Neural encoding of music, self, other and synchrony in dyadic dance

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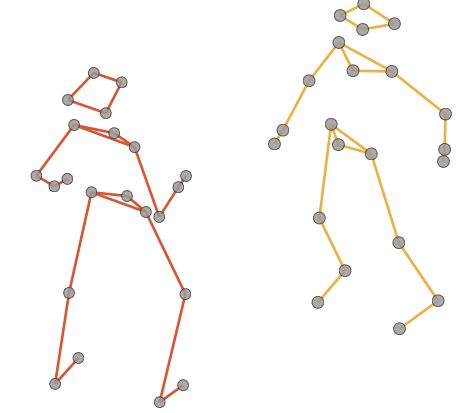
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Introduction

Though dance is a universal form of human expression[1–3], the brain mechanisms supporting it are still poorly understood.

The neuroscientific study of naturalistic dance is highly challenging:
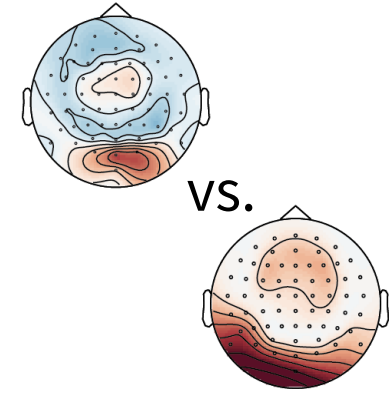
Dance is highly social and interactive[4]

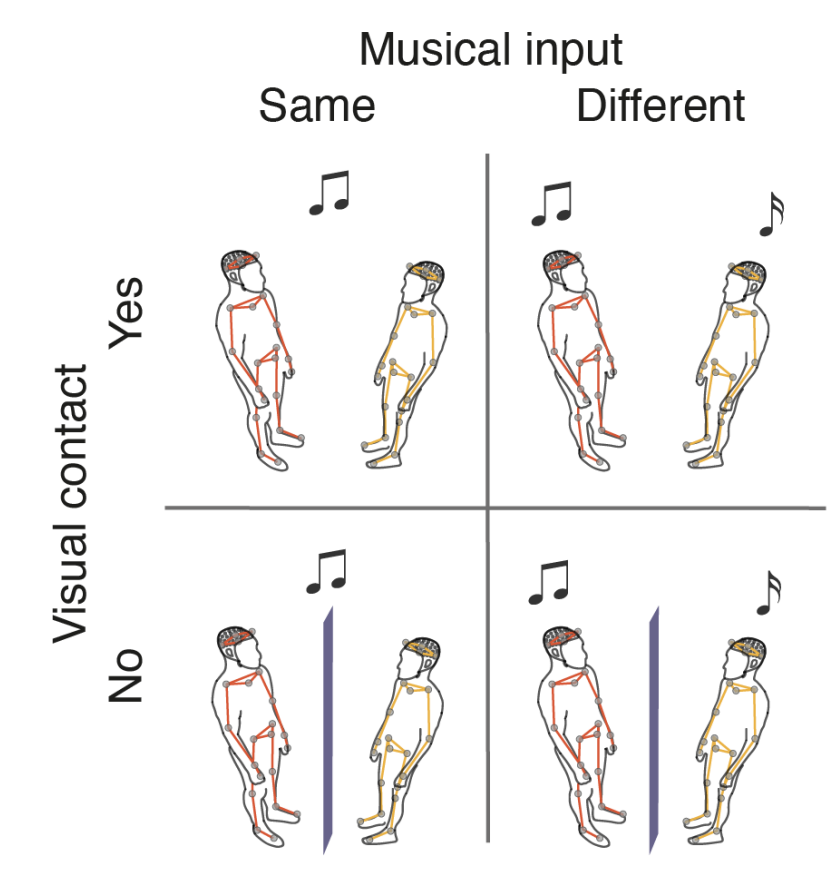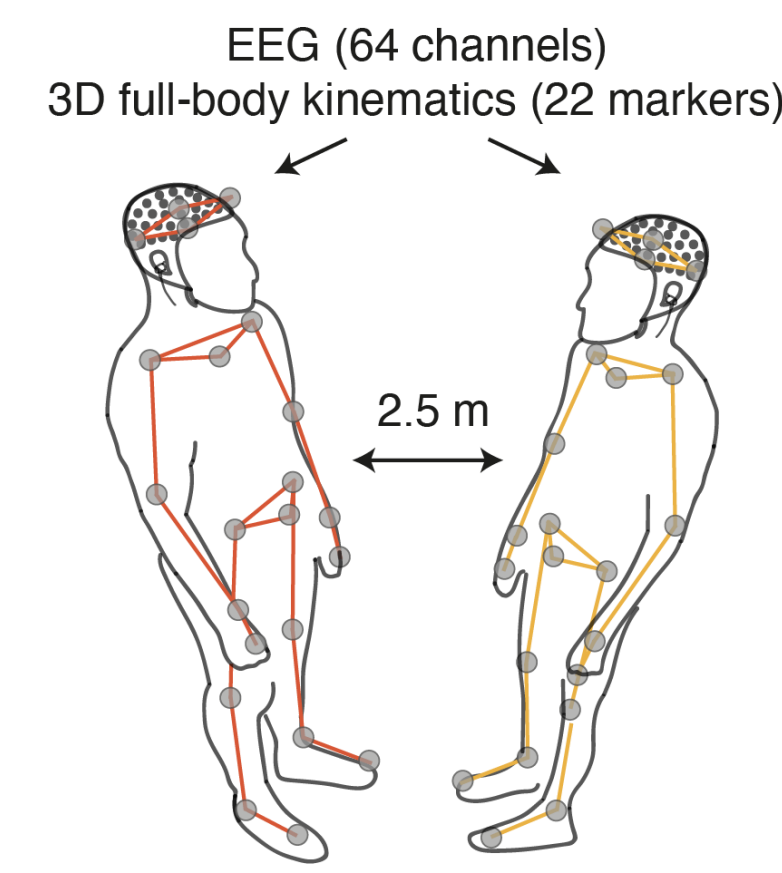Dance involves distinct, yet simultaneous neural processes[5]

