

Oscillatory properties of individual hippocampal neurons

Ole Paulsen, University Laboratory of Physiology, Oxford

Several mechanisms are likely to contribute to hippocampal theta activity, including the functional characteristics of the local synaptic circuitry and resonance properties intrinsic to individual neurons. Individual hippocampal neurons show frequency preference at theta and gamma frequencies, coinciding with natural oscillation frequencies of the network. We have investigated frequency preferences of different types of neuron using whole-cell patch-clamp recording from visually-identified neurons in hippocampal slices. Using current-based and conductance-based inputs applied through the recording pipette, both subthreshold resonance and suprathreshold spike frequency preference were investigated. The following general principles emerge from these studies: 1. Different types of neuron show distinct frequency preferences. 2. Pyramidal neurons show frequency preference at theta frequencies. 3. Distinct mechanisms of frequency preference are recruited at different membrane potentials. Thus, subthreshold resonance and suprathreshold spike frequency properties can be disassociated. 4. Increasing a tonic background conductance reduces the magnitude of subthreshold resonance in neurons. 5. Frequency preference is retained using conductance-based inputs. In conclusion, intrinsic frequency properties of hippocampal neurons could support the emergence of network oscillations in physiologically-relevant frequency ranges.