

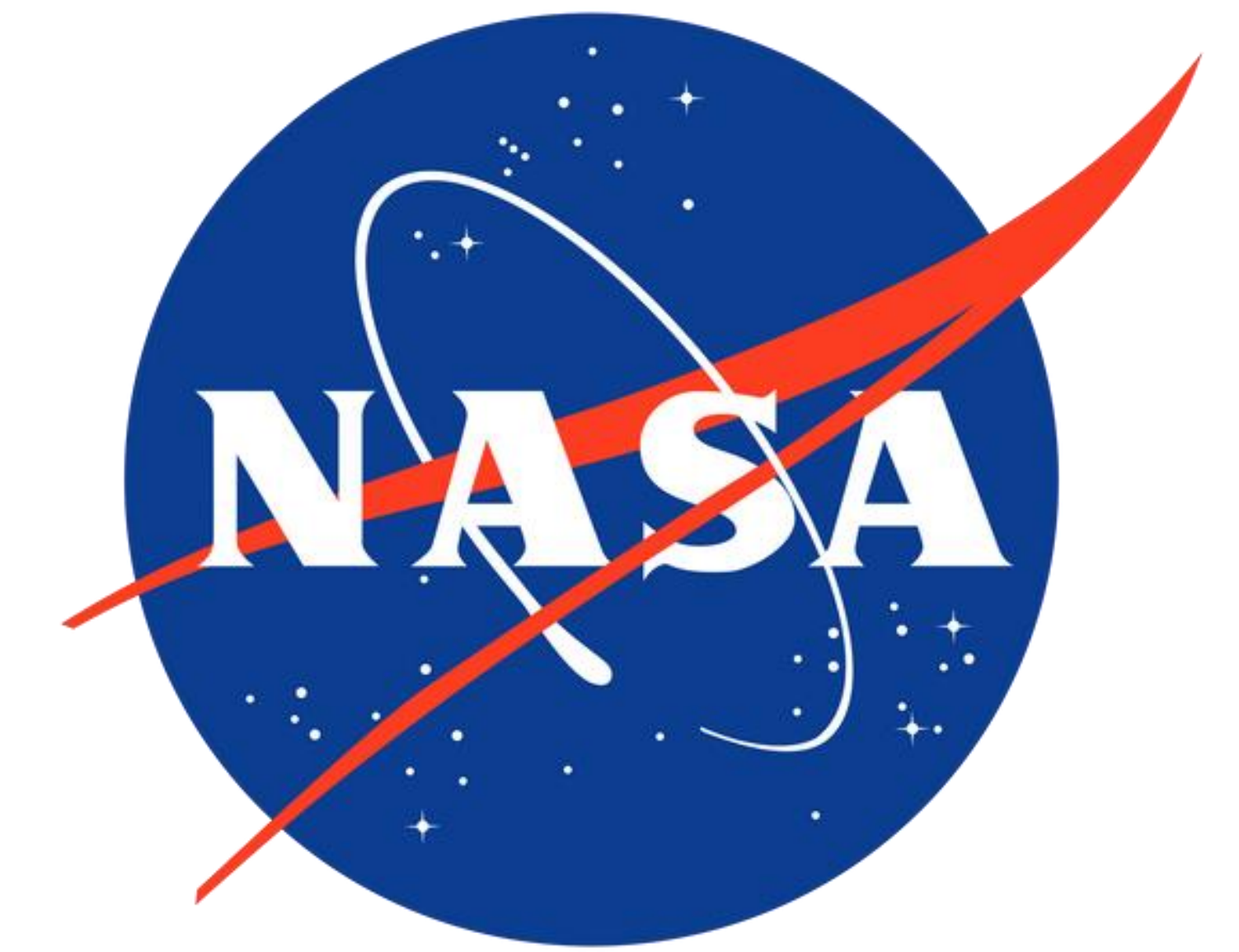


Effect of a Light Intervention on Morning Sleep Inertia Symptoms

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Introduction

- Light exposure at night improves sleep inertia symptoms in laboratory and at-home settings¹.
- Previous research suggests that light exposure in daytime is less effective in reducing sleep inertia².
- This study examines the effects of light exposure on sleep inertia upon morning waking in an at-home setting.

