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Electrophysiological changes associated with acute smartphone use and mental fatigue

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Introduction

The number of smartphone users has increased in recent years. Smartphones have become an integral part of our daily lives. While studies initially showed the deleterious effects of chronic use, acute smartphone use (i.e., a few tens of minutes) also seems to impact performance (Greco et al., 2017). The negative effects of acute use have been attributed to mental fatigue. However, smartphone use does not seem to have a significant mental workload. Objective markers such as an increase in theta and alpha waves recorded by electroencephalography (Tran et al., 2020), an increase in cardiac variability (Mizuno et al., 2011) or a reduction in pupil diameter (Herlambang et al., 2019) can attest to the presence of mental fatigue.

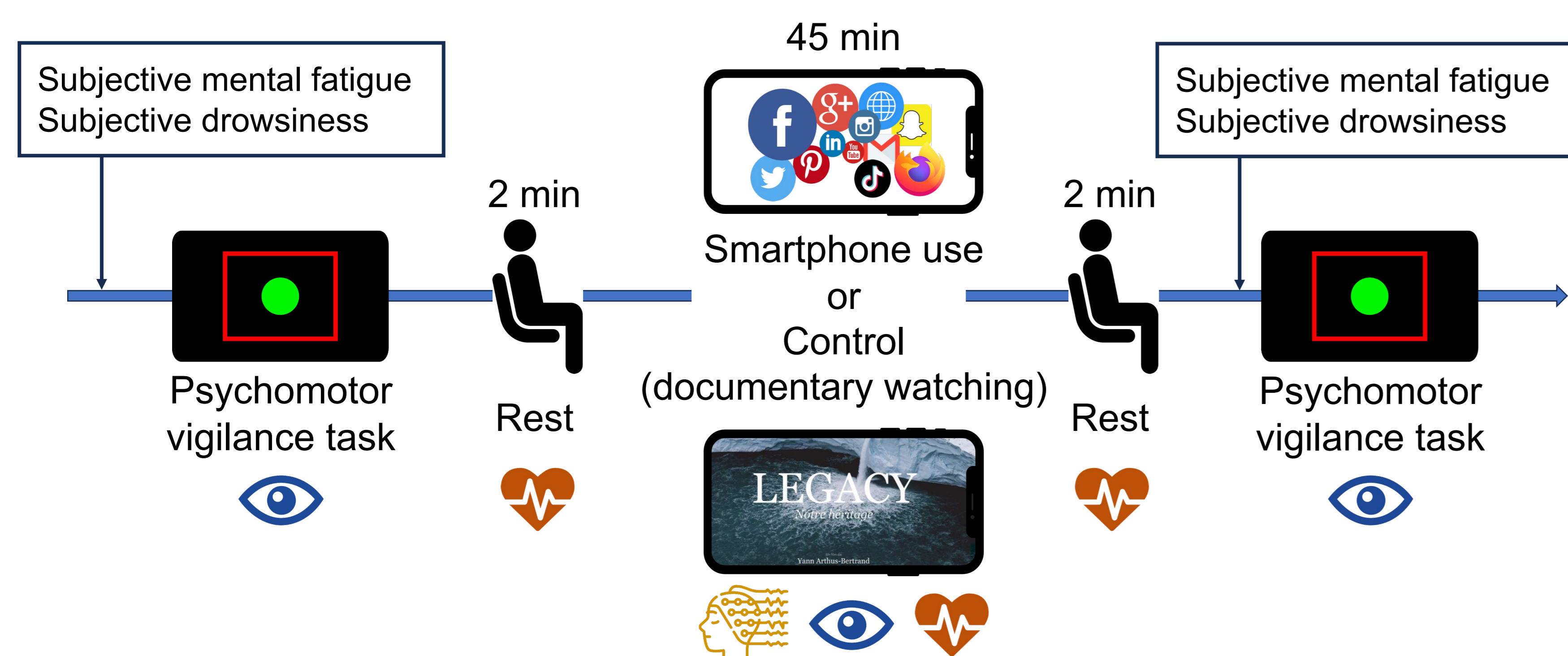
Objective

The aim of this study was to verify the presence of mental fatigue after acute smartphone use with different (electro)physiological measures:

