VISUAL PROCESSING

Eye-opening reorganization

Neocortical microcircuits that process sensory information consist of subnetworks of excitatory neurons. Neurons within a subnetwork respond to similar features of sensory stimuli and show highly structured synaptic connectivity, but the development of such microcircuitry is poorly understood. Now, a study by Ko, Cossell and colleagues in the mouse primary visual cortex (V1) shows that although stimulus feature-selective responses are detected in layer 2/3 (L2/3) at eye opening, preferential local connectivity between neurons responding to similar stimulus features does not develop until after the onset of vision.

It is unclear when the receptive fields (RFs) of V1 neurons become fully formed, despite the fact that previous studies have shown that V1 neurons can exhibit feature-selective responses to visual stimuli at eye opening. To investigate RF development further, the authors used *in vivo* two-photon calcium imaging to determine the spatial RF structures of V1 L2/3 neurons in mice at postnatal days 13–15 (P13–P15; when eye opening occurs) and P28–P35. P13–P15 and P28–P35 V1 neurons showed similar spatial RFs and, when presented with drifting gratings, similar orientation

selectivity responses. However, with repeated exposure to their preferred grating stimulus, P13–P15 neurons showed higher variability in their neuronal responses. This confirms that feature-selective responses are present at eye opening but that such responses are less robust than those in older neurons. It also suggests that feedforward connections to V1 are established by this time.

The authors examined the functional connectivity between neurons in local V1 L2/3 networks at eye opening and at P22–P26. They used *in vivo* two-photon calcium imaging in V1 to characterize the neuronal responses to natural movies and drifting gratings, and then performed multiple whole-cell recordings in slices taken from the same tissue to establish the connectivity between neurons. The overall connectivity between local L2/3 neurons was similar at both ages; however, the recurrent connectivity between neurons that responded to similar stimulus features was much higher at P22–P26.

These findings suggest that synaptic connectivity in V1 subnetworks undergoes considerable reorganization following the onset of vision, with an increase in recurrent connectivity between functionally

correlated neurons. This is further supported by the finding that V1 neurons that did not show reliable responses to visual stimuli had a lower rate of recurrent connectivity in the mature V1 than in the immature V1.

The authors constructed a network model of the neocortex to examine the mechanisms underlying the reorganization of local synaptic connectivity in V1 following eye opening. This modelling approach suggested that the local recurrent connectivity that was seen in the experimental data could result from patterns of feedforward connections to V1 that are generated by activity-dependent mechanisms of synaptic plasticity.

Together, these data show that feedforward neural pathways encoding sensory features are already in place by the time of eye opening, and that with the onset of vision, considerable reorganization of local intracortical connectivity in V1 takes place that leads to the development of functional microcircuits. These microcircuits may allow visual stimuli to be more robustly represented in the cortex.

Darran Yates

ORIGINAL RESEARCH PAPER Ko, H. et al. The emergence of functional microcircuits in visual cortex. *Nature* **496**, 96–100 (2013)

“ These findings suggest that synaptic connectivity in V1 subnetworks undergoes considerable reorganization following the onset of vision ”