

"Body Movement Shapes Selectively the Neural Representation of Musical Rhythms"

Chemin, Baptiste ; Mouraux, André ; Nozaradan, Sylvie

Abstract

It is increasingly recognized that motor routines dynamically shape the processing of sensory inflow (e.g. hand movements to feel a texture or identify an object). These exploratory movements are often rhythmic, and it has been suggested that movement-perception shaping could be supported by movement-induced neural entrainment. In auditory perception, the shaping of perception by movement has been reported in humans using behavioral methods, but neurophysiological evidence is lacking. To fill this gap, we took advantage of a specific context, music. Participants listened to a cyclical rhythm before and after moving the body on this rhythm according to a specific meter. We found that the brain responses to the rhythm as recorded with EEG after body movement was significantly enhanced at meter frequencies to which participants had moved. These results provide evidence that body movement can shape selectively the subsequent perception and neural representation of auditory rhythms.

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BODY MOVEMENT SHAPES SELECTIVELY THE NEURAL REPRESENTATION OF MUSICAL RHYTHMS



Baptiste CHEMIN¹, André MOURAUX¹, Sylvie NOZARADAN¹

¹ Institute of Neuroscience (IONS), Université catholique de Louvain (UCL), Belgium



Introduction

Listening to musical rhythms entrains the perception of a meter (i.e., abstract temporal periodic grid), even if the auditory input is not periodic.

Body movements synchronized to a musical rhythm modulate this feeling (1), and are used to disambiguate the perception of complex rhythm in music education.

In this study, we investigate **how movements may shape the neural representation of musical rhythms**.

Our approach is based on the electroencephalographic (EEG) recording of **steady-state evoked potentials (SS-EPs)** to tag the neural entrainment to musical rhythm (2). Indeed, listening to musical rhythms elicit multiple SS-EPs in the EEG spectrum corresponding to the neural activity, with *selective enhancement* at frequencies corresponding to the *perceived* meter (3).

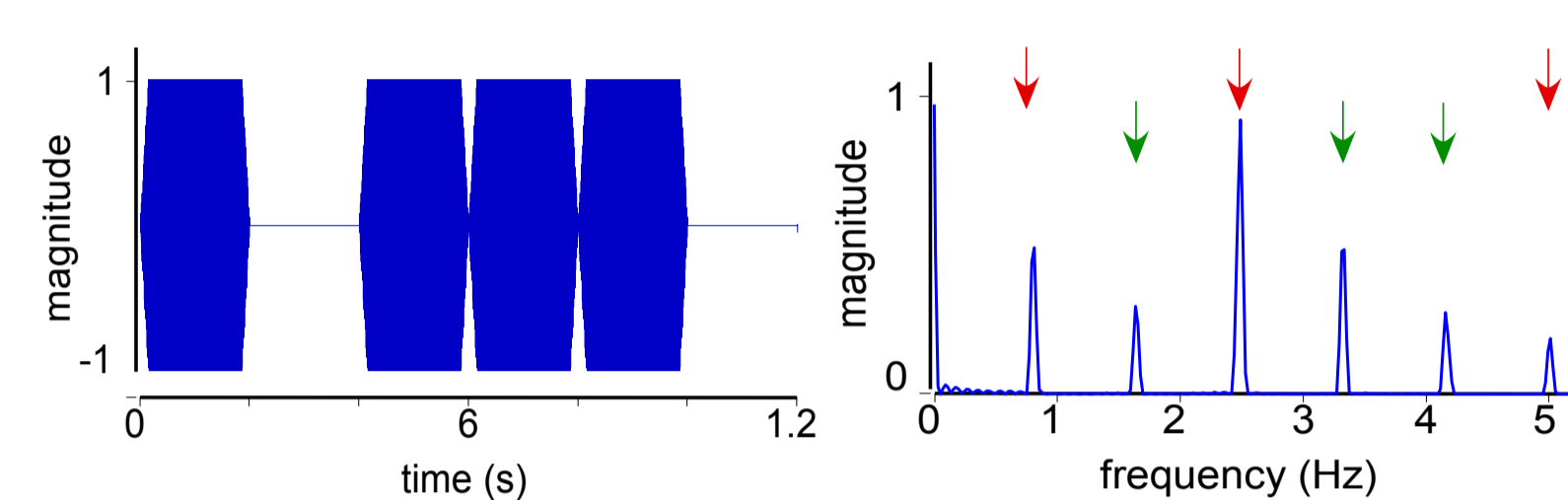
The study aims to highlight a selective enhancement of neural entrainment, set off by cross-modal integration at specific frequencies.

