

How SMART is it to go to bed with a PHONE?

The impact of blue-enriched smartphone light exposure before falling asleep on sleep-dependent memory consolidation in adolescents

Recently, the use of blue-enriched light in electronic devices for reading, communication, and entertainment has increased immensely, especially in children and adolescents. As empirical evidence indicating that blue-light exposure (~450 nm) before sleep onset disturbs sleep quality is accumulating, we are interested in whether sleep-related memory consolidation processes and affective functioning are also modulated by blue-light exposure during bedtime in an adolescent population. The main objective of the present proposal is to focus on three research questions: (1) Does blue-light exposure (via smartphone) before falling asleep impact sleep physiology?, (2) Does blue-light exposure initiate changes in circadian timing (melatonin/cortisol secretion, body temperature)?, and (3) Does smartphone blue-light impact consecutive sleep-dependent declarative memory consolidation (as there is a disturbance/change in sleep physiology) as well as affective functioning? 60 adolescents aged between 16-18 years will be tested. The experiment will last five weeks in total, including 6 nights (3 adaptation and 3 experimental nights). Over the whole period of the study, the sleep-wake cycle will be monitored with sleep logs and actigraphy, and smartphone-use will be tracked with a mobile device application. During the laboratory nights, polysomnography, body temperature, salivary melatonin/cortisol levels and stress as well as affect scores will be measured. Light stimulation will take place during the last 2h before lights off. All adolescents will participate in three experimental light-conditions in a randomized order each separated by one week: (i) NORMAL, (i.e., smartphone use with regular screen, rich with blue light waves), (ii) FILTER, (i.e., orange-tinted blue light filter application) and (iii) ZERO (i.e., no smartphone use). To investigate the impact of smartphone usage before falling asleep on memory consolidation processes, we will assess declarative memory performance in a word-pair association task before and after sleep. In general, we expect blue-light exposure during bedtime to have a negative impact on sleep. More precisely, we assume that use of blue-light devices (NORMAL) (i) increases sleep latency while reduces the duration of NREM3 and REM sleep, (ii) leads to an attenuation of the evening increase in melatonin and subjective sleepiness as well as an increase in individual stress levels and negative affect scores, and (iii) decreases NREM2 sleep spindle activity (12-15Hz) and sleep-related memory consolidation compared to devices with an orange-tinted blue light filter (FILTER) or refraining from electronic devices at all (ZERO). Overall, this project will greatly contribute to our mechanistic understanding of the impact of technology in the bedroom to adolescents' sleep, memory consolidation and emotion regulation – a question that has never been so timely. Adolescents in industrialized nations are well known to be the most sleep-deprived population in society with currently limited knowledge of these effects on their cognition and well-being. We are convinced that our research proposal will offer significant and highly relevant scientific output that is further echoed by immense societal relevance.