

Circadian Phase Shifting Response of Long-Evans Rats

The human circadian system exhibits a sub-additive response to polychromatic (“white”) light sources due to spectral opponency formed in the bipolar cells in the human retina. Mice have very rudimentary color vision and do not appear to exhibit circadian sub-additivity in response to white light. Rats, commonly used as experimental animals, have more robust color vision than mice, but it is yet unknown whether they exhibit circadian sub-additivity. Both rats and mice are dichromats with a cross point at approximately 405 nanometers (nm). Polychromatic light sources composed of irradiances in the same side of the cross point are expected to be additive while those composed of irradiance on opposite sides of the cross point are expected to have a sub-additive response.

Method

Phase shifts in wheel running activity onsets from the control and the light pulse periods were used to develop absolute and spectral sensitivity functions in response to 368 nm (ultraviolet [UV]) fluorescent lamps, 476 nm (blue) and 521 nm (green) light-emitting diodes (LEDs) in 64 Long-Evans rats. Additivity tests were performed using polychromatic light sources composed of combinations of fractional irradiances of 476 nm and 521 nm, 476 nm and 368 nm, and 521 nm and 368 nm.

Sponsors

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In this study, rats were exposed to light pulses from ultraviolet “blacklight blue” fluorescent lamps, and blue and green LEDs.

Results

The rats’ phase shifting response to a polychromatic light source composed of the 476 nm and 521 nm light sources was additive (Fig. 1a), as expected, since both light sources stimulated the long wavelength side of the cross point. The additivity tests showed that the rats exhibit an enhanced (“super-additive”) phase shifting response to a polychromatic light source composed of the 368 nm and 476 nm light sources (Fig. 1b) and an additive or super-additive phase shifting response to a polychromatic light source composed of the 368 nm and 521 nm light sources (Fig. 1c), depending on the irradiance combination.

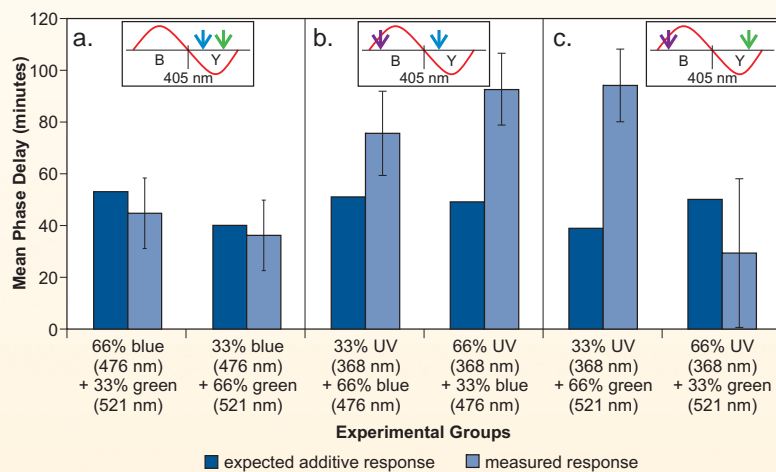


Figure 1. Mean phase delays from combined pulses of blue + green, UV + blue, and UV + green light sources.

Conclusion

A similar study using Sprague Dawley rats is underway. Replication of these results are recommended. If replicated, these results will allow scientists to parametrically study light/dark patterns experienced by humans in animal models to further understand how circadian entrainment and disruption affect biological functions.