Researchers illustrate how caregiver speech shapes the infant brain

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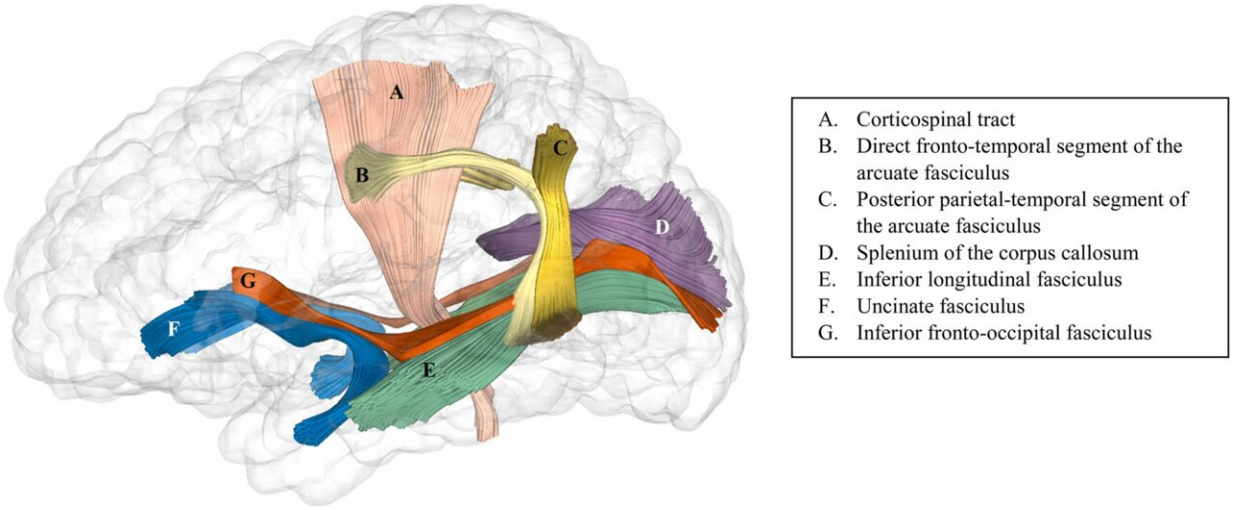

Glass brain image with a priori tracts of interest. Credit: *Developmental Cognitive Neuroscience* (2023). DOI: 10.1016/j.dcn.2023.101240

A team led by a University of Texas at Dallas neurodevelopment researcher has uncovered some of the most conclusive evidence yet that parents who talk more to their infants improve their babies' brain development.

The researchers used MRI and audio recordings to demonstrate that caregiver speech is associated with infant brain development in ways that improve long-term language progress. Dr. Meghan Swanson, assistant

professor of psychology in the School of Behavioral and Brain Sciences, is corresponding author of the study, which was published online April 11 and in the June print edition of *Developmental Cognitive Neuroscience*.

"This paper is a step toward understanding why children who hear more words go on to have better language skills and what process facilitates that mechanism," Swanson said. "Ours is one of two new papers that are the first to show links between caregiver speech and how the brain's white matter develops."

White matter in the brain facilitates communication between various gray matter regions, where information processing takes place in the brain.

The research included 52 infants from the Infant Brain Imaging Study (IBIS), a National Institutes of Health Autism Center of Excellence project involving eight universities in the U.S. and Canada and clinical sites in Seattle, Philadelphia, St. Louis, Minneapolis, and Chapel Hill, North Carolina. Home language recordings were collected when children were 9 months old and again six months later, and MRIs were performed at 3 months old and 6 months old, and at ages 1 and 2.

"This timing of home recordings was chosen because it straddles the emergence of words," Swanson said. "We wanted to capture both this prelinguistic, babbling time frame, as well as a point after or near the emergence of talking."

It's long been known that an infant's home environment—especially the quality of caregiver speech—directly influences language acquisition, but the mechanisms behind this are unclear. Swanson's team imaged several areas of the brain's white matter, focusing on developing neurological pathways.

"The arcuate fasciculus is the fiber tract that everyone in neurobiology courses learns is essential to producing and understanding language, but that finding is based on adult brains," Swanson said. "In these children, we looked at other potentially meaningful fiber tracts as well, including the uncinate fasciculus, which has been linked to learning and memory."

The researchers used the images to measure fractional anisotropy (FA). This metric for the freedom or restriction of water movement in the brain is used as a proxy for the progress of white matter development.

"As a fiber track matures, water movement becomes more restricted, and the brain's structure becomes more coherent," Swanson said. "Because babies aren't born with highly specialized brains, one might expect that networks that support a given cognitive skill start out more diffuse and then become more specialized."

Swanson's team found that infants who heard more words had lower FA values, indicating that the structure of their white matter was slower to develop. The children went on to have better linguistic performance when they began to talk.

The study's results align with other recent research showing that slower maturation of white matter confers a cognitive advantage.

"As a brain matures, it becomes less plastic—networks get set in place. But from a neurobiological standpoint, infancy is unlike any other time. An infant brain seems to rely on a prolonged period of plasticity to learn certain skills," Swanson said. "The results show a clear, striking negative association between FA and child vocalization."

Sharnya Govindaraj, co-first author of the paper, a cognition and neuroscience doctoral student and a member of Swanson's Baby Brain Lab, said at first she was surprised by the results.

"We initially didn't know how to interpret these negative associations that seemed very counterintuitive. The whole concept of neuroplasticity and absorbing new knowledge had to fall into place," she said. "Which ability we're looking at also matters a great deal, because something like vision matures much earlier than language."

As the parent of a toddler in a bilingual household, Swanson was curious about how this relationship functions for infants exposed to more than one language.

"Raising a bilingual child, it is remarkable how she is not confused by languages, and she knows who she can use which language with," Swanson said.

Swanson said she also has gained a deeper level of appreciation and gratitude for what she, as a researcher, asks parents in her studies to do.

"When participants sign up, I'm asking them to commit to a year and a half," she said. "Because of the commitment of all the parents in prior studies, I and others have the knowledge that allows us to communicate with our children in a way that supports their development."

Swanson said the take-home message is that parents have the power to help their children develop.

"This work highlights parents as change agents in their children's lives, with the potential to have enormous protective effects," Swanson said. "I hope our work empowers parents with the knowledge and skills to support their children as best they can."

More information: Katiana A. Estrada et al, Language exposure during infancy is negatively associated with white matter microstructure in the arcuate fasciculus, *Developmental Cognitive Neuroscience* (2023).

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