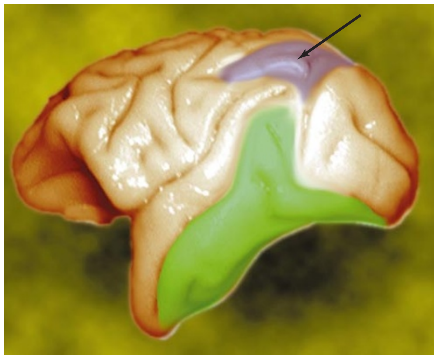

Figure 1 **Lateral view of the macaque brain. The purple and green areas show cortical regions that are involved in processing spatial and object information, respectively. The area reported by Sereno and Maunsell lies within the intraparietal sulcus, shown by the arrow.**

selective activity, even when the monkey was required to refrain from grasping the object. Nonetheless, in all of these experiments the monkeys were trained to manipulate the test objects and, presumably, had developed the representations required for their hand manipulation through both visual and somatosensory information.

What makes the findings of Sereno and Maunsell remarkable is that their monkeys were not involved in a hand-manipulation task, and they could not touch the stimuli (two-dimensional images of objects). In fact, the animals were trained only to perform a simple fixation task or a visual delayed match-to-sample task. During the fixation task, the monkeys looked at a screen, holding their gaze on a central spot, while a shape was presented within the receptive field of the recorded neuron. During the delayed match-to-sample task, the animals fixated a central spot and, shortly afterwards, a sample shape was superimposed on the spot. This was then replaced by three shapes equidistant from the fixation spot, and the monkeys had to make an eye movement to the test shape that matched the sample shape for a juice reward. Surprisingly, many of the recorded parietal neurons — just like the temporal or prefrontal cells reported by other investigators — showed differences in activity as different shapes were presented during the fixation task. Some also showed shape selectivity during the delay period of the match-to-sample task.

Why should shape be represented in the posterior parietal cortex? Our perception of shapes is probably mediated by neurons in the temporal lobe. Although lesions in this area of the brain severely interfere with pattern perception and recognition, lesions in the parietal lobe only affect spatial vision (our sense of where things are), leaving pattern vision intact[3]. Most neurons in the temporal lobe respond selectively to simple or complex visual patterns, including views of human and monkey faces, indicating that this region is critical in shape perception. Shape selectivity is also found in areas of the prefrontal cortex. These are interconnected with the visual areas of the temporal lobe, and are thought to mediate the working memory for visual objects[8].

Neurons in the temporal lobe tend to be position and size invariant; that is, they lack properties that are critical for manipulating objects by hand. Although no data are available, shape selectivity in the posterior parietal cortex may turn out to be specific for the size range of objects that an animal could possibly manipulate. Shape selectivity in the parietal cortex may also be specific for orientation with respect to a reference frame centred on the viewer or on some other object — a property that is rarely seen in the responses of temporal neurons. On the other hand, selectivity to material properties of objects, such as colour and textures, would be meaningless for a system that underlies hand-manipulation of objects, but essential for certain recognition tasks. So the existence of separate temporal and parietal shape representations may be partly due to the different output requirements of the visual system, as neuropsychological studies also suggest[9].

Finally, based on the neuronal properties of the posterior parietal cortex, it has been suggested that this region of the brain is the main area that mediates visuospatial attention[10,11] or, alternatively, an animal's intention to reach a particular point in space[12]. The data presented by Sereno and Maunsell indicate that at least some areas of the parietal cortex may be important for switching attention or instigating an intentional movement, not only to particular locations, but also to particular objects that are targets for either action or identification. Shape- and location-triggered attentional or intentional shifts are bound to require neurons that discriminate shapes to some extent. □

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1. Jeannerod, M. *The Neural and Behavioural Organization of Goal-Directed Movements* (Oxford Univ. Press, 1988).
2. Sereno, A. B. & Maunsell, J. H. R. *Nature* **395,** 500–503 (1998).
3. Ungerleider, L. G. & Mishkin, M. in *Analysis of Visual Behavior* (ed. Ingle, D. J.) 549–586 (MIT Press, Cambridge, MA, 1982).
4. Logothetis, N. K. & Sheinberg, D. L. *Annu. Rev. Neurosci.* **19,** 577–621 (1996).
5. Colby, C. L. *Neuron* **20,** 15–24 (1998).
6. Taira, M., Mine, S., Georgopoulos, A. P., Murata, A. & Sakata, H. *Cerebral Cortex* **5,** 429–438 (1990).
7. Murata, A., Gallesse, V., Kaseda, M. & Sakata, H. *J. Neurophysiol.* **75,** 2180–2186 (1996).
8. Ó Scalaidhe, S. P., Wilson, F. A. W. & Goldman-Rakic, P. S. *Science* **278,** 1135–1138 (1997).
9. Goodale, M. A. & Milner, A. D. *Trends Neurosci.* **15,** 20–25 (1992).
10. Colby, C. L. *J. Child. Neurol.* **6,** 90–118 (1991).
11. Corbetta, M., Miezin, F. M., Shulman, G. L. & Petersen, S. E. *J. Neurosci.* **13,** 1202–1206 (1993).
12. Snyder, L. H., Batista, A. P. & Andersen, R. A. *Nature* **386,** 167–170 (1997).

Daedalus

Psychic misperceptions

In Everett's 'many worlds' view of quantum mechanics, the complete multidimensional Universe can be divided into many vector subspaces. Each subspace is a physically real 'parallel world'. Quantum-probability paradoxes neatly disappear. Schrödinger's famous cat, whose life hangs on one random quantum event, lives in some of the Everett worlds, but dies in others.

Clever, says Daedalus; but not clever enough. Why should the Universe divide so neatly into perfect physically real worlds? By choosing a different set of orthogonal vectors, you could divide it just as validly into worlds whose quantum states were hopelessly mixed. Their inhabitants would be like Schrödinger's cat before it is observed: neither alive nor dead, but in a ghostly, non-physical, quantum superposition of these states.

So Daedalus sees the complete Universe as a set of physically real Everett worlds, embedded in a matrix of quantally mixed, physically non-real, ghostly worlds. He identifies this mystic matrix with the spiritual world of ghosts, telepathy, and so on. Indeed, it may act as a telepathic channel for messages from other Everett worlds. This theory explains the deplorably unreliable nature of mystic insights, telepathic intuitions and so on. They may in fact refer to some other world.

But how to tell? Daedalus reckons that a complementarity principle must apply. To sustain the correct probabilities of its quantum states, a live Schrödinger cat in one world implies a dead one in another; a successful lucky chance in one world must fail in another. Daedalus recalls a study of intuition in business executives. Successful ones scored significantly better than chance; but failing ones scored worse than chance. Clearly, says Daedalus, these perverse 'anti-psychics' were, sadly for them, tuned to another world. So Daedalus plans to seek out such rare and gifted individuals among bankrupt businessmen, failed spiritualists and inspired losers of all kinds. He will then look for statistical agreements among their hopeless fantasies. Tantalizing glimpses of some other Everett world may emerge.

Although this world will probably be very close to ours in the universal 'holospace', Daedalus can see no way of exchanging material as well as ideas. He does wonder, however, whether its inhabitants find extra socks in the wash, but suffer mysterious losses of wire coat-hangers.

David Jones