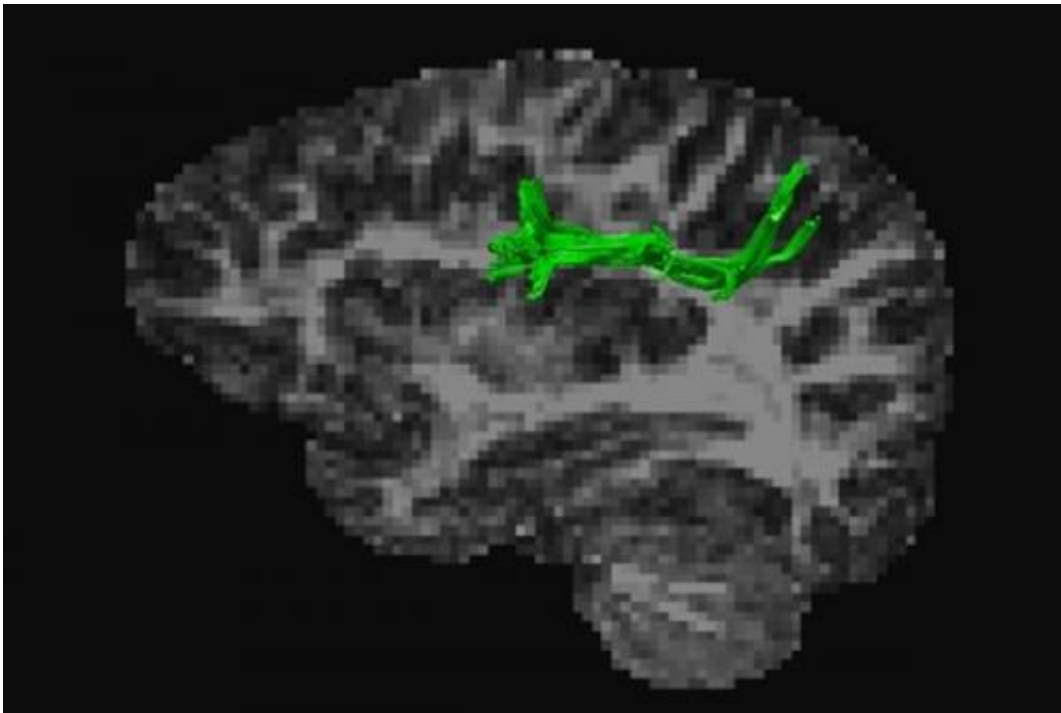


Quality of white matter in the brain is crucial for adding and multiplying

January 27 2014



The 'arcuate fasciculus anterior' (green) is a neural pathway that connects brain regions in the frontal and parietal lobes often used for arithmetic. The pathway is sheathed in myelin, or 'white matter'. The researchers found a positive correlation between the tract's white matter quality and proficiency in adding and multiplying. Credit: Leen Van Beek

A new study led by Professor Bert De Smedt (Faculty of Psychology and Educational Sciences, KU Leuven) has found that healthy 12-year-olds who score well in addition and multiplication have higher-quality white

matter tracts. This correlation does not appear to apply to subtraction and division.

'Grey' cells process information in the brain and are connected via [neural pathways](#), the tracts through which signals are transferred.

"Neural pathways are comparable to a bundle of cables. These cables are surrounded by an isolating sheath: myelin, or '[white matter](#)'. The thicker the isolating sheath and the more cables there are, the more white matter. And the more white matter, the faster the signals are transferred," explains educational neuroscientist Bert de Smedt.

While the correlation between arithmetic and white matter tracts linking certain [brain regions](#) is known, very little research has been done to test this correlation in normally-developing children. Nor has previous research teased out differences in neuroactivity when carrying out different arithmetic operations, e.g., adding, subtracting, multiplying and dividing.

In this study, the researchers had 25 children solve a series of different arithmetic operations while undergoing a brain scan. They then compared the quality of the children's white matter tracts with their arithmetic test performance.

"We found that a better quality of the arcuate fasciculus anterior – a white matter tract that connects brain regions often used for arithmetic – corresponds to better performance in adding and multiplying, while there is no correlation for subtracting and dividing."

"A possible explanation for this is that this white matter bundle is involved in rote memorization, whereas when we subtract and divide, such memorization plays less of a role. When subtracting and dividing we are more likely to use intermediary steps to calculate the solution,

even as adults."

Nursery rhymes

These findings also add insight into the link between reading and arithmetic, explains Professor De Smedt: "Reading proficiency and arithmetic proficiency often go hand-in-hand. The white matter tract that we studied also plays an important role in reading: when we learn to read, we have to memorize the correspondence between particular letters and the sound they represent. It is likely that a similar process occurs for addition and multiplication. Just think of the notorious times-table drills we all memorized as schoolchildren; it is almost like learning a nursery rhyme. Some of us can even auto-recall these sums."

"This also might explain why we often see arithmetic problems in children with dyslexia. Likewise, children with dyscalculia often have trouble reading," says Professor De Smedt.

The researchers now aim to explore how these results relate to children with impairments such as dyscalculia or head trauma. In a next step, the team will also investigate how white matter tracts can be strengthened through extra arithmetic training.

More information: The study "Left fronto-parietal white matter correlates with individual differences in children's ability to solve additions and multiplications: A tractography study" by Leen Van Beek, Pol Ghesquière, Lieven Lagae and Bert De Smedt is published in the journal *NeuroImage* and is available online at www.sciencedirect.com/science/.../S1053811913012494

Provided by KU Leuven

Citation: Quality of white matter in the brain is crucial for adding and multiplying (2014, January 27) retrieved 6 May 2024 from <https://medicalxpress.com/news/2014-01-quality-white-brain-crucial-adding.html>

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