How early math lessons change children's brains

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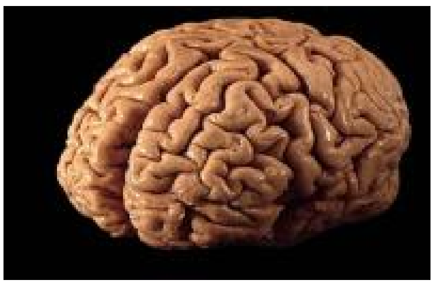

(Medical Xpress) -- Researchers from the Stanford University School of Medicine have demonstrated that a single year of math lessons is associated with unexpectedly big changes in the brain's approach to problem solving and that these changes can be seen in the brain scans of second- and third-graders

The latest findings are part of the ongoing effort by Vinod Menon, PhD, professor of psychiatry and behavioral sciences and of neurology and neurological sciences, to understand how children develop problem-solving skills in order to find better methods of teaching those who struggle with numbers.

His latest study, published online May 18 in the journal *Neuroimage*, is the first to ask how one year of early math lessons changes brain function. After third grade, tackling arithmetic problems engages striking new patterns of neural communication between brain regions involved in numerical thinking and those involved in working memory, the research showed.

“The surprise is that you would see significant changes within one year,” said Menon, senior author of the study. The findings were surprising in part because the study tracked changes over a one-year interval between second and third grades, rather than examining developmental changes between children and adolescents or adults, Menon said. “In spite of many individual differences, a year of schooling does have, on the average, a major impact on brain function and skill,” he said.

The study reveals that the way the brain is activated is different from one year to the next. “The brain regions haven’t changed — it’s the way they respond to simple and to complex arithmetic tasks that have changed,” Menon said. “Doing this type of developmental research allows us to examine the neural basis of skill acquisition much more precisely.”

Knowing that the brain changes so much — and understanding how it changes — provides a foundation for addressing children’s problems with math learning, Menon said. His lab is currently conducting studies of math anxiety, math abilities in children with autism, math learning disabilities and intensive math tutoring.

The new findings build on another recent study from the Menon lab, published April 25 in *Developmental Science*, that explored how children’s brains change as they adopt a more sophisticated strategy for solving arithmetic problems. That study divided second- and third-graders into groups according to the method they used to solve problems — counting on their fingers vs. retrieving facts from memory — and compared the brains of the children using the different approaches.

“We want to know how brain activity patterns change as children acquire more math proficiency and deeper knowledge,” Menon said. It is particularly important to look at small time intervals, such as the one-year interval of schooling his team examined, because prior research that compared children with adults inevitably missed many details of the developmental changes that take place as the brain matures.

The newest study examined 90 children recruited from a variety of schools. Half had just completed second grade; the other half had just completed third grade. All children had normal intelligence and had math reasoning scores between the 25th and 98th percentile. On average, the third-graders were one year older than the second-graders and had significantly better math-reasoning skills.

The children took standardized tests of their math abilities, reading abilities and working memory. They then had their brains scanned with functional magnetic resonance imaging while they did four tasks: complex addition, simple addition and two control tests. Complex addition used problems where one number in the sum ranged from 2 to 9 and the other ranged from 2 to 5 (such as 7+2=9). Simple addition used problems where one number was 1 (e.g. 5+1=7). Children were asked to indicate whether the sums they saw in the scanner were correct or incorrect.

The scientists found that children in third grade showed much more differentiated brain responses between complex and simple problems. They found significant change in the responses of two key regions of the brain to the different types of addition problems.Greater responses to complex addition problems were seen in third-graders’ brains in both the dorsolateral prefrontal cortex, a brain area responsible for manipulating information in working memory, and in the intraparietal sulcus, a posterior brain region essential for representing numerical quantity.

The study also points to greater cross-talk along pathways that integrate information between these regions and facilitate more efficient numerical problem solving over that one-year period. “Our study informs us about the anatomical regions and functional pathways where the plasticity is greatest,” Menon said.

The findings could eventually be applied to help develop better methods of learning, and as a foundation for remediating skills in the brains of children with math-related learning disabilities, such as dyscalculia. The ability to intervene with math difficulties early in a child’s school years could greatly help those who might otherwise not be able to pursue career paths that require math skills.

Provided by Stanford University Medical Center

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