MedicalXpress

Brain study reveals how successful students overcome math anxiety

October 20 2011

Using brain-imaging technology for the first time with people experiencing mathematics anxiety, University of Chicago scientists have gained new insights into how some students are able to overcome their fears and succeed in math.

For the highly math anxious, researchers found a strong link between math success and activity in a network of brain areas in the frontal and parietal lobes involved in controlling attention and regulating negative emotional reactions. This response kicked in at the very mention of having to solve a mathematics problem.

Teachers as well as students can use the information to improve performance in mathematics, said Sian Beilock, associate professor in psychology at the University of Chicago. Beilock and PhD student Ian Lyons report their findings in the article, "Mathematics Anxiety: Separating the Math from the Anxiety," published Oct. 20 in the journal Cerebral Cortex.

"Classroom practices that help students focus their attention and engage in the math task at hand may help eliminate the poor performance brought on by math anxiety," said Beilock, a leading expert on mathematics anxiety and author of the book Choke: What The Secrets Of The Brain Reveal About Getting It Right When You Have To.

Instead of feeling anxious about an impending math task, students who could focus their attention were able to complete difficult math

problems more successfully. Perhaps counter-intuitively, their success wasn't just about activating areas of the brain involved in math calculation. For math-anxious individuals to succeed, they need to focus on controlling their emotions, Beilock said.

Lyons and Beilock said their work implies that teaching students to control their emotions prior to doing math may be the best way to overcome the math difficulties that often go along with math anxiety. Without this initial step, simply providing additional math instruction or allowing students to become distracted by trying to squelch emotions once a math exam has begun is likely to prove ineffective in producing math success.

The study, which the National Science Foundation funded, began by administering a questionnaire to a group of UChicago students to determine if they had math anxiety. Students answered questions about how anxious they felt when registering for a math course, walking to a challenging math class, being handed a math textbook and so on. Lyons and Beilock then invited a group of students who were especially anxious about these math-related tasks to have their brains scanned using functional magnetic resonance imaging (fMRI) while they performed difficult math problems and a similarly difficult spelling task. A group of non-math-anxious students was selected as a control group.

In the fMRI scanner, students watched a computer screen for different cues in the form of simple, color-coded shapes. One shape indicated to students they were about to answer questions that tapped their spelling skills, and another shape indicated they were about to do a series of math problems. After a short delay, students then performed a few math or spelling problems. By analyzing brain responses during the cue and problems separately, Lyons and Beilock were able to look at what went on in highly math-anxious student's heads, even before the actual math began.

For the highly math-anxious, the researchers found a strong connection between math performance and activity in a network of brain areas in the frontal and parietal lobes.

The more these frontal and parietal regions were activated in math-anxious students when anticipating an impending math task, the more their math performance looked like the non-math-anxious control group. Indeed, highly math-anxious students who showed little activation in these regions when preparing to do math got only 68 percent of math problems correct. But those who showed the strongest activation got 83 percent correct — nearly on par with low math-anxious controls (88 percent correct). This relationship was not seen for the spelling task.

The study found that for the highly math-anxious students who performed well on the math task, the brain activity that started during the anticipation phase initiated a cascade of brain activity during completion of the math task itself. This activity did not involve areas typically associated with performing numerical calculations. Rather, it was seen in subcortical structures — especially caudate and nucleus accumbens — associated with motivation and juggling risks and rewards with the demands of the task at hand.

"Essentially, overcoming math anxiety appears to be less about what you know and more about convincing yourself to just buckle down and get to it," Beilock said. "But if you wait till the math exam has already started to deal with your anxiety, it's already too late," Lyons added.

For students who were not anxious about math to begin with, there was no relationship between activation in brain areas important for focusing attention, controlling emotion and math performance. This shows that approaching math may be entirely different for high and low math-anxious students. "Think about walking across a suspension bridge if you're afraid of heights versus if you're not — completely different

ballgame," Lyons said.

The study also sheds light on how people who get nervous about doing math can put their fears aside in everyday situations, such as balancing a checkbook or figuring out a tip among friends or coworkers. Taking a few breaths before jumping in can help one focus less on preparing to do math, and more on what actually needs to be done. "When you let your brain do its job, it usually will," Lyons said. "If doing math makes you anxious, then your first task is to calm yourself down."

Provided by University of Chicago