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SENSORY SYSTEMS

Fast adaptors

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To deal with the huge range of inputs to which they are exposed, most sensory systems show adaptation — if a stimulus is repeated or sustained, the sensory response will decrease or even disappear. Adaptation seems to occur at various levels in a sensory pathway, and new data from Chung *et al*. suggest that synaptic depression at thalamocortical synapses is an important component of this process, at least in the somatosensory system.

When a rat's whisker is deflected, neurons in the somatosensory thalamus and cortex fire strongly. But if the whisker is deflected repeatedly, the responses quickly wane. Recordings from the thalamus and cortex show that cortical neurons adapt to this kind of repetitive stimulation more quickly and more strongly than do thalamic neurons, and that they recover more slowly. This supports the idea that cortical adaptation reflects further processes, over and above those that lead to thalamic adaptation.

There are several possible mechanisms of cortical adaptation. For example, slower adaptation in the cat visual cortex results from membrane hyperpolarization, probably due to activation of a potassium current. Another proposed mechanism is enhancement of inhibitory transmission. But a leading candidate is short-term synaptic depression, either at thalamocortical synapses or at recurrent excitatory cortico-cortical synapses (which normally amplify the signal).

Chung *et al*. recorded the responses of cortical neurons to direct stimulation of the ventroposteriomedial nucleus (VPM) of the thalamus. After adaptation, the responses of cortical neurons to thalamic stimulation were smaller, indicating that the thalamocortical synapses were depressed. By contrast, cortical responses to stimulation of other cortical neurons did not decrease after adaptation, indicating that, under these conditions, recurrent cortico-cortical synapses do not become depressed. The authors suggest that this lack of depression might be observed because the cortical neurons respond to only the first few stimuli in a train (owing to thalamocortical depression), so their synapses have time to recover during the rest of the train.

Further recordings ruled out other potential mechanisms of adaptation. The cortical cells showed no changes in membrane potential, input resistance or membrane excitability following adaptation, indicating that such postsynaptic effects are unlikely to account for rapid adaptation in this system. This contrasts with the previous finding that slower adaptation in the visual system results from membrane hyperpolarization in the cortex, and may represent a general difference between fast and slow adaptation.

References and links

ORIGINAL RESEARCH PAPER

Chung, S. *et al*. Short-term depression at thalamocortical synapses contributes to rapid adaptation of cortical sensory responses *in vivo*. *Neuron* **34**, 437-446 (2002) | PubMed |

FURTHER READING

Carandini, M. & Ferster, D. A tonic hyperpolarizaton underlying contrast adaptation in cat visual cortex. *Science* **276**, 949-952 (1997) | Article | PubMed |