Scientists Discover the Part of the Brain That Causes Some People to Be Lousy in Math

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Most everyone knows that the term "dyslexia" refers to people who can't keep words and letters straight. A rarer term is "dyscalculia," which describes someone who is virtually unable to deal with numbers, much less do complicated math.

Scientists now have discovered the area of the brain linked to dyscalculia, demonstrating that there is a specific part of the brain essential for counting properly. In a report published in the March 13 issue of the *Proceedings of the National Academy of Sciences* (PNAS), researchers explain that the area of the brain known as the intraparietal sulcus (IPS), located toward the top and back of the brain and across both lobes, is crucial for the proper processing of numerical information.

According to Fulvia Castelli, a postdoctoral researcher at the California Institute of Technology and lead author of the paper, the IPS has been known for years as the brain area that allows humans to conceive of numbers. But she and her coauthors from University College London demonstrate that the IPS specifically determines how many things are perceived, as opposed to how much.

To explain how intimately the two different modes of thinking are connected, Castelli says to think about what happens when a person is approaching the checkout lines at the local Trader Joe's. Most of us are impatient sorts, so we typically head for the shortest line.

"Imagine how you really pick the shortest checkout line," says Castelli.

"You could count the number of shoppers in each line, in which case you'd be thinking discretely in terms of numerosity.

"But if you're a hurried shopper, you probably take a quick glance at each line and pick the one that seems the shortest. In this case you're thinking in terms of continuous quantity."

The two modes of thinking are so similar, in fact, that scientists have had trouble isolating specific networks within the IPS because it is very difficult to distinguish between responses of how many and how much. To get at the difference between the two forms of quantity processing, Castelli and her colleagues devised a test in which subjects performed quick estimations of quantity while under functional MRI scans.

Specifically, the researchers showed subjects a series of blue and green flashes of light or a chessboard with blue and green rectangles. The subjects were asked to judge whether they saw more green or more blue, and their brain activity was monitored while they did so.

The results show that while subjects are exposed to the separate colors, the brain automatically counts how many objects are present. However, when subjects are presented with either a continuous blue and green light or a blurred chessboard on which the single squares are no longer visible, the brain does not count the objects, but instead estimates how much blue and green is visible.

"We think this identifies the brain activity specific to estimating the number of things," Castelli says. "This is probably also a brain network that underlies arithmetic, and when it's abnormal, may be responsible for dyscalculia."

In other words, dyscalculia arises because a person cannot develop adequate representations of how many things there are.

"Of course, dyscalculics can learn to count," Castelli explains. "But where most people can immediately tell that nine is bigger than seven, anyone with dcyscalculia may have to count the objects to be sure.

"Similarly, dyscalculics are much slower than people in general when they have to say how many objects there are in a set," she adds. "This affects everyday life, from the time when a child is struggling to keep up with arithmetic lessons in school to the time when an adult is trying to deal with money."

The good news is that the work of Castelli and her colleagues could lead to better tools for assessing whether a learning technique for people with dyscalculia is actually working. "Now that we have identified the brain system that carries out this function, we are in a position to see how dyscalculic brain activities differ from a normal brain," Castelli says.

"We should be in a position to measure whether an intervention is changing the brain function so that it becomes more like the normal pattern."

The article is titled "Discrete and analogue quantity processing in the parietal lobe: A functional MRI study." Castelli's coauthors are Daniel E. Glaser and Brian Butterworth, both researchers at the Institute of Cognitive Neuroscience at University College London.

Source: Caltech