Medical Xpress

Wearable brain imaging device shines a light on how babies respond in real-world situations

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Mother Mererid and baby Mabli were volunteers in the study. Credit: Liam Collins-Jones/UCL

A new technology which uses harmless light waves to measure activity in babies' brains has provided the most complete picture to date of brain functions like hearing, vision and cognitive processing outside a conventional, restrictive brain scanner, in a new study led by researchers at UCL and Birkbeck.

The wearable brain imaging headgear, which was developed in collaboration with UCL spin-out Gowerlabs, found unexpected activity in the prefrontal cortex, an area of the brain that processes emotions, in response to social stimuli, appearing to confirm that babies start processing what is happening to them in social situations as early as five months old.

This latest technology can measure neural activity across the whole outer surface of a baby's brain. An earlier version developed by the same team could only measure activity in one or two parts of a baby's brain at a time.

The researchers say this technology could help to map the connections between different brain regions and establish what distinguishes typical and atypical neurodevelopment in the crucial early stages of childhood and shed light on conditions of neurodiversity such as autism, dyslexia and ADHD.

The development of the new device and the results of early tests are documented in a study, published in *Imaging Neuroscience*.

Dr. Liam Collins-Jones, first author of the study from UCL Medical Physics & Biomedical Engineering and the University of Cambridge, said, "Previously we developed a wearable imaging approach that could map activity in specific areas of the brain.

"But this made it difficult to get a complete picture as we could only focus on one or two areas in isolation, whereas in reality different parts of the brain work together when navigating real-world scenarios.

"The new method allows us to observe what's happening across the whole outer brain surface underlying the scalp, which is a big step forward. It opens up possibilities to spot interactions between different areas and detect activity in areas that we might not have known to look at previously.

"This more complete picture of brain activity could enhance our understanding of how the baby brain functions as it interacts with the surrounding world, which could help us optimize support for neurodiverse children early in life."

Professor Emily Jones, an author of the study from Birkbeck, University of London, said, "This is the first time that differences in activity across such a wide area of the brain have been measured in babies using a wearable device, including parts of the brain involved in processing sound, vision and emotions.

"The technology developed and tested in this study is a stepping stone towards a better understanding of the brain processes that underlie social development, which we haven't been able to observe before, outside of the very restrictive bounds of an MRI scanner.

"With this we should be able to see what's happening in babies' brains as they play, learn and interact with other people in a very natural way."

The new device was tested on sixteen babies aged five-to-seven months. Wearing the device, the babies sat on their parent's lap and were shown videos of actors singing nursery rhymes to mimic a social scenario, and videos of moving toys, such as a ball rolling down a ramp, to mimic a non-social scenario.

The researchers observed differences in brain activity between the two scenarios. As well as the unexpected findings in the pre-frontal cortex observed in response to social stimuli, the researchers found that activity was more localized in response to social stimuli compared to non-social stimuli, validating previous findings from optical neuroimaging and MRI studies.

Currently, the most comprehensive way to see what's going on in the human brain is with magnetic resonance imaging (MRI), which involves the subject lying very still within the scanner for potentially 30 minutes or more.

The drawback of this approach is that it is difficult to mimic natural scenarios, such as interacting with another person or performing a task, particularly with infants who would need to be asleep or restrained in order for an MRI to successfully image their brain activity.

To help overcome this, in recent years, this team of researchers have used a form of optical neuroimaging, called high-density diffuse optical tomography (HD-DOT), to develop wearable devices that are able to study brain activity more naturally. The technology also has the benefit of being cheaper and more portable than MRI.

In the new study, the researchers developed an HD-DOT optical neuroimaging method capable of scanning the whole of the infant's head.

The device used in the study was adapted from a commercial system developed by Gowerlabs, a UCL spin-out company that was founded in 2013 by researchers from UCL's Biomedical Optics Research Laboratory.

Dr. Rob Cooper, senior author of the study from UCL Medical Physics & Biomedical Engineering, said, "This device is a great example of academic research and commercial technological development working hand-in-hand.

"The long-standing collaboration between UCL and Gowerlabs, along with our academic partners, has been fundamental to the development of wearable HD-DOT technology."

Dr. Collins-Jones will give a talk about this research at the British Science Festival on Saturday 14 September.

More information: Liam H. Collins-Jones et al, Whole-head high-density diffuse optical tomography to map infant audio-visual responses to social and non-social stimuli, *Imaging Neuroscience* (2024). DOI: 10.1162/imag_a_00244

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