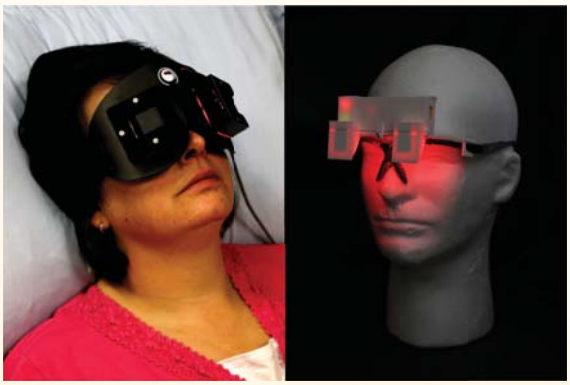
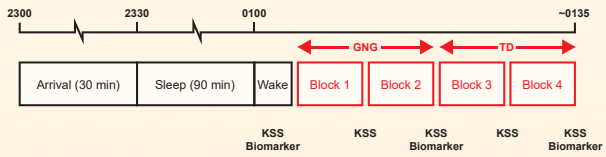
Red Light Delivered During Sleep to Reduce Sleep Inertia

Sleep inertia is a term associated with grogginess and poor performance after waking. The goal of this study was to investigate whether retinal exposure to red light prior to or following waking reduced sleep inertia as measured by performance tasks and self-reports of sleepiness.

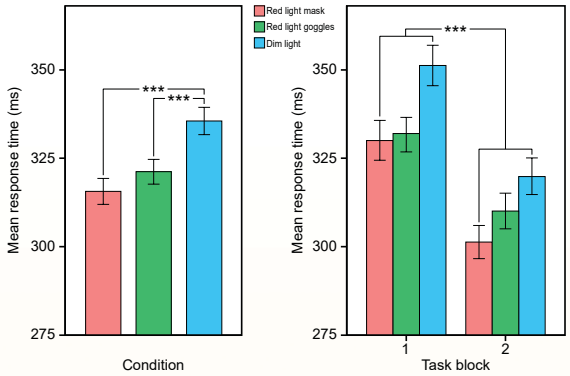
Every participant (n = 20) slept in the laboratory for 90 minutes, followed upon awakening by a 35 minute test session where they performed two auditory performance tasks and provided self-reports of sleepiness. All participants were exposed to three experimental conditions on separate nights, one week apart: (1) a "dim light" condition where participants were awakened and not exposed to any light treatment while their eyes were open; (2) a "red light goggles" condition where participants' corneas were exposed to 50 lx of red light from 631 nm LEDs while their eyes were open after awakening; and (3) a "red light mask" condition where participants' corneas were exposed to 56 lx from 628 nm LEDs through closed eyelids while sleeping and, upon awakening, participants received no red light with their eyes remaining open.



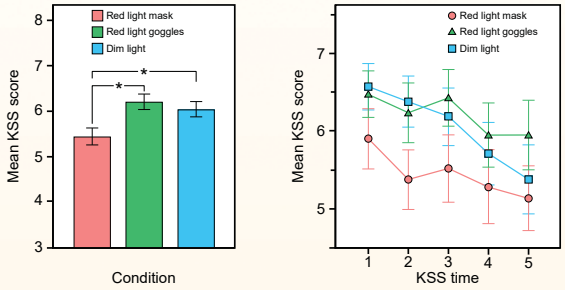
The red light mask and the red light goggles used in the study.



Subjects were administered a "go/no-go" (GNG) task (Blocks 1 and 2) and a "target detection" (TD) task (Blocks 3 and 4). The GNG task presented a target ("go") tone and an inhibitor ("no-go") tone. A response to a "no-go" tone was recorded as a "false positive;" lack of response to a "go" tone was recorded as a "missed stimulus." The TD task presented either a "warned" or an "unwarned" stimulus, the former involving a warning plus a target stimulus and the latter involving only a target stimulus. Premature responses were recorded as a "false positive," responses between the warning and target stimuli were recorded as a "false positive," and response times > 500 ms were recorded as a "miss." As indicated in this figure, subjects were also administered Karolinska Sleepiness Scale (KSS) questionnaires and biomarker (salivary melatonin and cortisol) assays (not reported here) throughout the study's experimental condition.



Mean response times to alertness tasks across conditions. The error bars represent confidence intervals and the asterisks represent statistically significant differences (p < 0.001).



Mean ± standard error of the mean of KSS scores recorded across conditions and questionnaire administration times, ranging from 1 ("extremely alert") through 9 ("very sleepy, great effort to keep awake, fighting sleep"). The asterisks represent statistically significant differences (p < 0.05).

Results

- Compared to the dim light condition, auditory performance was significantly better for the two red-light conditions.
- Subjects' performance and alertness improved the longer they were awake.
- Subjects reported feeling more awake after the red light mask condition compared to the other conditions.

Implications for Practice

Light delivered through closed eyelids can be used to help reduce sleep inertia and reduce reaction times (i.e., improve performance) in those who need to awaken for tasks in the middle of the night, such as submariners, warfighters, firefighters, medical residents, etc.

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