Spike-timing-dependent synaptic plasticity and synaptic democracy in dendrites

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Abstract:

We explored in a computational study the effect of dendrites on excitatory synapses undergoing spike-timing-dependent plasticity (STDP) using both cylindrical dendritic models and reconstructed dendritic trees. We show that even if the initial strength, g(peak), of distal synapses is augmented in a location independent manner, the efficacy of distal synapses diminishes following {STDP} and proximal synapses would eventually dominate. Indeed, proximal synapses always win over distal synapses following linear {STDP} rule, independent of the initial synaptic strength distribution in the dendritic tree. This effect is more pronounced as the dendritic cable length increases but it does not depend on the dendritic branching structure. Adding a small multiplicative component to the linear {STDP} rule, whereby already strong synapses tend to be less potentiated than depressed (and vice versa for weak synapses) did partially "save" distal synapses from "dying out." Another successful strategy for balancing the efficacy of distal and proximal synapses following {STDP} is to increase the upper bound for the synaptic conductance (g(max)) with distance from the soma. We conclude by discussing an experiment for assessing which of these possible strategies might actually operate in dendrites.

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