Exploring the role of spatial attention in movement simulation

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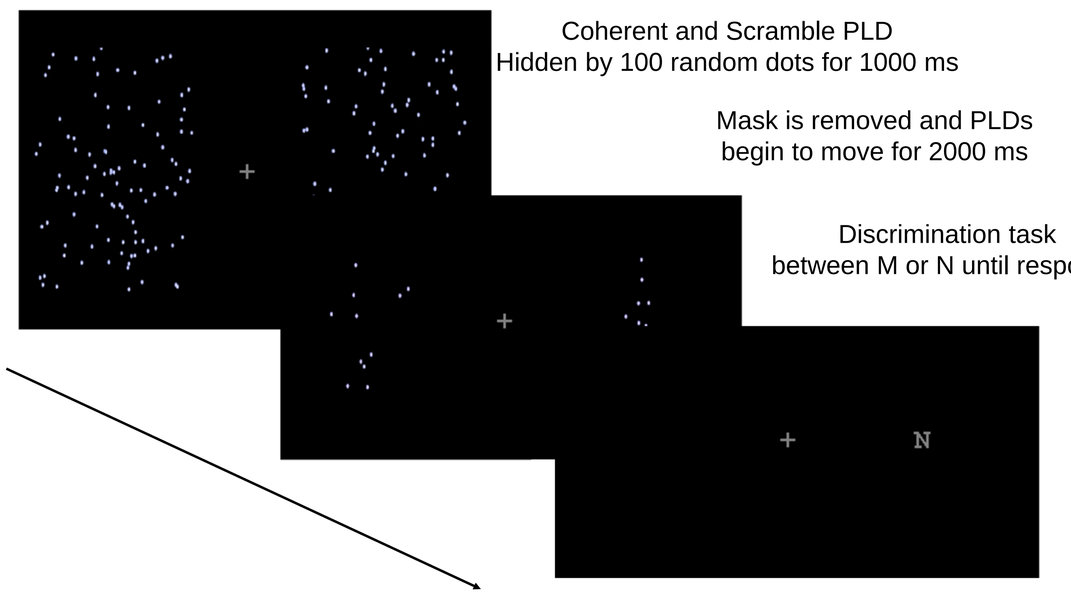
Background

- Previous research has used EEG 'mu' frequency (~ 8-13 Hz) changes to infer the recruitment of sensorimotor activation during biological movement observation.
- This sensorimotor activation is thought to be an indication of online movement simulation. It has been demonstrated that top-down attentional processes modulate the engagement of sensorimotor simulation during movement observation (Siqi-Liu et al., 2018)
- What remains unknown is whether biological motion exogenously captures spatial attention and, in turn, modulates sensorimotor simulation.

Experiment

- Participants completed a dot-probe paradigm while EEG data were recorded from 64 electrodes**.**
- Cues were point-light displays (PLDs) of human figures walking (left or right) from a sagittal view and scrambled versions of the same PLDs (taken from Troje & Westhoff, 2006). Both PLDs were presented laterally for each trial for 2000ms.
- Masked static PLDs images served as a pre-cue baselines for each trial displayed for 1000ms. Participants were instructed to ignore static images and cues, only to respond to identify a subsequent target (either 'N' or 'M') that replaced either the PLD or the scrambled PLD.

