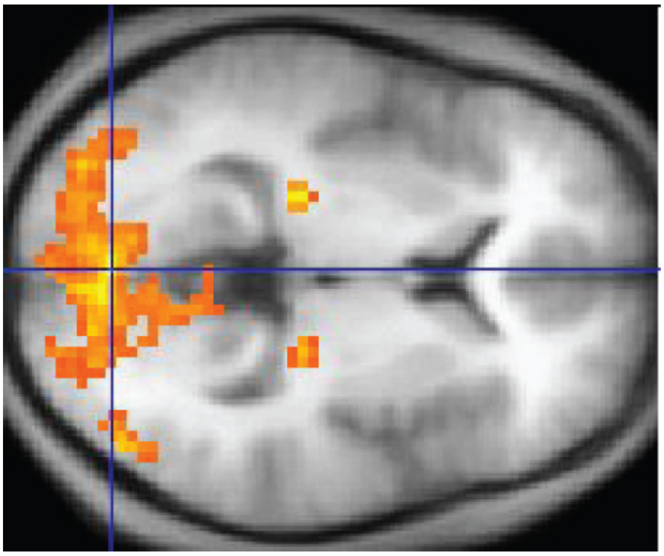
Brain study suggests neural networks related to mathematics are different from those used for language

12 April 2016, by Bob Yirka



An fMRI image with yellow areas showing increased activity. Credit: Wikipedia/ CC BY 3.0

(Medical Xpress)—A pair of researchers with Université Paris-Sud and Université Paris-Saclay has found via fMRI human brain studies that the neural networks used to process mathematics are different from those that are used to process language. In their paper published in *Proceedings of the National Academy of Sciences*, Marie Amalric and Stanislas Dehaene describe experiments they conducted with volunteers willing to undergo fMRI scans while engaging in various tasks and what they found as a result.

It has long been debated between scientists in various fields whether the brain works on math problems using the same mechanism as it does when working out word problems, especially when the two intersect such, as in algebra. At issue was the feeling by many mathematicians, that they were using a different part of their brain when working out math problems than when dealing with language issues. In this new effort, the research pair sought to settle the debate once and for all by actually watching the brain work as it handled problems of both types.

The experiments consisted of asking 30 volunteers (15 mathematicians and 15 well read non-mathematicians) to undergo fMRI scanning while they were asked to respond 'true' or 'false' to various questions, some of which required mathematical thought.

The researchers report that when both types of people were asked non-math related questions, their brains responded in ways that have been previously associated with language processing. But when the questions required higher level mathematical processing, the parietal, the prefrontal and inferior temporal regions in the brains of the mathematicians all lit up. Conversely, because they were not trained in higher level math, the same areas in the brains of the non-mathematicians lit up only when asked more general questions about numbers and math formulas. In both groups, regions of the brain associated with language processing did not light up when the volunteers were pondering math questions.

The brain scans show, the researchers claim, that the human brain has different neural networks for handling math skills than it has for language processing and furthermore that the brain uses the same neural network to understand math in a basic way as it does when trying to make sense of numbers or space.

More information: Marie Amalric et al. Origins of the brain networks for advanced mathematics in expert mathematicians, *Proceedings of the National*

Academy of Sciences (). DOI: 10.1073/pnas.1603205113

Abstract
The origins of human abilities for mathematics are debated: Some theories suggest that they are founded upon evolutionarily ancient brain circuits for number and space and others that they are grounded in language competence. To evaluate what brain systems underlie higher mathematics, we scanned professional mathematicians and mathematically naive subjects of equal academic standing as they evaluated the truth of advanced mathematical and nonmathematical statements. In professional mathematicians only, mathematical statements, whether in algebra, analysis, topology or geometry, activated a reproducible set of bilateral frontal, Intraparietal, and ventrolateral temporal regions. Crucially, these activations spared areas related to language and to general-knowledge semantics. Rather, mathematical judgments were related to an amplification of brain activity at sites that are activated by numbers and formulas in nonmathematicians, with a corresponding reduction in nearby face responses. The evidence suggests that high-level mathematical expertise and basic number sense share common roots in a nonlinguistic brain circuit.