Monkey See, Monkey Do: Brain's Path From Sight to Action

By HENRY FOUNTAIN

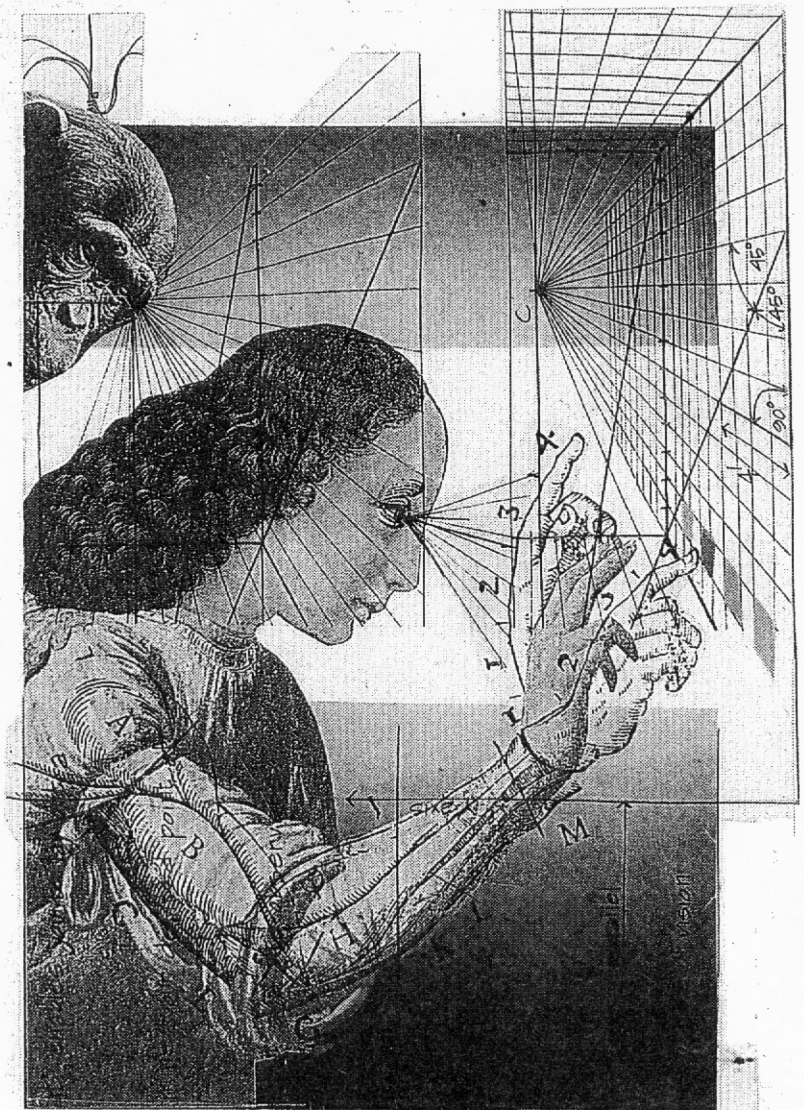
As anyone who has endured a sales meeting knows, to achieve a goal, it is best to have a plan. And what is good for the Avon lady is good for the brain as well, even if the goal is as modest as getting an arm to reach for an object. The brain must get from Point A, where it receives a visual image, to Point B, where it signals arm muscles to act.

Researchers at the California Institute of Technology have now mapped part of this process, one step in the path from image to action. Their work holds promise that people who are paralyzed will someday be able to put limb-related brain activity to use.

It would seem logical to assume that when the brain wants to move an arm toward an object, it plans the movement from the arm's frame of reference — from where the arm is in relation to the object, like a ringing telephone. The telephone might be above and to the left of the arm at first, for example, and the brain would make use of these coordinates, which are constantly changing as the limb moves.

But to their surprise, the researchers found that this was not the case. It is the frame of reference of the eye that the brain uses in developing what the researchers call a "reach plan." So the object might be above and to the left of the arm, but if it is below and to the right in the field of view, that is what counts.

"We and others had thought that as soon as you got to a place in the brain where action was being planned for limb movements, it would be in limb coordinates," said Dr. Richard A. Andersen, an author of a paper that describes the work in the current issue of the journal Science. Although the brain eventually does transform the information into limb-related coordinates to signal the muscles, "The plan to make a movement occurs before the visual stimulus is recomputed," said Dr. Andersen, who directs the laboratory where the work was undertaken.



Joan Hall

The researchers trained monkeys to push a grid of buttons on a board and measured the electrical activity in neurons in the part of the brain, the posterior parietal cortex, in which plans for reaching are thought to be formulated. Tiny electrodes were implanted in the neurons of the monkeys to measure their activity.

The scientists set up two conditions for the monkeys: one where they gazed at the same button while reaching for the other buttons, and one where they reached for the same button over and over while shifting their gaze to the other buttons. They found that when the monkeys' gaze was fixed, the arm movements had no effect on neural activity. But when it was the gaze that moved, the neurons fired at a faster rate.

Once the researchers figured out what was happening, Dr. Andersen said, they realized that it made sense. For one thing, by using visual coordinates, the brain avoids having to do a lot of computation. Viewing a cluttered desk, for example, the brain uses visual coordinates from the image to plan how to reach one object. If the brain used limb coordinates instead, it would have to first convert the visual coordinates into the coordinates of the arm relative to all of the objects to determine how to get around them.

Dr. Andersen said the knowledge might eventually be used to help people with paralyzed limbs, who are still capable of thinking about moving a limb but cannot do so.

Much research in this field is being done with the motor cortex, in the frontal lobe of the brain, where the transformation into limb coordinates

Research that holds promise for people who are paralyzed.

for signaling the muscles appears to occur. But using the parietal reach area might offer some advantages, Dr. Andersen said. Since the motor cortex is more concerned with the biodynamics of the limb, there is some evidence that it degenerates from the disuse that comes from paralysis. The parietal region, however, appears to be unaffected.

One possibility, Dr. Andersen said, would be to implant an array of wires in the parietal lobe that would record the impulses as the brain plans a movement and use them to move a prosthetic device, or perhaps a computer cursor. The researchers have implanted an experimental array in one of their monkeys that will eventually be rigged to move an animated arm on a computer screen.

The trick for the researchers is to train the monkey to only *think* about moving its arm.