Material and methods

Recording EEG while participants listen to an ambiguous rhythm, and **comparing** the EEG spectrum **before** and **after** disambiguating **body movement training**.

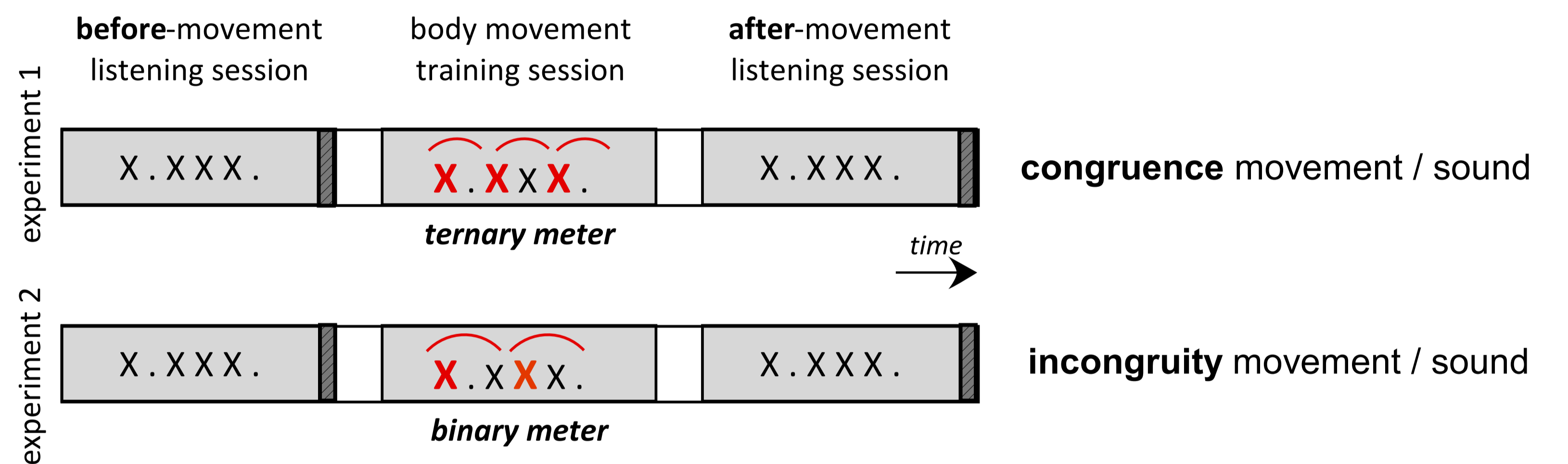
Auditory rhythmic stimulus: time course, envelope spectrum and ambiguousness.

33 s epochs
10 epochs / session
Task: detecting tempo changes in 2 epochs / 10
11th epoch: hand tapping in sync with the rhythm