music
self
other
synchrony

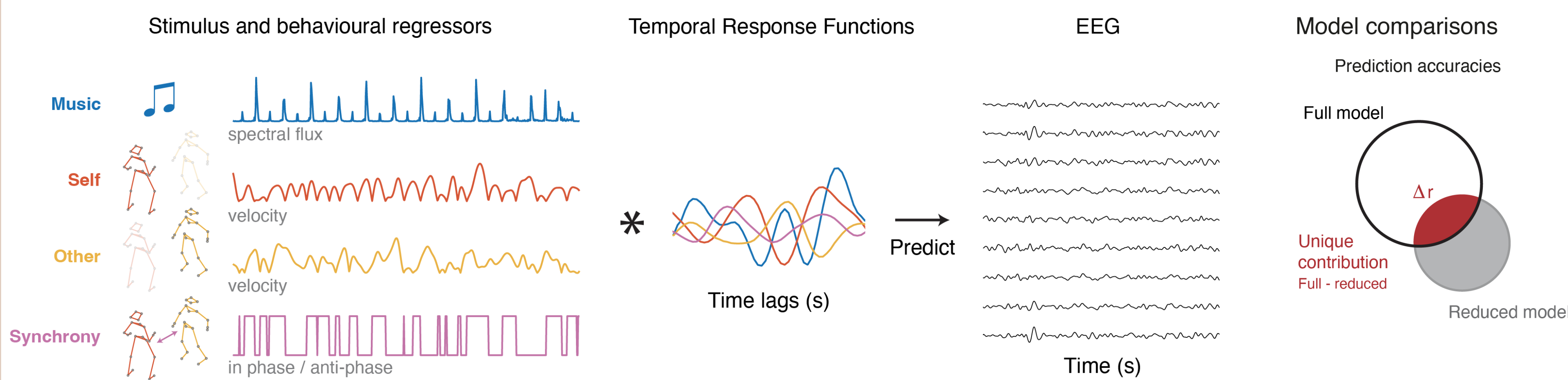Methods like EEG are prone to motion artefacts[4–6]

vs.

