HIGHLIGHTS

NEURONAL CIRCUITS

Mapping the cortical highways

Our understanding of cortical connections resembles the road atlas I keep in my car. It defines the long-distance connections between places — the motorways and main roads — with impressive detail and accuracy, but as soon as I reach a city and want to find my destination — one small street among thousands — my atlas is considerably less informative. Similarly, although the connections between different areas of cortex, and from neocortex to other brain structures, are well understood, our knowledge of the local connectivity within the neocortex is much less advanced.

Most neurons in the cortex are excitatory, and the rules that govern their local connections are unknown. Perhaps they are interconnected probabilistically, with no specificity at the level of individual neurons. But equally, they might form connections according to strict and intricate rules that we simply have not deciphered yet. A new study by Kozloski *et al.* suggests that the latter is closer to the truth.

Studying cortical slices from mouse brain, Kozloski *et al.* electrically stimulated individual pyramidal neurons (the 'trigger' neurons) in layer 5 of the visual cortex. The trigger neurons all belonged to a homogeneous population of neurons, which project to the superior colliculus and to neurons within the local cortex. Using optical probing and calcium-sensitive dyes, the researchers could visualize action potential activity in neurons in the surrounding cortex, and see which neurons responded to the stimulus. These 'follower' neurons showed calcium transients during the train of action potentials that was used to stimulate the trigger neurons.

Kozloski and colleagues characterized the follower neurons anatomically and physiologically. Surprisingly, the follower neurons represented only a few of the many possible anatomical types of cortical neuron. They belonged to three main classes — pyramidal, fusiform and triangular — with distinct morphologies. Each class also had stereotyped physiological responses. Even the positions of the follower neurons within the cortex appeared to be stereotyped and predictable between animals. Fusiform followers, for example, always fell along a semicircle below and about 50 micrometres away from the trigger neurons, whereas pyramidal follower neurons formed a narrow horizontal band that included the triggers. Remarkably, the variance in position of the followers was less than that of the trigger neurons.

These data indicate that the neocortex contains extremely stereotyped local microcircuitry. It remains to be seen whether similar circuitry will be seen in other areas of cortex, and the developmental processes that govern the formation of these connections are a mystery. It will be interesting to see whether activity-dependent competition, which is so important in shaping the circuitry of much of the brain, can be reconciled with the apparently rigid way in which these connections are controlled. But a street map of cortical microcircuitry would go a long way towards the formation of realistic theories of cortical function.

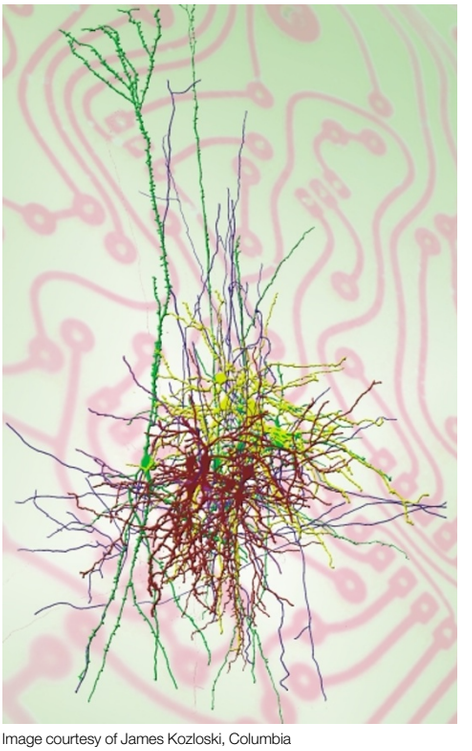

Image courtesy of James Kozloski, Columbia University, New York, USA.

Rachel Jones

References and links

ORIGINAL RESEARCH PAPER Kozloski, J. *et al.* Stereotyped position of local synaptic targets in neocortex. *Science* **293**, 868–872 (2001)
FURTHER READING Peterlin, Z. A. *et al.* Optical probing of neuronal circuits with calcium indicators. *Proc. Natl Acad. Sci. USA* **97**, 3619–3624 (2000)
WEB SITE Yuste's lab