CORTICAL PLASTICITY

Out with the old

The highly plastic nature of cortical function — typified by the functional reorganization that follows the loss of sensory input to a particular region — is well known; however, the extent to which structural changes at the level of the individual neuron contribute to such plasticity was unclear. Hübener and colleagues now show that dramatic dendritic spine turnover accompanies functional reorganization in the visual cortex after a retinal lesion.

The authors mapped the responsiveness of neurons in the visual cortex to stimuli in different parts of the visual field over a 2-month period after focally lesioning the contralateral retina. As expected, there was a loss of responsiveness in the cortical region that formerly received input from the now-damaged cells

— the lesion projection zone (LPZ) — immediately after the lesioning, followed by a gradual increase in responsiveness in this area to stimulation in adjacent parts of the visual field.

To monitor the structural changes that accompanied this recovery, the authors carried out long-term two-photon imaging of the cortex through windows cut into the skulls of mice expressing a fluorescent protein in their neurons. By focusing on the apical dendritic tufts of layer-5 pyramidal neurons, the authors revealed a dramatic reorganization at the level of the dendritic spines. Spine turnover increased 3.5-fold in the LPZ, and within 2 months 91% of the original spines were lost and replaced with new spines. The extent of spine replacement in individual animals was related to the degree of functional recovery.

To determine whether the increased spine turnover reflected the functional reorganization or was simply the result of loss of input, the authors carried out similar imaging after lesioning the retinae of both eyes entirely to completely eliminate retinal input to the cortex. No

functional recovery was seen in these animals, and spine turnover was much lower than in focally lesioned mice, indicating that reduced retinal activity alone does not cause the structural changes that were observed after the focal lesioning. Further confirmation of the importance of the new spines for the functional reorganization came from the observation that new spines in the LPZ of focally lesioned animals were more likely to be stabilized and retained, at least for the 2-month period examined, than new spines in control mice.

These results indicate that the functional changes that take place in the cortex after modification of sensory input are likely to be the result of synaptic reorganization at the level of individual dendritic spines. The factors that regulate the loss and addition of new spines in this situation remain to be determined.

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ORIGINAL RESEARCH PAPER Keck, T. *et al.*
Massive restructuring of neuronal circuits during functional reorganization of adult visual cortex.
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