Research question and experimental design

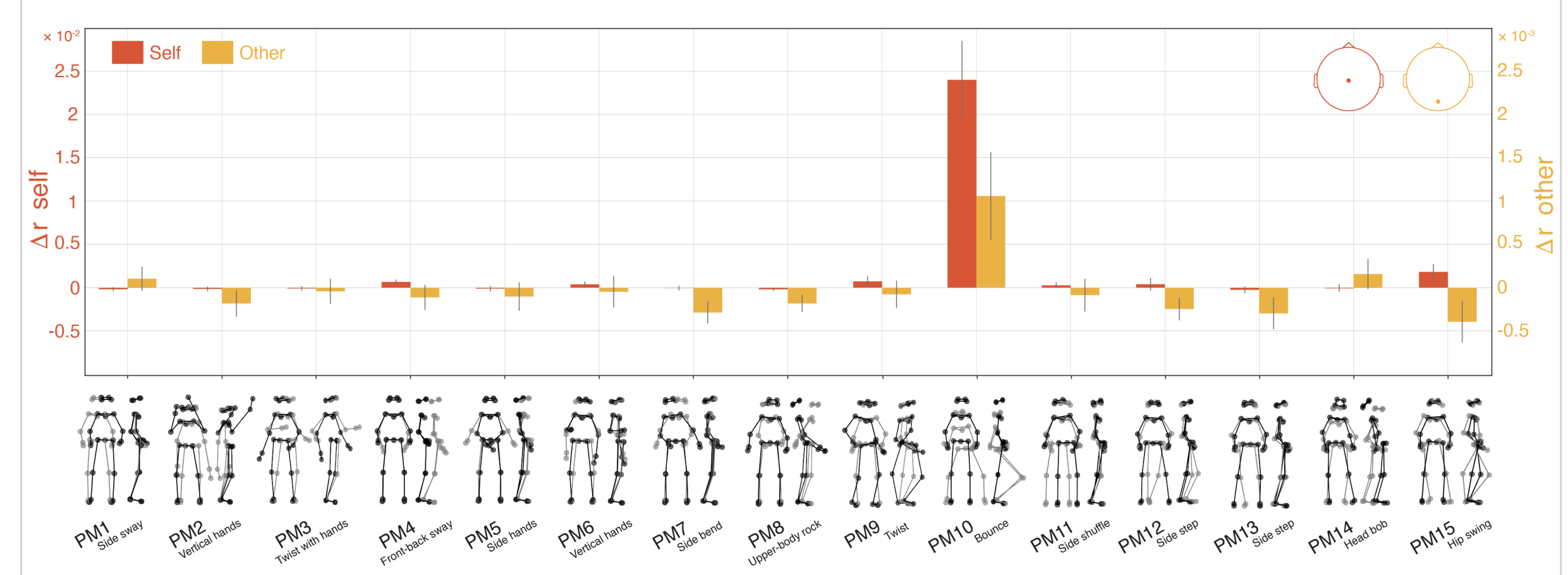How can we tease apart distinct neural processes occurring during dyadic dance?

