Light Measuring Device for Correcting Circadian Disruption

Mark S. Rea

Rensselaer Polytechnic Institute

Humans are genetically programmed as a diurnal species, active in the light and asleep in the dark. Commonly, adolescents and young adults experience age-dependent delayed sleep phase with respect to socially accepted activity-rest periods; they commonly are awake until early morning and, except for weekends, experience daily short, unconsolidated episodes of sleep. These intermittent and irregular activity and rest periods result from the inherent conflict between the age-dependent delayed sleep phase and the socially imposed requirements on this age group for work and school. An inability to entrain their activity to a regular, consolidated 24-hour activity-rest pattern obviously reduces sleep duration and efficiency. Compromised sleep then leads to inattention and fatigue when awake and, presumably, to an unusually high degree of psychosocial stress in this population.

The goal of this project is to develop a personal, self-contained circadian light and activity measurement device to help consolidate sleep in young adults and thereby reduce psychosocial stress in this population. Since light and dark are the most important stimuli for circadian entrainment, the envisioned device will record light-dark and activity-rest patterns for several days. Based upon these data, a personal "prescription" for light and dark exposure will be provided to each subject to promote sleep consolidation. The "prescription" will be based upon a phasor analysis of the light and activity data obtained from the personal device. The phasor analysis is a new method for determining entrainment phase and magnitude for individual subjects. The phasor analysis comes from signal processing and determines circadian entrainment based on the synchrony between the light-dark pattern experienced by subjects and their measured activity-rest pattern. The sleep laboratory at Brown University will be the site of the studies to determine how the phasors are affected by a controlled light intervention. Yale University will measure the impact of the light intervention on circadian gene expression. These data will be used to determine whether there is a genetic basis for determining the efficacy of a light treatment.

Proposed measures of psychosocial stress are (i) a stress-trait assessment, (ii) daily markers of stress, (iii) weekly somatic stress responses assessments, (iv) sleep duration and efficiency, and (v) morning cortisol levels. These outcome measures for each person will be correlated with their own phasor magnitudes and angles. It is envisioned that these relationships can then be used as the basis for conducting limited field trials with the developed personal device. Using phasor analysis, entrainment phases and magnitudes will be determined both before and after the light "prescription."