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ATTENTION

Fine-tuning the synaptic signal

Attention enhances the perception of sensory stimuli, but the mechanisms underlying this phenomenon were not well understood. Now, Usrey and colleagues show that attention tunes transmission at thalamocortical synapses.

The authors recorded activity in layer 4 neurons of the primary visual cortex (V1) in monkeys performing a visual spatial attention task. The monkeys were trained to look at a fixation dot in the centre of a screen and, at the same time, to detect a change in the contrast of one of two drifting gratings shown at different locations on the same screen. In 95% of the trials, the colour of the fixation dot indicated which grating would change (and therefore should be attended), whereas in the remaining 5% the cue was false, so that here, the monkeys would attend the grating that did not change. Importantly, the two gratings were positioned so that one fell within the receptive field of a particular recorded V1 neuron.

In addition to recording electrodes in V1, the authors implanted stimulation electrodes in the lateral geniculate nucleus (LGN) of the thalamus, which provides monosynaptic input to the V1 neurons. This set-up enabled them to record spikes in V1 neurons resulting from stimulation of LGN neurons, both in trials in which attention was directed towards a V1 neuron's receptive field ('attend-towards' trials) and when attention was directed away from it ('attend-away' trials). The authors found that synaptic efficacy in thalamocortical synapses (that is, the percentage of LGN neuron stimulations that evoked a spike in the V1 neuron) was greater in attend-towards than in attend-away trials. Interestingly, in attend-away trials, LGN neuron stimulation often had no effect on V1 neuron spiking, indicating that attention suppresses synaptic efficacy in LGN synapses with 'non-relevant' V1 neurons.

The authors also assessed whether attention modulated spike synchrony in pairs of postsynaptic neurons. Synchronized spiking in a pair of neurons results from the coincident arrival of inputs either from a common axon or from different axons. It can convey either signal or noise, but synchronized 'noise spikes' are more likely to occur in a neuron pair that receives input from the same axon. The authors identified (on the basis of neuronal responses to the drifting gratings) V1 neuron pairs that received the same axonal input and showed that these pairs exhibited less synchronous spiking in attend-towards than in attend-away trials, possibly indicating that attention reduces noise processing. In addition, the authors provided evidence that attention increased synchronous spiking in V1 neurons receiving input from different LGN neurons, suggesting that attention increases signal processing.

These findings show that attention increases synaptic efficacy and improves signal-to-noise processing, providing a synaptic mechanism by which attention may fine-tune sensory processing.

Leonie Welberg

> “V1 neuron pairs that received the same axonal input … exhibited less synchronous spiking in attend-towards than in attend-away trials”

ORIGINAL RESEARCH PAPER Briggs, F., Mangun, G. R. & Usrey, W. M. Attention enhances synaptic efficacy and the signal-to-noise ratio in neural circuits. *Nature* http://dx.doi.org/10.1038/nature12276 (2013)