-  Pupillometry (pupilar diameter)
-  Heart rate variability (RMSSD, and LF/HF ratio)
-  Electroencephalography (theta and alpha waves)

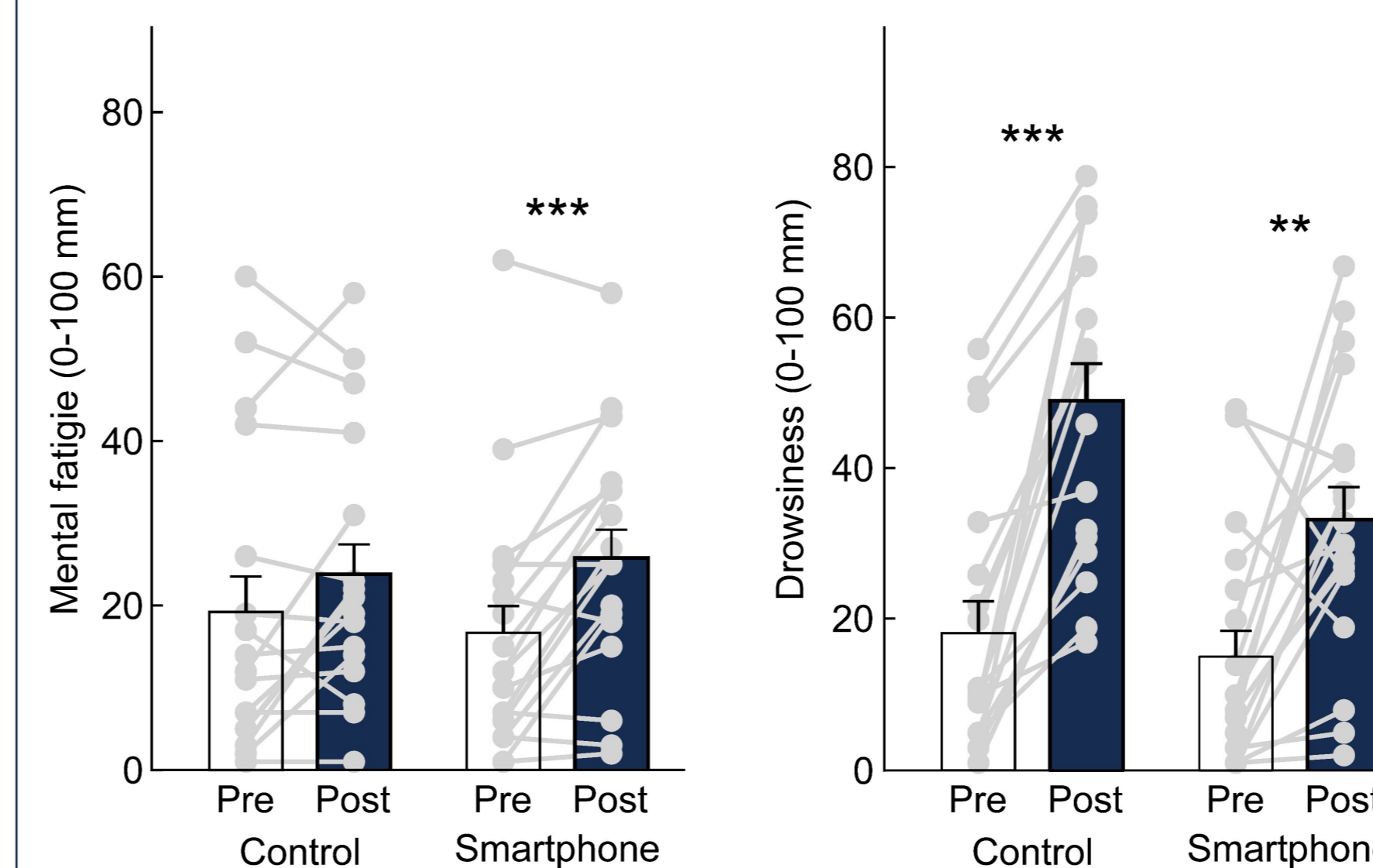
Methods

Eighteen healthy participants (7 ♂ and 11 ♀, age: 22.6 ± 2.3 years) were recruited for the experiment including three sessions: a familiarization and two experimental sessions performed in a pseudorandom order.

