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**NOTES FOR TALK ON**

# "LEARNING RULES IN THE HIPPOCAMPUS AND CEREBELLUM"

**by Prof. Samuel WANG**
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## Malleability of spike-timing-dependent plasticity at the CA3-CA1 synapse.

**Wittenberg GM, Wang SS.**
**J Neurosci. 2006 Jun 14;26(24):6610-7**

The magnitude and direction of synaptic plasticity can be determined by the precise timing of presynaptic and postsynaptic action potentials on a millisecond timescale. In vivo, however, neural activity has structure on longer timescales. Here we show that plasticity at the CA3-CA1 synapse depends strongly on parameters other than millisecond spike timing. As a result, the notion that a single spike-timing-dependent plasticity (STDP) rule alone can fully describe the mapping between neural activity and synapse strength is invalid. We have begun to explore the influence of additional behaviorally relevant activity parameters on STDP and found conditions under which underlying spike-timing-dependent rules for potentiation and depression can be separated from one another. Potentiation requires postsynaptic burst firing at 5 Hz or higher, a firing pattern that occurs during the theta rhythm. Potentiation is measurable after only tens of presynaptic-before-postsynaptic pairings. Depression requires hundreds of pairings but has less stringent long timescale requirements and broad timing dependence. By varying these parameters, we obtain STDP curves that are long-term potentiation only, bidirectional, or long-term depression only. This expanded description of the CA3-CA1 learning rule reconciles apparent contradictions between spike-timing-dependent plasticity and previous work at CA3-CA1 synapses.