EEG (64 channels)
3D full-body kinematics (22 markers)
2.5 m

Musical input
Same   Different

Visual contact
Yes
No

Methods

Modelling brain processes: multivariate Temporal Response Function (mTRF)[7–10]:

Stimulus and behavioural regressors

Music — spectral flux
Self — velocity
Other — velocity
Synchrony — in phase / anti-phase

Temporal Response Functions — Time lags (s)

Predict

EEG — Time (s)

Model comparisons — Prediction accuracies
Full model
Δr
Unique contribution
Full - reduced
Reduced model

Kinematic feature selection

Bounce movements explain most neural encoding of self and other

Self   Other

Δr self / Δr other

Results

Each model unveiled distinct brain processes that significantly contributed to EEG activity.
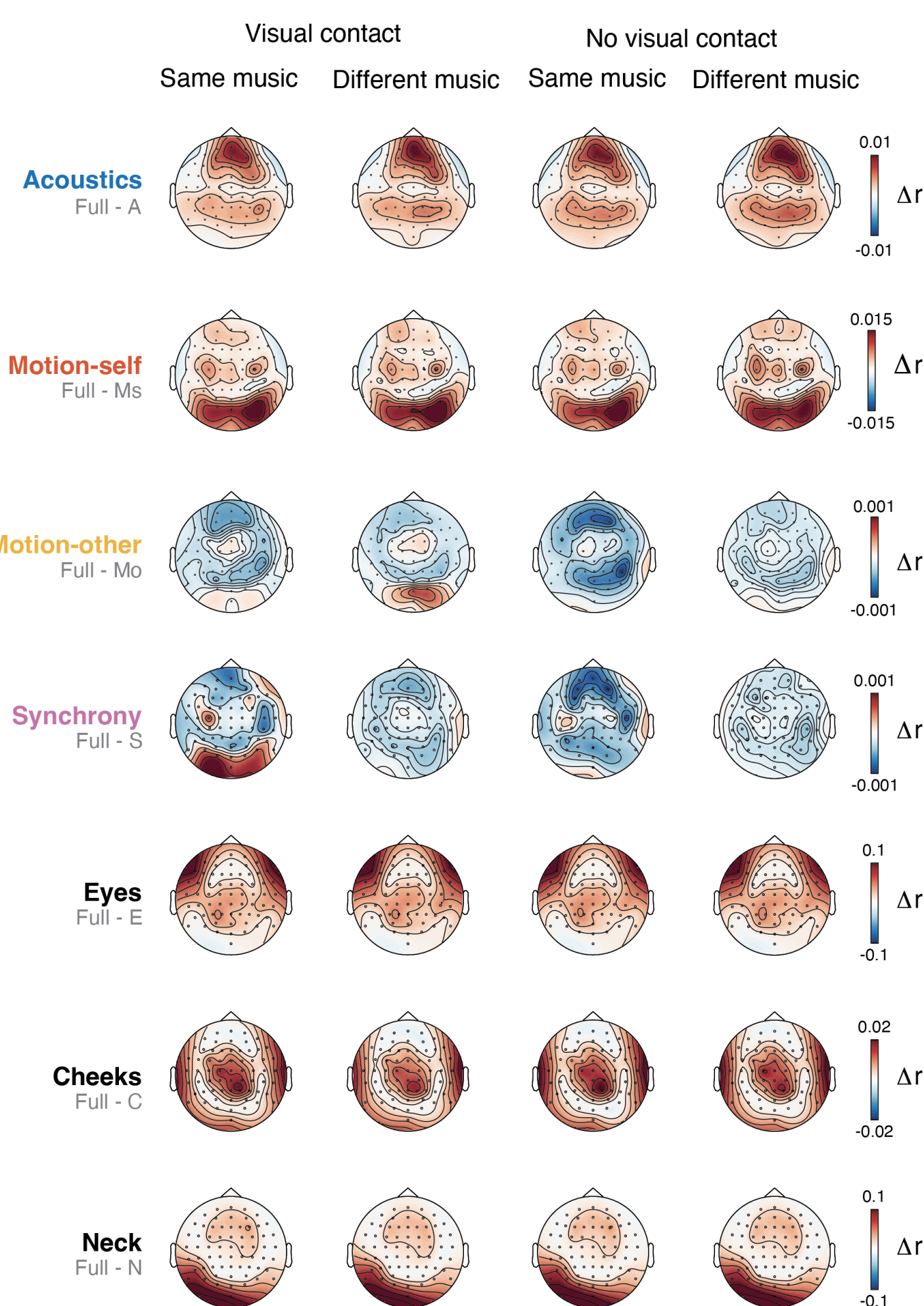
- Each variable's contribution to EEG activity exhibited **distinct, physiologically-plausible, spatial localization**[8,9,12,13].

