Spiking neuron model of a key circuit linking visual and motor representation of actions

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Action perception and the control of action execution are intrinsically linked in the human brain. Experiments show that concurrent motor execution influences the visual perception of actions and biological motion (e.g. [1]). This interaction likely is mediated by action-selective neurons in premotor and parietal cortex. We have developed a model based on biophysically realistic spiking neurons that accounts for such interactions. The model is based on two coupled dynamic neural fields[2], one modeling a representation of perceived action patters (vision field), and one representing associated motor programs (motor field), each implemented by 30 coupled spiking ensembles. Each ensemble contains 80 excitatory and 20 inhibitory adaptive Exponential Integrate-and-Fire (aEIF) neurons [3]. Within each field asymmetric recurrent connections between the ensembles stabilize a traveling pulse solution, which is stimulus-driven in the visual field and autonomously propagating in the motor field after initiation by a go-signal. Both fields are coupled by interaction kernels that results in mutual excitation between the fields of the traveling pulse propagate synchronously and in mutual inhibition otherwise. We used the model to reproduce the result of a psychophysical experiment that tested the detection of point-light stimuli in noise during concurrent motor execution[1], and for the simulation of the modulation of motor behavior by concurrent action vision[4]. The proposed model reproduces correctly the interactions between action vision and execution in these experiments.

References

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