Learning rules for spike timing-dependent plasticity depend on dendritic synapse location

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Previous studies focusing on the temporal rules governing changes in synaptic strength during spike timing-dependent synaptic plasticity (STDP) have paid little attention to the fact that synaptic inputs are distributed across complex dendritic trees. During STDP propagation of action potentials (APs) back to the site of synaptic input is thought to trigger plasticity. Yet in pyramidal neurons AP backpropagation is decremental. This raises the question whether STDP learning rules depend on synapse location. Using paired recordings between layer 2/3 and layer 5 pyramidal neurons we show here that the timing requirements for STDP depend on synaptic distance from the soma. This finding could be explained by distance-dependent differences in the underlying dendritic voltage waveforms driving NMDA receptor activation during STDP induction. Our results suggest that synapse location within the dendritic tree is a crucial determinant of STDP, and that synapses undergo plasticity according to local rather than global learning rules.