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Poster presentation

Inhibitory feedback in a small CA3-network

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Pyramidal cells perform computations on incoming inputs under the influence of two types of feedback inhibition. Several lines of evidence point towards the existence of at least two functionally separated inhibitory feedback loops in the hippocampus: 1) a loop with slow kinetics projecting to the distal dendrite of pyramidal cells (mainly O-LM interneurons) 2) a loop with fast kinetics (mainly basket cells) projecting to the soma of pyramidal cells. This elementary network is essential for the generation of biological relevant rhythms such as gamma and theta. However, the implications for the type of computation the pyramidal cells perform has not been investigated as of yet. We investigate a small network consisting of a pyramidal cell [1] and an interneuron [2].

We inject Gaussian white noise into the dendrite, which evokes both spikes and bursts. We investigate both the Spike-Triggered Average and the Spike-Triggered Covariance [3,4]. Moreover, we look at the inter-event-intervals between both spikes and bursts. We then add an interneuron, vary the synapse-strengths and EPSC and IPSC kinetics, and repeat the same analysis.

The STA and STC on the pyramidal cell show that this model behaves in first approximation as a basic integrator: With sufficient positive input bursts and spikes will be evoked. Which of the two is determined just after the (first) spike. Positive input will result in a burst; negative input will result in a spike. Stronger feedback inhibition, in the slow as well as in the fast loop, increases the event-rate of the pyramidal cell, since spikes are favored over bursts. This happens because the feedback inhibition prevents the dendritic calcium spike [5], and therefore the burst. In contrast to spikes, bursts will activate the slow AHP-current, which lengthens the inter-event-interval.

The finding that inhibition can increase the firing rate of pyramidal cells has been shown before [4-6]. It has been shown that O-LM interneurons, modelled here in the slow loop, show strong facilitation, and do not normally activate until after several pyramidal spikes [7]. Moreover, these interneurons are shown to inhibit other interneurons [8]. Therefore, we hypothesize that these slow loop O-LM cells could stop the fast loop after several fast spikes and switch the network to a different state, functioning as a type of "brake" on the fast inhibitory feedback loop.

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