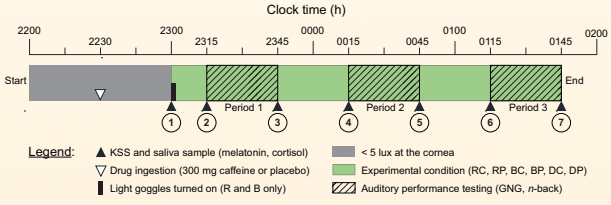
How Light and Caffeine Affect Nighttime Alertness and Performance

Caffeine has traditionally played a key role in nighttime military operations, but recent research has shown that exposure to light can also be an effective measure for improving alertness and performance while reducing fatigue. This study investigated how exposure to low levels of blue and red light, administered alone and in combination with caffeine, affect alertness and performance at night.

Methods

Thirteen adult participants (8 females, 5 males; mean ± standard deviation age = 44.2 ± 8.4 years) successfully completed the study. Participants were exposed to either 50 lux of "red" (R) (λmax = 631 nm, full width at half maximum [FWHM] = 19 nm), 50 lux of "blue" (B) (λmax = 450 nm, FWHM = 25 nm), or <5 lux of dim (D) (3500K) light at the cornea. Each of those light exposures was combined with either a placebo (P) or a caffeine (C) condition, resulting in 6 combinations (i.e., RC, RP, BC, BP, DC, and DP).

While experiencing these conditions, the participants underwent GO/NOGO (GNG) and *n*-back auditory performance testing that was presented on personal computers. In the GNG task, participants were instructed to respond to target stimuli as quickly as possible and not respond to inhibitory stimuli. For the *n*-back tasks, participants were presented with a sequence of tones and asked to react as quickly as possible upon hearing a tone that was either similar (S) or dissimilar (D) to a tone occurring a specific number (represented by *n*) of positions back in the sequence. Three difficulty levels were used in this task (1-back/1 pitch, 2-back/1 pitch, and 1-back/4 pitches). Participants responded by pressing the spacebar of their computer keyboard.

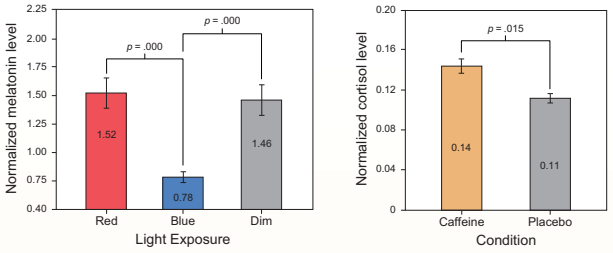


The study protocol, showing the schedule for drug ingestion (either 300 mg of caffeine or a placebo), the auditory performance testing periods (3 per experimental session), the administration of Karolinska Sleepiness Scale (KSS) questionnaires, and salivary melatonin and cortisol sampling.

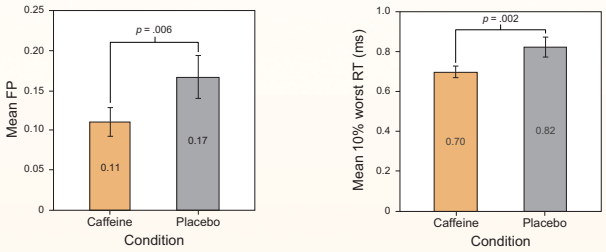
Sponsor

Office of Naval Research

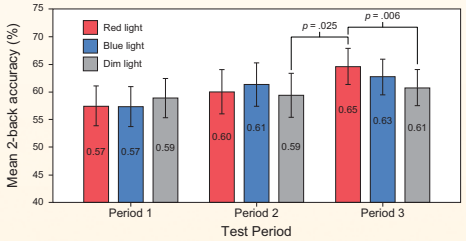
Results



Mean ± SEM normalized melatonin levels for the 3 light exposures (left) and cortisol levels for the caffeine and placebo conditions.



Mean ± SEM false positives (left) and 10% worst reaction times (right) recorded for the GNG task in the caffeine and control conditions.



Mean ± SEM of accuracy for the 2-back task by test period and light exposure. Accuracy for this task showed a statistically significant light × test period interaction. *Post hoc* comparisons revealed that responses to the stimuli in the R exposure during Period 3 were significantly more accurate than those for the D exposure in Periods 2 and 3.

Conclusions

- The impact of light and caffeine on performance is task dependent
- Light, especially red light, improved accuracy on the 2-back test compared to dim light
- Caffeine reduced false positive responses and 10% worst reaction times on the GNG task compared to the placebo
- Melatonin levels were significantly reduced with the blue light exposure only
- Caffeine increased cortisol levels compared to the placebo

Rensselaer

Lighting Research Center

Lighting Research Center, Rensselaer Polytechnic Institute • 21 Union Street • Troy, NY 12180 • (518) 687-7100 • www.lrc.rpi.edu