Circadian Effectiveness of Polychromatic Lights:

Suppressing Human Nocturnal Melatonin

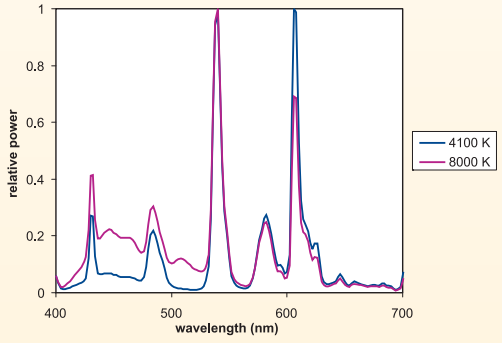
Light incident on the retina provides the stimulus for vision as well as for circadian regulation of biological functions in most animal species.

The human circadian system's spectral response peaks at short visible wavelengths, while the visual system has a peak spectral response at middle visible wavelengths.

In 2005, scientists at the LRC developed a mathematical model for human circadian phototransduction based on neuroanatomy and on empirical data. This model can be used to rank order the relative effectiveness of different light sources in activating the circadian system.

Experiment

The LRC tested the model's accuracy for predicting the relative effectiveness of two polychromatic light sources at suppressing nocturnal melatonin. Forty subjects were subjected to brief exposures to four different light levels (30, 100, 300, and 1000 photopic lux at the cornea) and two different "white" lamp spectra (4100 and 8000 K).

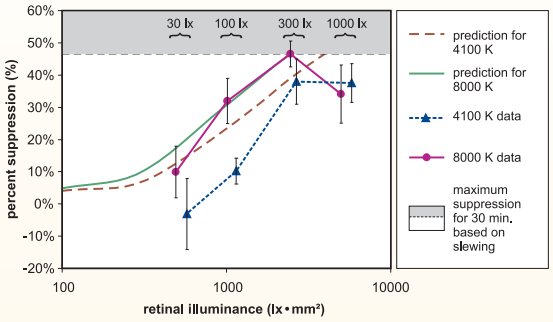


	4100 K lamp	8000 K lamp
CCT	3572 K	6593 K
CRI	82	87
(x, y)	(0.41, 0.41)	(0.31, 0.34)

Relative SPDs, CCT, CRI, and chromaticity coordinates (*x*, *y*) of the light seen by the subjects in the experimental boxes generated by the 4100 and 8000 K fluorescent lamps.

Results

Results suggest that the LRC's model can properly order the relative magnitudes of the two circadian stimuli. However, nocturnal melatonin suppression seems to follow a rate-limited response (slew rate) to light that cannot be predicted from the magnitude of the suppressing light stimulus alone.



Predicted melatonin suppression together with mean (±S.E.M.) measured melatonin suppression values for eight lighting conditions. The predictions are based upon calculations of circadian stimulus using the model for human circadian phototransduction, a four-parameter logistic function for light-induced nocturnal melatonin suppression, and a hypothesized slew rate of light-induced nocturnal melatonin suppression.

This study is a first step toward validating the effectiveness of the LRC's model of human circadian phototransduction. The results may also reveal some practical considerations for applying light to help maintain synchronization between circadian rhythms and environmental events (entrainment).

A journal article published in *Neuroscience Letters* in 2006 details the study and discusses some practical implications of these results.

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