Exploring the role of spatial attention in movement simulation

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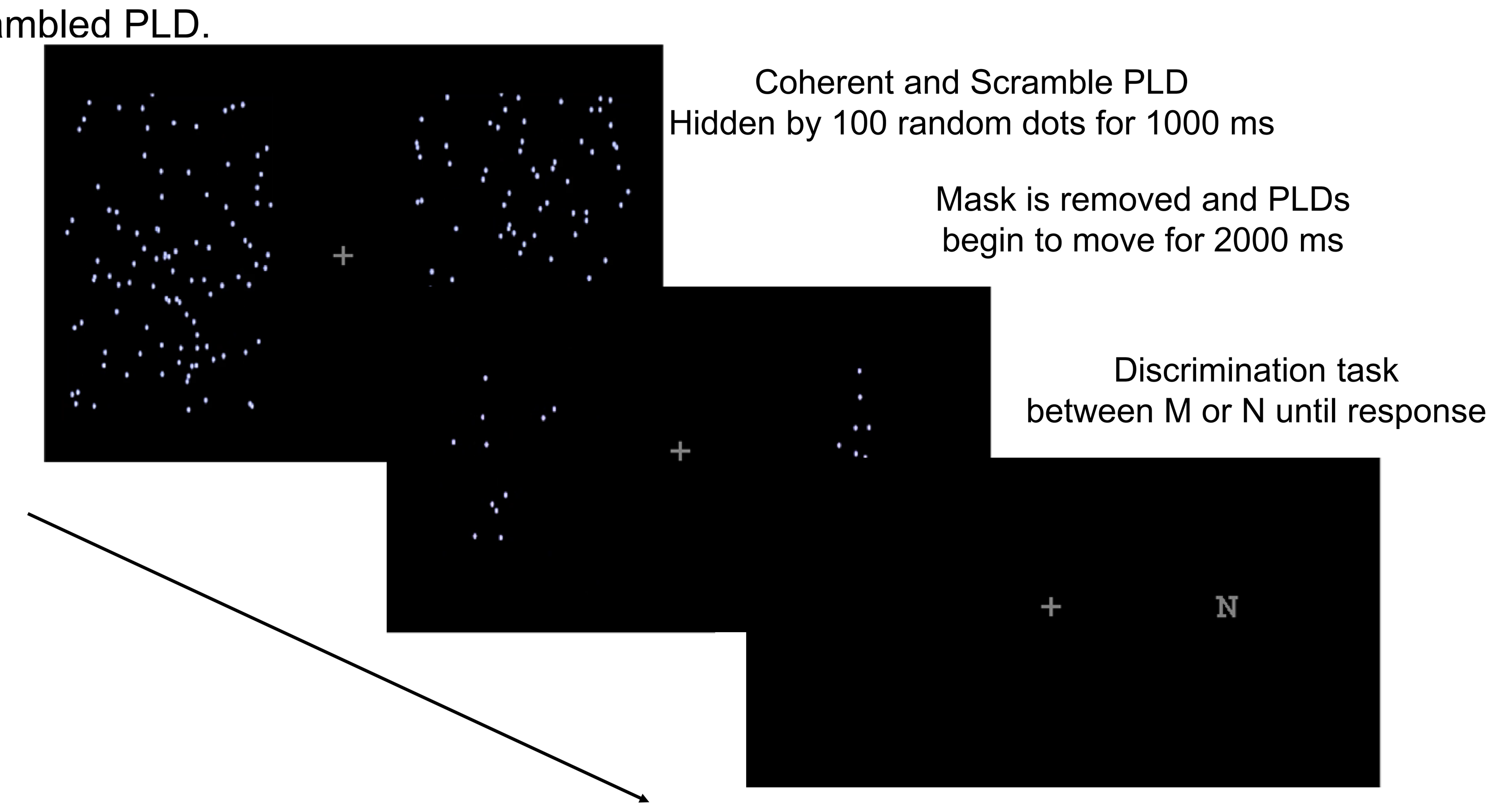
Background

- 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 was 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

- A total of 63 first year psychology students were recruited from a London University.
- 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

