Neural coupling while tapping and walking to the beat: Effects of dual tasks in older adults

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BACKGROUND

- **Aging** makes performing **dual tasks** more challenging, which can lead to falls and injuries when walking while performing a cognitive ta sk.[1]
- **Rhythmic auditory cues (RAC)** while walking can decrease motor variability. [2]
- Motor improvements may be linked to the **coupling of cortical activity to the beat**, as shown during finger tapping[3]. It remains unknown however if such coupling happens while walking.
- **Cognitive functions** may modulate RAC-induced motor benefits [4,5], and thus potentially neural coupling.

OBJECTIVES

Investigate neural coupling during tapping and walking and its link to cognition in older adults

METHODS

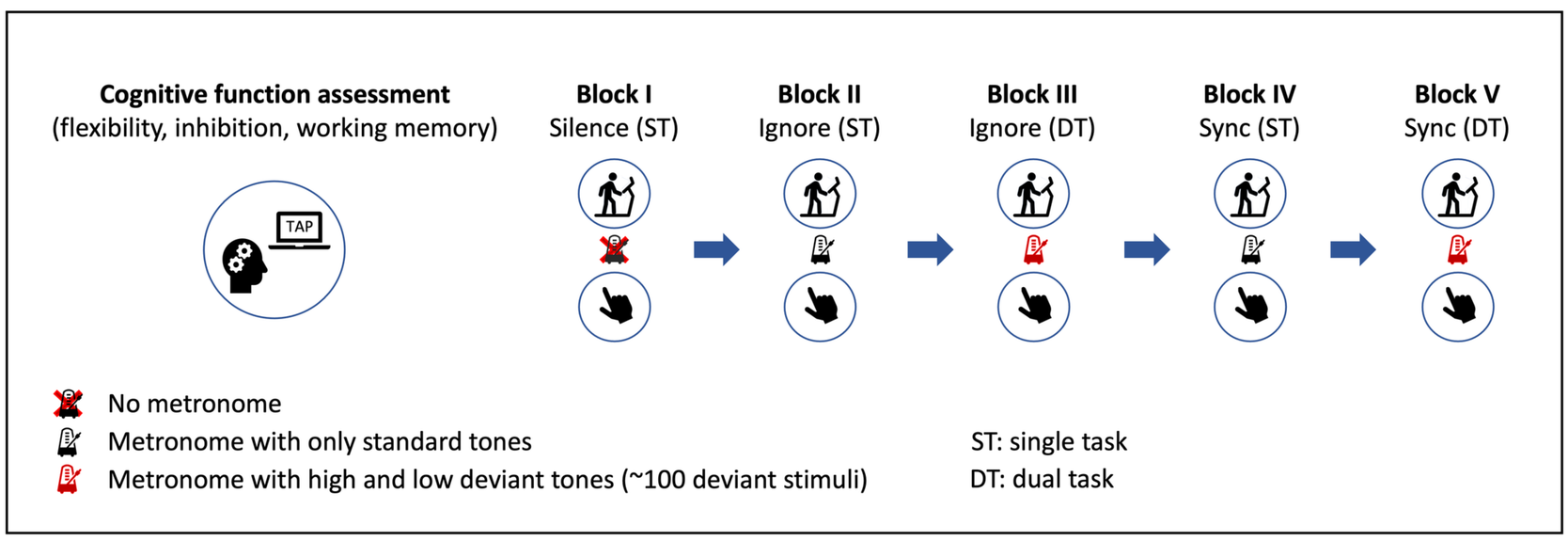
11 **healthy** adults (6 ♀ and 5 ♂)
Aged **65 and over**

Steps were recorded with an instrumented treadmill (AMTI, Watertown, USA).

Taps were recorded with a force-sensitive resistor (FSR).

EEG was recorded with a 64-electrode mobile system (LiveAmp, Brain Vision, Munich, Germany).

Stimuli: auditory metronomes matching spontaneous motor tempi.