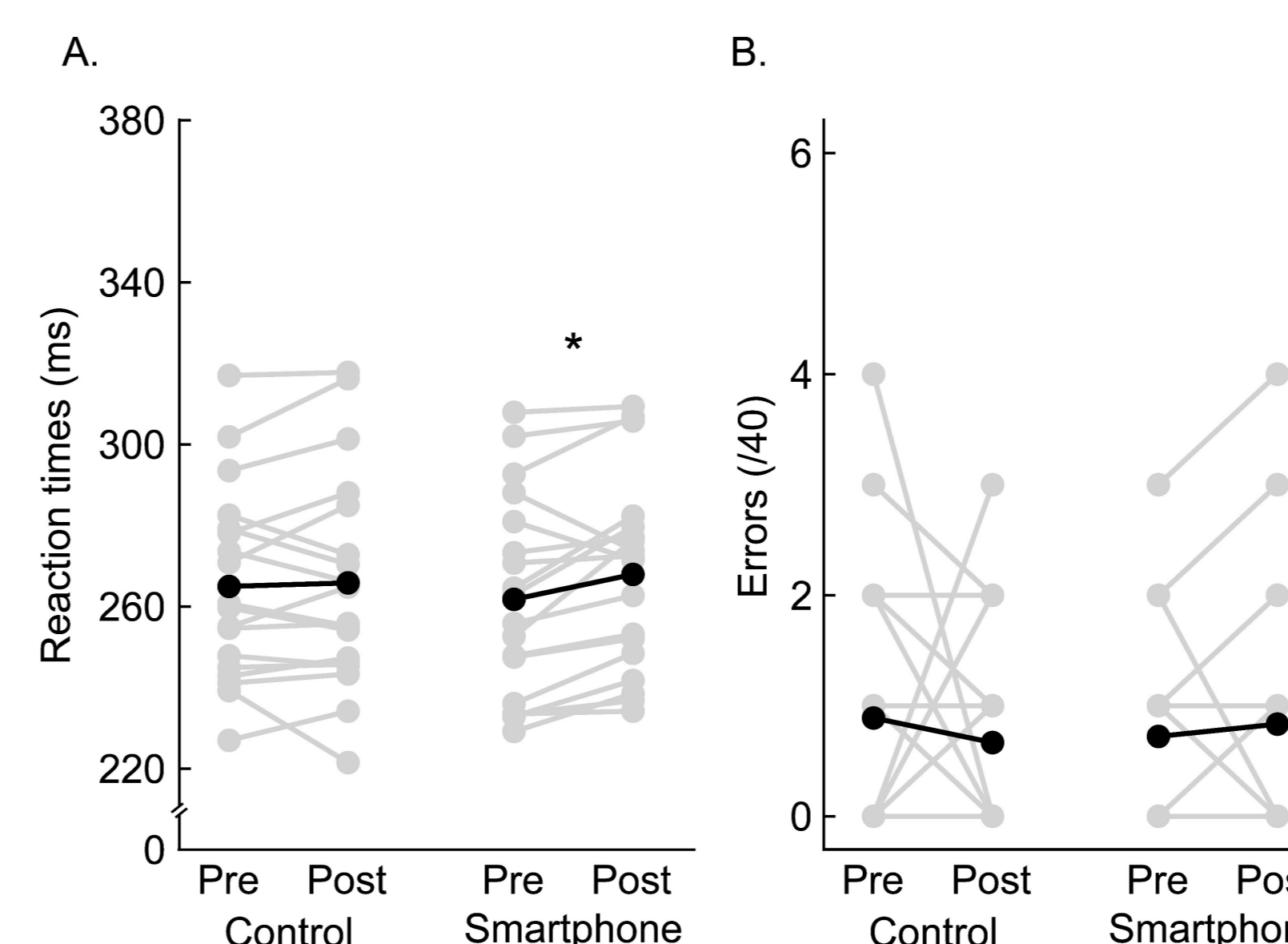


Results

Subjective evaluation



Behavioral performances



