

Spontaneous intrapersonal synchrony and the effect of cognitive load

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INTRODUCTION

Spontaneous INTERpersonal Synchronization increases with sensory coupling^{1, 2, 3}, like in audiences clapping^{4, 5}, pedestrians walking^{6, 7} etc. Posited as a strategy to conserve brain resources, it is predicted to increase under high cognitive load⁸.

Spontaneous INTRApersonal Synchronization could therefore occur, as periodic behaviors within individuals could be inherently coupled, possibly to conserve resources. Musicians combine two unrelated beats into one composite pattern rather than tracking them independently⁹; this tendency could extend beyond perception into production.

Hypotheses: (1) Periodic behaviors by an individual will be more synchronous when produced simultaneously than when separately, and (2) more so with additional cognitive load.

METHOD

Participants:

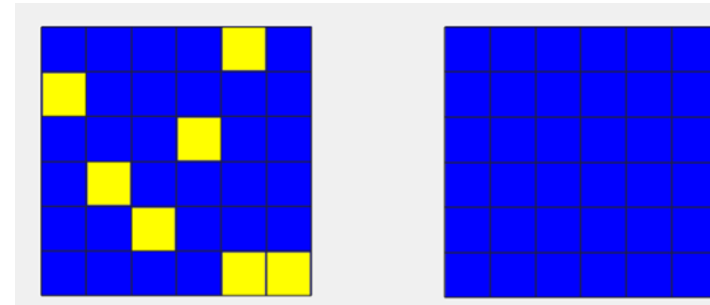
(N=24), 14 females & 10 males (Mean age = 22.6, SD = 5.5)

Periodic Tasks:

- Tapping – Finger-tapping on a mic repetitively
- Walking – Walking on a gait mat
- Ticking – Vocalizing the word 'Tick' repetitively

Cognitive Load Tasks:

- Counting backwards in 3's & 7's (2 levels of difficulty)
- Matching patterns of 4 to 9 squares (6 levels of difficulty)



Design:

#	Task Condition	Experiment 1		Experiment 2	
1	Single (Pre-load)	Tap only	Walk only	Tap only	Tick only
2	Dual (Pre-load)	Tap + Walk		Tap + Tick	
3	Dual + Expecting Load	Tap + Walk + Await counting		Tap + Tick + Await patterns	
4	Dual + Enduring Load	Tap + Walk + Count backwards		Tap + Tick + Match patterns	
5	Dual (Post-load)	Tap + Walk		Tap + Tick	
6	Single (Post-load)	Walk only	Tap only	Tick only	Tap only

Measurement & Metric:

