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Study links bilingual babies' vocabulary to early brain differentiation

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This is one of the babies in the experiment wearing an EEG cap that measures brain activity. Credit: University of Texas at San Antonio

Babies and children are whizzes at learning a second language, but that ability begins to fade as early as their first birthdays.

Researchers at the University of Washington's Institute for Learning & Brain Sciences are investigating the brain mechanisms that contribute to infants' prowess at learning languages, with the hope that the findings could boost bilingualism in adults, too.

In a new study, the researchers report that the brains of babies raised in bilingual households show a longer period of being flexible to different languages, especially if they hear a lot of language at home. The researchers also show that the relative amount of each language – English and Spanish – babies were exposed to affected their vocabulary as toddlers.

The study, published online Aug. 17 in *Journal of Phonetics*, is the first to measure brain activity throughout infancy and relate it to language exposure and speaking ability.

"The bilingual brain is fascinating because it reflects humans' abilities for flexible thinking – bilingual babies learn that objects and events in the world have two names, and flexibly switch between these labels, giving the brain lots of good exercise," said Patricia Kuhl, co-author of the study and co-director of the UW's Institute for Learning & Brain Sciences.

Kuhl's previous studies show that between 8 and 10 months of age, monolingual babies become increasingly able to distinguish speech sounds of their native language, while at the same time their ability to distinguish sounds from a foreign language declines. For instance, between 8 and 10 months of age babies exposed to English become better at detecting the difference between "r" and "l" sounds, which are prevalent in the English language. This is the same age when Japanese babies, who are not exposed to as many "r" and "l" sounds, decline in their ability to detect them.

"The infant brain tunes itself to the sounds of the language during this sensitive period in development, and we're trying to figure out exactly how that happens," said Kuhl, who's also a UW professor of speech and hearing sciences. "But almost nothing is known about how bilingual babies do this for two languages. Knowing how experience sculpts the

brain will tell us something that goes way beyond language development."

In the current study, babies from monolingual (English or Spanish) and bilingual (English and Spanish) households wore caps fitted with electrodes to measure brain activity with an electroencephalogram, or EEG, a device that records the flow of energy in the brain. Babies heard background speech sounds in one language, and then a contrasting sound in the other language occurred occasionally.

For example, a sound that is used in both Spanish and English served as the background sound and then a Spanish "da" and an English "ta" each randomly occurred 10 percent of the time as contrasting sounds. If the brain can detect the contrasting sound, there is a signature pattern called the mismatch response that can be detected with the EEG.

Monolingual babies at 6-9 months of age showed the mismatch response for both the Spanish and English contrasting sounds, indicating that they noticed the change in both languages. But at 10-12 months of age, monolingual babies only responded to the English contrasting sound.

Bilingual babies showed a different pattern. At 6-9 months, bilinguals did not show the mismatch response, but at 10-12 months they showed the mismatch for both sounds.

This suggests that the bilingual brain remains flexible to languages for a longer period of time, possibly because bilingual infants are exposed to a greater variety of speech sounds at home.

This difference in development suggests that the bilingual babies "may have a different timetable for neurally committing to a language" compared with monolingual babies, said Adrian Garcia-Sierra, lead author and a postdoctoral researcher at UW's Institute for Learning &

Brain Sciences.

"When the brain is exposed to two languages rather than only one, the most adaptive response is to stay open longer before showing the perceptual narrowing that monolingual infants typically show at the end of the first year of life," Garcia-Sierra said.

To see if those brain responses at 10-12 months related to later speaking skills, the researchers followed up with the parents when the babies were about 15 months old to see how many Spanish and English words the children knew. They found that early brain responses to language could predict infants' word learning ability. That is, the size of the bilingual children's vocabulary was associated with the strength of their brain responses in discriminating languages at 10-12 months of age.

Early exposure to language also made a difference: Bilingual babies exposed to more English at home, including from their parents, other relatives and family friends, subsequently produced more words in English. The pattern held true for Spanish.

The researchers say the best way for children to learn a second language is through social interactions and daily exposure to the language.

"Learning a second language is like learning a sport," said Garcia-Sierra, who is raising his two young children as bilingual. "The more you play the better you get."

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