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Activity-dependent stochastic resonance in recurrent neuronal networks[1]

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An important source of noise for neuronal networks is that of the stochastic nature of synaptic transmission. In particular, there can occur spontaneous asynchronous release of neurotransmitter at a rate that is strongly dependent on the presynaptic Ca2+ concentration and hence strongly dependent on the rate of spike induced Ca2+. Here it is shown that this noise can lead to a new form of stochastic resonance for local circuits consisting of roughly 100 neurons - a "microcolumn"- coupled via noisy plastic synapses. Furthermore, due to the plastic coupling and activity-dependent noise component, the detection of weak stimuli will also depend on the structure of the latter. In addition, the circuit can exhibit short-term memory, by which we mean that spiking will continue to occur for a transient period following removal of the stimulus. These results can be directly tested in experiments on cultured networks.

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