Learning a second language -- Is it all in your head?

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Think you haven't got the aptitude to learn a foreign language? New research led by Northwestern University neuroscientists suggests that the problem, quite literally, could be in your head.

"Our study links brain anatomy to the ability to learn a second language in adulthood," said neuroscientist Patrick Wong, assistant professor of communication sciences and disorders at Northwestern and lead author of a study appearing online today (July 25) in *Cerebral Cortex*.

Based on the size of Heschl's Gyrus (HG), a brain structure that typically accounts for no more than 0.2 percent of entire brain volume, the researchers found they could predict -- even before exposing study participants to an invented language -- which participants would be more successful in learning 18 words in the "pseudo" language.

Wong and his colleagues measured the size of HG, a finger-shaped structure in both the right and left side of the brain, using a method developed by co-authors Virginia Penhune and Robert Zatorre (Montreal Neurological Institute). Zatorre and Penhune are well known for research on human speech and music processing and the brain.

"We found that the size of left HG, but not right HG, made the difference," said Northwestern's Catherine Warrier, a primary author of the article titled "Volume of Left Heschl's Gyrus and Linguistic Pitch." Anil K. Roy (Northwestern), Abdulmalek Sadehh (West Virginia University) and Todd Parish (Northwestern) also are co-authors.

The study is the first to consider the predictive value of a specific brain structure on linguistic learning even before training has begun. Specifically, the researchers measured the size of study participants' right and left Heschl's Gyrus on MRI brains scans, including calculations of the volume of gray and white matter.

Studies in the past have looked at the connection between brain structure and a participant's ability to identify individual speech sounds in isolation rather than learning speech sounds in a linguistic context. Others have looked at the connection between existing language proficiency and brain structure.

"While our study demonstrates a link between biology and linguistics, we do not argue that biology is destiny when it comes to learning a second language," Wong emphasized. Adults with smaller volumes of left HG gray matter need not despair that they can never learn another language.

"We are already testing different learning strategies for participants whom we predict will be less successful to see if altering the training paradigm results in more successful learning," Wong added.

According to Warrier, Northwestern research professor of communication sciences and disorders, the researchers were surprised to find the HG important in second language learning. "The HG, which contains the primary region of the auditory cortex, is typically associated with handling the basic building blocks of sound -- whether the pitch of a sound is going up or down, where sounds come from, and how loud a sound is -- and not associated with speech per se," she said.

The 17 research participants aged 18 to 26 who had their brain scans taken prior to participating in the pseudo second language training were previously participants in two related studies published by Wong and his research team.

The three studies have identified behavioral, neurophysiologic and, with the current study, neuroanatomic factors which, when combined, can better predict second language learning success than can each single factor alone.

In a behavioral study, Wong's group found that musical training started at an early age contributed to more successful spoken foreign language learning. The study participants with musical experience also were found to be better at identifying pitch patterns before training.

In a neurophysiologic study -- again with the same participants -- Wong's team used functional magnetic resonance imaging to observe what parts of brain were activated when participants listened to different pitch tones. They found that the more successful second language learners were those who showed activation in the auditory cortex (where HG resides).

The participants all were native American English speakers with no knowledge of tone languages. In tone languages (spoken by half the world’s population), the meaning of a word can change when delivered in a different pitch tone. In Mandarin, for example, the word "mi" in a level tone means "to squint," in a rising tone means "to bewilder" and in a falling and then rising tone means "rice."

For the study reported in "Cerebral Cortex," Wong's 17 participants entered a sound booth after having their brains were scanned. There they were trained to learn six one-syllable sounds (pesh, dree, ner, vece, nuck and fute). The sounds were originally produced by a speaker of American English and then re-synthesized at three different pitch tones, resulting in 18 different "pseudo" words.

The participants were repeatedly shown the 18 "pseudo" words and a black and white picture representing each word's meaning. Pesh, for

example, at one pitch meant "glass," at another pitch meant "pencil," and at a third meant "table." Dree, depending upon pitch, meant "arm," "cow," or "telephone."

As a group - and sometimes in fewer than two or three sessions – the nine participants predicted on the basis of left HG size to be "more successful learners" achieved an average of 97 percent accuracy in identifying the pseudo words. The "less successful" participants averaged 63 percent accuracy and sometimes required as many as 18 training sessions to correctly identify the words.

"What's important is that we are looking at the brain in a new way that may allow us to understand brain functions more comprehensively and that could help us more effectively teach foreign languages and possibly other skills," said Wong.

Source: Northwestern University