Abstract View

COMPUTATIONAL MODEL OF CARBACHOL-INDUCED DELTA, THETA AND GAMMA OSCILLATIONS IN THE HIPPOCAMPUS.

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Field potential recordings from the rat hippocampus contain distinct frequency bands of activity, including delta (0.5-2 Hz), theta (4-12 Hz), and gamma (30-80 Hz), that are correlated with the behavioral state of the animal. The cholinergic agonist carbachol (CCH) induces oscillations in the delta (CCH-δ), theta (CCH-θ), and gamma (CCH-γ) frequency range in the hippocampal slice preparation. Specifically, with increasing CCH-concentration asynchronous CCH-θ, synchronous CCH-δ, and synchronous CCH-θ is found [Fellous JM, and Sejnowski TJ, Hippocampus 10:187-197(2000)]. In a network model of area CA3, the time scale for CCH-δ corresponds to the decay constant of the gating variable of the calcium dependent potassium (K-AHP) current, that of CCH-θ to an intrinsic subthreshold membrane potential oscillation of the pyramidal cells, and that of CCH-γ to the decay constant of GABAergic inhibitory synaptic potentials onto the pyramidal cells. In model simulations, the known physiological effects of carbachol on the muscarinic and K-AHP currents, and on the distribution of the strengths of excitatory postsynaptic potentials can reproduce the transition from asynchronous CCH-θ to CCH-δ, and from CCH-δ to synchronous CCH-θ. The simulations also exhibit the nested CCH-γ-CCH-δ and CCH-γ-CCH-θ that were observed in experiments. The model also predicts a state with all three frequency bands present, which has not yet been observed experimentally.
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