COGNITIVE SCIENCE

My, How You've Grown!

Cognitive scientist Jessica Cantlon investigates how kids' brains change as they acquire intellectual skills.

By Susan Hagen

HOW DOES LEARNING CHANGE THE BRAIN?

That's a question that Jessica Cantlon, assistant professor of brain and cognitive sciences, has been asking—and with the help of children, Big Bird, and a functional magnetic resonance imaging (fMRI) machine, she has begun to find the answer.

Children whose neural maps more closely resembled those of adults scored higher on standardized math and verbal tests in Cantlon's study. In other words, the brain's neural structure, like other parts of the body, develops along predictable pathways as it matures.

Cantlon's study also confirmed locations in the brain where the developing abilities lie. For verbal tasks, adult-like neural patterns in the Broca area—which is involved in speech and language—predicted higher verbal test scores in children. For math, better scores were linked to more mature patterns in the intraparietal sulcus, a region

ADAM FENSTER

LOOKING TO LEARN: Research assistants Vy Vo (left) and Courtney Lussier help Mason Ray, 4, of Penfield, N.Y., become acquainted with an fMRI machine. Cognitive scientist Jessica Cantlon (opposite) is carrying out research using brain imaging to find out how kids' brains change as they learn.

of the brain known to be involved in the processing of numbers.

Cantlon used fMRI to observe the neural activity of children and adults while they watched a video from *Sesame Street*. Scientists are just beginning to use brain imaging to understand how people process thought during real-life experiences. For example, researchers have compared scans of adults watching an entertaining movie to see if neural responses are similar across different individuals.

"But this is the first study to use the method as a tool for understanding development," Cantlon says.

The novel use of brain imaging during everyday activities like watching television opens the door to studying other thought processes in naturalistic settings and may one day help to diagnose and treat learning disabilities. It isn't possible at this point to measure the thought processes of the children while they're engaged in an actual classroom lesson, but by using the educational television show, Cantlon has sought to do the next best thing.

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Eventually, insight from fMRI may help pinpoint the cause when a child experiences difficulties mastering school work. "Psychologists have behavioral tests for trying to get to the bottom of learning impairments, but these new imaging studies provide a totally independent source of information about children's learning based on what's happening in the brain," she says.

Until the advent of fMRI the only way to evaluate children's cognitive development was behavioral testing. "A future goal for cognitive neuroscientists is that brain data could be used to inform diagnoses and interventions in learning—but that is still a distant goal," says Cantlon.

She and her former research assistant, Rosa Li, now a graduate student at Duke, published their findings in the journal *PLoS Biology*.

For the investigation, 27 children between the ages of 4 and 11 and 20 adults watched the same 20-minute *Sesame Street* video. Like the regular program, the recording featured a variety of short clips focused on numbers, words, shapes, and other subjects. The children then took standardized IQ tests for math and verbal ability.

To capture neural responses, researchers turned to fMRI. Unlike X-rays, CAT scans, and other types of brain imaging, fMRI involves no risks, injections, surgery, or exposure to radiation. Using magnetic fields, the scans virtually segment the brain into a three-dimensional grid of about 40,000 pixels, known as voxels, and measure the intensity of neural signals in each of those tiny sectors. The study, which was carried out over three years, produced 609 scans of each participant—one every two seconds—as they watched the video clip. Using statistical algorithms, the researchers then created neural maps of the thought processes for the children and the adults and compared the groups.

Using normal activities, such as television watching, may provide more accurate indications of children's learning and brain development than the short, simple tasks typical of fMRI studies, Cantlon and Li argue. Like the *Sesame Street* video, they say, academic lessons in schools are delivered in a richly complex environment.

To test that assumption, Cantlon and Li had the children perform traditional fMRI tasks by matching simple pictures of faces, numbers, words, or shapes. During the more limited activities, the neural responses didn't predict children's test scores, as they did when children watched the video.

While the authors don't advocate television watching, the study does show that "neural patterns during an everyday activity like watching television are related to a person's intellectual maturity," Cantlon says. "It's not the case that if you put a child in front of an educational TV program that nothing is happening—that the brain just sort of zones out. Instead, what we see is that the patterns of neural activity that children are showing are meaningful and related to their intellectual abilities." ®