HIGHLIGHTS

SENSORY SYSTEMS

Mapping out the fly brain

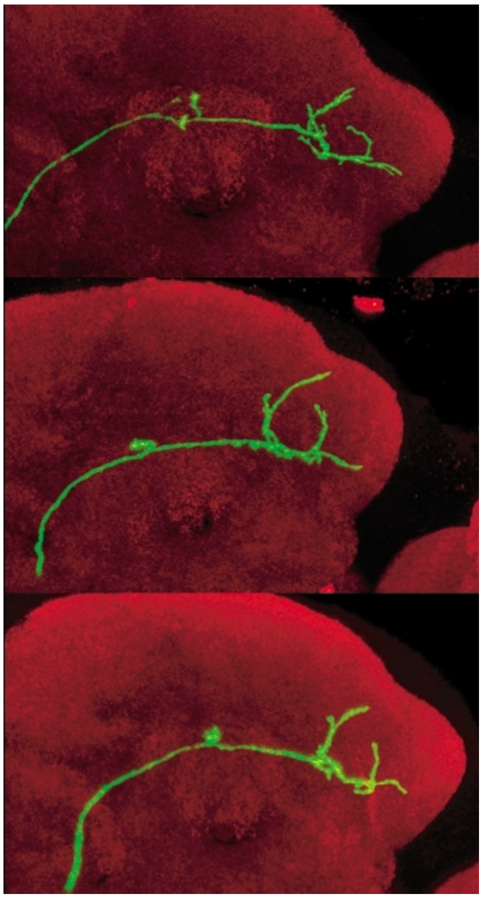
New insight into how the olfactory system might organize and integrate its inputs has come from two groups that have mapped out the way in which projections from the antennal lobe in *Drosophila* are arranged higher up in the brain. The results, published in *Cell*, show that the olfactory map changes in character, but remains very specifically organized, as information passes through the fly's olfactory system.

The olfactory sensory neurons in *Drosophila* each express only one odorant receptor gene, and neurons expressing the same receptor project to the same glomerulus within the antennal lobe (the first staging post in the system). This spatial segregation, if it were maintained further up in the brain, might allow the olfactory system to use a map to represent different odours by their patterns of activation.

The two groups used different techniques to trace the axons of single projection neurons as they left the antennal lobe and projected up to higher sensory centres (the mushroom bodies and lateral horn of the protocerebrum). Marin *et al.* used the MARCM (mosaic analysis with a repressible cell marker) method, which labels single clones of cells with Gal4. Wong *et al.* used a slightly different method of genetic labelling, the FLP-out technique, in which individual neurons that express a Gal4 transgene are labelled with a green fluorescent protein (GFP) reporter. Both techniques allow the visualization of single neurons and their projections.

The results of both studies show that projection neurons from a particular glomerulus have very similar stereotyped terminal fields in the protocerebrum, whereas neurons from different glomeruli have very different patterns of termination. This indicates that the spatial segregation of different olfactory inputs that is set up in the antennal lobe is conserved in the higher olfactory centres of the fly brain. However, the map in the protocerebrum differs from that in the antennal lobe. The axonal arborizations of projection neurons in the protocerebrum are more widespread and diffuse; although the projections from different glomeruli are spatially separate, they often interdigitate. This might allow the integration of sensory information from different glomeruli at the same time as maintaining the discriminability of inputs from different receptors.

Vertebrate olfactory systems are similar to that of *Drosophila* in the periphery, in that sensory neurons that express a particular receptor project to specific glomeruli in the olfactory bulb. There is also some evidence that the mouse olfactory bulb might project to the olfactory cortex in a similar spatially specific but convergent manner, pointing to common strategies for encoding olfactory information. Whether these strategies depend on spatial patterns of activation, or involve temporal coding that relies on oscillations and synchrony of neural activity, is still unclear, but the spatial specificity of the *Drosophila* system does support the idea that spatial patterning is important in the processing of olfactory inputs.



In three individual flies, projection neurons arising from the same glomerulus show similar patterns of axon branching in the lateral horn of the protocerebrum. Courtesy of G. Jefferis, Stanford University.

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References and links

ORIGINAL RESEARCH PAPER Wong, A. M. *et al*. Spatial representation of the glomerular map in the *Drosophila* protocerebrum. *Cell* **109**, 229–241 (2002) | Marin, E. C. *et al*. Representation of the glomerular olfactory map in the *Drosophila* brain. *Cell* **109**, 243–255 (2002)

WEB SITES
Axel's lab: http://cpmcnet.columbia.edu/dept/neurobeh/axel/overview.html
Luo's lab: http://www.stanford.edu/group/luolab/