

ASSOCIATIVE LONG-TERM POTENTIATION (LTP) OR DEPRESSION (LTD) IS PRODUCED IN HIPPOCAMPUS DEPENDENT UPON THE PHASE OF RHYTHMICALLY ACTIVE INPUTS. P.K. Stanton, J. Jester, S. Chattarji, and T.J. Sejnowski. Dept. Biophysics, Johns Hopkins Univ., Balto., MD 21218.

Hippocampal LTP is an enduring increase in synaptic efficacy following brief high-frequency afferent stimulation. Separate afferents activated together exhibit associative LTP of inputs that alone do not elicit LTP, and inputs silent during postsynaptic burst firing show reduced synaptic efficacy termed LTD. LTP also occurs following short, rhythmic high-frequency bursts (100 Hz) separated at θ rhythm frequencies (5 Hz). We report here that phase of arrival of a weak input within the rhythm of a strong (potentiating) one determines whether associative LTP (inputs in phase) or LTD (out of phase) occurs.

Extra- and intracellular recordings were made in rat hippocampal slices (400 μm thick) in an interface chamber at 34°C. Stimuli were to separate inputs on the Schaffer collateral and subicular sides of CA1 pyramidal cell apical dendrites, or to commissural and mossy fiber inputs to CA3. Strong stimuli consisted of trains of 10 bursts of 5 pulses each (100 Hz burst frequency, 200 msec interburst interval). Weak stimuli (5 Hz trains) were positively correlated (in phase) by superimposing on the middle of each burst, or negatively correlated (out of phase) by symmetric placement between bursts.

When weak and strong inputs were in phase, associative LTP of the weak input epsp and population spike was seen 15-60 min post-tetani in field CA1. If either the Schaffer collateral or subicular side received the weak stimuli ($\Delta\text{EPSP} = +49.8 \pm 7.8\%$, $n=20$; $\Delta\text{Spike} = +65.4 \pm 16.0\%$, $n=14$). In contrast, if weak and strong inputs were 180° out of phase, a specific associative LTD of the weak input population spike was observed ($-46.5 \pm 11.4\%$, $n=10$), with no change in epsp slope. In field CA3, commissural fiber synapses also exhibited associative LTP when in phase with strong mossy fiber stimuli, and associative LTD when out of phase. Thus, pyramidal cells show enhanced or reduced efficacy of specific synapses depending upon precise timing between inputs. (Supported by Office of Naval Research Grant #N00014-88-K-0198)

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