Investigating the Effects of Exposure to Blue-Enriched Light or Peppermint Odor on Alertness, Mood, and Performance Upon Awakening from Deep Sleep at Night

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Introduction

- Sleep inertia refers to the brief period of impaired alertness and cognitive performance experienced immediately after waking from sleep.
- This period of impairment poses a significant safety risk to military personnel who may be required to perform safety-critical tasks soon after waking.
- We investigated two countermeasures to mitigate the neurobehavioral consequences of sleep inertia following awakening from deep sleep at night.

Methods

- N = 12 participants (6F; 23.3 ± 4.2 y) completed a two-week, within-subjects, randomized, cross-over intervention study including two in-laboratory overnight visits.
- Prior to each laboratory visit, participants followed an at-home sleep schedule of 8.5 h for 5 nights and 5 h for 1 night (Fig. 1).
- During each overnight visit, participants performed baseline (BL) tests pre-sleep and experienced one intervention (**light** or **peppermint**) and a **control** condition upon awakening from slow wave sleep (SWS) (Fig. 1).
- At 2, 17, 32, and 47 min after awakening (Test Bouts 1-4), participants completed a 5-min psychomotor vigilance task (PVT), a subjective scale of alertness (Karolinska Sleepiness Scale, KSS), and visual analogue scales (VAS) of mood (Fig.1, inset).
- Following this sleep inertia measurement period, all lights were turned off and participants were allowed to return to sleep. They were then awoken again from their subsequent SWS period and exposed to the alternative condition (control or intervention). Following this second awakening, participants were allowed to sleep until their habitual wake time (Fig. 1).
- The **control** condition involved a dim, red ambient light (<1 lux) (Fig 2A). An odorless mask was also worn in the peppermint control condition.
- The **light** intervention involved exposure to a blue-enriched light canvas, illuminated for 1 hour (243 lux, 338 melanopic lux at angle of gaze) (Fig. 2B).
- The **peppermint** intervention involved wearing a mask infused with peppermint oil over the nose and mouth for 1 min in dim, red light (Fig. 2C).

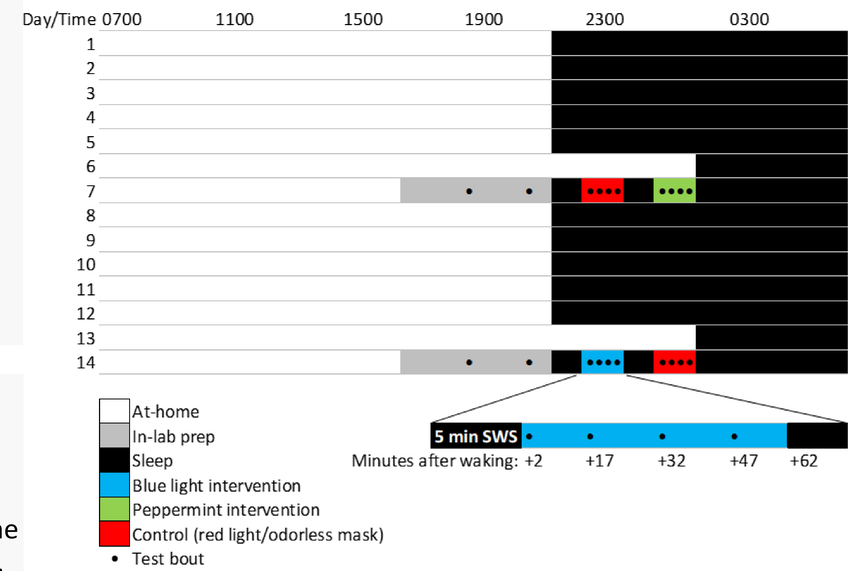

Fig. 1: Protocol overview

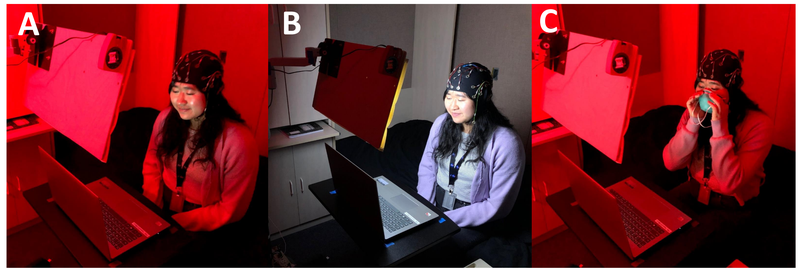

*Fig. 2: Example set up for: A) **Control** condition; B) **Light** intervention; C) **Peppermint** intervention*

Results

- Compared to the **control** condition, participants exposed to blue-enriched **light**:
  - had fewer PVT lapses ($\chi 2 = 5.285$, $p = .022$),
  - felt more alert (KSS: $F_{1,77} = 4.955$, $p = .029$; alert: $F_{1,77} = 8.226$, $p = .005$), and
  - had better mood (cheerful: $F_{1,77} = 8.615$, $p = .004$; depressed: $F_{1,77} = 4.649$, $p = .034$; lethargic: $F_{1,77} = 5.652$, $p = .020$).
- Exposure to **peppermint** oil did not improve any outcome measures on any of the tasks compared to control condition (all $ps > .05$).

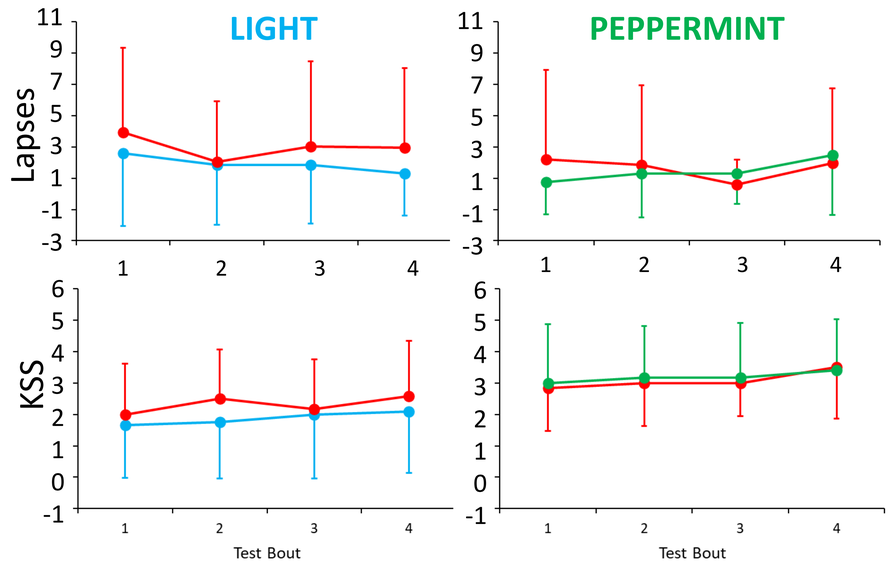

*Fig. 3: Mean (± SD) change from baseline: Lapses (top); Karolinska Sleepiness Scale (KSS, bottom) in the **light** (left); **peppermint** (right) intervention compared with **control***

Discussion

- Participants had fewer lapses of attention and reported feeling more alert, more cheerful, less depressed, and less lethargic upon awakening when exposed to blue-enriched **light** compared to dim, red light. Brief exposure to a **peppermint** odor, however, did not appear to improve performance, alertness, or mood under the experimental conditions.
- Continued exploration into light and other reactive countermeasures, and potentially their combination, is needed in order to provide evidence-based guidance on effective sleep inertia countermeasures.

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