

Goal directed behavior guided by a spiking neuron model of prefrontal cortical function

Randal A. Koene, R.C. Cannon & M.E. Hasselmo
Center for Memory and Brain
Department of Psychology & Program in Neuroscience
Boston University
2 Cummington Street, Boston, MA 02215
randalk@bu.edu

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An integrate-and-fire model of goal directed function in prefrontal cortex (PFC) was used to replicate results in a visual go/no-go conditioned stimulus task (W.Schultz *et al.*, *Cerebral Cortex*, 2000). In the task, three possible visual stimuli were randomly presented to monkeys: One stimulus produced reward if the monkey responded with specific movement (rewarded movement). Another stimulus produced the reward if the monkey refrained from performing the movement (rewarded non-movement). And the third stimulus produced no immediate reward, but the unrewarded trial was repeated unless the monkey performed the specific movement (unrewarded movement). In the model of PFC, sensory input states and motor actions are all represented by individual cortical minicolumns. And spike timing dependent synaptic plasticity (STDP) encodes transitions between the states and actions. The transitions are represented by sparse intercolumnar connections linked with dense intracolumnar connections. Short-term memory (STM) is needed to encode associations between states visited and actions performed at arbitrary time intervals. The model of STM function is based on intrinsic membrane currents that maintain persistent firing and allow ordered repetition and replacement of firing patterns. Once a sequence of states and actions that leads to a goal is encoded, associative spread from the goal representation enables retrieval of the sequence. At each state, such retrieval enables selection of appropriate action to reach the goal. Thus, the model corresponds to a cortical implementation of state-action mappings in reinforcement learning. Encoding and retrieval are carried out in distinct phases of network oscillations. Simulations with the model replicated activity recorded in orbitofrontal neurons by W.Schultz: A subset of the neurons activated in response to specific stimuli. Another subset of the neurons activated in anticipation of and during go/no-go action. And a third subset activated in anticipation of and during receipt of reward. Supported by NIMH MH 60450, MH60013, MH61492 and DA16454.