- 2x2x2 repeated measures ANOVA was conducted on RTs with a factor of coherent PLD location (right or left) X probe location (right or left) X PLDs walk direction (right and left).
- Main effect for cue location, F (1, 55) = 4.474, p = .039, $\eta\rho^2$ = .075. RTs were lower for responses to probes replacing either cue in the left visual space (M = 829.08, SE = 20.37) compared to probes replacing the cue in the right visual field (M = 836.90, SE = 22.43).
- An interaction effect was between the location of the coherent PLD and the location of the probe, F (1, 55) = 24,925, p = .001, $\eta\rho^2$ = .304. Post-hoc comparisons were conducted by means of pairwise-sample t-tests (Bonferroni adjusted α = .008).
- RTs to probes that appeared in the left visual space were marginally significantly lower (t (55) = 1.71, p = .008) when the probe replaced the scramble PLD (M = 829.37, SD = 175.21) compared to when the probe replaced the coherent PLD (M = 839.05, SD = 160.51). RTs to probes that appeared in the right visual (t (55) = 2.284, p = .001) were smaller when the probe replaced the scrambled PLD (M = 819.10, SD = .148.39) compared to when it replaced the coherent PLD in the same space (M = 844.45, SD = .167.97). When the coherent PLD occupied the left visual space responses to probes were faster (t (55) = 2.92, p = .005) when replacing the scramble PLD (M = 819.11, SD = 148.39) compared with the coherent PLD (M = 839.10, SD = .160.52).

