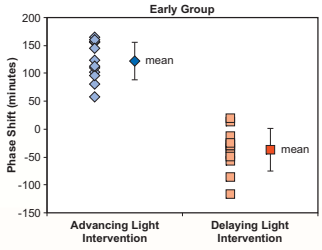
Effects of Chronotype, Sleep Schedule and Light/Dark Pattern on Circadian Phase

Chronotype characterizes individual differences in sleep/wake rhythm timing, which also impact light exposure patterns. The present study investigated whether early and late chronotypes respond differently to controlled advancing and delaying light exposure patterns while on a fixed, advanced sleep/wake schedule.

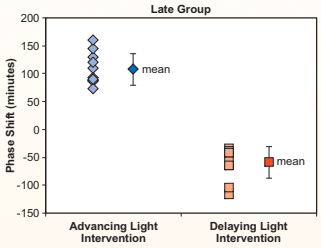
Participants wore orange-tinted glasses and short-wavelength (blue) LED goggles to affect their sleep/wake patterns.

In a mixed design, 23 participants (11 late chronotypes; 12 early chronotypes) twice completed a two-week, advanced sleep/wake protocol, once with an advancing light exposure pattern, once with a delaying light exposure pattern. In the advancing light exposure pattern, participants received short-wavelength light from light emitting diodes (LEDs) (λmax = 476 ± 1 nm, full-width-half-maximum ~ 20 nm) for 2 hours in the morning and short wavelength-restricting orange-tinted glasses that filter nearly all optical radiation below 525 nm for 3 hours in the evening. In the delaying light exposure pattern, participants received 2 hours of short-wavelength restricting orange-tinted glasses in the morning and 3 hours of short-wavelength light in the evening. Personal light/dark and activity/rest patterns were continuously monitored for each participant with a Daysimeter-D. Salivary dim light melatonin onset (DLMO) was also measured at baseline and after each lighting intervention.

The study results showed that, compared to baseline, DLMO was significantly delayed after the delaying light intervention and significantly advanced after the advancing light intervention in both groups. There was no significant difference in how the two chronotype groups responded to the light intervention.



Phase shifts for the 12 participants in the Early Group. The mean ± SD phase advance was 122 ± 34 min when participants were in the advancing light intervention and the mean ± SD phase delay was 37 ± 38 min when participants experienced the delaying light intervention.



Phase shifts for the 11 participants in the Late Group. The mean ± SD phase advance was 108 ± 28 min and the mean ± SD phase delay was 59 ± 28 min when participants experienced the advancing and the delaying light interventions, respectively.

The present results demonstrate that circadian phase changes resulting from lighting interventions are consistent with those predicted by previously published phase response curves (PRC) for both early and late chronotypes. The light/dark exposure pattern is a central consideration because it drives circadian phase, but the homeostatic system also plays a role in affecting behavior, which may consequently affect sleep/wake schedules and light/dark exposures patterns. Future studies should investigate the relationships between chronotype, social schedules, sleep/wake schedules *and* personal light/dark exposure patterns, with the goal of improving sleep, performance and wellbeing.

Publication

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