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Brain connectivity predicts reading skills

Children could benefit from personalized lessons based on brain scans.

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Reading ability in children seems to be linked to the strength of connections in the brain.

The growth pattern of long-range connections in the brain predicts how a child's reading skills will develop, according to research published today in *Proceedings of the National Academy of Sciences*[1].

Literacy requires the integration of activity in brain areas involved in vision, hearing and language. These areas are distributed throughout the brain, so efficient communication between them is essential for proficient reading.

Jason Yeatman, a neuroscientist at Stanford University in California, and his colleagues studied how the development of reading ability relates to growth in the brain's white-matter tracts, the bundles of nerve fibres that connect distant regions of the brain.

They tested how the reading skills of 55 children aged between 7 and 12 years old developed over a three-year period. There were big differences in reading ability between the children, and these differences persisted — the children who were weak readers relative to their peers at the beginning of the study were still weak three years later.

The researchers also scanned the brains of 39 of the children at least three times during the same period, to visualize the growth of two major white-matter tracts: the arcuate fasciculus, which conects the brain's language centres, and the inferior longitudinal fasciculus, which links the language centres with the parts of the brain that process visual information.

Differences in the growth of both tracts could predict the variations in reading ability. Strong readers started off with a weak signal in both tracts on the left side of the brain, which got stronger over the three years. Weaker readers exhibited the opposite pattern.

Learning from experience

The growth of white-matter tracts is governed by pruning, the process that eliminates extraneous nerve fibres and neuronal connections; and myelination, in which individual nerve fibres in the tracts are enveloped by a fatty, insulating tissue that increases the speed of transmission. Both processes are influenced by experience — underused nerve fibres are pruned, whereas others are myelinated — so they occur at different rates and times in different people.

"We think the relative timing of pruning and myelination differs between strong and weak readers," says Yeatman. "In good readers, both processes are unfolding together at an even rate. In poor readers, the two processes are out of sync. You have rapid, early growth, and the tracts develop before [the children] even start learning to read."

Cathy Price, a neuroscientist who studies speech and reading at University College London, says the study suggests that the strength of connectivity in the tracts can be used to predict reading ability in childhood and the teenage years. The findings could also help researchers to understand the relationship between the strength of connections and reading skill.

Yeatman says that individual children might benefit from reading lessons that are tailored to their patterns of brain development. In the future, it may be possible to determine exactly when pruning is taking place — children may find it easiest to learn to read at this stage of development, when there is greater potential for remodelling in the brain. "We'd really like to find a way of predicting who's going to struggle with reading before they start struggling," he says.

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References

1. Yeatman, J. D., Dougherty, R. F., Ben-Shachar, M. & Wandell, B. A. *Proc. Natl Acad. Sci. USA* http://dx.doi.org/10.1073/pnas.1206792109 (2012).