Hebbian associative plasticity induced by a novel *paired associative stimulation* protocol shapes the properties of the Mirror Neuron System

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Hebbian associative plasticity and, in detail, spike-timing dependent plasticity (STDP) has been implied in the formation of the association between sensory and motor representations of actions in the Mirror Neuron System (MNS); however, such inductor role of STDP still needs empirical support[1].

To address this issue, we have assessed whether a novel paired associative stimulation (PAS) protocol, a non-invasive brain stimulation protocol known to activate STDP[2], can induce the formation of atypical (i.e., absent in normal conditions), visuo-motor associations, in turn reshaping motor resonance.

Twenty healthy participants underwent our novel mirror-PAS protocol (m-PAS) during which they were exposed to 180 repeated pairings of transcranial magnetic stimulation (TMS) pulses, applied over the right primary motor cortex (M1), time-locked with the view of index-finger movements of the right (ipsilateral) hand at a frequency of 0.2 Hz. In two different sessions, the *inter-stimulus interval* (ISI) between the onset of the visual action stimulus and TMS pulse was varied following the chronometry of motor control (25 ms) or that of MNS activation (250 ms). Before and after each m-PAS session, motor resonance was assessed by recording Motor Evoked Potentials (MEPs) induced by single-pulse TMS applied to the right M1, during the observation of both contralateral (left) and ipsilateral (right) index-finger movements or static hands.

As expected from literature[3], before m-PAS, a facilitation of cortico-spinal excitability (MEPs) occurred only during the view of left, contralateral (with respect to the TMS side) index-finger movements. The m-PAS successfully induced new ipsilateral motor resonance responses, indexed by an atypical facilitation of cortico-spinal excitability by the view of ipsilateral (i.e., right) hand movements. Crucially, this effect occurred only if the associative stimulation followed the chronometry of motor control (ISI of 25 ms).

The present findings provide empirical evidence that Hebbian associative plasticity, and thus STDP, shapes the visual-motor matching properties of the MNS, which could be modulable by our PAS protocol. The m-PAS represents a promising non-invasive protocol to shed light on the neurofunctional bases of the human MNS.

References

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