MODULATION OF SLEEP-RELATED MOTOR MEMORY BY EXERCISE-INDUCED CHANGES IN SLEEP ARCHITECTURE

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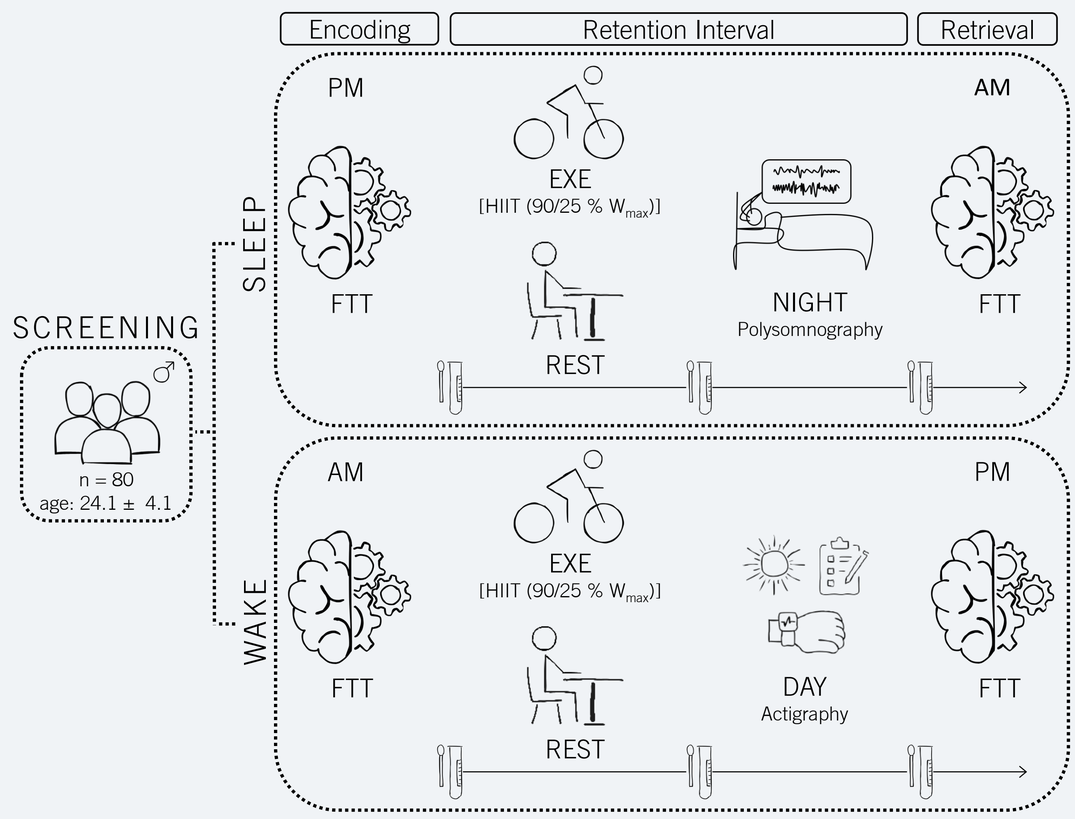
INTRODUCTION

Sleep and exercise have both been shown to facilitate motor memory consolidation, with acute exercise (EXE) also modulating sleep. However, whether exercise-induced changes in sleep architecture, such as sleep stages or sleep oscillations, are related to improved memory remains unclear. Our preliminary work provides initial evidence for this potential link.[1] Several psychophysiological responses to exercise, such as increased cortisol, body temperature, and heart rate, along with reduced heart rate variability throughout the night, have been linked with these sleep changes and memory consolidation.[2]

AIM: To investigate whether exercise-induced changes in sleep architecture are associated with motor memory consolidation and to identify underlying psychophysiological mechanisms.

METHODS

EXPERIMENT



MEASURES

- **Finger Tapping Task (FTT)** as motor sequence learning task to examine motor memory consolidation
- **Cortisol** to detect stress response using saliva samples
- **Body temperature** to measure body temperature and temperature gradient using iButtons
- **Questionnaires** to assess daytime sleepiness (KSS), self-rated pleasure and arousal (SAM), physical activity (IPAQ) and subjective sleep quality (PSQI, sleep diaries)

RESULTS

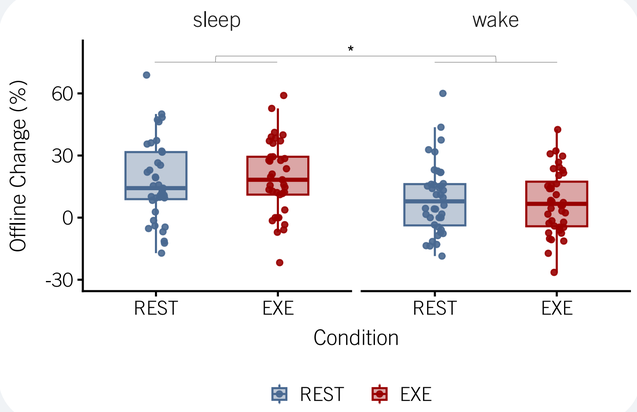


Figure 1: Mean FTT offline changes expressed as the percentage change from the end of encoding to retrieval, shown separately for each group and condition; * $p < .05$.