Methods

- $N = 29$ healthy adults (16 female; $27.1 \text{ years} \pm 5.1$).
- Participants slept in their own homes and were remotely monitored via an infrared camera.
- Study staff called participants on a pre-set cell phone at their habitual waketime the morning after an experimental night.
- After awakening, participants donned light-emitting glasses and were randomly assigned to the on (**light intervention**) or off (**control**) condition.
- Test battery: a visual 5-minute Psychomotor Vigilance Task (PVT; NASA PVT+ App), Karolinska Sleepiness Scale (KSS), nine visual analog scales (VAS) of mood, and a 3-minute auditory/verbal Descending Subtraction Task (DST) performed at 2 (T1), 12 (T2), 22 (T3), and 32 (T4) minutes after awakening.
- Mixed-effect models were performed with fixed effects of test bout (T1-T4), condition (**control**, **light**), and test bout $\times$ condition, with a random effect of participant (intercept). Covariates: baseline scores, duration of ambient light exposure > 10 lux during the testing period (Actiwatch Spectrum PRO), total sleep duration from the prior night (EEG), sex, and randomization order.

Results

- There was a significant main effect of condition for PVT Speed with those in the **light condition** performing worse than the **control condition** ($p = .049$) (Fig. 1A).
- There was a significant main effect of test bout for PVT Lapses ($p = .028$) (Fig. 1B), DST Total Responses ($p = .023$), DST Correct Responses ($p < .001$) (Fig. 1C), and VAS Alert ($p < .001$) (Fig. 1D), with impairment dissipating across time since awakening.
- There were no other significant main or interaction effects ($p > .05$).

