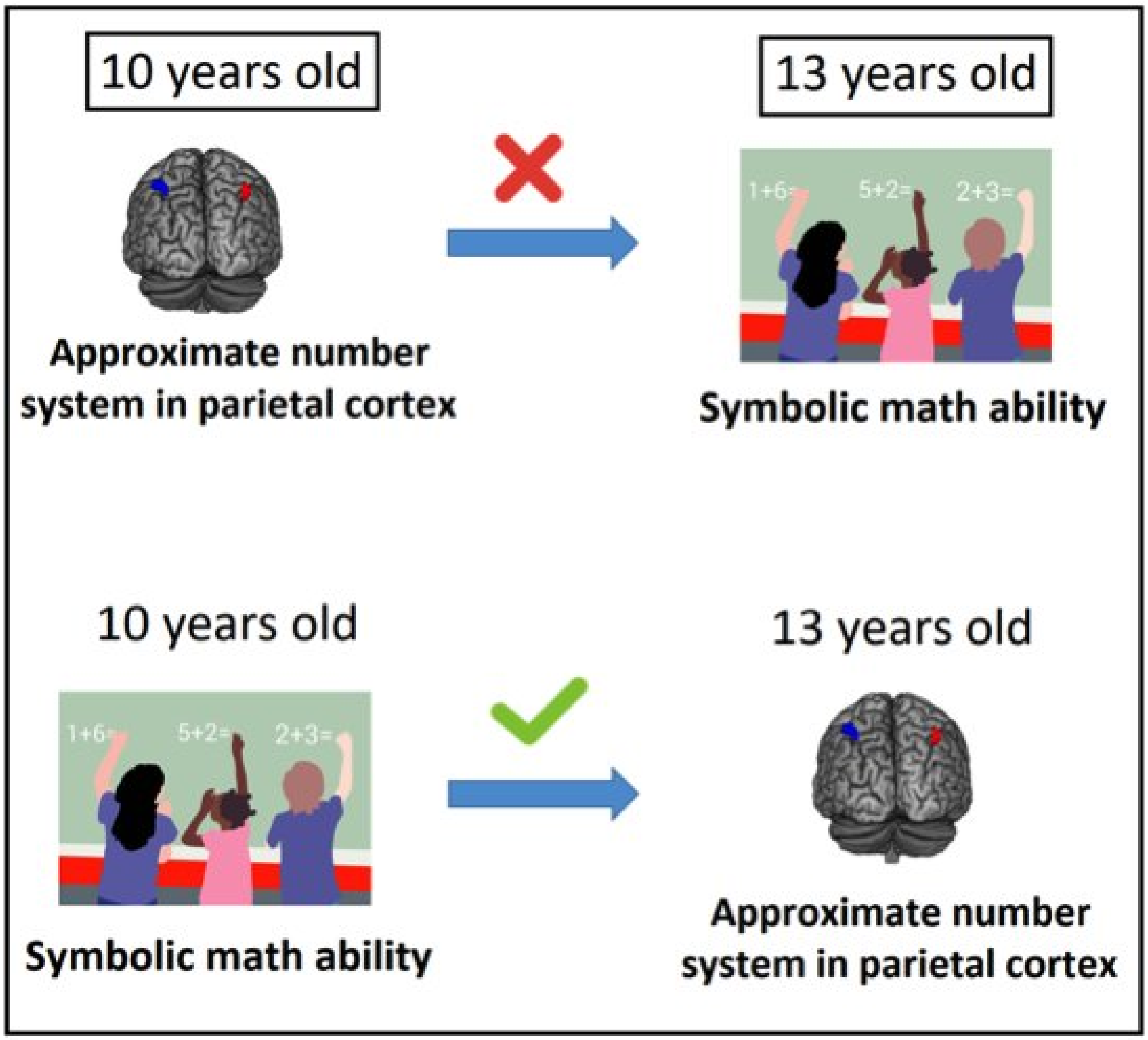
Medical Xpress

Learning arithmetic refines the primal brain system for representing quantity

July 24 2018, by Joan Brasher



Credit: Vanderbilt University

A wildebeest knows when it is outnumbered by a pack of hungry hyenas, thanks to an imprecise, primal brain function called the Approximate Number System, or ANS. Animals have it and human babies are born with it. Scientists have long believed that human's ability to solve symbolic math problems such as 3+2=5 depended on the precision of one's ANS.

But a new Vanderbilt study supported by the National Institute of Child Health and Development, published in the journal *Human Brain Mapping*, challenges the causal role of ANS in mathematical ability.

"Our study shows that gaining expertise with symbolic math, which is a human cultural invention, actually refines this evolutionarily ancient system of quantity representation, not the other way around," said lead author Macarena Suárez Pellicioni, an educational neuroscience post-doctoral researcher at Vanderbilt's Peabody College of education and human development. "Previous studies may have inappropriately concluded that the ANS scaffolds symbolic math because they did not follow participants over time to look for causal relations, or they did not account for individual differences in initial ability levels of the variables being studied."

Suárez Pellicioni and her team measured children's precision of ANS in the parietal cortex using functional Magnetic Brain Imaging. They found that a 10-year-old's ability to solve symbolic math problems predicted more precise quantities in the ANS about three years later.

No evidence was found for early ANS predicting later symbolic math ability (see Figure 1). This suggests that early symbolic math refines the ANS, but that early ANS does not scaffold later development of symbolic math.

James R. Booth, Patricia and Rodes Hart Professor in the Department of

Psychology and Human Development at Peabody, is co-author of the study. He is internationally recognized for neuroimaging studies of how children develop language, reading and math skills.

"Our finding is a nice example of the power of education in modeling the brain," he said. "This has important implications for intervention."

Many studies have sought to train the ANS by asking participants to make estimations of dot patterns or line lengths. However, the suggestion that training the ANS may improve symbolic math may be misguided, Booth believes.

"Our research suggests that children would benefit more from the precision that only numbers can provide—so math instruction should emphasize building strong symbolic abilities," he said.

Booth puts forth that the core problem in math disabilities, or dyscalculia, may be in symbolic knowledge, leading to a less precise ANS.

"Not only do we need to re-evaluate theories that argue for a causal role of ANS in math disability, but the team suggests that interventions should focus on building knowledge of symbols and their meanings," he said. "Studies suggest that training children to compare symbolic numbers, instead of dots, lead to greater improvement in arithmetic."

More information: Macarena Suárez-Pellicioni et al. Fluency in symbolic arithmetic refines the approximate number system in parietal cortex, *Human Brain Mapping* (2018). DOI: 10.1002/hbm.24223

Provided by Vanderbilt University