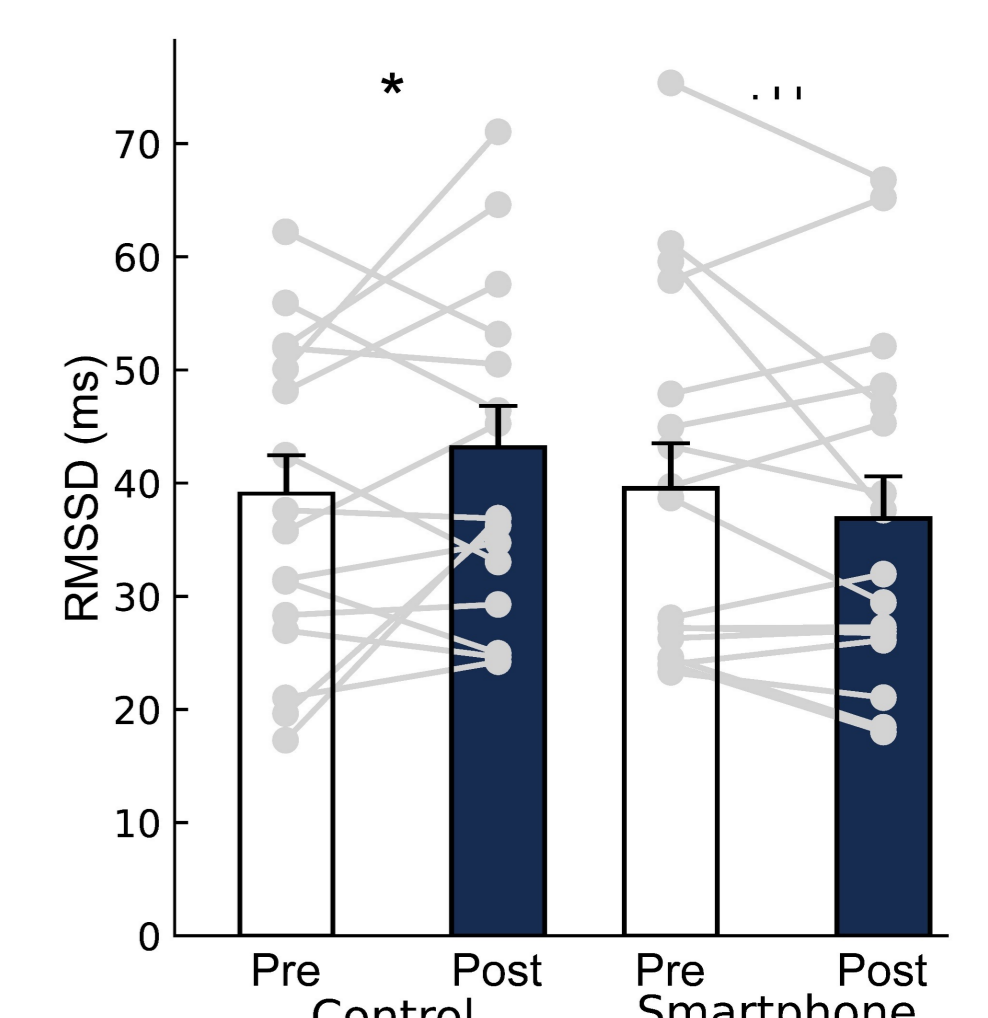
Electrophysiological markers

Pupillometry:

