NEURONAL NETWORKS

Vibrations in the memory

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OF the many secrets that each of us carries in our brains, the one that we would all dearly love to know is how we remember things. How is it that *Music, when soft voices die,/ Vibrates in the memory*? How do we instantly pick out the individual face of a friend in a crowd, identify the aroma of freshly ground coffee, and carry out a conversation in a noisy café, all the while maintaining a coherent and stable view of the world? This complex process of segmentation and recognition may involve a temporal code based on the oscillatory activity of neural networks in the cerebral cortex. Whittington *et al.*, in a combined theoretical and experimental study of isolated networks described on page 612 of this issue[1], have been able to identify a network of inhibitory neurons as the likely source of these cortical oscillations.

Investigations of memory have concentrated on one part of the temporal lobe of the cerebral cortex known as the hippocampus. The link between hippocampus and memory was established through neurological patients who, through the misfortune of disease, stroke, surgery or accident, had impaired temporal lobe function. These patients appeared normal, except that they had no memory of events that had occurred a few minutes previously. Their tragic condition — temporal lobe amnesia — led to wide-ranging studies of the role of the hippocampus and related cortical structures in memory.

A central problem in memory is how information is represented by neurons[2]. One way in which memory could work is that neurons in the cerebral cortex could learn to 'recognize' the various things that make up our world. So individual neurons might learn to recognize the smell of coffee, the texture of a cup or the taste of cream, for example. But the number of such high-level 'feature detector' neurons scales unfavourably with the number of things to be encoded, and so most theories use combinations of neurons, each of which represents a simple feature, to code for different things. Each neuron then participates in the representations of many different things.

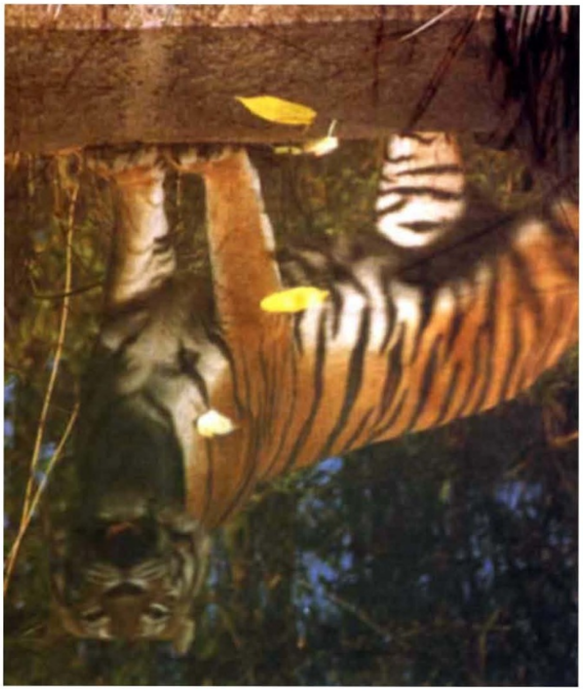
Population-based coding schemes dra-

VISUAL NEUROSCIENCE

Reflections on transparent motion

THIS striking image exemplifies the phenomenon of transparent motion, which has long been a puzzle. Objects in the visual world are constantly passing in front of one another, yet the brain has no difficulty in distinguishing them, in this case to perceive floating leaves drifting in one direction as the tiger moves in another. Extracting such information from the jumble that reaches the eyes is not trivial. But insights into how the task is accomplished come from a paper on page 609 of this issue, in which Bradley *et al.* describe the firing properties of neurons in a part of the monkey visual system known as the middle temporal (MT) cortical area.

MT is one of the 'higher' visual areas, in that the input it receives has already been sequentially processed by 'lower' brain regions, and in particular it seems to be concerned with the detection of motion. Neurons within MT are sensitive to the speed and direction of moving objects, and each neuron has a preferred direction of motion that stimulates its maximal response. Many are inhibited by motion in the opposite direction, and this inhibition is believed to help eliminate noise and ensure an accurate representation of the moving stimulus. But many also respond to stereoscopic disparity, which corresponds to the visual plane in which the stimulus occurs. The significance of this has been a mystery, because at first glance depth and movement appear to be unconnected. Yet it also seemed unlikely that a single brain area would be devoted to two unrelated tasks, and so the field has been in search of a unifying explanation.



Bradley *et al.* have now provided it. They recorded from neurons in area MT of rhesus monkeys trained to fixate on a display screen. Individual neurons were first stimulated by a pattern of dots moving in their preferred direction. Having confirmed the inhibitory effect of adding further dots moving in the opposite direction, the authors separated the two sets of dots into different visual planes (with coloured glasses similar to those used for viewing old 3D movies). They found that the inhibitory effect is strongest when both sets of dots lie in the same visual plane, and that it becomes weaker as the disparity increases. Similar results are obtained whether the two patterns overlap or are merely adjacent. The results suggest a simple explanation for how and why MT integrates direction and depth cues. Transparent motion normally arises when objects pass each other in different planes. By not having inhibition between movement in different planes, the brain can interpret the two movements as independent. If instead the two movements occur within the same plane, transparent motion is less likely, and the brain looks for other explanations (for instance, random noise).

Is this consistent with what we know from human psychophysics? In fact, for simple patterns such as two sets of dots moving past each other, subjects have no difficulty in perceiving two sets of coherent motion, even when both occur in the same plane. But for more complex stimuli, the task becomes more difficult, and the authors previously showed that stereoscopic disparity between the two directions can improve performance. They suggest that, in the real world, the visual system makes use of many clues to arrive at the correct interpretation, and they raise the possibility that MT may exploit not only depth, but also other features such as colour or texture to distinguish between the components of transparent motion. Faced with threats such as tigers hiding in the undergrowth, it is easy to believe that the primate visual system will have evolved to use all the help it can get.

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