Investigating Cognitive Control and Chronotypes in Psychomotor Vigilance Task using EEG

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Introduction

Background

- Human cognitive performance varies throughout the day, peaking in the afternoon and dipping early in the morning and late at night. These fluctuations are closely tied to the body's natural circadian rhythms(Blatter et al., 2007)
- The Psychomotor Vigilance Task (PVT) is a simple and reliable measure of cognitive performance, frequently used in circadian and sleep research. Previous studies suggest that the interaction between chronotypes (morning-types vs. evening-types) and the time of day significantly affects vigilant attention. Martínez-Pérez et al. (2020) found that the impact of chronotype on vigilant attention is more pronounced in evening-types than in morning-types.
- The P1 component is directly related to cognitive control mechanisms that are activated during tasks requiring sustained attention, such as the PVT. (Ahumada-Ménde et al,2022)

Research Question

- How individual chronotypes and time of day interact to influence cognitive control performance during the PVT?
- H_0 for Behavioural data: There is no significant difference in reaction times on the PVT between morning and evening sessions.
- H_0 for EEG data: There is no significant interaction between individual chronotypes and time of day on the P1 ERP component. (Ahumada-Ménde,2022)

Methods

Experimental Design:

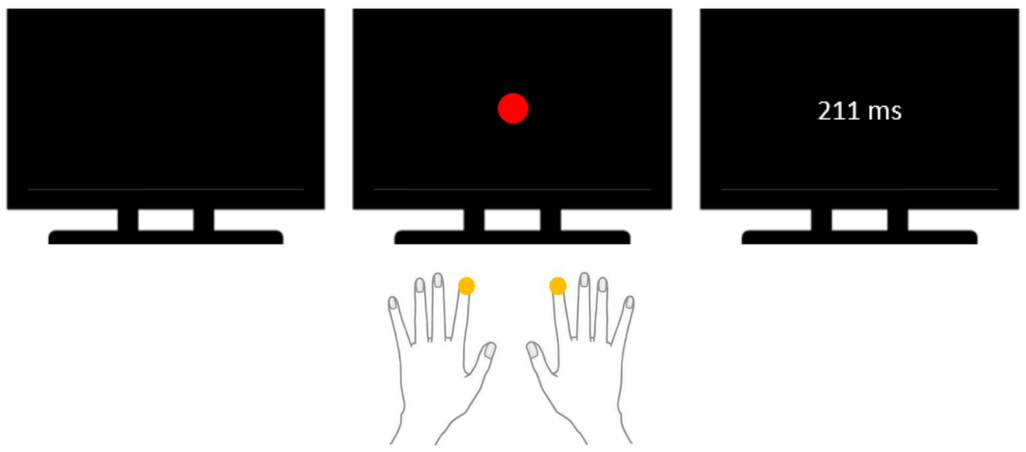
- Within-subjects design with 20 evening-type male participants identified as evening-types through an online pre-questionnaire (Horne et al, 1976), aged between 19-30 (mean age 24.7, SD of age: 2.8).
- Participants completed the PVT in morning (8 am) and evening (6 pm) sessions.
- Brain activity recorded by EEG-system

EEG Data Collection:

- BrainVision Analyzer used for preprocessing.
- Focused on the P1 ERP component within the 70-130 ms interval (Moriya & Nittono, 2011).
- Selected channels: P7, P8, P3, Pz, P4, Oz (Ahumada-Méndez et al., 2022).

Statistical Analysis:

- Data analyzed using repeated measures ANOVA with a significance level of 0.05 (Martinez-Perez et al., 2020).
- Analysis performed using Python 3.9 for robust statistical processing and visualization.

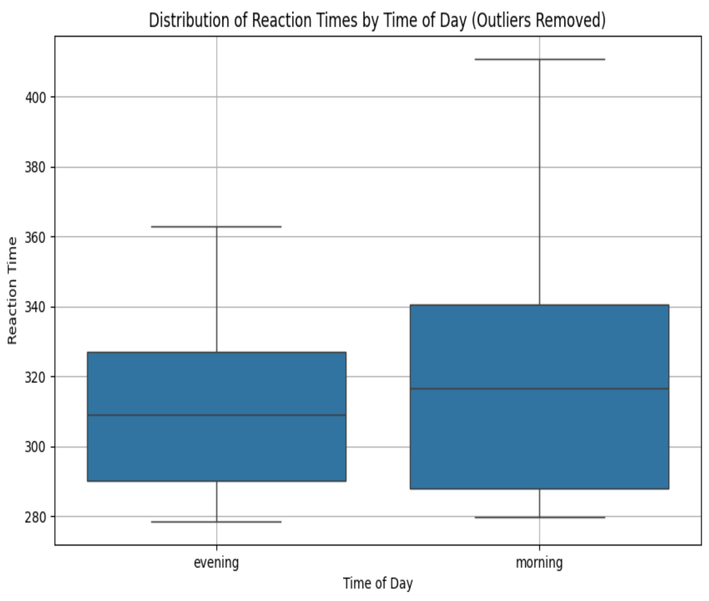


Results

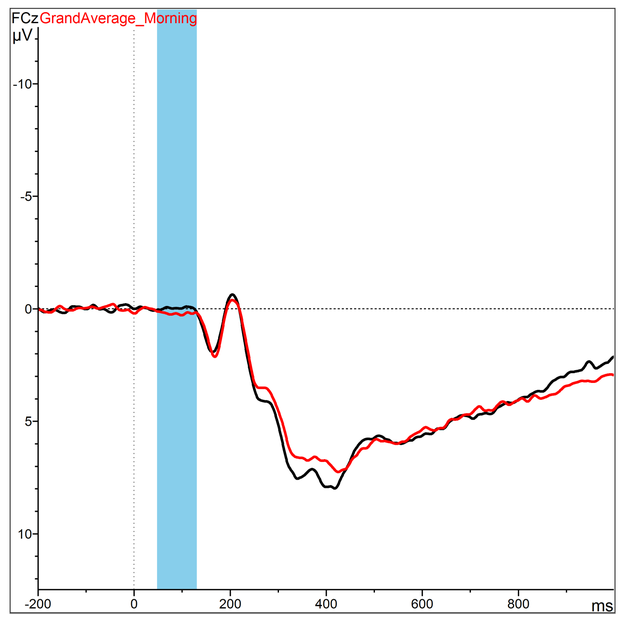
Morning vs. Evening Data:

- Repeated measures ANOVA results showed **no significant effect of time of day on reaction** time ($p > 0.05$).
- **No significant interaction** between chronotype and time of day on the P1 ERP component ($p > 0.05$).

Behavioral data



EEG Data



Conclusion

- No significant effect of time of day on reaction times in the PVT
- No significant interaction between chronotype and time of day on P1 ERP component.
- Findings suggest evening-type participants' cognitive performance remains stable across morning and evening.
- Further research needed with diverse chronotypes and larger samples to deepen understanding.

References

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