How hearing impairment in infants can impact language development

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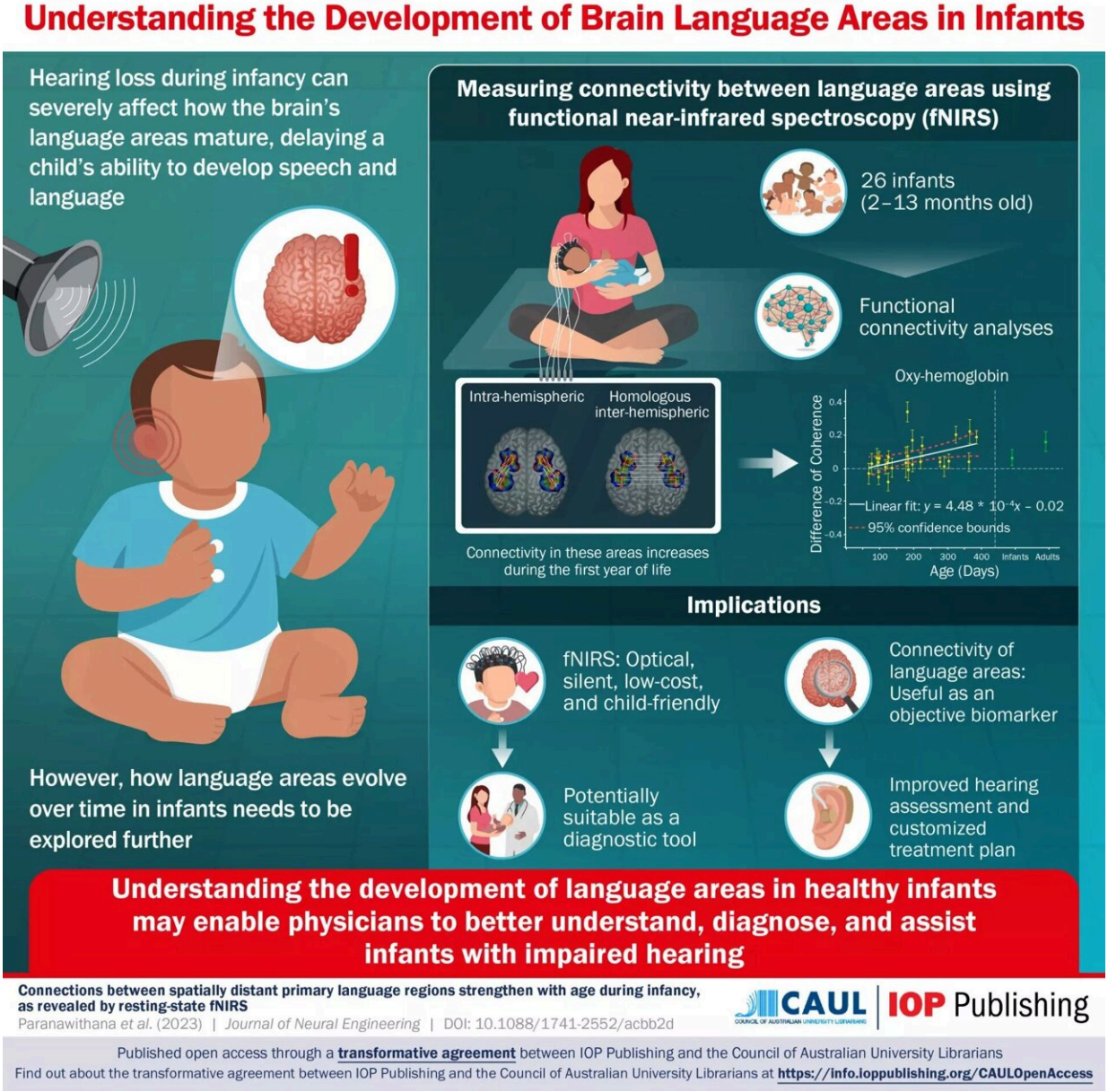

Credit: IOP Publishing

Hearing impairment can affect children's ability to develop language and speech skills. Several diagnostic tests are required to determine the extent of hearing impairment in infants, leading to delays in treatment.

Now, researchers from Australia have conducted non-invasive measurements of the brain activity of infants to map the changes in connectivity between different language areas over time. Their findings could pave the way for novel biomarkers and improved diagnostic tools for infants with hearing problems.

The human brain is a remarkable organ that comprises several connected networks that work in synchronization to perform everyday tasks, including speech and language processing. In the initial stages of life, children develop speech and language skills through sensory functions, such as hearing.

Most studies indicate that networks in the brain mature during childhood itself, facilitating the early development of language areas in the brain. Unfortunately, for children with a hearing impairment (which can be due to several factors like congenital defects, injuries, disease, among others), this development can be hindered due to reduced auditory inputs.

Diagnosing hearing impairments in infants is challenging. Physicians usually need to run multiple diagnostic tests to estimate the level of hearing impairment in infants and determine whether they need a cochlear implant or a hearing aid. This is a highly stressful process, not only for the children but also for their parents. More concerning is the fact that prolonged hearing loss can severely affect how the brain's

language areas evolve, delaying a child's ability to develop speech and language.

Could studying the functional connectivity changes that occur in the brains of normal hearing infants help establish the typical developmental trajectory of language areas in early childhood? This question motivated Ph.D. student Ishara Paranawithana, from Monash University, and his team of researchers from Australia, to explore how different language areas in the brain develop and interconnect over time as an infant grows older. Their paper has been published in the *Journal of Neural Engineering*.

To maximize the impact of these important findings, Paranawithana and colleagues published this study through a transformative agreement between IOP Publishing and the Council of Australian University Librarians (CAUL). This agreement allows authors at more than 30 institutions across Australia and New Zealand to publish their work as open access at no cost to them. These articles are immediately available and free for everyone to access.

"I am a great advocate for open science, which promotes sustainable and equitable access of scientific research to anyone who might be interested. By publishing under a transformative agreement, we hoped to make our research findings readily accessible to a much wider brain research community, regardless of their ability to afford high subscription fees. This publication model is a great way to further our understanding on niche research topics while promoting diversity, inclusion, and equity more broadly in scientific research," says Paranawithana.

For the study, the team recruited 26 infants between 2 and 13 months of age, as well as 12 adults with healthy hearing. Using a technique known as functional near-infrared spectroscopy, they non-invasively imaged the

brains of all participants. The team then conducted data processing and statistical analyses to obtain a measure of the connectivity between distinct language areas in each individual's brain. Since the age of the infants varied considerably, this led to the quantification of how these regions become increasingly functionally linked together with age, approaching the connectivity levels seen in adults by the end of the first year.

How are these findings beneficial in the long run? "Mapping out the developmental trajectory of language areas of normal hearing infants could potentially allow us to better understand the altered connectivity and its effects on language delays in hearing impaired infants," remarks Paranawithana. He further adds, "Such tools will allow clinicians to conduct more accurate hearing assessments so that an appropriate hearing device can be confidently selected and fine-tuned to optimize the outcome of each patient."

This study is a stepping stone toward new diagnostic methodologies that could revolutionize how physicians assess hearing in babies. Techniques such as functional near-infrared spectroscopy, which are relatively inexpensive and child-friendly, could ensure that infants with impaired hearing get access to effective treatments earlier in life. This would also enable them to keep up with their peers and enjoy their daily activities without feeling left behind.

More information: Ishara Paranawithana et al, Connections between spatially distant primary language regions strengthen with age during infancy, as revealed by resting-state fNIRS, *Journal of Neural Engineering* (2023). DOI: 10.1088/1741-2552/acbb2d

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