10th Joint Symposium on Neural Computation, UC Irvine, May 17, 2003

Effects of a synaptic learning rule on the sparseness of odor representations in a model olfactory system

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In vivo recordings from the locust mushroom body demonstrate high specificity in Kenyon cells' (KCs) responses during odor processing. We explored the possibility that a form of plasticity may control and tune synaptic weights to the mushroom body to provide specificity of KCs' responses to familiar or meaningful odors. To test our hypothesis, we compared a spike-rate dependent plasticity learning mechanism with spike-timing dependent plasticity (STDP) in a network model that included a one-dimensional chain of simplified KCs each receiving *N* inputs with realistic spike trains. Slow temporal patterns and transient synchronization between spike trains in different afferents were modeled. In the model, both trained networks responded with the same pattern of spiking KCs, which usually included only 1-3 "odor-specific" neurons, independently of the initial (before training) synaptic weights to the KCs. However, at high initial weights specificity was better represented in the network with STDP-based learning rule. This network trained by a set of odors responded to any single odor from the set with firing patterns that were identical to those in the network trained by this odor alone. The finding indicates that STDP preserves the network's ability to respond with different patterns for different odors from a training set. The study suggests a possible role for synaptic plasticity in enabling efficient decoding of temporal patterns.