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The emergence of motion-processing circuits in the visual cortex

AUDREY SEDERBERG, MATTHIAS KASCHUBE, Princeton University — Direction selectivity in the visual cortex is a paradigm for understanding the dynamics underlying learning in neural circuits. Experimental work has shown that neurons can become selective for a given direction of motion after a few hours of training with a bidirectionally moving stimulus. Here we show that this property naturally arises in models based on Hebbian synaptic plasticity if cortical neurons inhibit each other sufficiently. Specifically, we analyze a model of synaptic dynamics defined by a learning rule based on simple pre- and post-synaptic firing rate correlations. We also adjust the level of inhibitory inputs; these have the same structure as excitatory inputs, but lag by a constant phase. When inhibition is slightly stronger than excitation, we find stable, selective states. Previous work has focused on spike-time dependent plasticity and has needed a learning threshold to prevent a trained cell from reverting to its non-selective state. We find that neither spike-time dependent plasticity nor a learning threshold is required, but inhibition is necessary for strong direction selectivity.

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