- Each variable's model weights **resembled established event-related brain responses** implicated in the perception of sensory stimuli (visual or auditory) and motor control[11–13].
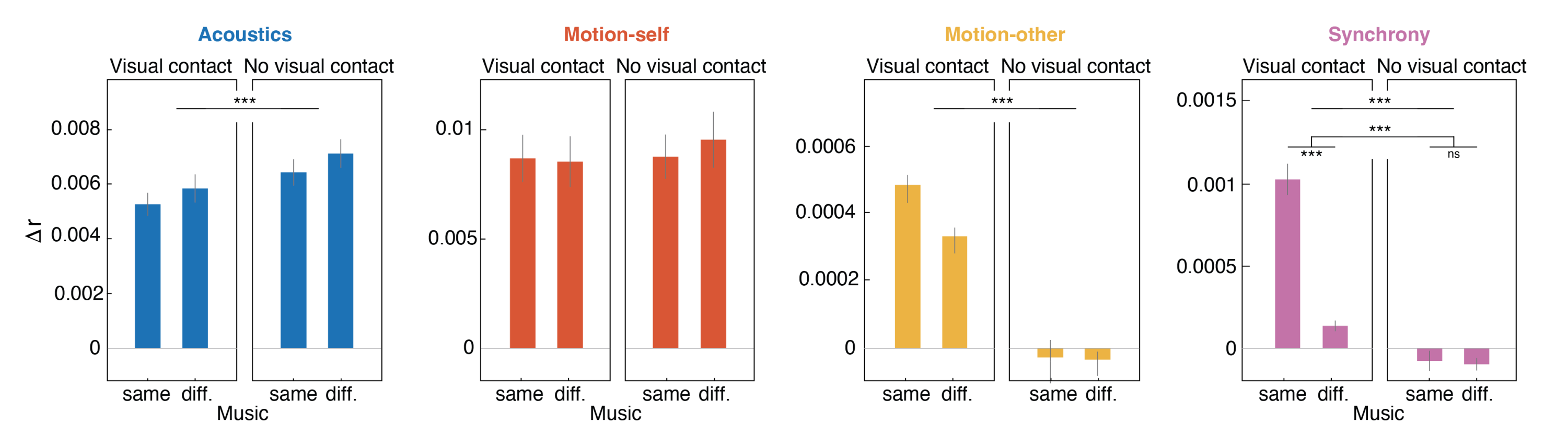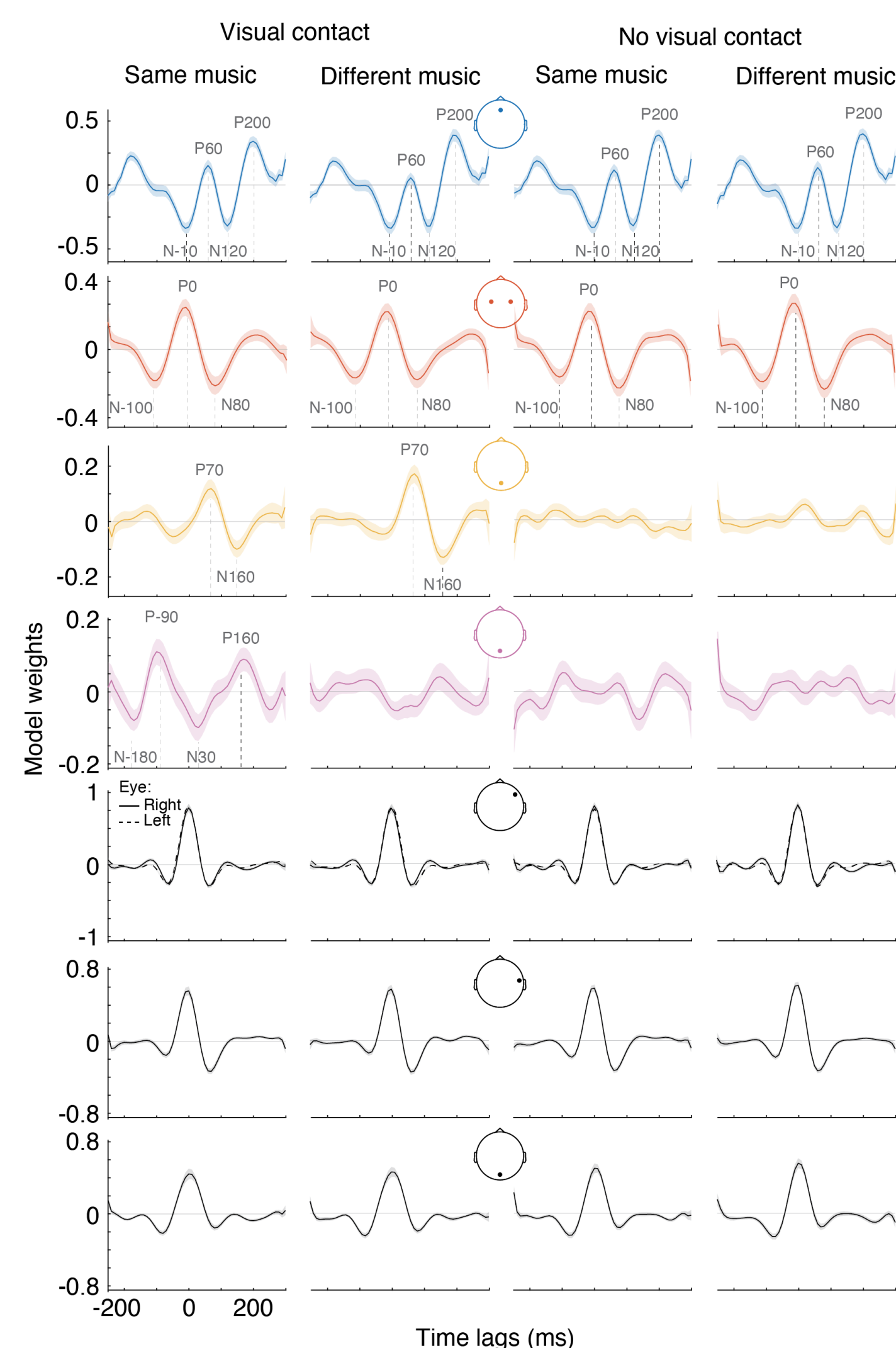
Repeated-measures ANOVA (with "musical input" and "visual contact" as factors) **further upheld the physiological foundation** of the modelled processes. Notably:

