Correlations Between White Matter Microstructure and Reading Performance in Children

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Synopsis: We measured the relationship between white matter integrity (assessed by diffusion tensor imaging, DTI) and reading ability in thirteen children with and without reading problems. Fractional anisotropy (FA), a measure of white matter microstructure, was significantly different between the two groups of children in a region within the white matter of the left temporo-parietal lobe that had been previously identified in adult poor readers. FA in this region was also correlated with reading ability (r = .68). These observations suggest that white matter integrity in this left temporo-parietal region is important for the development of skilled reading.

Introduction: Developmental Dyslexia is characterized by impaired development of reading and spelling skills. Both structural and functional neuroimaging studies examining the neural basis of dyslexia have shown significant differences between dyslexics and normal readers in frontal and temporo-parietal brain regions. Specifically, DTI in adults has shown a correlation between white matter microstructure, as measured by fractional anisotropy (FA), and reading performance[1]. FA values in a white matter region of the left temporo-parietal lobe of adults were correlated with reading performance in both poor and normal readers. The current study was designed to investigate whether anatomical differences seen in adults would be present in children at an age when reading skills are rapidly developing. White matter microstructural differences in children would support the premise that white matter integrity is fundamental to the reading process rather than the alternate hypothesis that differential reading experiences account for the white matter difference reported in adults.

Materials and Methods: We used whole-brain DTI to measure FA in both dyslexic and normal reading children. Children (n=13), ranging in age from 9 to 13, underwent a battery of behavioral tests and DTI. FA images were spatially normalized to the MNI EPI template using SPM99 by applying parameters calculated from the non-diffusion weighted T2 images. Subsequent analyses, including investigation of both group differences and correlations, were restricted to a region of interest (ROI) in the left temporo-parietal region implicated by the earlier adult study. We also segmented the white mater in each subject and restricted the ROI to include only those voxels that fell within the white matter for each subject.

Results: Significant group differences in FA were found in a cluster of voxels in the left temporo-parietal region (Maximum voxel x = -28, y = -26, z = 28; $\underline{p}$ = .006, uncorrected) (See Figure 1). The mean FA values were 0.48 (SEM = .01) for the normal readers and .39 (SEM = .01) for the poor readers. The mean FA value of this cluster significantly correlated with oral reading of single real words and pseudo-words (See Figure 2), as well as spelling and rapid naming, accounting for 34% to 53% of the variance for each of the behavioral measures. The FA value in this region was not significantly correlated with age or measures of intelligence.

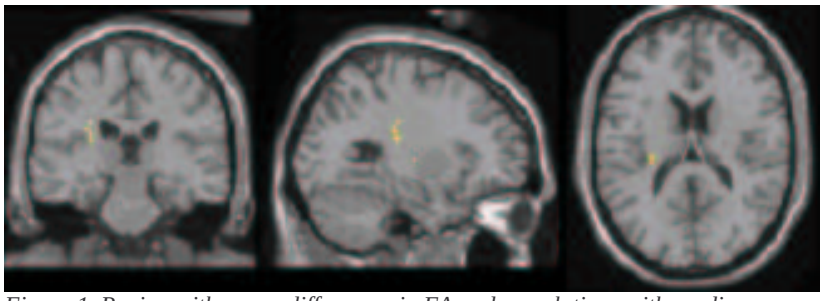

Figure 1. Region with group differences in FA and correlations with reading.

Conclusions: Results extend the previous study with adults, suggesting that the integrity of white matter microstructure in the left temporo-parietal region is important for the development of proficient reading and spelling skills.

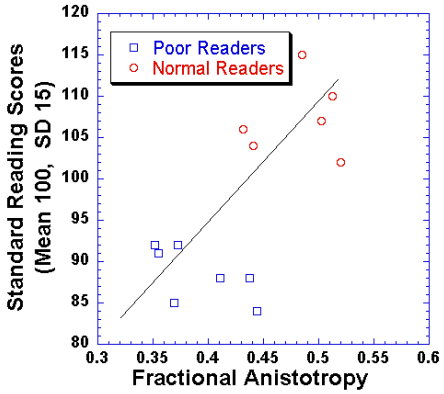

Figure 2. Correlation of FA with reading.

References:

[1]Torkel, K., Hedehus, M., Temple, E., Salz, T., Gabrieli, J.D.E., Moseley, M.E., Poldrack, R.A. Microstructure of temporal-parietal white matter as a basis for reading ability: Evidence from diffusion tensor magnetic resonance imaging. *Neuron, 25*, 493-50;

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