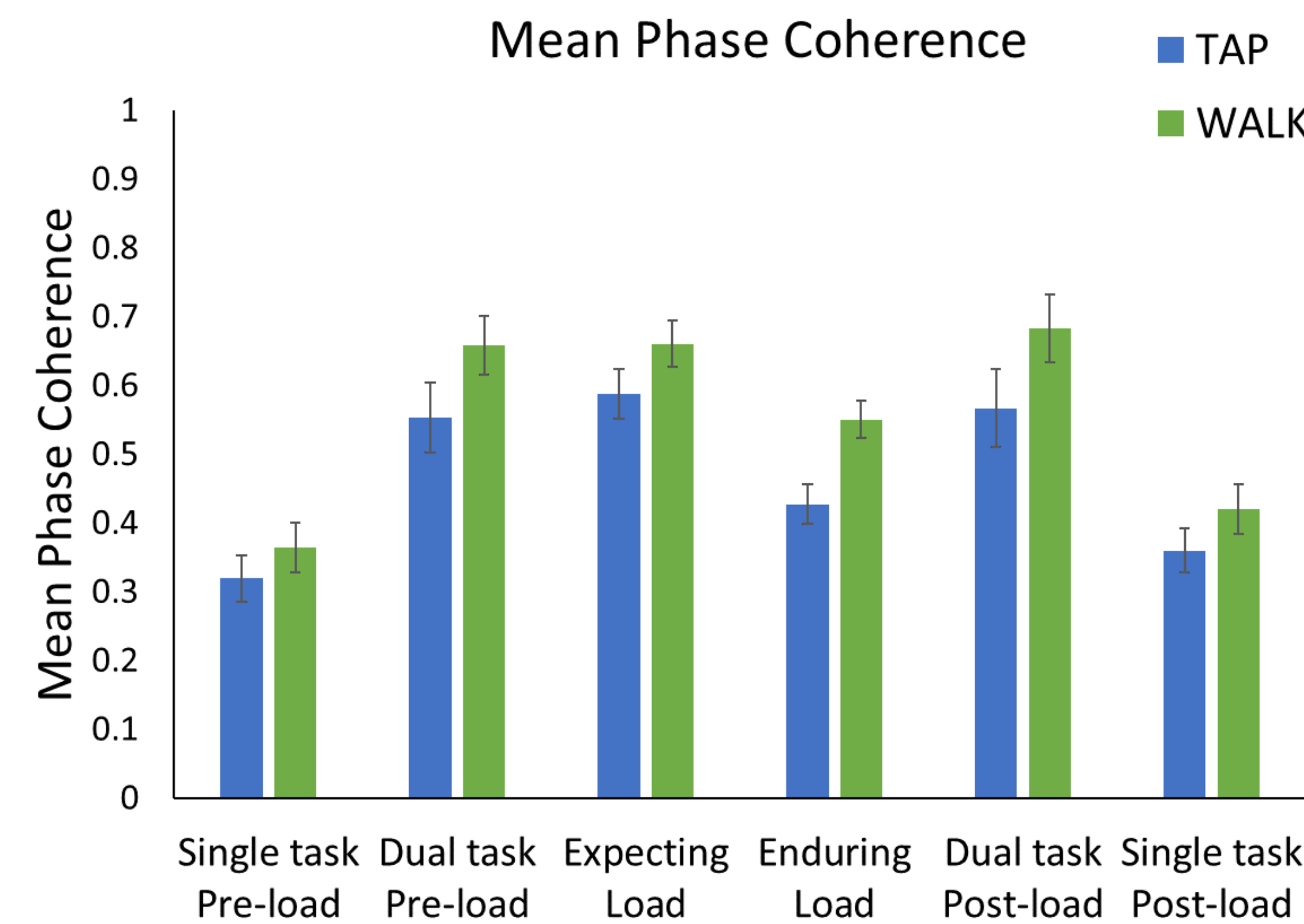
- Tapping & Ticking times computed in MATLAB using audio intensity peaks extracted from Praat
- Walking times extracted from gait mat data
- From each array of time difference (td) between exclusive pairs of closest repetitions, 2 arrays of relative phase angles calculated based on task rates (f_1, f_2): $\theta_i = td * f_i * 2\pi$

