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Mirror, mirror on the screen: Influencing motor cortex excitability through action observation and Hebbian associative plasticity

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Introduction. Hebbian plasticity has been implicated in the formation of associations between sensory and motor representations of actions, contributing to the emergence of the motor resonance phenomenon (i.e., activation of the motor system at the sight of other people's actions, driven by the action observation network, and underlying different facets of social cognition).
Methods. Our research group developed a visuomotor Paired Associative Stimulation protocol (mirror PAS, m-PAS) to modulate motor resonance responses through Hebbian associative plasticity. The m-PAS repeatedly pairs transcranial magnetic stimulation (TMS) pulses over the primary motor cortex (M1) with visual stimuli depicting actions that are not associated, in baseline, with the motor resonance phenomenon. After its administration, atypical motor resonance emerges during PAS-conditioned action observation. Recent advances obtained with this protocol will be presented.
Results. On healthy participants, we deepened m-PAS aftereffects through TMS and electroencephalography (EEG) co-registration, highlighting that novel PAS-induced motor resonance responses are linked to modulations of M1 beta-band cortical connectivity, only partially overlapping interregional communication patterns related to the typical phenomenon. On patients, data from the stroke population with upper limb hemiparesis shows m-PAS effectiveness in modulating ipsilesional motor cortex excitability in a muscle-specific fashion, according to the kinematic characteristics of the movement visually conditioned during the protocol.
Conclusion. Our findings suggest that visuomotor associative plasticity driven by action observation is crucial in influencing motor resonance responses and M1 excitability. The m-PAS can be a powerful tool to causally modulate the visuomotor plastic properties of mirror networks in the healthy and damaged brain.

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