DRIVING ASSOCIATIVE PLASTICITY INTO MOTOR AND VISUO-MOTOR NETWORKS ENHANCE ACTION PERCEPTION AND IMITATION

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Background: Social interactions heavily depend on the ability to perceive and predict the actions of others. These cognitive processes are supported by an Action Observation Network (AON), characterized by bidirectional connections linking high-order visual areas like the posterior superior temporal sulcus (pSTS) to parieto-frontal motor regions, including the inferior frontal cortex (IFC). Despite the recognized significance of IFC in the AON, the precise nature of its interaction with pSTS for facilitating action perception remains poorly understood.

Aims: This research aims to investigate the plasticity and functional relevance of the IFC-pSTS pathway to action prediction through the application of Transcranial Magnetic Stimulation (TMS).

Method: In the main study, participants engaged in two tasks: an action prediction task (AP), that required predicting the final outcome of a reaching-grasping action from the initial phases of the movement, and a non-biological movement control task. Participants underwent TMS testing via cortico-cortical paired associative stimulation (ccPAS), a protocol designed to induce Hebbian spike-timing-dependent plasticity (STDP) in the IFC-pSTS pathway, thereby strengthening the directional connectivity from IFC to pSTS. Control ccPAS conditions were employed to evaluate pathway- and direction-specific changes in action perception. Additionally, preliminary studies were conducted to establish ccPAS protocols for inducing STDP in the target cortico-cortical networks.

Results: The findings revealed that ccPAS aimed at enhancing IFC-pSTS connectivity led to improved performance in action prediction tasks. No similar improvement was observed in the control task or following control ccPAS conditions.

Conclusions: Our unique approach provides unprecedented causal evidence, highlighting the pivotal role of backward IFC-pSTS connectivity in the ability to predict the outcome of observed actions. These findings deepen our mechanistic understanding of AON functions, shedding light on the malleability and functional relevance of the IFC-pSTS pathway within the AON concerning action prediction. This study provides novel insights into the functional architecture and dynamics of the AON, with significant theoretical and practical implications.

Keywords: Brain plasticity, Transcranial magnetic stimulation, Perception, Action

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