Scientists settle centuries-old debate on perception

10 April 2011, by Anne Trafton

'The Sense of Touch,' by Jusepe de Ribera, depicts a blind man holding a marble head in his hands.

More than 300 years ago, scientist William Molyneux posed the following puzzle: Imagine a person blind from birth who suddenly is able to see. Immediately after gaining sight, would he be able to visually distinguish between objects that he could previously identify by touch?

"Ever since then, this has been one of the foremost questions in the philosophy of mind," says Pawan Sinha, professor in MIT's Department of Brain and Cognitive Sciences (BCS). However, the question remained only a thought experiment for centuries, as there was no good way to test it - until now.

In a study of blind patients in India whose sight was restored in late childhood or adolescence, Sinha and his colleagues found that the patients were not immediately able to make the connection between what they saw and what they felt. However, they acquired that skill within days after surgery.

The findings, which appear in the April 10 online edition of *Nature Neuroscience*, suggest that the answer to Molyneux's question is no. The brain does not have an innate ability to connect different types of sensory input; however, it can quickly learn to do so.

Illumination

Sinha and his colleagues identified research subjects for the study through Project Prakash, an initiative Sinha founded in India with a dual mission: restoring sight to children who have treatable forms of blindness, and investigating how the brain learns to process visual input. ("Prakash" is the Sanskrit word for light.)

Most cases of blindness in India are caused by vitamin A deficiency, cataracts, retinal or optical dystrophies, or microphthalmos (poorly developed eyes). About half of these cases are treatable or preventable, but many blind children never receive medical care, especially in rural areas. Since its founding in 2004, Project Prakash has screened more than 24,000 children and treated about 700.

The latest study is a good example of Project Prakash's dual mission, says Sinha. "These children have been treated and their lives have hopefully been improved, and that has also allowed us to answer a question that scientists have been puzzling about for over three centuries," he says.

Sinha, who has published several other research papers on Prakash patients, started this study at the suggestion of Richard Held, MIT professor emeritus of brain and cognitive sciences, who is also an author of the paper. Starting with a 2007 trip to India, the researchers tested five patients on the Molyneux question, ranging in age from 8 to 17. Each had been born blind (four with congenital cataracts, one with corneal opacity).

Each subject (who agreed in advance to participate in the study) was tested within 48 hours of surgery, shortly after his or her bandages were removed.

In the first test, the children were shown a novel object made from plastic parts, which was then taken away. Then they were shown two objects and asked to identify the original one. That test establishes that the children can see well enough to identify the relevant properties of the object, and that they understand the task. The patients performed this test with more than 90 percent accuracy. The patients also performed well in a test where they had to identify, by touch alone, an object that they had earlier handled.

Finally, the patients were asked to visually identify an object they had previously held. In those cases, their answers were not much more successful than if they had guessed.

However, when the researchers tested the patients again, in one case just a week later, they showed dramatic improvement in the touch-to-vision test. The children were tested with different objects than those they encountered during the first session, and they did not receive any kind of training between the two sessions.

This rapid improvement was surprising, says Yuri Ostrovsky, a BCS postdoctoral associate and an author of the paper. He points out that many visual tasks, such as face perception, can take six to 12 months to learn after sight is restored.

Making connections

The researchers believe that the brain learns to make connections between different types of sensory input by analyzing the timing of each stimulus. For example, when you look at your cell phone and hear it ring, your brain receives time-synchronized inputs from different senses. "The brain essentially has to look at the time sequence and figure out the correspondence," Sinha says.

David Somers, associate professor of psychology at Boston University, described the experiment as "very elegant" and said the Project Prakash studies have made valuable contributions to neuroscientists' understanding of brain development and plasticity (the ability to change in response to sensory information).

"Traditionally in neuroscience, many insights come from misfortune - someone has an accident and suffers brain damage, or a surgery goes wrong," says Somers, who was not involved in this study. "We've had to wait for the brain to break in interesting ways, and then we go in to analyze it. Here, we've got the opposite situation."

In ongoing studies, Sinha and his colleagues are using brain scans to look for brain regions that may be activated by a certain object, no matter what type of sensory information comes into the brain. For example, they can scan a person's brain while he or she looks at a pattern of lines, and then scan again when the person is given a tactile pattern with a similar set of lines. If any part of the brain responds to both stimuli, it would suggest that that brain region encodes that pattern, regardless of the sensory modality through which it was detected.

The overall goal of the effort is to understand the learning process through which the visual world begins to cohere into meaningful objects and is linked with information from the other senses, says Sinha, adding that Project Prakash provides a unique window onto this developmental process.

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