Neuro-dynamical model for the coupling of action perception and execution

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Action perception and action execution are intrinsically linked in the human brain, likely mediated by 'mirror circuits' in parietal and premotor cortex. We present a physiologically-inspired neural model that, based on physiologically plausible mechanisms, accounts for a variety of experiments testing the interaction of action perception and execution. METHODS: The model is based on coupled dynamic neural fields that encode action sequences. Each action is represented by a vision field and a motor field, which encode the perceived action and the associated motor program. Fields representing the same action are coupled in a way that supports synchronous traveling-pulse solutions, and fields encoding different actions inhibit each other. The model comprises a visual pathway that processes image sequences, and a motor pathway that produces joint angle sequences output. RESULTS: Using the same set of parameters, the model reproduces psychophysical and fMRI experiments on the influence of action execution on action perception and vice versa. It reproduces electrophysiogical data about the population encoding of executed and perceived actions in mirror neurons in premotor cortex. In addition, it reproduces the spontaneous synchronization of motor behaviour when two agents observe each other. CONCLUSION: The model provides a unifying account for a multitude of experiments investigating the interaction between action perception and execution and makes specific predictions about the behavior of different neuron classes at the single-cell level.

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Teaser:

A physiologically-inspired neural model that accounts for the neural encoding of perceived actions and motor plans, and their interactions. It provides a unifying account for a multitude of experiments, ranging from psychophysics over electrophysiology to functional imaging.