Title: The effects of screen illumination on: sleep efficiency and architecture, physiology, emotion and behavior- possible effect on human health

Theme: Health

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Introduction

Millions of computers, tablets, TVs, and smart-phones are sold every month worldwide and the use time of these devices is increasing constantly. Today, people are exposed to long-term illumination that emerges from the screens of these devices that emit short-wavelength (SWL) lighting, during day and night hours. The results of previous studies showed that these devices emit SWL-lighting, which can suppress melatonin (MLT) production and affect sleep (Cajochen et al., 2011, Chang et al., 2012; Wood et al., 2013). In order to better understand the relationship between exposure to SWL-screen illumination and human behavior, measurements that examine the effect of luminescence from these screens on sleep structure and quality should be used, as well as on functioning indicators, such as cognitive (CPT-III), emotional (BSI), and physiological tasks variables that were not simultaneously tested in previous studies.

Research layout: 19 subjects were studied using repeated measurements on two independent variables. The first independent variable is two levels of light intensity: low level - 84 lux and high level - 350 lux. The second independent variable is two wavelength conditions: short-wavelength – blue, about 485 nm, and long-wavelength – red, approximately 610 nm. Each participant was experience all four experimental conditions.

Procedure: Subject were asked to sit in front of a computer screen for two hours at a distance of about 60 cm from the screen and perform the on-screen tasks between the hours of 21:00 and 23:00 h. At the end of two hours of exposure to screen light, the subjects were connected to the sleep test system. Body temperature was measured at 21:00, 23:00, and close bedtime. Three measurements were taken 0, 60, and 120 min after awakening CPT test, BSI questionnaire, and the ESS questionnaire were preformed at the morning.

Results:

Body temperature: According to the hypothesis, exposure to SWL caused non-dropping of body temperature in contrast to normal dropping of body temperature after exposure to illumination with long wavelength light ($F_{(5,14)}$ =6.9, *p<0.05).* **Sleep architecture:** We found a main effect of type of wavelength on sleep architecture, time and sleep efficacy (SE). Short wave length caused a significant decrease in Total Sleep Time $F_{(1,18)}$ =21.45, *p<0.05*, deceased SE $F_{(1,18)}$ =24.5, *p<0.05*, increased Sleep latency $F_{(1,18)}$ =14.03, *p<0.05*, and increased nocturnal Wake time $F_{(1,18)}$ =24.39, *p<0.05*, decreased Slow Wave Sleep $F_{(1,18)}$ =42.549, *p<0.05*, compared to long wavelength. **ESS**: We found a main effect of wavelength on the ESS, with subjects reported higher sleepiness scores after exposure to SWL compared to long wavelength, $F_{(1,18)}$ =4.8, *p<0.05*. **BSI:** Analysis did not yield significant results, although subjects did report more negative feelings after exposure to SWL in the high intensity light condition. **CPT**: Two of eight CPT parameters were significant. SWL increased significantly d' and omissions $F_{(1,18)}$ =5.34, *p<0.05*, $F_{(1,18)}$ =6.019, *p<0.05.*

Discussion: SWL screen illumination prevents the normal decline in the body temperature curve at night. SWL decreased total sleep time (TST), sleep efficiency (SE), and slow wave sleep (SWS), increased sleep latency and light sleep. Subjects reported significant sleepiness after SWL illumination at night. In CPT test subjects made more errors in the SWL condition. The results of this study show that exposure to SWL from computer screens at night may have negative effects on health

References

Cajochen C, Frey S, Amdres D, et al. (2011). Evening exposure to light –emitting diodes (LED)-backlit computer screen affects circadian physiology and cognitive performance. J. App Phhysiol. 110: 1432-1438.

Chang AM, Shanthi N, st Hilaire M, et al. (2012). Human response to bright light of different durations. J. Physiol. 590: 3103-3112.

Wood B, Rea MS, Plitnick B, Figueiro MG. (2013). Light Level and of exposure determine the impact of self-luminous tablets on melatonin suppression. Appl. Ergon. 44: 237-240.