Individual differences in the non-image forming effects of light on human sleep

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Objectives: Non-image-forming (NIF) responses to light modulate human physiology. However, how NIF light responses modulate human sleep and if these effects are different across individuals remain scarcely understood. Here we investigated NIF responses to light on sleep in individuals genotyped for the PERIOD3 (PER3) variable-number-tandem-repeat (VNTR) polymorphism.

Methods: Eighteen healthy young men (20–28 years; mean _ SEM: 25.9 _ 1.2) homozygous for the PER3 polymorphism were matched by age, body-mass index and ethnicity. The study protocol comprised a balanced cross-over design during the winter, in which participants were exposed to light of 40 lux at 6500K (blueenriched) and at 2500K (non-blue enriched), during 2 h in the evening.

Results: Blue-enriched light induced significant increases in all-night NREM sleep slow-wave activity (SWA: 1.0–4.5 Hz) in the occipital cortex only for the PER35/5 individuals, relative to the non-blue enriched ($P = 0.02$). Dynamics of SWA across sleep cycles indicated increased occipital NREM sleep SWA for virtually the entire sleep episode, but only in the PER35/5 individuals. Furthermore, they experienced blue-enriched light as being two times brighter, relative to the PER34/4 individuals ($P = 0.03$). Intriguingly, this subjective perception of brightness significantly predicted their increased occipital SWA throughout the sleep episode ($r = 0.34$, $P = 0.04$).

Conclusions: Our data indicate that humans homozygous for the PER35/5 allele are more sensitive to NIF light effects, as indexed by specific changes in their sleep EEG activity. Ultimately, individual differences in NIF light responses on sleep may depend on a clock gene polymorphism involved in sleep-wake regulation.