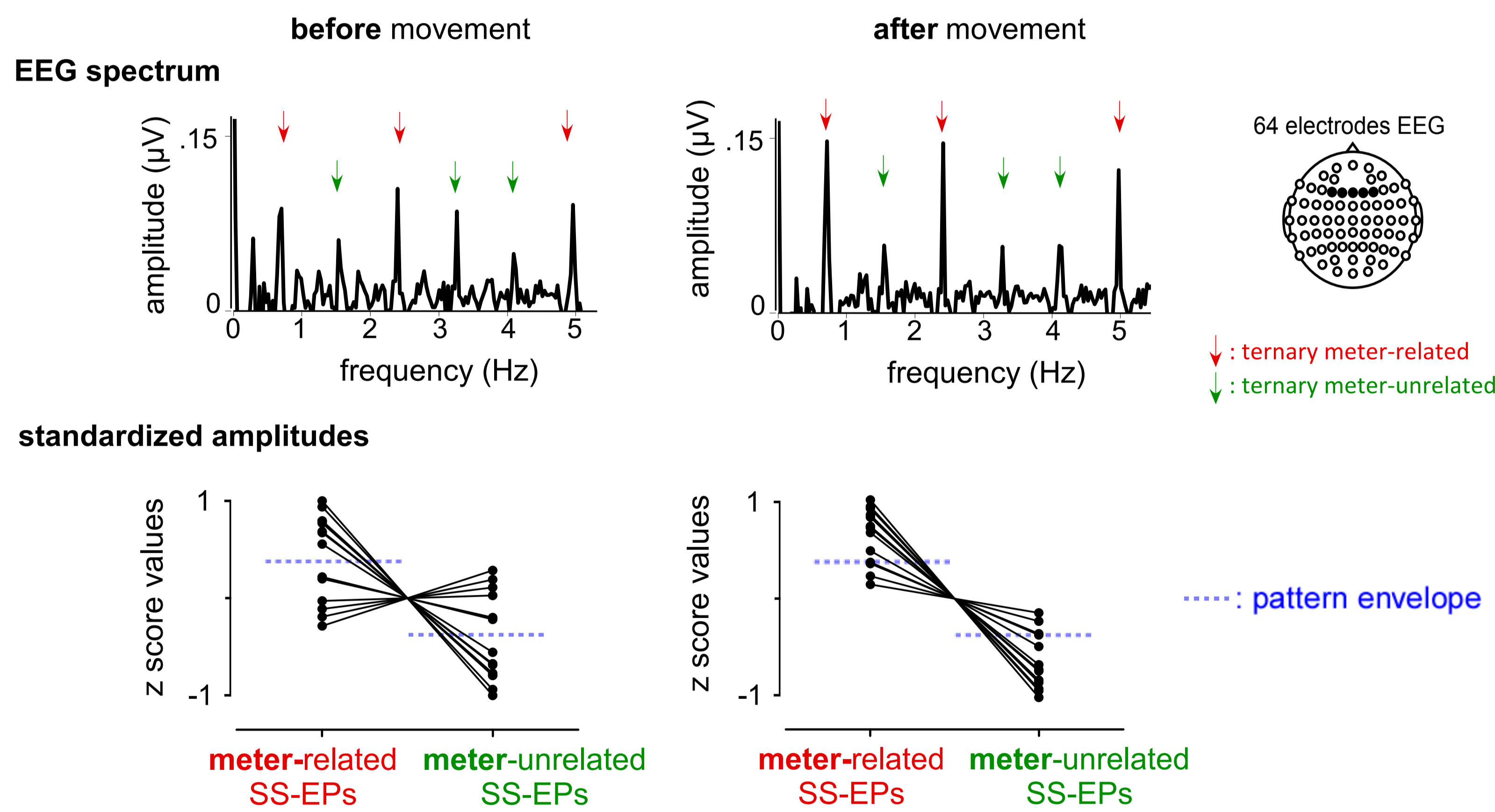
Ambiguousness:
The rhythm can be perceived in *different meters*, i.e. ternary meter or binary meter. Note that the structure of the rhythm itself is likely to favor a ternary meter interpretation.
↓ : ternary meter-related
↓ : ternary meter-unrelated

Experimental design:

