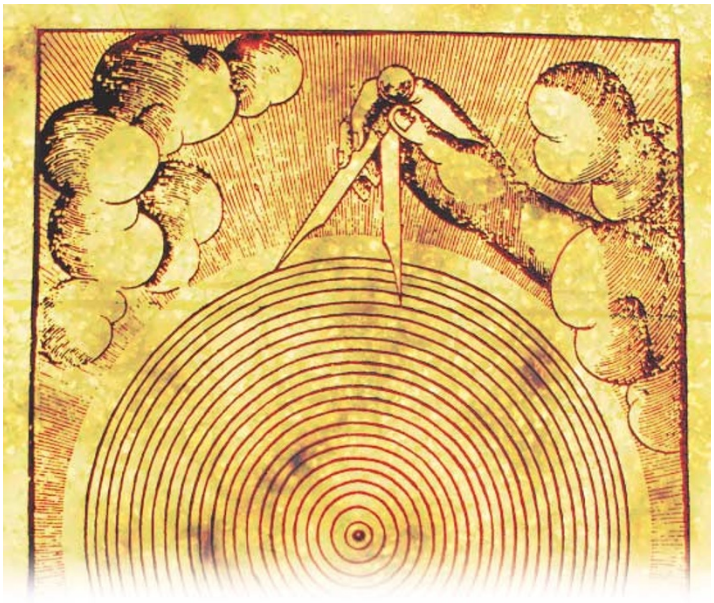
HIGHLIGHTS

SYNAPTIC PLASTICITY

Scaling synaptic strength

The number and strength of synapses onto a neuron change during development, particularly as synaptic connections are refined as a result of activity-dependent mechanisms. But how can the activity of a neuron remain stable when the strengths of its inputs change radically? New evidence supports the idea that the strengths of synapses onto a neuron are scaled up or down to stabilize its firing rate.



Desai *et al.* studied the visual cortex in rats between 12 and 23 days after birth. At this point in development, the synaptic input to cortical neurons normally increases steadily. Recordings from these neurons showed a consistent increase in the frequency of spontaneous miniature excitatory postsynaptic currents (mEPSCs), which occured when a single quantum of neurotransmitter was spontaneously released at a synapse. As the number of synapses and the frequency of mEPSCs rose, the size of the mEPSCs dropped markedly.

These results are consistent with previous *in vitro* findings that the strength of excitatory synapses can be scaled up or down to compensate for changes in firing rates. The synaptic scaling appears to adjust the strength of all of the synapses onto a neuron on the basis of the average postsynaptic activity of that neuron.

Desai and colleagues also found that the reduction in mEPSC amplitudes could be prevented if the rats were reared in the dark. This indicates that the reduction in mEPSC amplitude is driven by the increase in visual system activity that normally accompanies increased synaptogenesis. Monocular deprivation, achieved by blocking the activity of one eye by injecting the sodium channel blocker tetrodotoxin, had a similar effect in the areas of cortex that received input from only the deprived eye.

Recordings from different layers of cortex, in animals that underwent monocular deprivation at different ages, showed that different cortical layers have specific critical periods for synaptic scaling. In layer 4, deprivation later in development (days 21–23 after birth) had no effect on mEPSC amplitude (the mEPSCs were the same size as those on the non-deprived side). In layer 2/3, on the other hand, deprivation between days 14 and 16 had no effect, but deprivation between days 21 and 23 did prevent the reduction in mEPSC size that occurred on the control side.

The mechanism of this scaling effect is unknown, but it will be interesting to see whether it occurs in other parts of the nervous system. It is possible that it represents a general mechanism for stabilizing firing rates, despite plastic changes in synaptic strength or number.

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References and links

ORIGINAL RESEARCH PAPER Desai, N. S. *et al.* Critical periods for experience-dependent synaptic scaling in visual cortex. *Nature Neurosci.* 24 June 2002 (doi:10.1038/nn878)

WEB SITES

Nelson/Turrigiano lab:
http://pyramid.bio.brandeis.edu/