Biophysically plausible neural model for the interaction between action observation and action execution

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INTRODUCTION: It has been suggested that neural representations for action perception and action execution are closely linked in the human brain. Previous studies show that the execution of motor behavior influences concurrent visual action observation, and specifically the perception of biological motion. The detailed neural mechanisms that support this interaction are unknown. METHODS: We extended a physiologically-inspired model for visual action recognition (Fleischer et. al. J. Nsc. 2013) by a neural representation of motor programs, which is coupled reciprocally with visual recognition layer that is modeled by a dynamic neural network. Visual and executed actions are represented by a localized activation maxima that propagates in the visual and in the motor representation, which are modeled by dynamic neural fields that are implemented with biophysically realistic spiking neurons. An appropriately designed coupling between both representations results in interactions between action observation and action execution that mimic experimental results on the interactions between motor execution and recognition (Christensen et al., J. Nsc. 2011; Kilner et al., 2003). RESULTS: Consistent with the experimental data, we find a facilitation of the detection of visual action patterns by concurrent motor execution if the executed motor pattern is spatio-temporally compatible with the observed pattern, and interference if it is incoherent, e.g. in presence of time delays between observed and executed actions. CONCLUSION: Simple dynamic neural networks with biophysically realistic neurons can reproduce basic signatures of perception-action coupling in behavioral experiments.

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