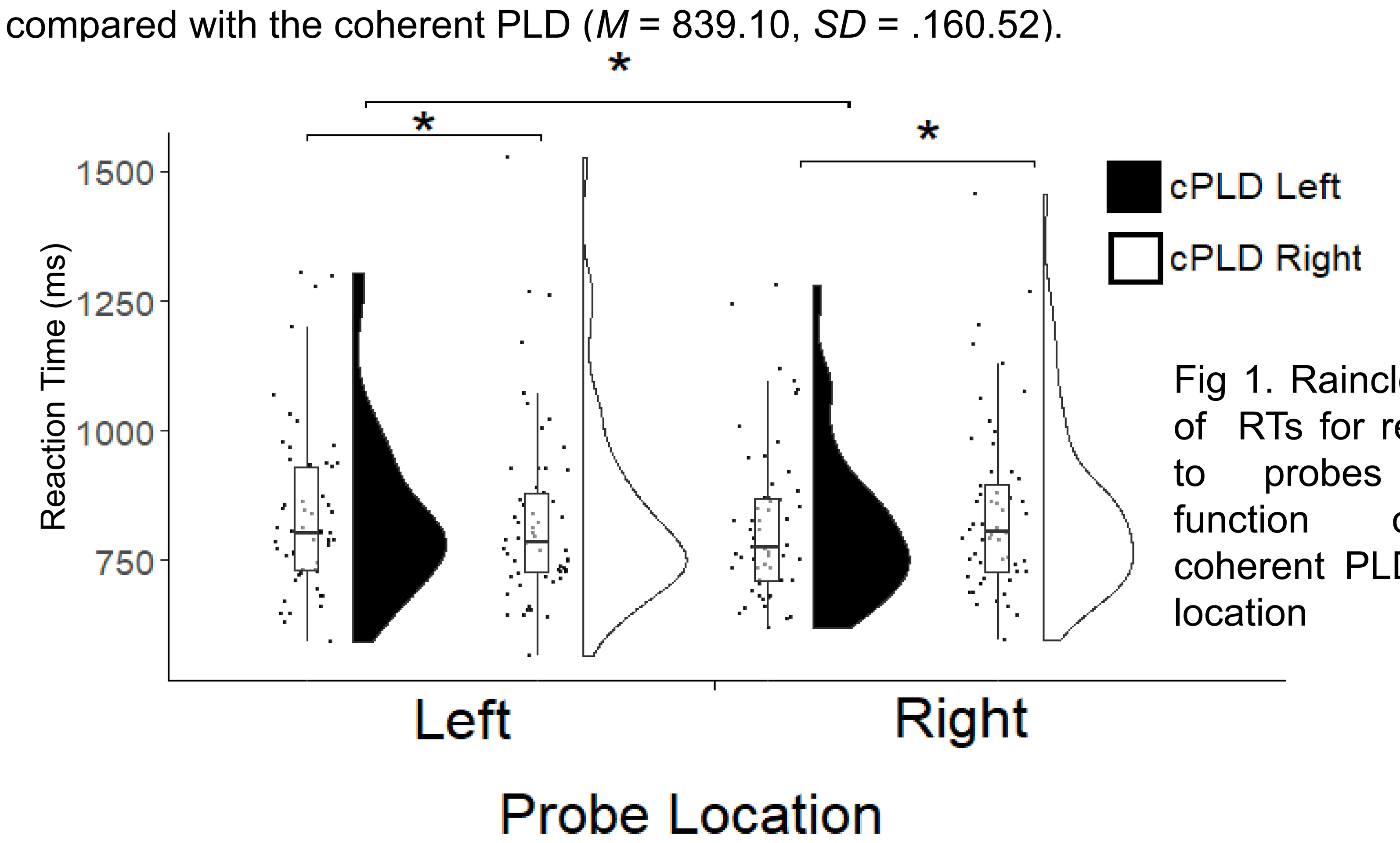
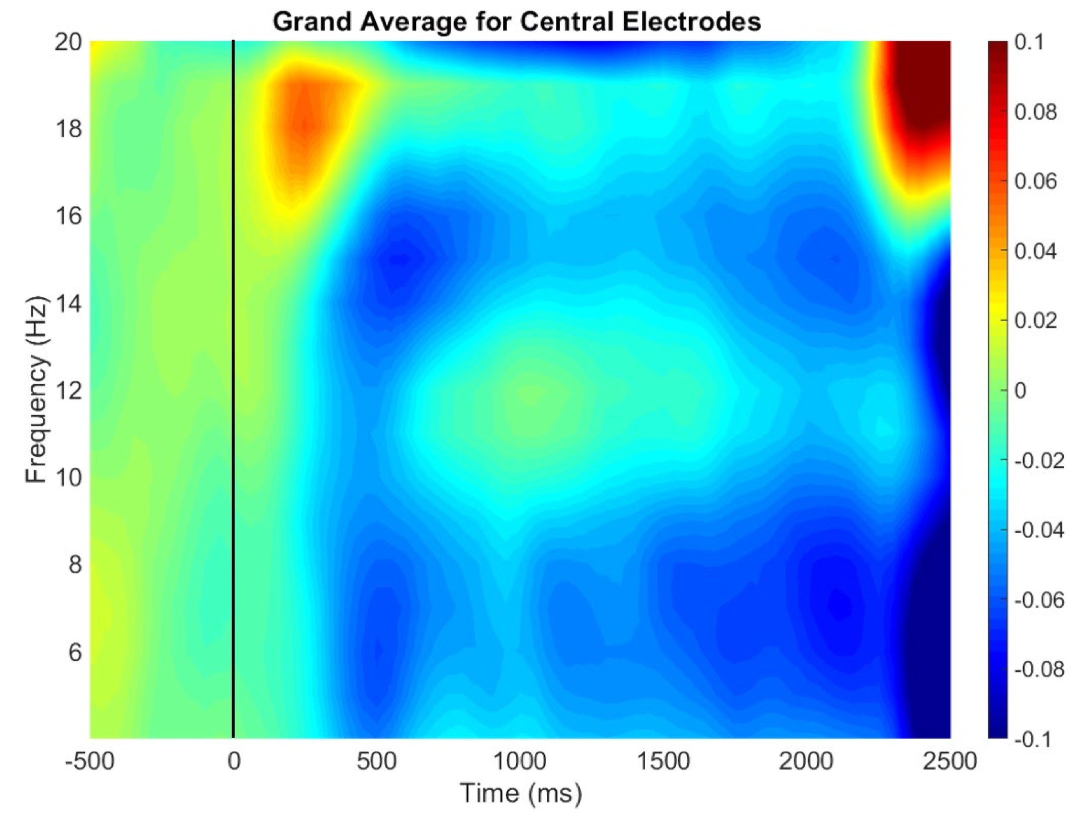
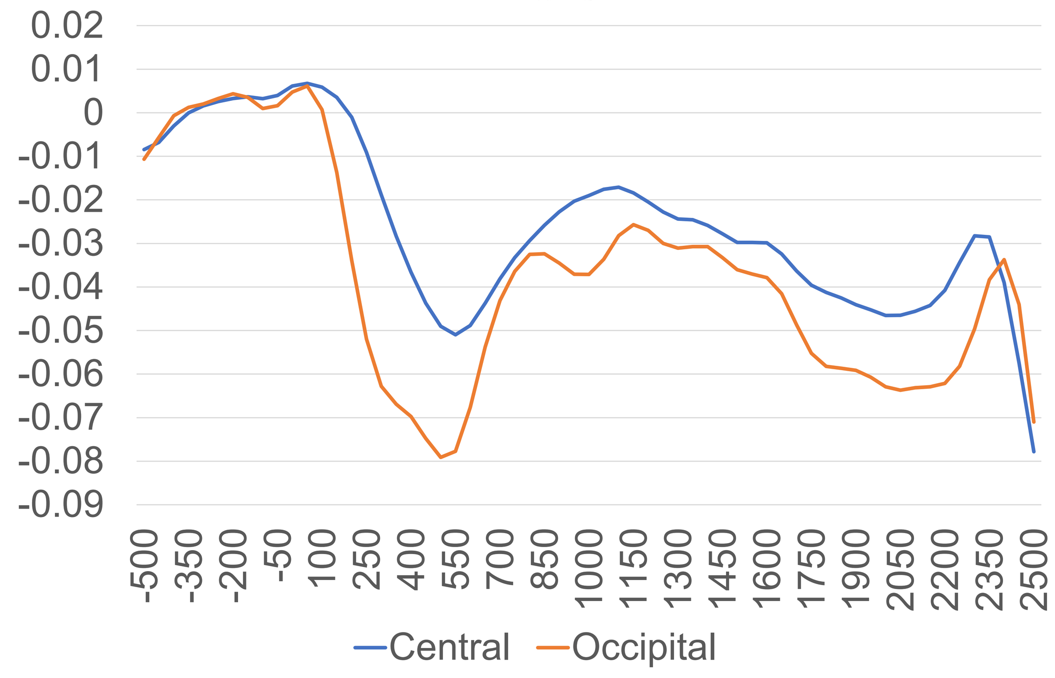


