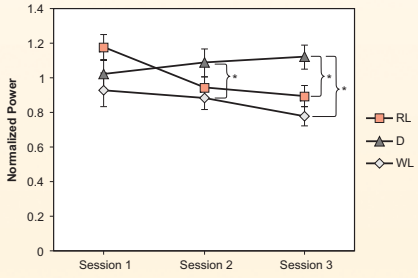
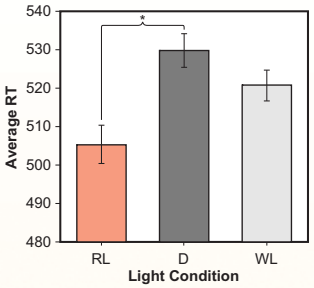
Daytime Light Exposure: Effects on Biomarkers, Measures of Alertness, and Performance

Light can elicit an alerting response in humans, independent from acute melatonin suppression. Recent studies have shown that red light significantly increases daytime and nighttime alertness. The main goal of the present study was to further investigate the effects of daytime light exposure on performance, biomarkers and measures of alertness. It was hypothesized that, compared to remaining in dim light, daytime exposure to narrowband long-wavelength (red) light or polychromatic (2568 K) light would induce greater alertness and shorter response times.

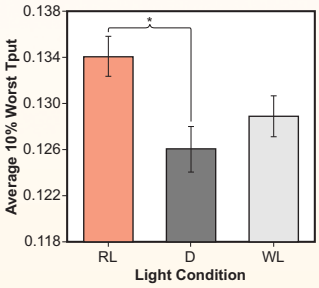
Thirteen subjects experienced three lighting conditions: dim light (<5 lux), red light (λmax = 631 nm, 213 lux, 1.1 W/m²), and white light (2568 K, 361 lux, 1.1 W/m²), three times during the day: 1) 07:00-09:00; 2) 11:00-13:00; and 3) 15:00-17:00. The results demonstrated, for the first time, that red light can increase short-term performance as shown by significant ($p < 0.05$) reduced response time and higher throughput in performance tests. There were significant decreases ($p < 0.05$) in alpha power and alpha-theta power after exposure to the white light, but this alerting effect did not translate to better performance. Alpha power was significantly reduced after red light exposure in the middle of the afternoon.



Average ± SEM of the alpha power (8–12 Hz) for each lighting condition (red light [RL], dim light [D], and white light [WL]) at each session (Session 1 = 07:00–09:00; Session 2 = 11:00–13:00; Session 3 = 15:00–17:00). Power in the alpha range was more significantly reduced after white light exposure than after dim light in the middle of the day and in the middle of the afternoon. Alpha power was significantly lower after red light exposure in the middle of the afternoon.



Average ± SEM of response time (RT) for each lighting condition: red light (RL), dim light (D), and white light (WL). Overall, subjects performed significantly faster after exposure to the red light condition than after exposure to the dim light condition, suggesting that red light reduces response times in a GONOGO task and improves performance.



Average ± SEM of 10% worst throughput (Tput) for each lighting condition: red light (RL), dim light (D), and white light (WL). 10% worst Tput were significantly greater after the red light condition than after the dim light condition.

In terms of practical application, office workers could consider the use of personal light treatment devices such as red-light glasses or an array of red LEDs around their computer screen for a period in the afternoon. While field studies are needed to further investigate this hypothesis, the addition of red light could provide the extra alerting stimulus needed to fight the post-lunch dip, together with current ambient light levels typically found in office spaces (100-200 lux at the cornea). The data suggest that much higher levels of white light than red light are needed to affect performance during the day; therefore, the use of personal devices delivering lower levels of red light would be a more energy-efficient solution for office spaces, rather than increasing ambient light levels to 1000 lux.

Sponsor

Office of Naval Research (# N00014-11-1-0572)

For more information

Sahin L, Wood BM, Plitnick B, Figueiro MG. 2014. Daytime light exposure: Effects on biomarkers, measures of alertness, and performance. *Behavioural Brain Research*, 274: 176-185.

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