Effects of calibrated changes in light colour along the blue-yellow dimension on the human circadian clock and sleep

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Background: Exposure to short-wavelength (≈480 nm) light in the evening can acutely suppress melatonin and increase alertness, impact on sleep, and induce circadian phase delays. These effects are thought to be mainly mediated via a pathway connecting the retina and the central circadian pacemaker located in the suprachiasmatic nuclei. Melanopsin-containing intrinsically photosensitive retinal ganglion cells (ipRGCs) seem to primarily drive this pathway. The extent to which the colour-sensitive cones contribute is less clear. Particularly changes in light along the blue-yellow dimension of colour vision could have a relevant additional contribution besides the ipRGCs.
Methods: Using calibrated silent-substitution modulations in light colour along the blue-yellow axis, we investigated whether mechanisms of colour vision affect the human circadian timing system and sleep in a Registered Report. In a repeated within-subjects 32.5-hour laboratory protocol, 16 participants (8 women, 18-35 years old) were exposed to three different light scenarios for one hour starting 30 min after habitual bedtime: a control condition ("background", 93.5 lux), intermittently flickering (1 Hz, 30 seconds on/off, against background light) yellow/brighter light (123.5 lux), and intermittently flickering blue/dimmer light (67.0 lux). Importantly, there was no difference in melanopsin excitation (163.2 ± 2.1 lux melanopic EDI) between the conditions. During the scheduled day in the lab, participants were in dim light (mostly <8 lux).
Results: Bayesian statistics did not yield conclusive evidence for differences between the three lighting conditions regarding phase delays (41.7 ± 53 min, sampled from the posterior distribution), melatonin secretion (18.7 ± 8 pg/ml), sleepiness during light exposure (7.8 ± 1.4 on the Karolinska Sleepiness Scale), psychomotor vigilance during light exposure (393 ± 24.4 ms; median reaction time on a 10-min Psychomotor Vigilance Task), or latency to 10 min of continuous sleep (11.4 ± 30.6 min).
Conclusions: In this study, we found no evidence that evening exposure for one hour starting 30 min after habitual bedtime with light changing along the blue-yellow dimension under typical light levels has a major impact on human circadian melatonin secretion, alertness, or sleep. Thus, our work underscores the primary role of melanopsin-containing ipRGCs in mediating the effects of light on circadian phase.