Fig 1. Raincloud plots of RTs for responses to probes as a function of the coherent PLD (cPLD) location

EEG Findings

- EEG data was analysed using continuous time-frequency analysis (complex demodulation) to analyse the modulation of power during movement observation. Analysis was conducted on two central electrodes C3 and C4 and two occipital electrodes O1 and O2.





To define the time windows for statistical analysis, data was extracted from the bandwidth 8-13 Hz, typically associated with the mu rhythm (Hobson & Bishop, 2016; 2017).

One-sample t-tests were conducted on the averaged data for central electrodes (C3 & C4) and occipital electrodes (O1 & O2) between -500-2500 ms.

Once five consecutive t-tests were significant (p < .05), a time window was extracted (see. Koelewijn, van Schie, Bekkering, Oostenveld, & Jensen, 2008).

- Time window for central electrodes 350 - 900 ms and between 1150 - 2500 ms post (all ts < 2.192, all ps < .05).
- Time window for occipital electrodes 200-1100 ms and between 1250-2500 ms post (all ts < 2.011, all ps < .05)

- 2x2x2x2 repeated measures were conducted for each time window, with the same factors of cPLD location (right & left), hemisphere (right & left), topographical location (central & occipital) and PLD walk direction (right & left)
- **Central 350-900 ms** - Analysis revealed hemispheric differences F (1, 44) = 5.199, p = .028, $\eta\rho^2$ = .106. With greater decrease in the left hemisphere (M = -.051, SE = .013) compared to the right hemisphere (M = -.037, SE = .012).
- Main effect for cPLD location F (1, 44) = 8.499, p = .006, $\eta\rho^2$ = .162. There was a greater decrease in amplitude when the coherent PLD appeared in the participants right and the scrambled PLD appeared in the left visual field (M = -.052, SE = .013) compared to when the coherent PLD appeared in the left visual field and the scrambled PLD occupied the right visual field (M = -.037, SE = .013).
- An interaction between topographical site and hemisphere, F (1, 44) = 9.762, p = .003, $\eta\rho^2$ = .182. Paired sample t-tests (α = .008) revealed a greater decrease in the left hemisphere (t (44) = -3924, p = .001) for the central electrode (M = -.06, SD = .07) compared to the central electrode on the right hemisphere (M = -.02, SE = .08).
- **Central 1250 – 2000 ms** - Main effect for hemisphere F (1, 44) = 24.945, p = .001, $\eta\rho^2$ = .362. There was a greater decrease in the left hemisphere (M = -.054, SE = .012) compared to the right hemisphere (M = -.024, SE = .012).
- The second main effect was for the PLD walk direction F (1, 44) = 4.961, p = .006, $\eta\rho^2$ = .031. There was a greater decrease in amplitude when the PLDs walked towards the right (M = -.045, SE = .012) compared to when they walked towards the left (M = -.033, SE = .012).
- Last, an interaction between topographical site and hemisphere, F (1, 44) = 7.832, p = .008, $\eta\rho^2$ = .151. Paired sample t-tests (α = .008) (t (44) = -5.072, p = .001), revealed a greater decrease in the left hemisphere for the central electrode (M = -.06, SD = .06) compared to the electrode on the right hemisphere (M = -.007, SD = .09).

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 alpha desynchronisation begun earlier and lasted for a longer period compared to mu. In addition, 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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