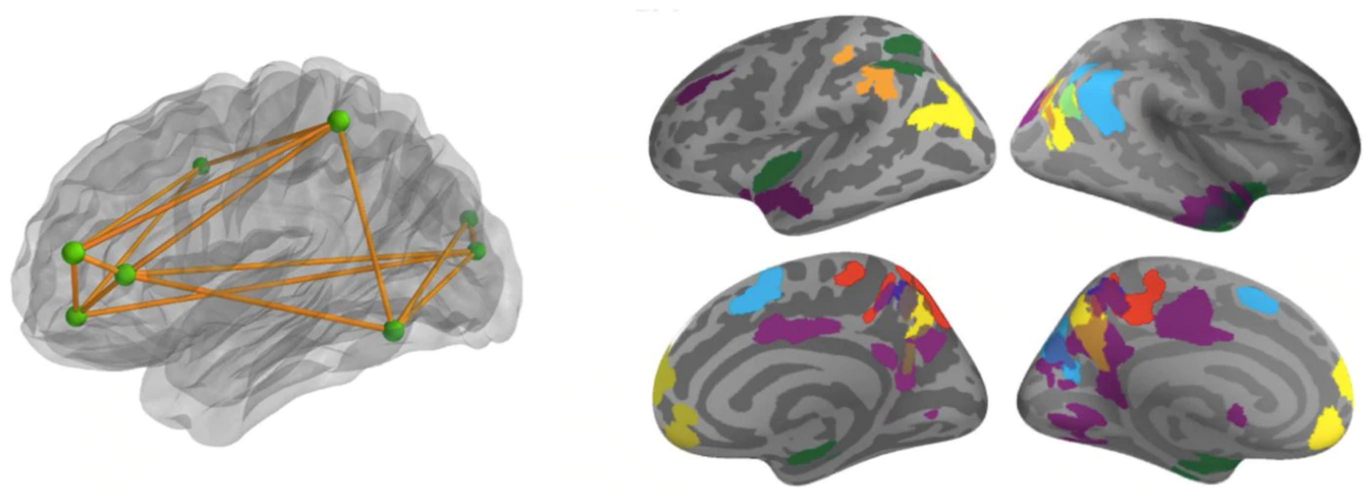
BRAINIAC

This is your brain on math

By **Kevin Hartnett** Globe Correspondent, September 17, 2015, 2:54 p.m.



Researchers identified three regions of the brain that predict improvement in math learning — the posterior parietal cortex, ventrotemporal occipital cortex, and the prefrontal cortex. STANFORD UNIVERSITY

Some people seem to learn math easily while others struggle right out of the gate. As a result, it’s natural to wonder whether our brains are just wired differently. Now, new research from a neuroscience lab at Stanford University finds evidence that indeed, differences in brain geography strongly affect how people develop in math.

In research published in the Journal of Neuroscience in August, lead author Tanya Evans and her colleagues presented data on 43 kids, who they followed from age 8 to age 14. During that period, they repeatedly gave the kids a variety of cognitive tests (IQ, memory, math, reading) and also took scans of the children’s brains “at rest.” By comparing these brain scans to how students performed in math as they grew up, the researchers were able to begin to zero in on the brain features that aid math learning.

“In order to masterfully acquire these skills, children need a great deal of cortical territory,” says Evans, a postdoctoral fellow in the lab of neuroscientist Vinod Menon.

"It's not just a math part of the brain, it's a network of regions."

The researchers identified three regions of the brain that predict improvement in math learning — the posterior parietal cortex, ventrotemporal occipital cortex, and the prefrontal cortex. The volume of these regions varied between individuals; having more gray matter correlated with performing better in math over time. More surprisingly, Evans found that the connections between these three regions matter a lot, too. Even the simplest cognitive tasks draw simultaneously on multiple regions of our brains, and the researchers found that success in math was related to how well those regions form a network.

"It's about multiple regions working in concert. The better they work in concert, the more essentially they speak to each other, the stronger the gains in numerical abilities," says Daniel Ansari, a neuroscientist at the University of Western Ontario who studies the foundations of math learning and was not involved in this study.

The idea of using brain scans to predict math ability raises uncomfortable questions about the biological basis of achievement. Evans is quick to say that brain scans can't be used to predict an individual's math future. There's too much variety in anatomical brain development and too many different ways a math education can unfold. In this way, the information revealed in brain scans is similar to health risk-factors in medicine. The BRCA1 gene, for instance, conveys a risk for breast cancer, but isn't at all deterministic, and understanding its role in cancer development opens up pathways for intervention.

"There's a remarkable amount of heterogeneity in how each kid can end up," Evans says. "That's pretty promising for parents. Just because at this age my kid is not performing as well as I'd like them to doesn't necessarily set them on a path to do poorly."

In fact, a major implication of this research is that it should be possible to improve kids' abilities to learn math if you know something about how their brains are designed. Similar work is already being done with reading. Researchers have identified the features of the brain that are abnormal in children with developmental dyslexia. They've also been able to design activities that actually reform those parts of the brain and make learning to read easier.

Evans and her colleagues envision using brain scans to identify children who are at-risk for struggling in math (rather than destined to struggle) and providing those children with interventions that reshape their brains.

“Our goal is to utilize brain research to inform us about the areas that are important for skill development and allow us to be able to design interventions for kids who are struggling,” says Evans.

Progress toward that point is likely to take awhile. Studies like this most recent one advance our understanding of how the brain works and also reveal the brain to be an even more complex place than we imagined — especially when it comes to how regions work together. Given that, a brain scan and matching interventions for every child, “is kind of science fiction at this point,” says Ansari, “but these findings are laying the groundwork.”

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