- Applying Kuramoto's model¹⁰, phase coherence(r) is given by,

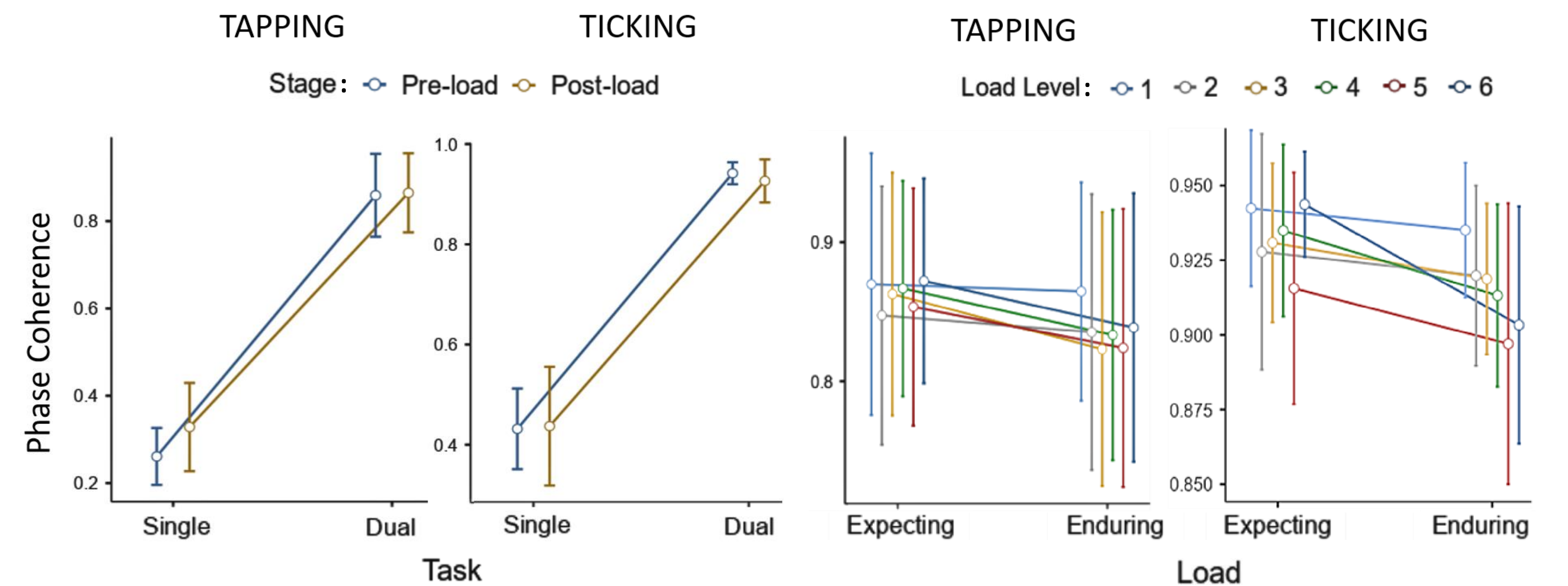
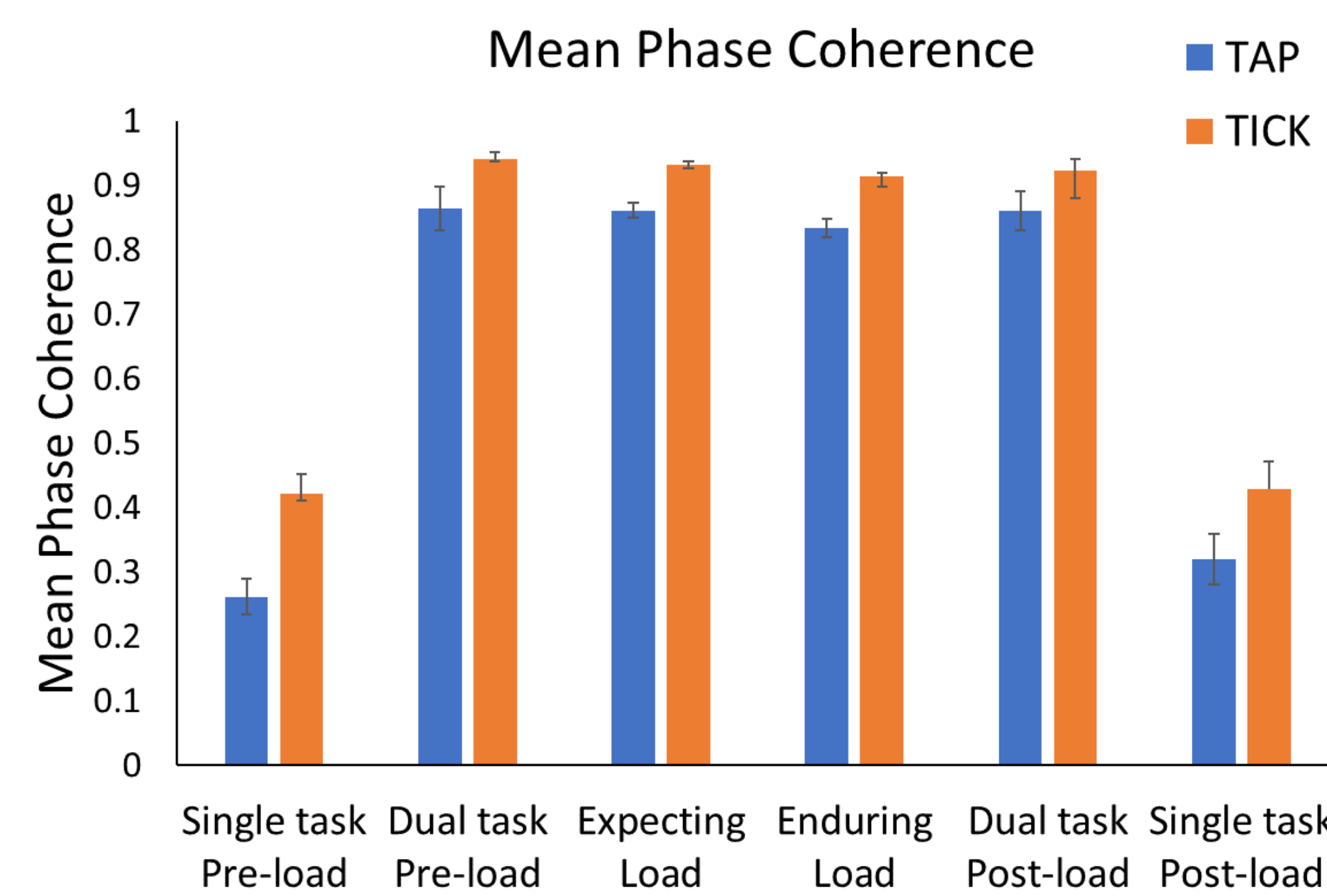
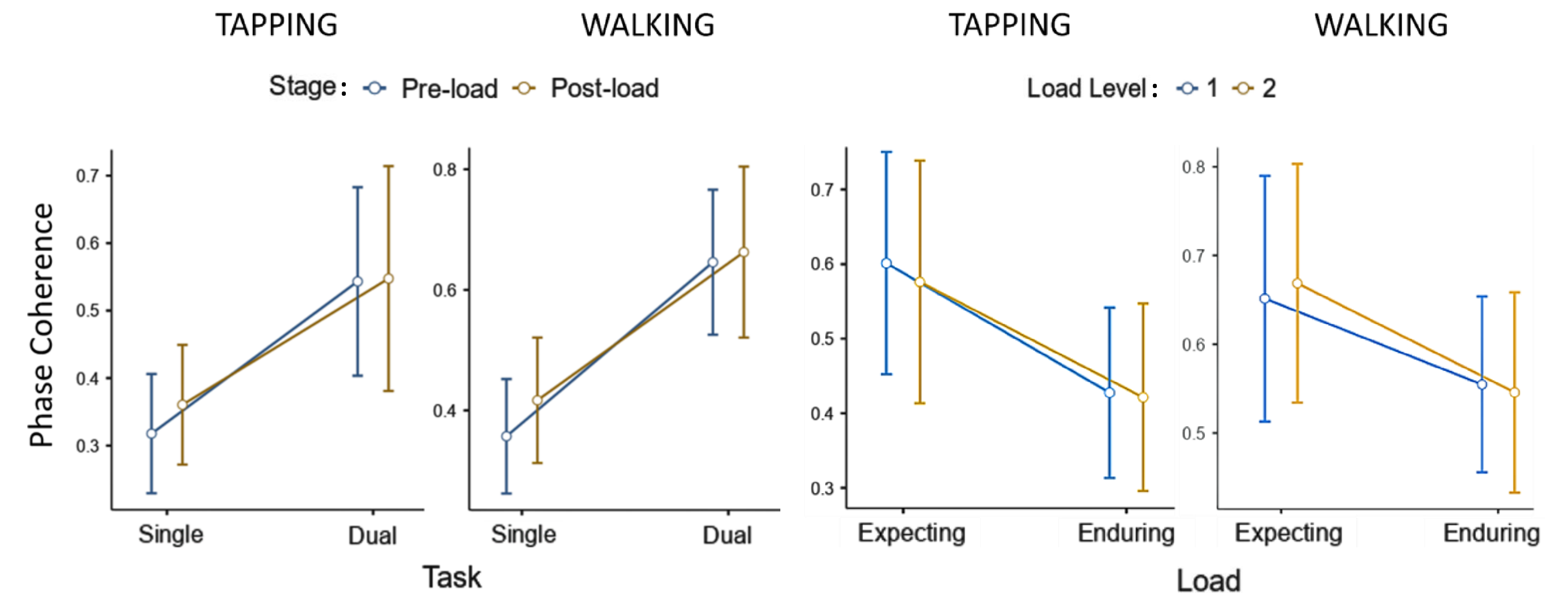
$$re^{i\psi} = \frac{1}{N} \sum_{j=1}^N e^{i\theta_j} \quad (0 \leq r \leq 1 \text{ for unit vector arrays})$$

RESULTS

(Across subjects)



(Within subjects)



DISCUSSION

Hypothesis 1:

- In both experiments, results supported hypothesis 1: spontaneous synchronization between the periodic tasks was significantly higher when performed simultaneously than separately. This suggests, periodic behaviours produced simultaneously could be inherently coupled within individuals, triggering spontaneous synchronization. Spontaneous INTRApersonal & INTERpersonal Synchronization mechanisms could therefore be similar.

Hypothesis 2:

- In both experiments, results did not support Hypothesis 2: spontaneous intrapersonal synchronization decreased under cognitive load. This is similar to performance degradation in periodic & cognitive tasks in dual tasks¹¹, possibly due to cognitive overload caused by dual task interference¹².

Future Studies:

- To minimize possible overload, we suggest using less demanding cognitive tasks, and lowering any possible extraneous load involved in task instructions.
- We suggest testing larger samples with a wider age range, and comparable musician / non-musician splits, to examine effects of age and music training.

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