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Effects of Low-Wavelength Light on the Continuous Performance Test and Subjective Sleepiness, Alertness and Fatigue

Kayumov L, Sokalsky S, Lowe A, Hawa R, Moller H, Bulmash EL, Hossain NK, Shapiro CM

Sleep Research and Human Performance Laboratory, Dept. of Psychiatry, University Health Network, Toronto, ON, Canada

Introduction: The goal of this study was to evaluate the effect of the absence of low-wavelength (<530 nm) light on subjective sleepiness/alertness/fatigue and objective performance. Subjective parameters were measured using the Stanford Sleepiness Scale (SSS), 7-item Fatigue Scale (FS), 7-item Alertness Scale (AS), Fatigue/Sleepiness/Alertness Visual Analogue Scales (VAS-F/VAS-S/VAS-A), and the Toronto Hospital Alertness Test (THAT) questionnaires. Objective performance of the subjects was evaluated on the Continuous Performance Test (CPT), a measure of sustained attention, by examining both errors of omission (i.e. failing to respond to target) and commission (responding to target inappropriately) along with the subjects reaction time. High errors of omission and/or commission suggest poor task orientation while a slow reaction time coupled to such errors would indicate inattentiveness.

Methods: The study data was taken from a group of 19 subjects (11 male, 8 female, mean age 24.7+/-4.6 years) over two nights (20:00 to 08:00h). All subjects underwent two overnight studies. Half of the group was shielded from low-wavelength light (wearing specific goggles) the first night and the other half were exposed to normal lighting conditions (both at 800 lux). The second night the groups switched conditions. Both nights, the subjects completed the subjective questionnaires (at 2 hours intervals) and CPT (at 3 hours intervals) throughout the night. The general linear model was used for the statistical analysis of all parameters (using SPSS for Windows).

Results: There were no significant differences in performance or subjective scores between the two nights. The SSS showed a normal circadian variation, with the sleepiest time between 6 a.m. and 8 a.m. during both the filtered and normal lighting conditions (F=37.7, p=0.0001, df=2.7; F=44.8, p=0.0001, df=3.3, respectively). The same pattern was observed on the FS in both conditions (F=38.3, p=0.0001, df=2.7; F=43.7, p=0.0001, df=3.4, respectively). The worst level of alertness was observed in the same time interval on both nights (F=30.8, p=0.0001, df=2.9; F=47.4, p=0.0001, df=3.8, respectively). The THAT and the VAS had similar circadian profiles on both nights as well. Interestingly, none of the CPT parameters revealed significant circadian variations throughout both nights, except for reaction time slowing towards the morning hours under filtered light (F=4.3, p<0.01, df=2.6). However, reaction time did not significantly differ at any time interval between the two conditions.

Conclusion: Taken together, the analysis of both subjective and objective data shows that the subjects were not affected by the absence of low-wavelength light. The same level of attentiveness and psychomotor performance were observed in both the presence and absence of low-wavelength light. Despite the circadian variations observed on the subjective scales, the subjects were able to perform at the same level throughout both nights. This emphasizes the discrepancy between objective testing, self-awareness and its relevance to performance levels.

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Evening Naps and Caffeine as Countermeasures for Sleepiness During Night Shift: A Field Study

Schweitzer PK,[1] Stone KL,[1] West AJ,[1] Erman MK,[2] Mitler MM,[2] Walsh JK[1,3]

(1) Sleep Medicine and Research Center, St. Johns Mercy Medical Center/St. Lukes Hospital, St. Louis, MO, USA, (2) Pacific Sleep Medicine Services, La Jolla, CA, USA, (3) Department of Psychology, St. Louis University, St. Louis, MO, USA

Introduction: Caffeine and/or napping prior to the night shift improves alertness and sustained attention in a 4-night simulated shift protocol, with the combination of napping and caffeine being slightly better than either napping or caffeine alone. The effectiveness of these combined countermeasures was tested in a field study during actual night shift work.

Methods: Subjects (Ss) at 2 study sites participated in a 4-consecutive-night crossover study comparing 2 conditions: (1) evening nap prior to the night shift on the first 2 nights plus caffeine 300 mg on all 4 nights (NC), and (2) placebo without napping all 4 nights (P). Condition order was counterbalanced. Thirty-nine Ss complied with the protocol and completed both study arms (28 m, 11 f; mean age 33, range 20-54). Caffeine or placebo was taken at the start of each shift. Three times during each night (at start, midway, and end of shift) Ss completed a 15-minute psychomotor vigilance task (PVT), the Karolinska Sleepiness Scale (KSS), and the Profile of Mood States (POMS). Ss slept at home during their usual hours, kept a sleep diary, and were monitored actigraphically. ANOVAs with repeated measures for condition, night, and time of night were the primary statistical method. A reciprocal transformation was used for reaction time of the slowest 10% of PVT responses (RT10) and a square root transformation was applied to PVT lapses (i.e., reaction time > 500 msec). Because of technical problems complete actigraphy data are available for only 25 Ss.

Results: Actigraph-estimated total sleep times (ATST) during the 2 NC evening naps were 73 and 58 minutes. ATST for daytime sleep did not differ between conditions; mean ATST for days 1-3 were 276, 312, and 316 minutes for NC, and 298, 333, and 304 minutes for P. In contrast, Ss reported sleeping less following nights 1 and 2 in the NC condition compared to P (p < .01). RT10 worsened across nights 1-4 (F(3,93)=17.5, p<.001) and showed a condition by time interaction (F(1,31)=8.7, p=.006). For P only, RT10 worsened from shift start (2.54) to shift end (2.24). In addition, at shift end, P RT10 was worse (2.24) than NC RT10 (2.43; p=.04). PVT lapses also showed a condition by time interaction (F(1,31)=5.0, p=.03). Transformed lapse frequency increased from 3.56 at shift start to 4.44 at shift end for P with no change for NC during the night. Lapses were more frequent across nights 1-4 (F(3,93)=15.5, p<.001). Mean transformed numbers of lapses were 2.88, 3.73, 4.37, and 4.23 for NC nights 1-4, and 3.38, 3.94, 4.3, and 4.38 for P nights 1-4. Subjective sleepiness showed a condition by time interaction (F(1,31)=13.0, p=.001) with increased sleepiness at shift end during P compared to NC (KSS=6.3 vs 5.6, p=.006). There was no change in sleepiness ratings across nights 1-4.

Conclusion: This rare field study of night shift workers documented that: 1) performance and alertness declined late in the night shift, 2) alertness and performance did not improve across successive night shifts (as found in some laboratory simulations), 3) a combination of napping and caffeine had modest positive effects on performance and subjective sleepiness in the early morning hours, and 4) daytime sleep duration of night workers is frequently less than 5 hours.

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