New Tools to Measure Light Exposure, Activity, and Circadian Disruption in Older Adults

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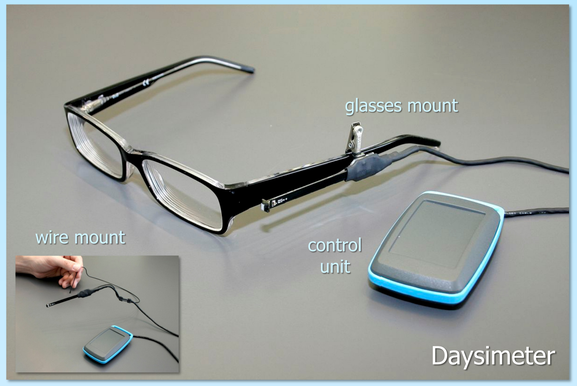
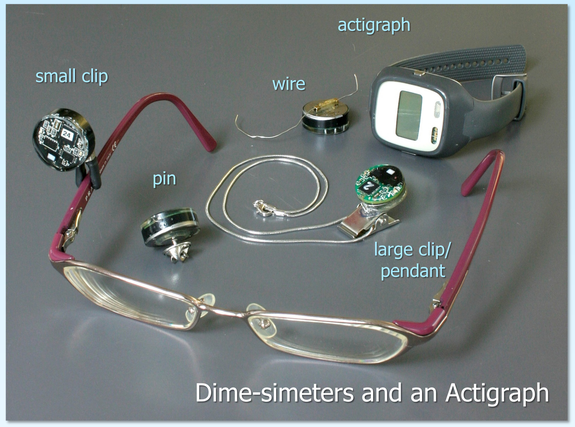
Introduction

Sleep disturbances in older adults may result from a lack of entrainment to a 24-hour light-dark cycle. Clinicians will not fully embrace light treatment for circadian disorders until light treatment has been shown to reliably reduce sleep disturbances in the field. Several practical measurement problems exist for obtaining human circadian light-exposure data as they might relate to quantifying circadian disruption in older adults.

Methods

Each of 14 healthy older adults (age 65 or older) wore a Daysimeter, three Dime-simeters, developed at the LRC, and a commercially available wrist actigraph for seven consecutive days; all devices measured activity as well as light. Saliva samples were collected every four hours. The current version of the Daysimeter is a head-worn device that places a calibrated red-green-blue (RGB) sensor package near the plane of the person's cornea. The Dime-simeter also contains a calibrated RGB sensor package, but is dime-sized and can be worn as a pin, a pendant, or can be attached to glasses or on the wrist.





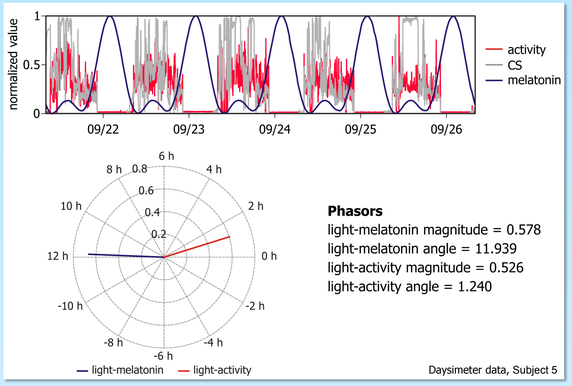


Figure 1.

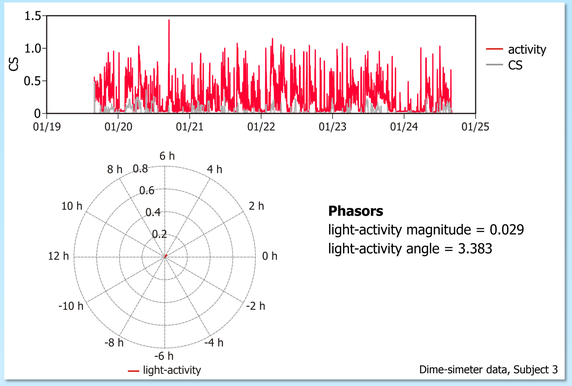


Figure 2.

Results

Phasor analysis was applied to the recorded light and activity data from each device to quantify circadian entrainment. Circadian entrainment has been defined in terms of the temporal correlation between the 24-hour light-dark stimulus pattern and the 24-hour activity-rest response pattern. Like healthy young adults, the healthy older adults exhibit high phasor magnitudes, suggesting good circadian entrainment. Figure 1 shows the results from a healthy 67-year-old subject. In contrast, Figure 2 shows results from an 81-year-old person with Alzheimer's disease with a short phasor and significant circadian disruption. Phasor analysis was also applied to the light and melatonin data. Figure 3 shows, as would be expected from entrained individuals, that healthy older adults have light-melatonin phasors that are separated 180° from the light-activity phasors with similar, high magnitudes.

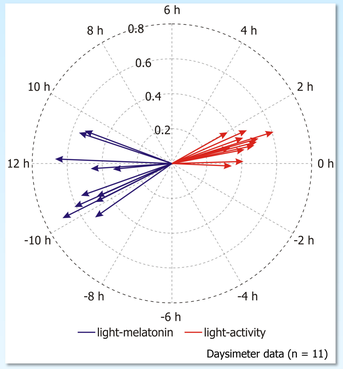


Figure 3. Phasor diagram with individual light-melatonin and light-activity phasors. The mean age of the healthy older adults was 70.5 years ±3.8 years std. dev.

Conclusions

Although the Daysimeter is placed in the proper geometry to measure light incident on the cornea as it would affect the circadian system, the Dime-simeters showed similar phasor magnitudes and angles although the absolute amounts of light and of activity recorded from these calibrated devices differed considerably. These quantities also differed among Dime-simeters when placed at different locations on the body. The actigraph also gave different results, but because it was not calibrated to any known standards, the values obtained from the instrument should only be considered as qualitative.

References

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Acknowledgments

Case Western Reserve University:
Patricia Higgins, PhD; Thomas Hornick, MD

Lighting Research Center, Rensselaer Polytechnic Institute:
Andrew Bierman, Dennis Guyon, Robert Hamner, Barbara Plitnick, Aaron Smith, Brittany Wood

Abstract ID number: 0943
Poster board ID number: 38

Sponsors

National Institutes of Health #R01AG034157, *Methodology Issues in a Tailored Light Treatment for Persons with Dementia*

Trans-National Institutes of Health Genes, Environment and Health Initiative (NIH-GEI), National Institutes of Health #U01DA023822, *Light measuring device for correcting circadian disruption*

SLEEP 2011 25th Annual Meeting of the
Associated Professional Sleep Societies, LLC
Minneapolis, MN, June 2011

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