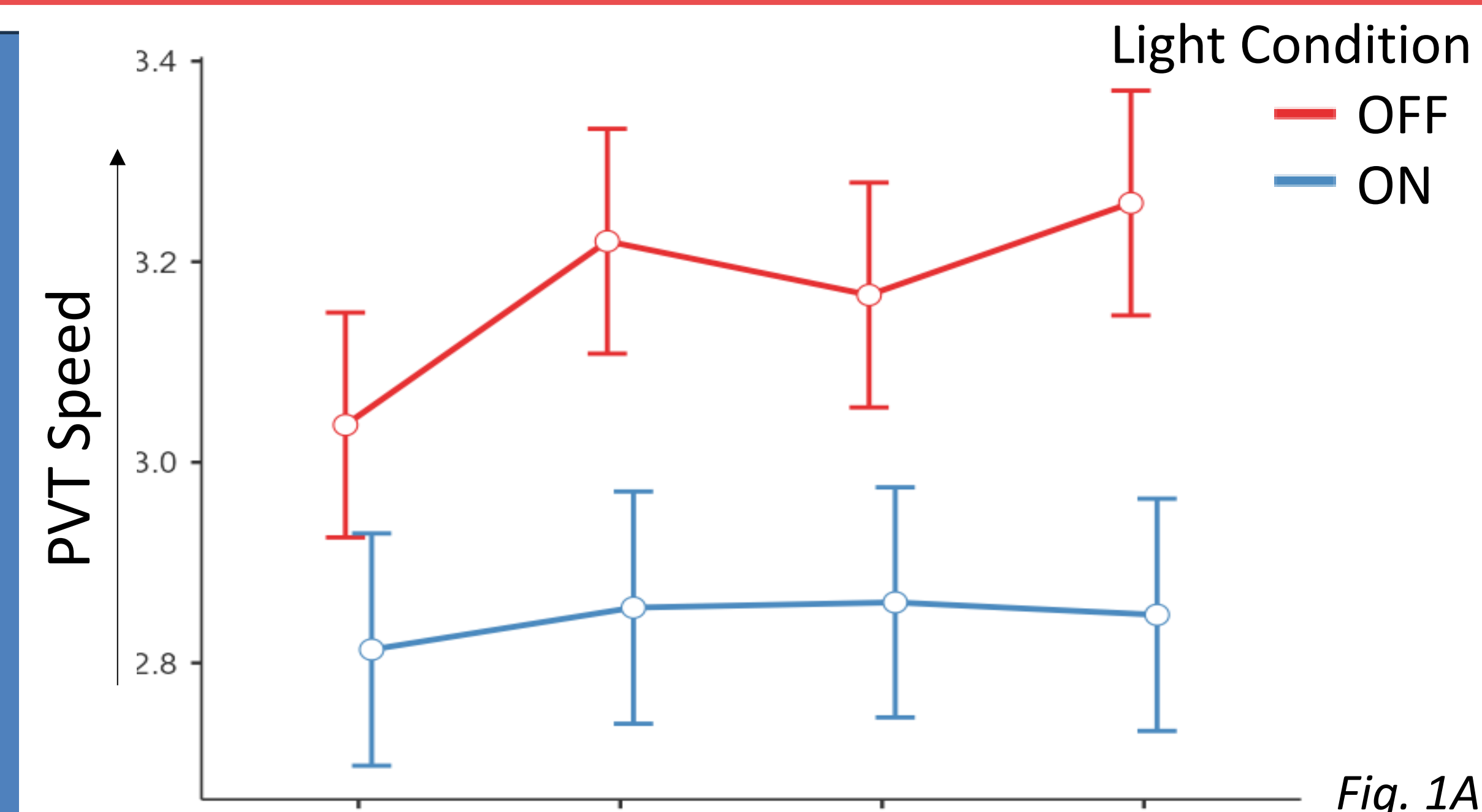


Fig. 1A

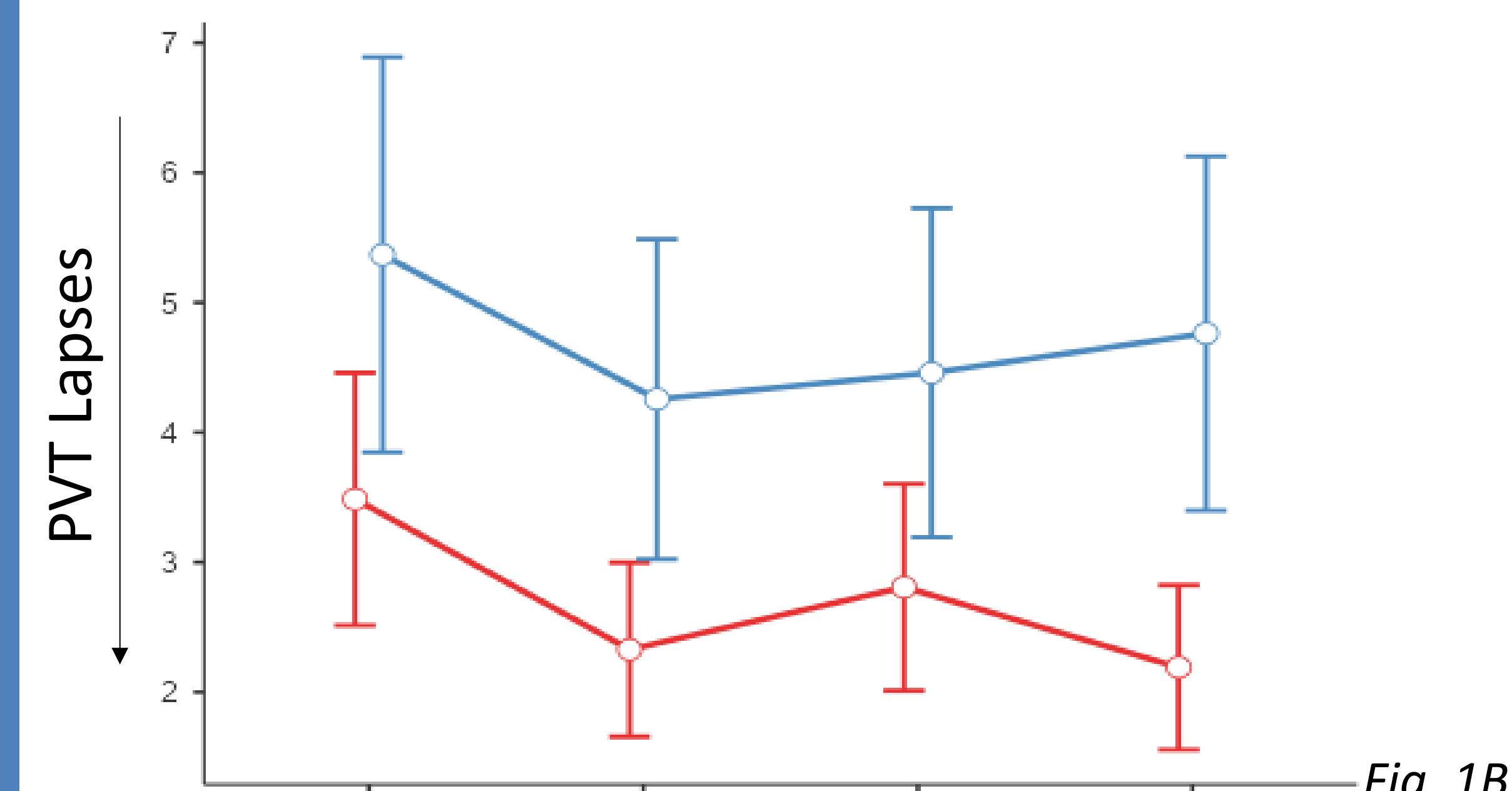


Fig. 1B

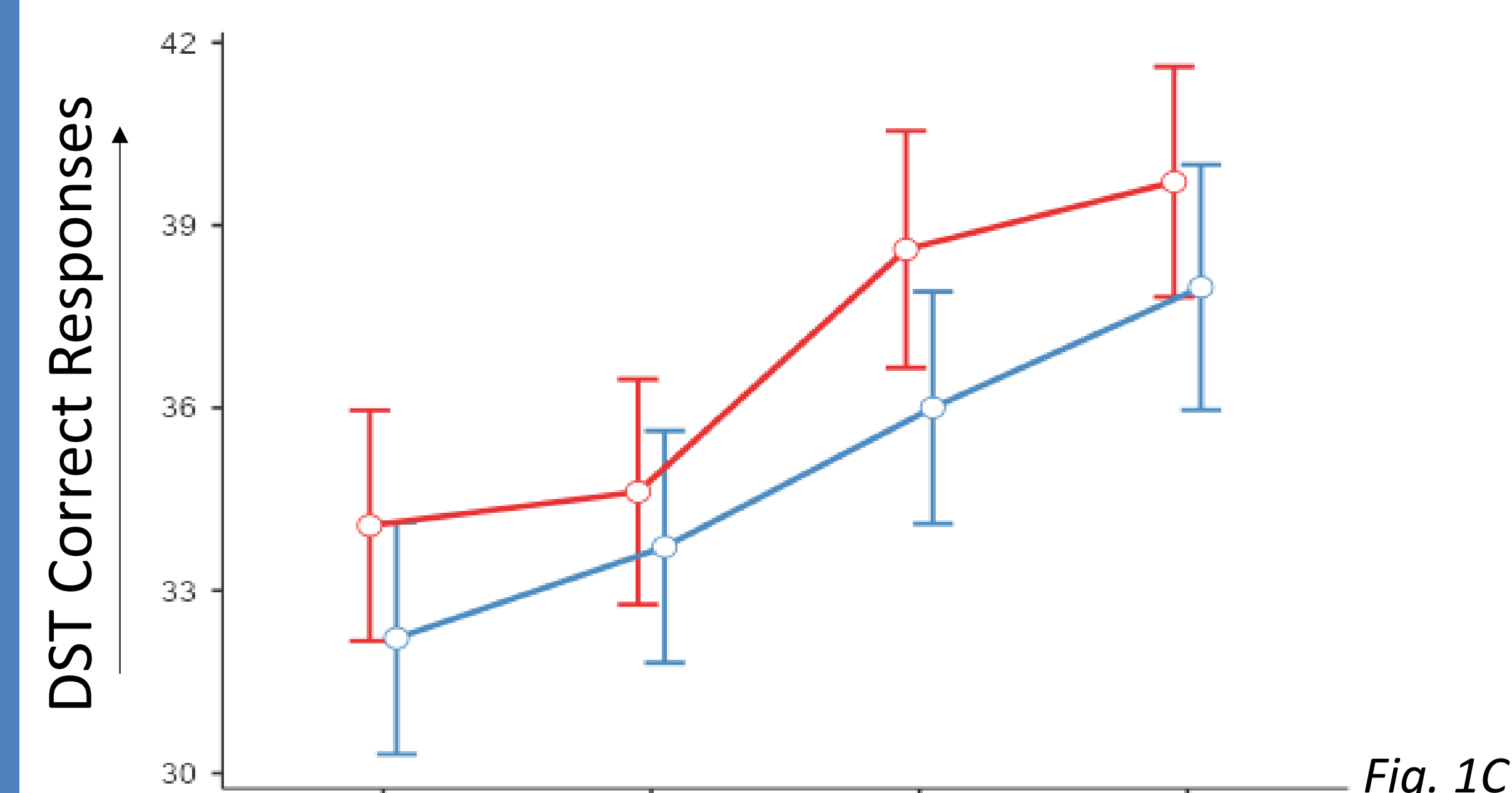


Fig. 1C

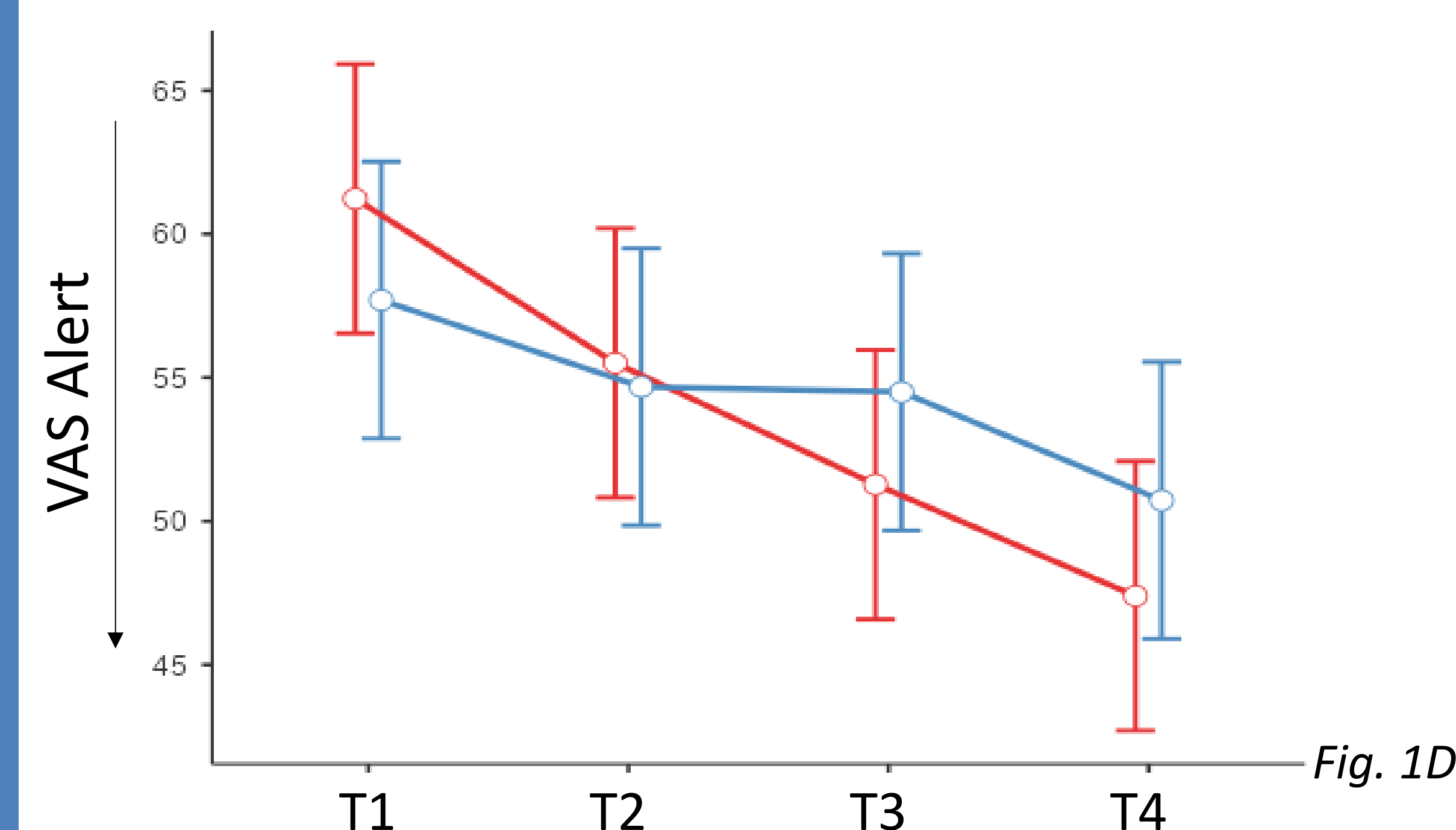


Fig. 1D

Figure 1.

Estimated marginal means ($\pm$ SE) for (A) PVT Speed (1000/reaction time, RT [ms]), (B) PVT Lapses (count of RT > 500 ms), (C) DST Correct Responses (count), and (D) VAS Alertness (100-point scale, 0: Alert - 100: Sleepy). **Blue: (intervention light ON); Red: control (intervention light OFF)**. Arrows represent direction of better performance/alertness.