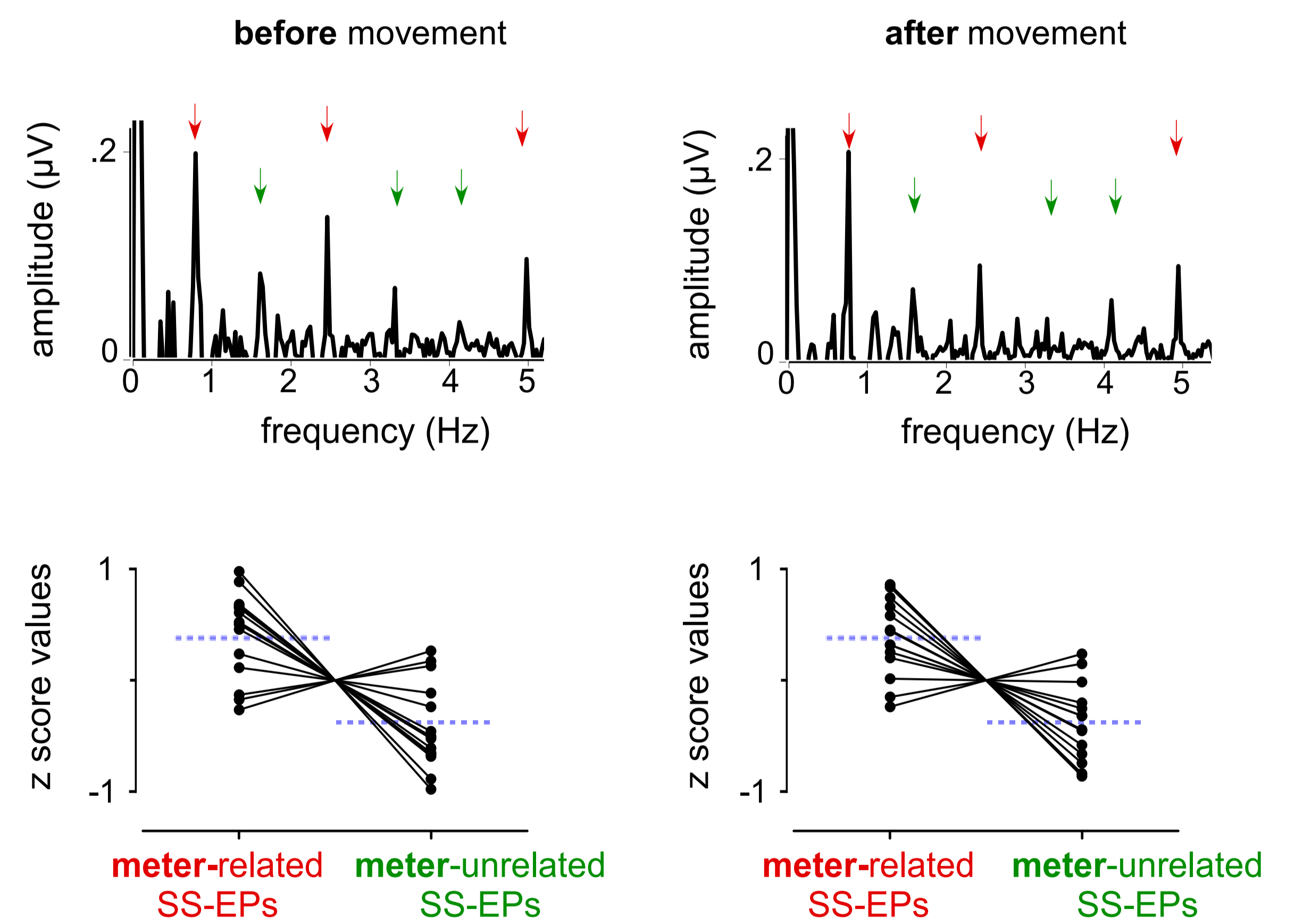


Results

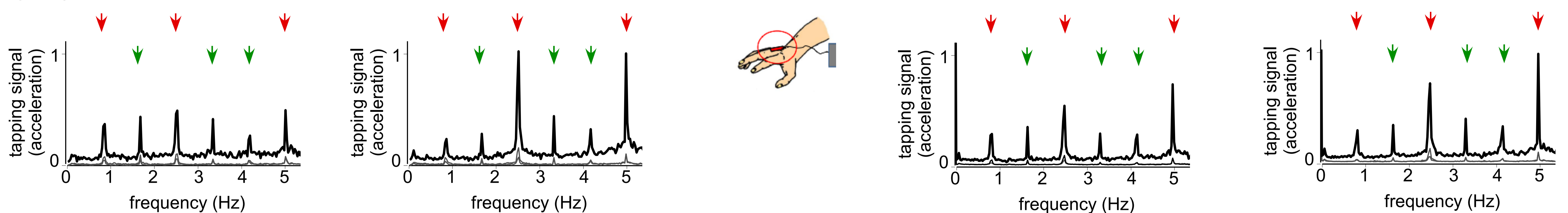
Experiment 1: congruence between sound and movement



Experiment 2: incongruity between sound and movement



tapping (in sync with the rhythm)



Conclusion

The SS-EPs were significantly enhanced at the **frequencies of convergence** between movement and sound, while they did not initially stand out significantly in the frequency spectrum of the EEG.

These results constitute direct evidence that the neural entrainment to musical rhythms is **not only determined by acoustic features** of the rhythmic sounds, but is also - and particularly in the context of ambiguous rhythms - **shaped by the previous experience of body movement**.

References

- (1) Phillips-Silver and Trainor. 2005. Science 308(5727):1430
- (2) Nozaradan S, Peretz I, Missal M, Mouraux A. 2011. J Neurosci 31(28):10234-40
- (3) Nozaradan S, Peretz I, Mouraux A. 2012. J Neurosci 32(49):17572-81