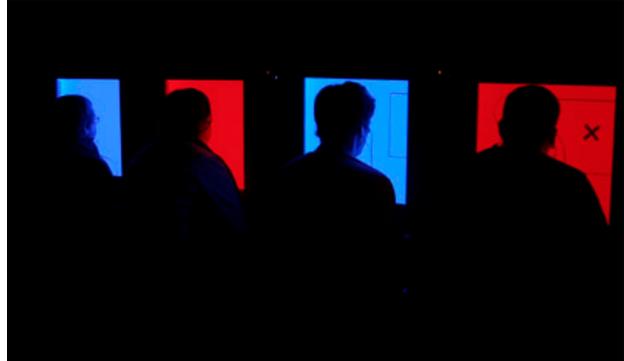


Red Light Increases Alertness During "Post-Lunch Dip"

Rensselaer's Lighting Research Center Examines the Effect of Light on Daytime Alertness

Acute or chronic sleep deprivation resulting in increased feelings of fatigue is one of the leading causes of workplace incidents and related injuries. More incidents and performance failures, such as automobile accidents, occur in the mid-afternoon hours known as the "post-lunch dip." The post-lunch dip typically occurs from 2-4 p.m., or about 16-18 hours after an individual's bedtime from the previous night.



A new study from the Lighting Research Center (LRC) at Rensselaer Polytechnic Institute shows that exposure to certain wavelengths and levels of light has the potential to increase alertness during the post-lunch dip. The research was a collaboration between Mariana Figueiro, LRC Light and Health Program director and associate professor at Rensselaer, and LRC doctoral student Levent Sahin. Results of the study titled "Alerting effects of short-wavelength (blue) and long-wavelength (red) lights in the afternoon," were recently published in [*Physiology & Behavior*](#) journal.

The collaboration between Figueiro and Sahin lays the groundwork for the possible use of tailored light exposures as a non-pharmacological intervention to increase alertness during the daytime. Figueiro has previously conducted studies that show that light has the potential to increase alertness at night. Exposure to more than 2500 lux of white light at night increases performance, elevates core body temperature, and increases heart rate.

In most studies to date, the alerting effects of light have been linked to its ability to suppress melatonin. However, results from another study led by Figueiro demonstrate that acute melatonin suppression is not needed for light to affect alertness during the nighttime. They showed that both short-wavelength (blue) and long-wavelength (red) lights increased measures of alertness but only short-wavelength light suppressed melatonin. Melatonin levels are typically lower during the daytime, and higher at night.

Figueiro and Sahin hypothesized that if light can impact alertness via pathways other than melatonin suppression, then certain wavelengths and levels of light might also increase alertness during the middle of the afternoon, close to the post-lunch dip hours.

During the study conducted at the LRC, participants experienced two experimental lighting conditions in addition to darkness. Long-wavelength "red" light ($\lambda_{\text{max}} = 630$ nanometers) and short-wavelength "blue" light ($\lambda_{\text{max}} = 470$ nanometers) were delivered to the corneas of each participant by arrays of light emitting diodes (LEDs) placed in $60 \times 60 \times 60$ cm light boxes.

Participant alertness was measured by electroencephalogram (EEG) and subjective sleepiness (KSS scale).

The team found that, compared to remaining in darkness, exposure to red light in the middle of the afternoon significantly reduces power in the alpha, alpha theta, and theta ranges. Because high power in these frequency ranges has been associated with sleepiness, these results suggest that red light positively affects measures of alertness not only at night, but also during the day. Red light also seemed to be a more potent stimulus for modulating brain activities associated with daytime alertness than blue light, although they did not find any significant differences in measures of alertness after exposure to red and blue lights. This suggests that blue light, especially higher levels of blue light, could still increase alertness in the afternoon. It appears that melatonin suppression is not needed for light to have an impact on objective measures of alertness.

“Our study suggests that photoreceptors other than the intrinsically photosensitive retinal ganglion cells respond to light for the arousal system,” said Figueiro. “Future research should look into the spectral sensitivity of alertness and how it changes over the course of 24 hours.”

Sahin, who has more than 10 years of experience in railway engineering, was interested in this study from a transportation safety perspective, and what the results could mean to the transportation industry. “Safety is a prerequisite and one of the most important quality indicators in the transportation industry,” said Sahin. “Our recent findings provided the scientifically valid underpinnings in approaching fatigue related safety problems in 24 hour transportation operations.”

From the present results, it is not possible to determine the underlying mechanisms contributing to light-induced changes in alertness because the optical radiation incident on the retina has multiple effects on brain activity through parallel neural pathways. According to Figueiro, that is an area that she would like to explore in future research.

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