Discussion

- These findings align with previous studies² suggesting that light exposure has limited effectiveness after waking in the morning.
- Consistent with results during the experimental night¹, performance on a visual PVT was worse in the light intervention condition. This may be due to glare from the light glasses interfering with screen visibility.
- Consistent with these observations, no impairment (nor improvement) was observed for the non-visual DST.
- Future research comparing different delivery methods of light, timing of light exposure, and assessment of visual comfort/acuity may yield more insight into the observed effect.
- Previous research at night¹ showed that light was more effective following awakening from N3 sleep. The current sample was too small to investigate this finding, although similar trends were observed in a subset waking from N3 ($n = 4$).
- We attempted to account for the effects of ambient light by including exposure as a covariate. Future research should explore whether specialized light interventions provide benefits beyond exposure to natural light, or common indoor lighting.

References

1. Hilditch, CJ, Pradhan, S, Costedoat, G, Bathurst, NG, Glaros, Z, Gregory, KB, Shattuck, NL, & Flynn-Evans, EE. (2024). An at-home evaluation of a light intervention to mitigate sleep inertia symptoms. *Sleep Health*, 10(1, Czeisler Festschrift Supplement), S121–S129.
2. Santhi, N, Groeger, JA, Archer, SN, Gimenez, M, Schlangen, LJM, & Dijk, D-J. (2013). Morning sleep inertia in alertness and performance: effect of cognitive domain and white light conditions. *PLOS ONE*, 8(11), e79688.