3-year study finds significant differences in white matter processes related to children's reading development

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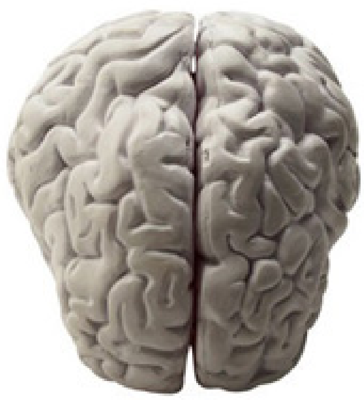

(Medical Xpress)—Researchers from Stanford and Israel's Bar Ilan University have found that differences in the rates at which white matter develops in children's brains may, as they write in their paper published in the Proceedings of the National Academy of Sciences, account for differences in their ability to learn to read.

White matter is composed of largely myelinated nerve fibers through which neural messages are passed among areas of grey matter. According to the study's authors, previous research has established that "white matter tissue properties are highly correlated with reading proficiency." The brain process of myelination protects neural fibers, while pruning eliminates those fibers deemed extraneous. The rate and timing of both processes are considered in the current study as they relate to the children's reading development. Differences in growth patterns in the brain can have a significant impact on the ability to learn to read, the researchers say, if such learning occurs at a less-than-optimal time.

To gain a better understanding of why there are differences in reading skill levels between young students when other environmental factors remain the same, the researchers enlisted the help of 55 test volunteer children between the ages of 7 and 12. Thirty-nine of the subjects allowed magnetic resonance imaging (MRI) to be completed throughout the three-year longitudinal study. Based upon this imaging, researchers discovered that some children rapidly developed white matter at an early age, whereas others had very little white matter early in life but experienced rapid growth later. They also found that there were differences in when pruning occurred.

What really stood out, however, was that the children who started out with greater amounts of white matter, but didn't experience much growth during the period when they were learning to read, were also the children who experienced the greatest difficulty grasping the skill. MRI results also revealed increased levels of neural pruning in this group during that same period, suggesting that newly developed reading skills weren't retained. Conversely, those children who rapidly developed white-matter during the time when they were learning to read became the best readers; and, this group's MRI results revealed minimal pruning during the same period.

Based upon the results of this study and the striking imaging differences between the two groups, researchers suggest that it might be possible to use brain scans as a means to determine the optimal time for teaching children to read, thereby increasing their chances of success.

More information: Development of white matter and reading skills, *PNAS*, Published online before print October 8, 2012, doi: 10.1073/pnas.1206792109

Abstract
White matter tissue properties are highly correlated with reading proficiency; we would like to have a model that relates the dynamics of an individual's white matter development to their acquisition of skilled reading. The development of cerebral white matter involves multiple biological processes, and the balance between these processes differs between individuals. Cross-sectional measures of white matter mask the interplay between these processes and their connection to an individual's cognitive development. Hence, we performed a longitudinal study to measure white-matter development (diffusion-weighted imaging) and reading development (behavioral testing) in individual children (age 7–15 y). The pattern of white-matter development differed significantly among children. In the left arcuate and left inferior longitudinal fasciculus, children with above-average reading skills initially had low fractional anisotropy (FA) that increased over the 3-y period, whereas children with below-average reading skills had higher initial FA that declined over time. We describe a dual-process model of white matter development comprising biological processes with opposing effects on FA, such as axonal myelination and pruning, to explain the pattern of results.