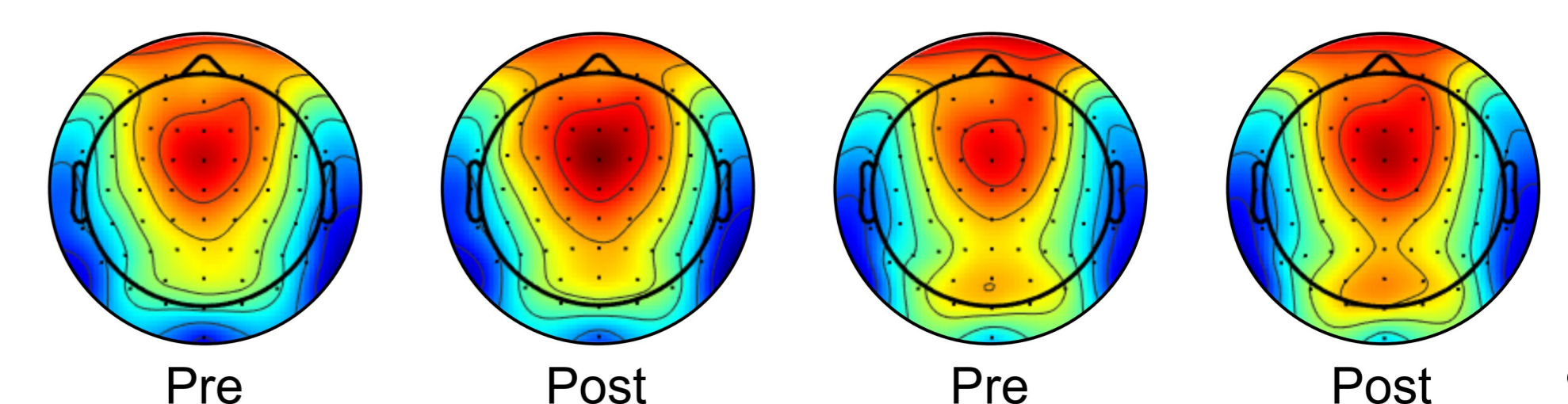
No effects of condition, time or interaction were observed on the pupil diameter recorded during the PVT tasks or when using the smartphone or watching the documentary.

Heart rate variability:

No effects were observed on RMSSD, and LF/HF ratio at rest. For smartphone and control interaction on RMSSD ($p = .010$) indicated an increase in RMSSD for control ($p = .04$). No effects were observed on LF/HF ratio.



Electroencephalography:

Theta power  Pre Control Post Pre Smartphone Post. Significant increase in theta power in frontal region, but for both experimental conditions. No effect was reported for alpha power.

Discussion

- Subjective mental fatigue and drowsiness increased after smartphone use but also after documentary watching → Difficult to dissociate these feelings
- Acute smartphone use impaired cognitive performance (i.e., vigilance)
- No clear (electro)physiological evidence of mental fatigue after acute smartphone use

References

Greco, G., Tambolini, R., & Fischetti, F. (2017). Negative effects of smartphone use on physical and technical performance of young footballers. *Journal of Physical Education and Sport*, 17(4), 2495–2501. Herlambang, M. B., Taatgen, N. A., & Cnossen, F. (2019). The role of motivation as a factor in mental fatigue. *Human Factors*, 61(7), 1171–1185. Mizuno, K., Tanaka, M., Yamaguti, K., Kajimoto, O., Kuratsune, H., & Watanabe, Y. (2011). Mental fatigue caused by prolonged cognitive load associated with sympathetic hyperactivity. *Behavioral and Brain Functions*, 7. Tran, Y., Craig, A., Craig, R., Chai, R., & Nguyen, H. (2020). The influence of mental fatigue on brain activity: Evidence from a systematic review with meta-analyses. *Psychophysiology*, 57(5), e13554.