MedicalXpress

Success in second language learning linked to genetic and brain measures

June 13 2016

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If you've had disappointing results in learning a new language as an adult, your struggle may have to do with your genes and brain structure.

A new study by researchers at the University of Washington shows that the final grades that college students received in a second-language class were predicted by a combination of genetic and brain factors.

Genetic variations of the COMT gene and a measure of the strength of the brain's communications network—known as "white matter"— jointly accounted for 46 percent of the reason for why some students performed better than others in the language class.

"We are interested in understanding why individuals learn differently, including those who perform well and those who perform poorly," said lead author Ping Mamiya, a research scientist at the UW's Institute for Learning & Brain Sciences (I-LABS).

"Our study shows for the first time that variations of the COMT gene are related to changes in the brain's white matter that are the result of learning," Mamiya said.

The *Proceedings of the National Academy of Sciences* will publish the study this week.

"We all know that human learning is highly complex and that a lot of factors play a role," said co-author Patricia Kuhl, co-director of I-LABS. "Second-language learning as an adult is difficult, and we thought studying how people learn something difficult would be a good way to tease out the interactions between genes and brains in learning."

The research team recruited first-year college students—20-years-old on average—who had just arrived in the U.S. from China. The 79 volunteers in the study had passed the university's minimum English requirement, and 44 of them immediately entered a three-week immersion class intended to help international students improve their English skills.

Over the course of the three-week language class and up to eight days after the class ended, the researchers performed brain scans of all the students, including a control group who had also just arrived from China

but did not get into the class.

The researchers used an MRI technique called diffusion tensor imaging (DTI), which gives clues about the structure of the brain's connections. Better structure helps signals transfer across the brain, which may lead to better learning.

The brain scans suggest that within a day of the immersive English training, white matter had already begun to change. Foreign language exposure increased the connectivity of the brain's language circuitry in enrolled students compared with students who were not enrolled in the language class. The increase went up over the course of the three-week training, and then reversed after the training ended.

"Being able to document these associations between brain structure and environmental stimulation in young adult human brains is really exciting," Mamiya said. "It is one of the highlights in this paper."

Since different forms of the COMT gene can have different effects on brain structure, the researchers suspected that the students' COMT genotype would be related to how much white matter changed from the language class.

Sure enough, using DNA samples taken from the students at the beginning of the language program, the researchers found that two specific forms of the COMT gene (Methionine/Valine or Valine/Valine) were linked to greater increases in brain connectivity in students who took the language class. Students with a third COMT genotype (Methionine/Methionine) did not show any white matter change in response to the language experience.

The combination of the COMT genotype and the white matter measure was so powerful on language learning that it accounted for 46 percent of

total variance in the students' final scores.

"Humans' abilities in learning any particular skill vary tremendously, and we want to know why," Kuhl said. "Knowing why answers a basic science question about how the environment, our genes, and our brains really work, but could also lead to interventions that improve learning."

More information: Brain white matter structure and COMT gene are linked to second-language learning in adults, *PNAS*, www.pnas.org/cgi/doi/10.1073/pnas.1606602113

Provided by University of Washington