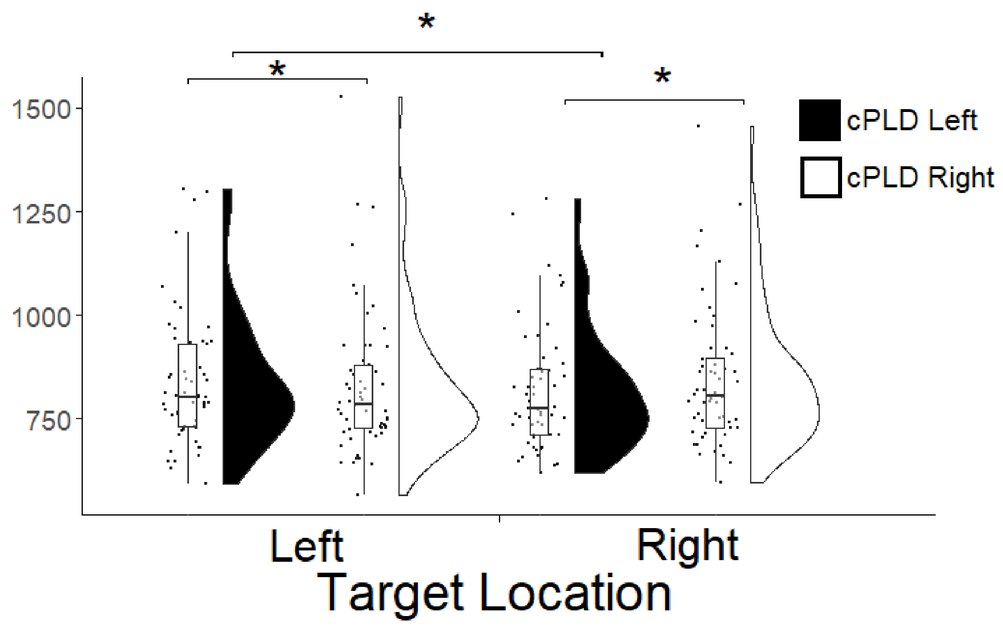


Participants

- For the behavioural analysis a total 56 participants were included; 22 males and 34 females, mean age 22.7 (*SD* = 3.83). For EEG analysis a total of 45 participants were; 18 males and 27 females, mean age 22.6 (SD = 3.74).

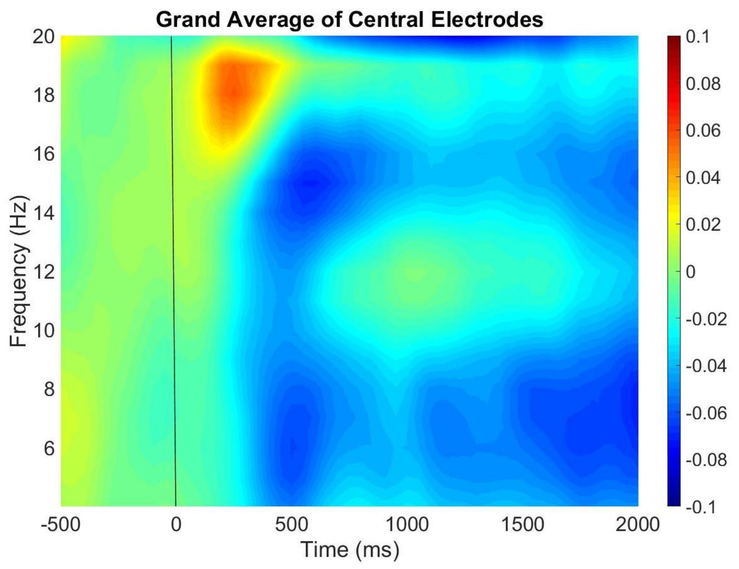
Behavioural Findings

- Main effect for cue location, (F = 4.474, p = .039). RTs were faster for responses to targets replacing either cue in the left visual space compared to targets replacing the cue in the right visual field.
- Interaction effect between the location of the coherent PLD and the location of the target, (F = 24,925, p = .001). Post-hoc comparisons were conducted by means of pairwise-sample t-tests (Bonferroni adjusted α = .008):
  - RTs were always faster to targets that replaced the scrambled PLD, whether the cue appeared in the left (t = 1.71, p = .008) or right (t = 2.284, p = .001) visual field.
- Further, when the coherent PLD occupied the left visual space responses to targets were faster (t = 2.92, p = .005) when replacing the scramble PLD, compared with the coherent PLD.