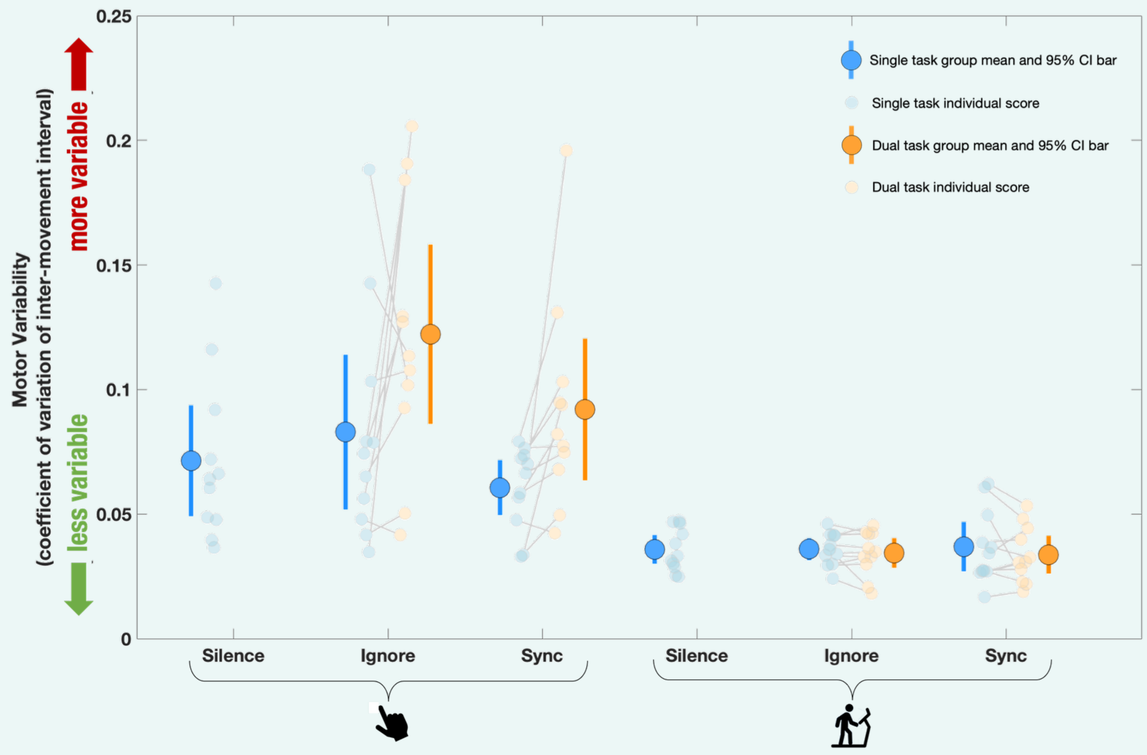


Experimental protocol.

