REGIONAL CORRELATION OF FRACTIONAL ANISOTROPY IN BRAIN WITH READING ABILITY IN CHILDREN

C. Beaulieu[1], C. Plewes[1], L. Paulson[1], D. Roy[2], L. Snook[1], S. McCrea[1], L. Phillips[2]
[1]Biomedical Engineering, University of Alberta, Edmonton, Alberta, Canada, [2]Education, University of Alberta, Edmonton, Alberta, Canada

INTRODUCTION : MRI studies of dyslexia, primarily by functional MRI thus far, have yielded a better understanding of the development of neural mechanisms for reading [1] and visualized changes in the brain of children after remediation [2]. Reading is a complex skill requiring the coordination of many brain regions yet there is only one published paper looking directly at the white matter tract integrity of the fibres connecting relevant cortical regions. In that study, diffusion tensor MRI measures of axonal white matter integrity within the left temporo-parietal region of the brain demonstrated significant correlations with reading scores in both normal and reading impaired *adults* suggesting that functional connectivity between brain regions is important for reading ability [3]. The hypothesis is that inefficient connections could hinder reading performance. The purpose of this study was to determine whether similar correlations between fractional anisotropy (FA) in the brain and reading ability exist in a cohort of 8-12 year old children with varying levels of skill.

METHODS : Healthy children (N=32) aged 8 – 12 years (mean 11.1±1.3 yrs) with no history of neurological injury or psychiatric disease were scanned on a 1.5T Siemens Sonata scanner for ~ 26 min including anatomical imaging and DTI. DTI used 3 mm thick slices with no gap, matrix of 128x128 zero filled to 256x256 resulting in a voxel size of 0.85 x 0.85 x 3.0 mm^3, 8 NEX, 40 contiguous slices for whole brain coverage, TE/TR of 88 ms/6400 ms, b=0s/mm^2 and six sets with b=1000s/mm^2. At the time of the MRI, the children underwent a comprehensive cognitive assessment (3 h) that yielded age-normalized parameters for reading ability (Woodcock Word ID score), non-verbal intelligence, and a number of other attributes. A whole-brain, voxel-based morphometry correlation analysis was performed with SPM99. The b0 images of each subject were normalized to the standard MNI EPI template and the resulting transformation parameters were applied to the FA maps. A voxel intensity threshold of FA<0.2 was used to eliminate voxels that contained gray matter in some subjects. Clusters with significant correlations between FA and Word ID were determined from linear regression.

RESULTS AND DISCUSSION : The children had a wide range of reading ability as assessed by the Woodcock Word ID which ranged from 72 – 129 (a score of 100 is considered average). Clusters of voxels with significant correlations between fractional anisotropy and Word ID were observed in the white matter of the left hemisphere **(Figure 1)**. The largest cluster consisted of 26 contiguous voxels and the data of the most significant voxel in that cluster is presented in **Figure 2**. The FA in this voxel did not correlate with age or the test of non-verbal intelligence (TONI). The location of our most significant findings in the children (X=-26, Y=-4, Z=20) is similar to that reported by Klingberg et al for adults (coordinates X=-28, Y=-20, Z=28) [3]. Higher reading performance correlates with larger fractional anisotropy values which could be interpreted that the white matter tract in this region has better connectivity. This significant brain region appears to correspond to the left arcuate fasciculus, a part of the superior longitudinal fasciculus white matter tract which connects the two well known language areas, Wernicke's and Broca's. In summary, quantitative diffusion tensor imaging has provided evidence for a relationship between localized white matter connectivity in the brain and reading performance in a cohort of 8-12 year old children.

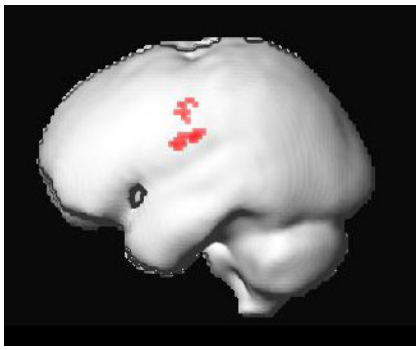

FIGURE 1 : Clusters in the left hemisphere with significant correlation between fractional anisotropy and reading ability (Word ID) in the group of 32 children.

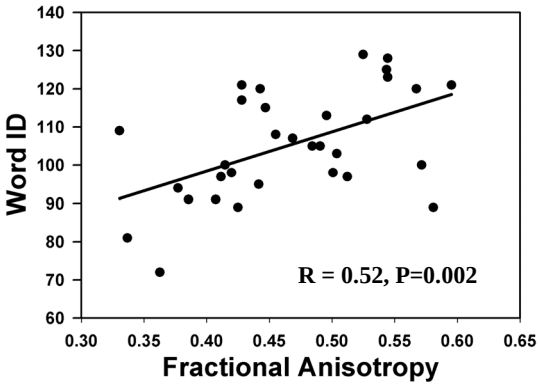

FIGURE 2 : Plot of Word ID versus fractional anisotropy at a local maximum (X=-26, Y=-4, Z=20) in the largest cluster.

REFERENCES: [1] Turkeltaub *et al* Nature Neurosci 6, 767 (2003); [2] Temple *et al* PNAS 100, 2860 (2003); [3] Klingberg *et al* Neuron 25, 493 (2000).

ACKNOWLEDGEMENTS : CLLRNet, AHFMR, CIHR, CFI, ASRA, UHF