- Self-generated movements yielded similar contributions across conditions.
- Other-generated movements contributed to EEG activity only in visual contact conditions.


a Unique contributions
b Temporal response function weights

Acoustics Full - A
Motion-self Full - Ms
Motion-other Full - Mo
Synchrony Full - S
Eyes Full - E
Cheeks Full - C
Neck Full - N

Acoustics
Motion-self
Motion-other
Synchrony

Visual contact / No visual contact
same diff.   Music

In a follow-up analysis, we modelled EEG signals using the kinematics of specific body parts.

This analysis further supported the conclusion that neural processes related to self-generation of movements (e.g. lateralized motor activity) can be effectively isolated.

a   Left   Right   Left - Right   b   Head
Hands
Feet
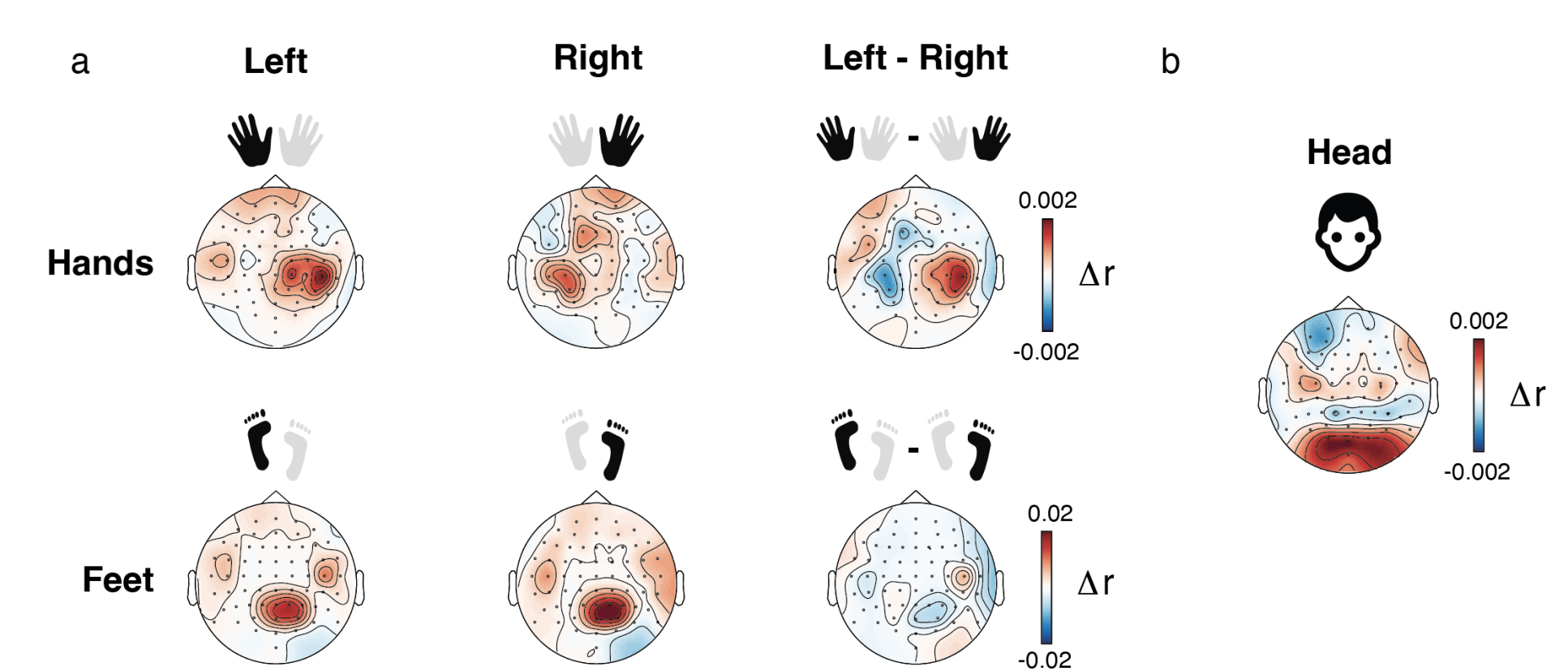
Conclusion

Our study teases apart distinct neurophysiological processes that occur simultaneously during a complex naturalistic interaction such as dyadic dance. These processes capture:
the perception of the music, of others' body movements, interpersonal synchrony, and motor control.

We provide multiple pieces of evidence showing that these processes correspond to well-established neural markers of sensory processing and motor control.

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