Unswerving nerves keep us on course

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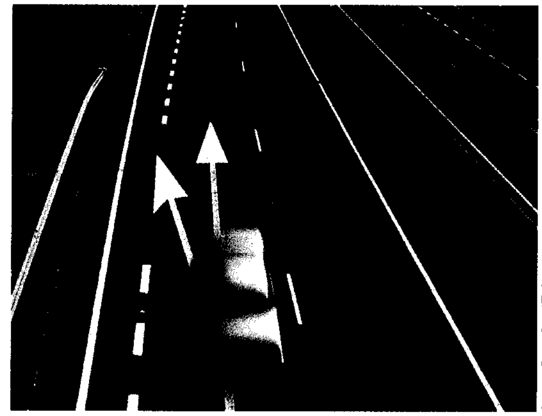
EVEN the most accident-prone motorist can glance at road signs without veering off the highway. But experiments on monkeys have only now begun to reveal how our brains avoid such catastrophes. Richard Andersen and his colleagues at the California Institute of Technology in Pasadena have identified a group of brain cells that enable us to keep heading in the same direction even when our eyes are moving.

We can tell which way we are going because, as we travel forwards, the world ahead of us appears to expand. To take a well-known image, as the Starship Enterprise zooms through space, its crew sees a pattern of stars flying outwards from a central point which defines the direction of movement.

But if a crew member's eyes follow the course of one particular star moving to the left, the entire field of view will appear to move to the right. When this apparent movement is superimposed on the expanding star pattern, the point from which the pattern is expanding will appear to move to the left (see Figure). Without a mechanism to compensate for eye movements, the crew of the Enterprise would instinctively change the direction of their craft whenever they glanced sideways.

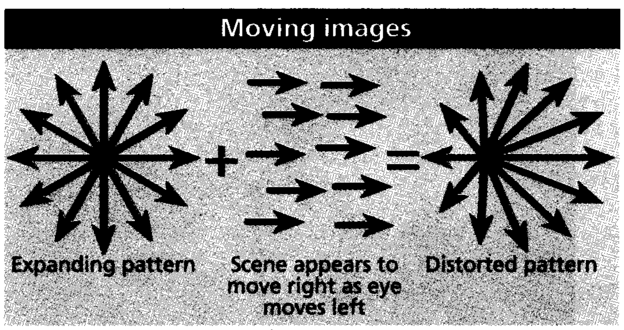
Until now, this mechanism has eluded neuroscientists. But in the latest issue of *Science* (vol 273, p 1544), Andersen's team provides the first clues to how it works. The researchers placed rhesus monkeys in front of an expanding pattern of dots like the pattern of stars seen from the bridge of the Enterprise. They then trained each monkey to move its eyes so that it tracked a single, large dot which was part of the expanding pattern and moving to the left.



Straight ahead: the visual cortex allows drivers to glance sideways without spinning off the road

Andersen and his team recorded the electrical activity of nerve cells in part of the brain's visual cortex called the dorsomedial superior temporal area. This contains cells that respond to moving patterns, including some that fire most strongly when presented with an expanding scene that is indicative of forward movement.

The researchers first identified brain cells that fired strongly in response to the pattern of dots expanding from a central point in each monkey's field of view. When each animal's eyes moved left to follow the large dot, some of these neurons dramatically decreased their rate of firing—they evidently did not register that the expanding pattern had been distorted as a result of eye movement.



'The key to the compensation mechanism is a signal direct from our moving eyes'

Other neurons, however, continued firing as before, having compensated for the fact that eye movement had shifted the central point of the expanding pattern to the left. Andersen argues that the brain uses these "shifting" neurons to determine the true direction of movement.

Next, the researchers tried moving the screen—still with the same expanding display—so that the large dot remained straight ahead of the monkey, which was able to follow it without moving its eyes. In this case, both sets of neurons changed their pattern of firing in the same way, responding as if the direction of movement had shifted. This suggests that the key to the compensation mechanism is a signal direct from our moving eyes which feeds back to the shifting neurons, says Andersen.

Now that Andersen's team has identified the neurons that keep us on a steady course, the next problem is to work out how the brain receives the information needed to compensate for eye movement. "There is evidence that there is compensation in the right direction, and in some cases of sufficient magnitude to fully compensate for eye movement," says Bill Warren, a neuroscientist at Brown University in Providence, Rhode Island. "But the detailed mechanism is still unclear." □