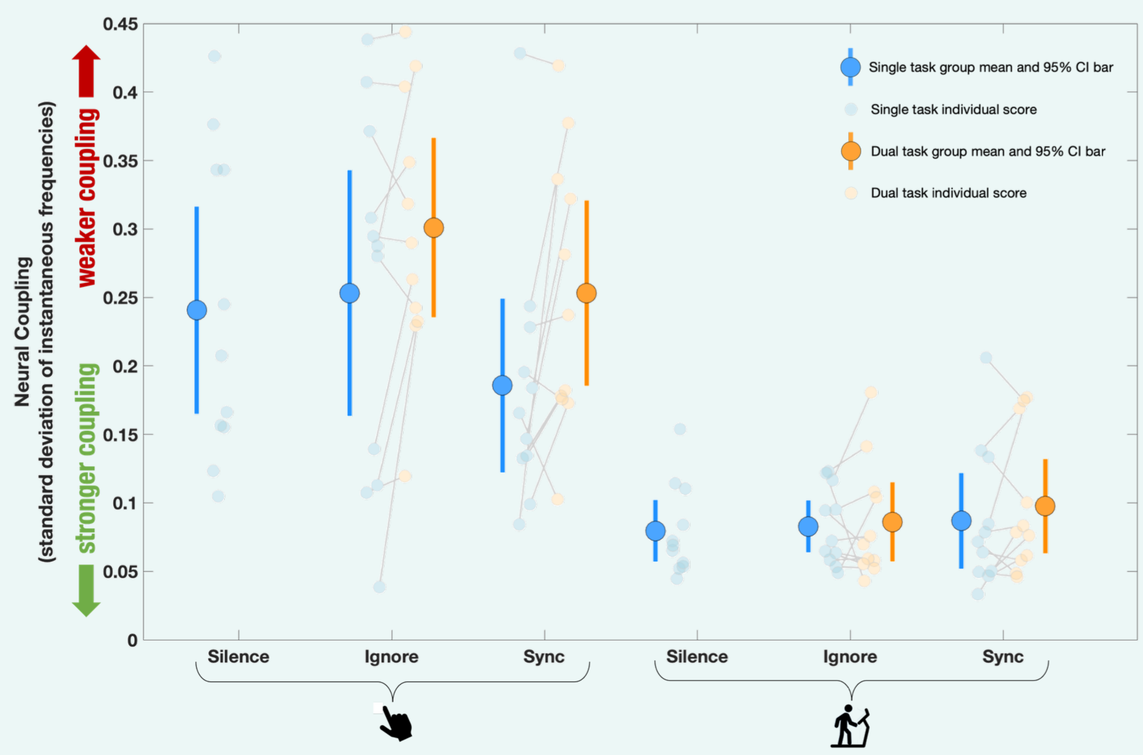
Linear mixed-effect models assessed fixed effects of movement (tapping vs. walking), listening modality (silence vs. ignoring vs. synchronizing to stimuli), and task complexity (single vs. dual) on both motor variability and neural coupling.

Pearson correlations assessed relationships between motor variability (dual-task cost) and cognitive functions, as well as between neural coupling (dual-task cost) and cognitive functions.

RESULTS



Motor variability. Group means with 95% CI bars plotted against each participant's score. There was a Movement*complexity interaction (p =.001) and main effects of movement (p < .001) and complexity (p = .004).



Neural coupling. Group means with 95% CI bars plotted against each participant's score. There were main effects of movement (p < .001) and complexity (p = .047).

Motor variability was **higher in dual than in single tasks, but only when tapping**. Variability was overall **higher while tapping than walking**.

Neural coupling was **stronger in single than dual tasks.** Neural coupling was also **stronger while walking than tapping**.

Neural coupling was positively correlated to working memory in the ignore tapping (r = .69) and ignore walking conditions (r = .58).

CONCLUSION

- **Neural coupling could underlie RAC effects on movement during cognitively-challenging tasks** .
- Walking, a whole-body continuous and automatic movement, is not impacted by dual tasking, unlike tapping. **Timing-control mechanisms could be partly movement and/or effector specific [6].** Additional testing and analyses are being conducted to confirm.
- **Working memory may modulate neural coupling** when participants are not explicitly told to synchronize to the stimuli.

References
1. Al-Yahya, E., et al. (2011). *Neuroscience and Biobehavioral Reviews*, **35(3)**: 715-728. 2. Ghai, S., et al. (2018). *Aging and Disease,* **9(5)**: 901-923. 3. Rosso, M., et al. (2021). *Frontiers in Human Neuroscience,* **15**: 668918.
4. Cochen De Cock, V., et al. (2018). *NPJ Parkinson's Disease*, **4(1)**: 1-8. 5. Dalla Bella, S., et al. (2018). *Annals of the New York academy of Sciences*, **1423(1)**: 308-317. 6. Qi, W., et al. (2019). *Scientific Reports*, **9(1)**: 7620.