EEG Findings

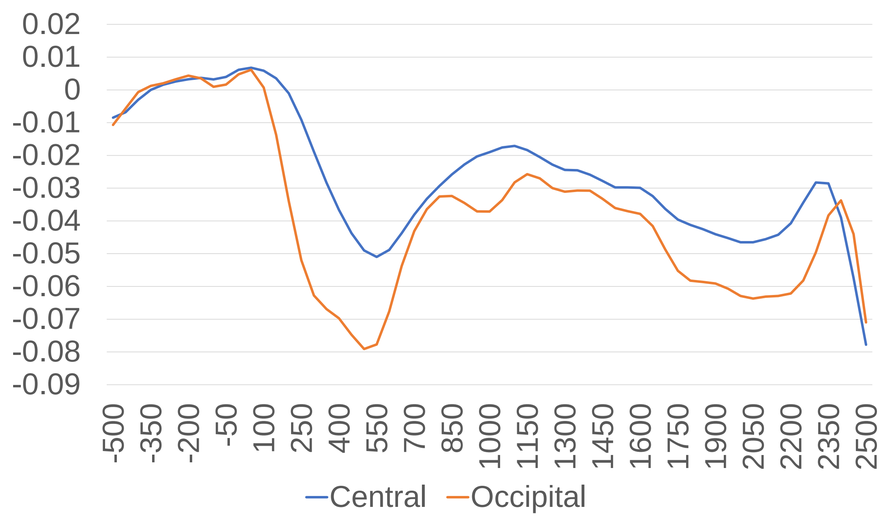
- EEG data were analysed using complex demodulation to define power modulations.
- Analysis was conducted on two central electrodes C3 and C4 and two occipital electrodes O1 and O2.



A time window was defined as 5 consecutive deviations from zero at central or occipital sites (see, Koelewijn, van Schie, Bekkering, Oostenveld, & Jensen, 2008) for 8-13 Hz (Hobson & Bishop, 2016; 2017).

Time window for central electrodes: 350 - 900 ms and between 1150 - 2500 ms post

Time window for occipital electrodes: 200-1100 ms and between 1250-2500 ms post



- **Central 350-900 ms** - Analysis revealed hemispheric differences (F = 5.199, p = .028). With greater decrease in the left hemisphere compared to the right hemisphere.
- Main effect for cPLD location (F = 8.50, p = .006). There was a greater decrease when the coherent PLD appeared in the participants right compared to when the coherent PLD appeared in the left visual field.
- Interaction between topographical site and hemisphere, (F = 9.762, p = .003). For central sites only (α = .008),), revealed a greater decrease in the left hemisphere compared to the electrode on the right hemisphere (t = 3924, p = .001).
- **Central 1150–2000 ms** - Main effect for hemisphere (F = 24.945, p = .001). There was a greater decrease in the left hemisphere compared to the right hemisphere.
- The second main effect was for the PLD walk direction (F = 4.961, p = .006). There was a greater decrease in amplitude when the PLDs walked towards the right compared to when they walked towards the left.
- Interaction between topographical site and hemisphere, (F = 7.832, p = .008). For central sites only, paired sample t-tests (α = .008) (t = 5.072, p = .001), revealed a greater decrease in the left hemisphere compared to the electrode on the right hemisphere.

Conclusion

- An attention bias to scramble PLDs was demonstrated. This may be an inhibition of return (IOR) effect or that ambiguous motion selectively attended.
- Onset of desynchronisation begun earlier and lasted for a longer period at occipital electrodes compared to central electrodes.
- Occipital alpha suppression was more robust than mu suppression suggesting the involvement of a strong attentional component.
- Lateralised mu and bilateral alpha desynchronisation were shown. Greater desynchronisation of mu was found in the left hemisphere.

References

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- Koelewijn, T., van Schie, H. T., Bekkering, H., Oostenveld, R., & Jensen, O. (2008). Motor-cortical beta oscillations are modulated by correctness of observed action. *Neuroimage*, *40*(2), 767-775.
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