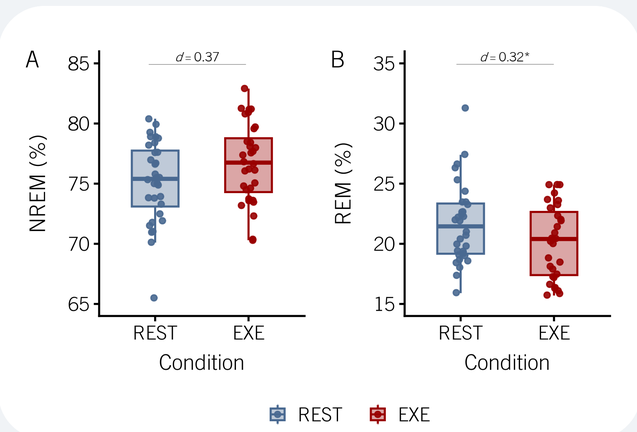


Figure 2: Mean percentage of NREM (A) and REM sleep (B) shown separately for each condition; * $p < .05$.

Sleep → Consolidation: sleep group showed superior offline changes (Fig. 1)

Exercise → Sleep: EXE significantly reduced REM sleep; other sleep stages were unaffected (Fig. 2)

Exercise → Consolidation: EXE did not modify offline changes in either group.

Exercise × Sleep Interaction: interaction between NREM sleep and condition on offline changes, mirrored by positive correlations in sleep spindles and SOSP only in the EXE condition (Fig. 3A-C, Fig. 4).

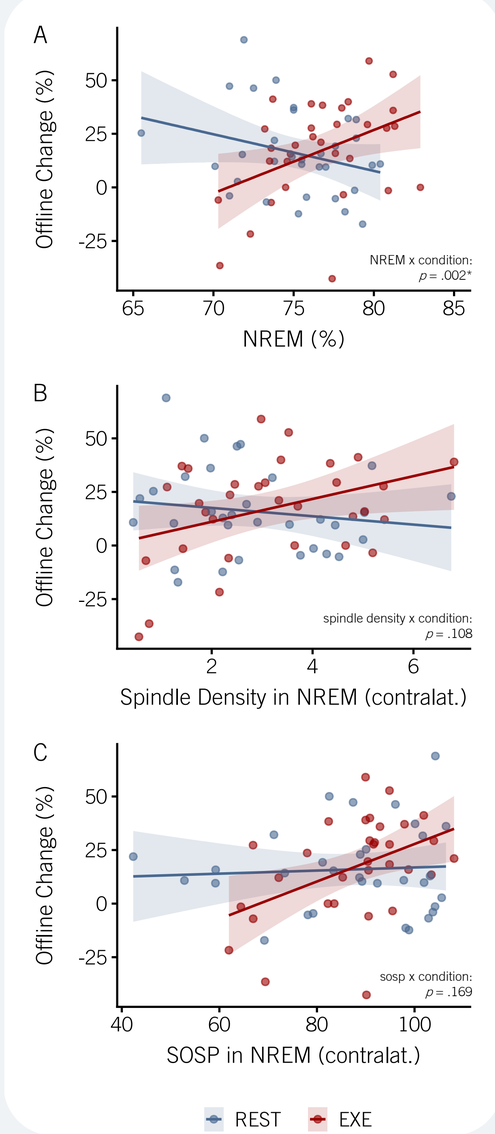


Figure 3: Associations between sleep and FTT offline changes by condition: (A) NREM %, (B) spindle density in NREM (contralateral hemisphere) and (C) % slow oscillations with a cooccurring spindle (SOSP); Lines and shaded areas show linear fits ±95% CI.

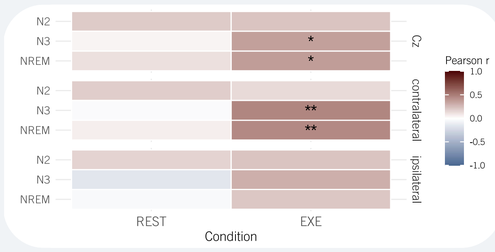


Figure 4: Pearson correlations between FTT offline changes and SOSP across NREM sleep stages and central electrodes, by condition, * $p < .05$.

DISCUSSION

- Exercise manipulated sleep architecture; sleep-related consolidation confirms prior findings.[3,4]
- NREM sleep, sleep spindles, and SOSP correlated with offline changes only in the exercise condition, suggesting a modulatory effect on memory consolidation.
- Exercise-induced increases in NREM effectiveness may reflect effects on synaptic tagging or changes in neurotrophic factors, warranting further investigation.[5]
- Analyses of physiological markers (e.g., temperature, cortisol) may clarify underlying mechanisms.[2]
- Limitation: These interaction effects were exploratory and not preregistered; preregistered analyses showed no overall link between exercise-induced sleep.

REFERENCES & CONTACT

PREREGISTERED

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Cooperation Partners

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