

A SYNAPTIC LEARNING RULE FOR LOCAL SYNAPTIC INTERACTIONS BETWEEN EXCITATION AND SHUNTING INHIBITION

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The basic requirement for direction selectivity is a non-linear interaction between two different inputs in space-time. In some models, the interaction occurs at the dendritic tree level among excitation and inhibition of the shunting type. How is the required spatial specificity achieved using an unsupervised learning rule?

We here propose an inhibition-directed, activity-based, unsupervised learning model that may account for direction selectivity in V1 cells. We carried out biophysical simulations in the program NEURON. Our results suggested model cells implementing our learning algorithm developed direction selectivity organically after unsupervised training. Initial connection bias can reduce the training time but is not strictly necessary. We further added a “matching rule” to our learning model. Model cells implementing this additional rule developed direction selective sub-unit structures on their dendrites. The same learning mechanism could also account for an OFF-ON-ON synaptic connection scheme we reported earlier that was direction selective to both normal and reverse-phi motion. We believe that these learning rules are also applicable---with minor modifications---to retinal direction selectivity.