAINMENT FOR SHIFTING FROM DAY TO NIGHT FLIGHT OPERATIONS

Nita Shattuck<sup>1</sup>, Panagiotis Matsangas<sup>1</sup>, James Reily<sup>2</sup>,  
Meghan McDonough<sup>3</sup>, Donnla O'Hagan<sup>1</sup>, Kathleen Giles<sup>1</sup>

Naval Postgraduate School <sup>1</sup> United States Coast Guard <sup>2</sup> United States Navy <sup>3</sup>

**Introduction:** A midair collision during a routine nighttime air refueling training mission in the early morning hours of December 6, 2018, resulted in the tragic deaths of six Marine aircrew members and the loss of two US Marine Corps aircraft. Fatigue and the transition from day to night flights were called out as a problem area that continues to plague aviation commands. The goal of this study was to provide recommendations to the fleet regarding the limitations and best practices for shifting aviators from day to night operations to mitigate aviator fatigue and facilitate circadian re-alignment.

**Methods:** Longitudinal (10-day) within-subject assessment of aviators (N=9) in hybrid conditions. Aviators completed validated questionnaires for sleepiness and workload. Performance was assessed in simulated flight scenarios (one morning and three night sessions). The efficacy of a single 4-hour exposure of blue-enriched white light (~1000 lux) was assessed with the dim-light melatonin onset procedure. The study protocol attempted to replicate the work and rest patterns of aviators in the field who work during the day but could potentially be required to quickly shift their schedules to support night flight operations.

**Results:** The circadian phase of all participants was successfully delayed an average of 1.3 hours (range: 0.88-1.93 hours). Despite the lack of control over light exposure or other activities over the study period, participants reported less sleepiness and reduced subjective workload with improved flight performance.

**Conclusion:** Conclusions from the literature review and our study indicate that circadian entrainment in complex military operational settings should use light management as the dominant method for shifting the circadian clock. Based on these conclusions, we developed general recommendations and two circadian synchronization plans for aircrew switching from day to night operations. One plan shows a schedule that prepares for night operations by steadily shifting the daily schedule over multiple days. The other plan shows a schedule for aircrew who are required to shift from day to night operations abruptly without notice.

**Support (If Any):** Supported by the Assistant Commandant of the Marine Corps.

## 0228

### USING BLUE LIGHT THERAPY TO FACILITATE RECOVERY OF SLEEP AND PSYCHOLOGICAL FUNCTIONING IN PTSD

William Killgore<sup>1</sup>, Edward Pace-Schott<sup>2</sup>, Michael Grandner<sup>1</sup>,  
John Vanuk<sup>1</sup>, Deva Reign<sup>3</sup>, Natalie Dailey<sup>1</sup>

University of Arizona College of Medicine <sup>1</sup> MGH <sup>2</sup> University of Arizona <sup>3</sup>

**Introduction:** Sleep problems are often described as the “hallmark symptoms” of post-traumatic stress disorder (PTSD). Patients with PTSD show numerous disruptions of emotional functioning. Experimental evidence has shown that the ability to retain extinction memories following fear conditioning is impaired in people with PTSD. Because of the key role of sleep in

memory consolidation and emotional regulation, we hypothesized that regulating sleep and circadian rhythms with morning blue-wavelength light therapy would facilitate emotional recovery and the ability to retain extinction memories.

**Methods:** Eighty-four individuals with PTSD (56 female; Age=31.38, SD=8.9) underwent a well-validated fear conditioning and extinction protocol and were then randomly assigned to receive either 6-weeks of BLUE (469 nm; n=44) or placebo AMBER (578 nm; n=40) morning light therapy for 30-minutes daily. Participants returned to undergo post-treatment extinction recall when exposed to the same previously conditioned stimuli, and a functional magnetic resonance imaging (fMRI) while the same images were presented. Participants also completed a variety of emotional and mental health outcome measures and wore an actigraph to measure sleep over the 6-weeks.

**Results:** There was a significant interaction between light condition and time in bed and total sleep time ( $p < .05$ ) indicating significant increases in sleep with blue versus amber light over treatment. Additionally, declines in symptoms of PTSD on the Clinician Administered PTSD Scale (CAPS-5) correlated with improvements in sleep for the blue, but not the amber light, group (all  $p$ -values  $< .05$ ). During the fear conditioning and extinction paradigm, blue light was associated with significantly greater extinction recall compared to the amber light condition ( $p = .05$ ). Finally, blue light resulted in decreased fMRI activation within the right amygdala and increased activation within the ventromedial prefrontal cortex to the previously feared and extinguished stimuli.

**Conclusion:** Blue light treatment was more effective than amber placebo at increasing sleep quantity, shifting circadian bedtime, reducing PTSD symptom severity, facilitating the retention of extinction memories, and reducing neural fear responses to previously feared stimuli. We suggest that improvements in sleep led to greater consolidation of extinction memories. These findings suggest that blue light treatment may facilitate treatment gains by improving sleep.

**Support (If Any):**