# Baby brains help infants figure it out before they try it out

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Babies often amaze their parents when they seemingly learn new skills overnight—how to walk, for example. But their brains were probably prepping for those tasks long before their first steps occurred, according to researchers.

Researchers at Penn State are using new statistical analysis methods to compare how we observe infants develop new skills with the unseen changes in electrical activity in the brain, or electroencephalography (EEG) power. They found that most babies appear to learn new skills in irregular bursts, while their EEG power grows steadily behind the scenes.

Koraly Perez-Edgar, professor of psychology at Penn State, said the study—published today (Jan. 17) in *Child Development*—supports long-standing but untested beliefs about how infants develop.

"This is a question that has bedeviled psychologists for most of the last century. Our data help show how behaviors that we can observe in children are indeed non-linear, showing up in spurts," Perez-Edgar said. "However, the underlying forces that help support this observed behavior can be linear. For a long time there was a debate over whether both of these things could hold true."

Perez-Edgar said that while the famous child psychologist Jean Piaget theorized that young children develop in bursts instead of little by little over time, testing the theory was limited by the statistical analysis tools available to researchers. But with new modeling methods, the researchers were able to better examine how behavioral development is related to growth in brain activity.

"Psychologists have been suggesting that while on the surface development looks like these quick bursts, underneath there may be very continuous, slowly developing mechanisms that one day look like they popped out of nowhere," Perez Edgar said. "Like with kids learning to talk, it looks like they learn all these words overnight, but they've been listening and thinking and processing for a long time."

A total of 28 six-month-old infants were recruited and brought to the lab once a month until they turned one year old. During each visit, the baby participated in a cognitive test called the "a-not-b task," designed in the 1950s to measure an infant's understanding of object permanence: knowing something exists even if it's out of sight.

In the task, a researcher put a cardboard box with two wells—A and B—across from the infant. The researcher then hid a toy in one well and covered it with cloth, hiding it from view. The infant was considered successful if they correctly retrieved the toy twice from well A and then once from well B after the researcher hid it.

"How babies perform in this task tells us a lot about their development because it's a coordination of multiple skills," said Leigha MacNeill, Penn State graduate student in psychology. "They have to remember where the ball was moved, which is working memory. They have to know an object exists even though it's out of sight, and they need to track objects moving in space from one place to another. All of this also required them to pay attention. So there's a lot going on."

The researchers also measured the infants' EEG at each visit. A cap with six electrodes was placed on the baby's head, with each electrode measuring the electrical activity in different regions of the brain. Readings were taken for two minutes while the infants focused on a spinning wheel.

After analyzing the data, the researchers found that performance on the a-not-b task did indeed develop in bursts: with most of the infants, there wasn't a lot of development in the first or last months, but there was a big spike between seven and eleven months. At the same time, the researchers found that EEG power grew at a steady pace throughout the seven months.

"We saw that a nonlinear growth curve was the best way to describe most of the babies," MacNeill said. "Meanwhile, we found that there was significant linear change at all electrode locations. We also saw associations between EEG power in the occipital lobe and performance on the a-not-b task. Infants who had lower levels of occipital power at six months of age had faster increases in a-not-b performance over time."

Because the researchers analyzed each baby's personal development, in addition to taking an average of all the babies together, MacNeill said the results help shed some light on what's happening in the brain when infants are learning new skills.

"Infant behavior varies so much from baby to baby, so it's helpful to understand what's going on beneath the surface," MacNeill said. "This multi-method approach is helpful, because we can see both the infants' behavior and also what's going on in the brain. It gives us a better sense of where this variability comes from, and can help us see what's happening in the brain when the infant isn't getting better at the task verses when there's rapid development."

Provided by Pennsylvania State University

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