Unveiling the neurophysiological substrates of a visuo-motor *paired associative stimulation* protocol: a TMS-EEG study

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Introduction. The mirror-*Paired Associative Stimulation* (m-PAS) is a crossmodal version of the PAS protocol (Guidali et al., 2021) that can induce atypical visuo-motor associations (i.e., new ipsilateral motor resonance responses, assessed through cortico-spinal excitability). This induction is achieved thanks to the repeated association of transcranial magnetic stimulation (TMS) over the right primary motor cortex (M1) paired with the visual presentation of right-hand – i.e., ipsilateral to TMS – index finger movements (Guidali et al., 2020). In the present study, we sought to deepen its neurophysiological correlates by exploiting TMS in combination with electroencephalography (TMS-EEG) to clarify the global cortical dynamics underlying the aftereffects of its administration.

Methods. Twenty healthy participants underwent the m-PAS protocol in two different sessions, in a within-subject designed experiment. Here, we varied the inter-stimulus interval (ISI) between the movement onset of the visual stimulus and TMS pulse following the chronometry of motor control (25 ms, the ISI found effective in the original study – m-PAS$_{25ms}$) or that of MNS activation (250 ms – m-PAS$_{250ms}$) (Naish et al., 2014). Before and after each m-PAS session, TMS-evoked potential (TEPs) and Motor Evoked Potentials (MEPs) induced by single-pulse TMS applied to the right M1 were recorded during the observation of both contralateral (left) and ipsilateral (right) index-finger movements (or static hands).

Results. MEPs results replicate the findings of our original study (Guidali et al., 2020): the m-PAS $_{25ms}$ successfully induces new ipsilateral motor resonance responses, indexed by an atypical facilitation of cortico-spinal excitability by the view of ipsilateral (i.e., right) hand movements. Furthermore, during the observation of contralateral (i.e., left) hand movement, motor resonance is significantly reduced. Preliminary TMS-EEG analysis indicates amplitude modulations of mid-to-late M1 TEP components after the mPAS$_{25ms}$ application. Ongoing time-frequency and source-level connectivity analysis will help elucidating induced changes in the TMS-triggered oscillatory profile and inter-areal communication patterns.

Conclusion. Our results corroborate the evidence that the m-PAS protocol can remodel the visual-motor matching properties of the MNS and, in a broader perspective, associative plasticity within the motor system can be induced by exploiting a visual pathway. This modulation is detectable both at a peripheral (i.e., MEPs) and at a cortical level (i.e., TEPs).

References

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