Summary

Background: Since the discovery of ipRGCs (intrinsic photosensitive retinal ganglion cells) in the retina, new research possibilities for studying the effects of light on the regulation of various behavioral and physiological functions that are independent of image formation arose. As ipRGCs are most sensitive to light of short wavelengths (460-480nm), this dissertation focuses on current topics related to the use of blue light, emphasizing its influence on circadian rhythms, sleep and cognitive performance and possible applications in clinical and non-clinical settings.
Aims: The first study aimed to explore the effects of 20 minutes of narrow-bandwidth light exposure of different wavelengths on various neuropsychological and neurophysiological parameters of vigilance in healthy volunteers. The objective of the second study was to assess the effect of combining CBT-I (cognitive-behavioral therapy for insomnia) with wearing blue-light blocking glasses 90 minutes before bedtime on subjective and objective sleep parameters and daily symptoms (anxiety, depression, hyperarousal). The third study aimed to examine subjective sleep quality in a population of healthy volunteers and its association with evening and night light exposure to screens of media devices.
Methods: In the first study, twelve healthy volunteers went through 3 sessions of 20 minutes of light exposure of different wavelengths (455, 508, and 629 nm, with an irradiance of 14 μW/cm2), while EEG was recorded (including ERP (event-related potential) P300 and spectral characteristics) and behavioral data (subjective sleepiness, reaction time) gathered. In the second study, 30 patients completed a CBT-I group therapy program, with groups randomly assigned to either active (blue-light filtering glasses) condition, or placebo (glasses without filtering properties) condition. Patients were continually monitored by wristwatch actigraphy, kept their sleep diaries, and completed a standard questionnaire battery at admission and after the end of the program. Lastly, 693 participants in total completed an online questionnaire battery consisting of several sleep-related questionnaires: PSQI, FSS, MCTQ, MEQ and added questions assessing the timing and character of the evening and night exposure to electronic devices (TV, PC, tablets and phones) and the use of various filters blocking short-wavelength light.
Results: Our analyses showed that the short-wavelength light condition (455nm) in the first study, was found to be the most effective in terms of its alerting effect for the following variables: subjective sleepiness, the latency of P300 response and absolute EEG power in higher beta (24-34 Hz) and gamma (35-50 Hz) range. The second study showed a greater reduction of anxiety symptoms in the active vs. placebo group of patients and significant prolongation of subjective total sleep time in the active group. When pre- and post-treatment results were compared in both groups separately, significant differences were observed for the scores in the depression and hyperarousal scales in the active group only. In the active group, there was also a significant reduction of subjective sleep latency and an increase of subjective total sleep time without a change in objective sleep duration which was significantly shortened in the placebo group. In the third study, our analyses showed that longer cumulative exposure to screen light in the evening was associated with greater sleep inertia in the morning and longer sleep latency on workdays. Furthermore, exposure to screen light 1.5h before sleep or during night awakenings was also associated with a decreased chance to wake up before the alarm time, larger social jet-lag, more pronounce daytime dysfunction, decreased subjective sleep quality, and more fatigue. A statistical trend for an increase in the duration of sleep on weekdays was also found in participants using blue-light filters in the evening hours.
Conclusion: Our results provide valuable insight into the alerting effects of short-wavelength (blue) light. We also show that avoiding blue-light in the evening may help reduce the phase-delaying effect of light and facilitate an improvement in sleep parameters and psychiatric symptoms. Altogether, these results may contribute to the development of new lighting or light-filtering systems and may also be applicable for healthy sleep promotion in both the general and clinical populations.