WEB WATCH

How to visualize something really small

- Synapse Web
  http://synapses.bu.edu/

If you want to know how, you must pay a visit to Synapse Web, a fabulous web site of the Laboratory of Synapse Structure and Function at Boston University. Here, you will find information on the ultrastructure of the nervous system at all levels, with a particular emphasis on synapses.

Synapse Web includes introductory information on brain anatomy, and on the structure of dendrites, axons, astrocytes and synapses. It also includes brief accounts of some of the classical microscopic methods that are commonly used in structural studies. This section, which is illustrated by some simple animations, is poised to grow to include descriptions of more recently developed anatomical techniques.

The site also hosts an extraordinary Atlas of Ultrastructural Neurocytology by Josef Spacek, a reference resource in which you can find ultrastructural descriptions not only of neurons and glia, but also of blood vessels, the meninges and the diseased brain.

Last, for those researchers whose work draws heavily on neuroanatomical methods, Synapse Web hosts a collection of software tools to address the challenge of "how to visualize something really small". These tools are intended for the analysis and reconstruction of three-dimensional images from serial sections, and the web-site creators have shown, with some elegant examples, how such tools can be put to good use.

Synapse Web is supported by the Human Brain Project as part of their efforts to stimulate the development of neuroscience databases. This web site is a great initiative that will undoubtedly continue to mature, but it already deserves recognition and appreciation by the community.

Juan Carlos López

VISUAL SYSTEM

Cortical colour contrast

The earliest cortical area in the visual processing pathways is area V1. Although the properties of neurons in V1 have been studied extensively, there is still much controversy over how they contribute to the processing of visual stimuli; for example, do different neurons in V1 respond specifically to different parts of the stimulus — its colour, form or direction of motion, for example — or do they 'multiplex', responding to all of these aspects at the same time? A study published by Conway, Hubel and Livingstone in *Cerebral Cortex* lends weight to the former view.

The authors investigated the neural basis of colour contrast, which causes red, for example, to look more red if it is surrounded by or preceded by its opponent colour, green. They recorded from neurons in area V1 in macaque monkeys, whose colour vision is very similar to that of humans. The monkeys were shown coloured spots that were designed to selectively alter the level of stimulation of one set of cones (for example, the green spot used increased the excitation of M cones, but did not change the activity of S or L cones, when compared with the grey background). Conway *et al.* used these stimuli to map and characterize the receptive fields of the V1 neurons, and found that a subset of these cells could be classified as 'colour' cells, because they showed an 'on' (excitation) response to one colour (for example, red) and an 'off' response to the opponent colour (in this case, green).

These colour cells showed no direction selectivity and only very coarse orientation preference, which supports the idea that colour, form and motion are processed separately in V1, at least to some extent. But many of them showed another interesting property: they had double-opponent receptive fields. This means that the centre and the surround of the receptive field both responded with opposite signs to opponent colours, but that they also responded in the opposite direction to each other. For example, a cell with a red-on, green-off centre would respond with increased excitation to a red spot in the centre of the receptive field or to a green spot in the surround, and with inhibition to a green spot in the centre or a red spot in the surround.

When the authors used pairs of spots of opposing colours — one in the centre of a receptive field and one towards the edge — they found that the cells summed their responses linearly. So, the cell described above would respond more strongly to a red spot in the centre and a green spot in the surround than to either spot alone. This could be the neural basis of spatial colour contrast, because it would lead to a stronger 'red' response when the red stimulus was adjacent to a green patch.

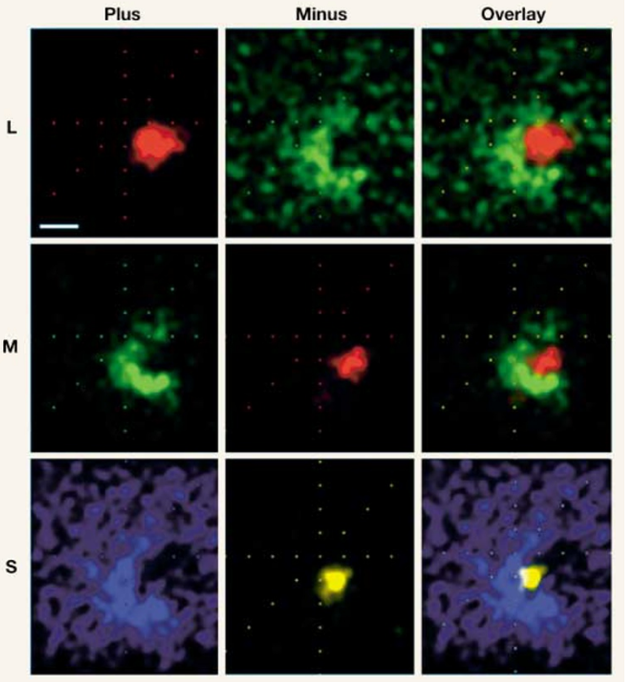
What about temporal colour contrast? When the monkeys viewed pairs of spots separated in time rather than in space, the cells showed temporal opponency: a cell that was excited by the onset of a red spot, for instance, would be suppressed by its offset, whereas a green spot that caused suppression at its onset would lead to the cell being excited at its offset. These temporal responses also summed linearly, so that, if our example cell was suppressed by a green spot and then excited by its offset, the total response to a subsequent red spot — which also excites the cell — was greater than if the red spot had not been preceded by the green spot. Again, this property could contribute to the psychophysical phenomenon of temporal colour contrast.

This kind of quantitative study allows us to compare neuronal properties with perceptual experience, as measured by psychophysics. Although it is still possible that cells in V1 'multiplex' different features of the visual world, these data support the view that only a subset of V1 neurons contributes to colour vision.

Rachel Jones

References and links

ORIGINAL RESEARCH PAPER Conway, B. R. Color contrast in macaque V1. *Cereb. Cortex* **12**, 915–925 (2002)



Receptive field map of a double-opponent cell in monkey V1. L, M and S are the cone types; responses are shown to a stimulus that increases (left column) or decreases (middle column) the L, M or S activity; an overlay (right column) illustrates the double opponency. © 2001 Society for Neuroscience (courtesy of B. Conway, Harvard Medical School).