Review of the Literature

DYSLEXIA

■ **Marc B. Taub, O.D., M.S.**

Southern College of Optometry
Memphis, TN

Abstract

Developmental dyslexia is a neurobiological based learning disability where individuals have difficulties with word decoding, word recognition and spelling. This may negatively impact other reading areas including reading comprehension and vocabulary growth. The difficulties encountered are present despite adequate intelligence, conventional education and motivation. Dyslexia is more common in males than females. It is estimated to affect between 5.3% and 11.8% of school aged children.

Taub MB. Review of the Literature: Dyslexia. J Behav Optom 2011;22:48-49

Krafnick AJ, Flowers DL, Napoliello EM, Eden G. Gray matter volume changes following reading intervention in dyslexic children. Neuroimage (2010), doi:10.1016/j.neuroimage.2010.10.062.

Over the past decade, there has been increased effort among neuroscientists to quantify and characterize changes in brain structure following controlled learning experiences. These efforts, including those focusing on the relationship between changes in brain structure and academic achievement have important implications for better understanding of learning and skill acquisition in the classroom. Through such studies, the neural basis for successful reading intervention can be better appreciated. This can hopefully lead to the development of programs to best help children with reading difficulties. This study examined changes in gray matter volume (GMV), an anatomical change, following intensive reading intervention in children with dyslexia.

Eleven children with dyslexia were recruited from a private school specializing in students with dyslexia. School records were used to identify students with Woodcock-Johnson III Letter-Word identification scores of less than 92. IQ scores obtained prior to the study using the Weschsler Abbreviated Scale of Intelligence (WASI) had to be greater than 80. All subjects were reported to be free of developmental disabilities, congenital or acquired neurological disorders or any injury or disease affecting brain function. A diagnosed language, hearing or psychiatric disorder, diagnosis of any major medical condition, any metallic implants, severe claustrophobia or any other contraindications to magnetic resonance imaging (MRI) scanning were also exclusionary factors. The following behavioral tests were performed both pre and post intervention: Woodcock-Johnson Word Identification and Passage Comprehension, Lindamood Auditory Conceptualization test, Rapid Automatized Naming, Digit Span and Symbol Imagery. Subjects underwent eight weeks of the Seeing Stars reading program which focuses heavily on imaging/visualization starting with single letters and increasing difficulty to image one syllable and up to two and three syllable words. This reading intervention was administered by specifically trained school employees. Anatomical scans (3D T1-weighted MPRAGE images) were acquired using a 3 Tesla Siemans Trio whole-body MRI system. The data from the first MRI was processed to create a GMV template specific to each individual as a baseline to assess change. All behavioral testing and imaging procedures were obtained before the reading intervention (T1), after reading intervention (T2) and after a period of no intervention (T3).

One-way repeated measures ANOVA showed significant within-subjects effects over the three time points for all behavioral measures with the exception of Digit Span. Post-hoc t-tests were also significant at $p<0.05$ for all tests except Digit Span when comparing scores between T1 and T2. ANOVA identified seven regions with significant changes in GMV: 1) left hemisphere- the anterior fusiform gyrus extending from the hippocampus, superior frontal gyrus, and precuneus; 2) right hemisphere-hippocampus, anterior

cerebellum, precuneus and caudate. Four regions (left anterior fusiform gyrus extending into the hippocampus, left precuneus, right hippocampus and right anterior cerebellum) showed significant change between T1 and T2 as well as T1 and T3. The percent increase in GMV ranged from 2.55 to 3.51% between T1 and T2. The same four regions along with the right caudate showed significant change between T1 and T3. The amount of change on the Lindamood Auditory Conceptualization test correlated positively with the change in GMV in the left precuneus and changes in the Word Attack correlated positively with GMV changes in the right cerebellum.

This study was successful in showing both anatomical and behavioral changes secondary to reading intervention in children with dyslexia. The authors admitted several limitations including small sample size and lack of a control group that did not receive the intervention. The authors indicated the use of a null period in the field of education is typical as it is difficult to withhold potential treatment from children that have fallen significantly behind their peers. Further investigation should focus on how these findings can be translated into refining interventions and improve the learning experience.

Facoetti A, Corradi N, Ruffino M, Gori S, et al. Visual spatial attention and speech segmentation are both impaired in preschoolers at familial risk for developmental dyslexia. Dyslexia 2010;16:226-239.

Phonolocial decoding requires precise mapping from orthographic to phonological representations. The authors of this study put forth that reading acquisition might be affected by a dysfunction in both the auditory-phonologial and visual-orthographic systems as previous studies have shown that children with developmental dyslexia are impaired in low level visual and/or attentional processing tasks. Visual spatial attention is important for orthographic processing. The current study was aimed at identifying pre-readers who were at risk for developing developmental dyslexia by examining both phonological processing and visual spatial attention prior to reading acquisition.

Eighty-seven five year olds in kindergarten in the Italian school system participated in this study. This level of schooling is considered to be pre-reading. Twenty children were considered at-risk based on the familial presence of dyslexia while the remaining 67 children were not at-risk. All children were native Italian speakers without documented history of brain damage, hearing or visual deficits. IQ was estimated using the Similarities and Cube Design subtests of the WPPSI scale and a letter identification task was used to assess the children's pre-reading level of letter knowledge. Participants completed four tasks. 1) Visual Spatial Attention-involved selecting the correct target presented left or right of central fixation. The target was preceded by uninformative information or a cue that the "real" target presentation was forthcoming. A trial was considered "valid" if the cue location was the same as the actual target and "invalid" if the location was different. If that cue and target were at different locations, the subject had to reorient their visual attention to the new location. 2) Peripheral Target Identification-to provide a baseline to compare accuracy in each group. 3) Phonolgical-included syllabic recognition, syllabic blending and syllabic segmentation subtests in the Phonological Awareness Battery. 4) Visual-to Phonological Mapping-A RAN task where the subject has to name colors as quickly as possible. Mean accuracy rates in the Visual Spatial Attention task were evaluated with ANOVA with 2 X 2 design where the within subject factor was Cue condition (valid and invalid) and the between-subject factor was group (no risk and at-risk). While the main effects of Cue condition and Group were not significant, the Cue condition X Group interaction was significant. The children without familial risk showed efficient automatic orienting of visual attention, because target identification was accurate when the target appeared at the valid location. The performance in at-risk children was not influenced by Cue condition. In the Peripheral Target Identification and Visual-to Phonological Mapping tasks, the effect of group was not significant. Only the syllabic segmentation (measures the ability to parse a spoken word into its constituent syllables) of the three Phonological tasks showed significance.

Pre-reading children at risk for developmental dyslexia showed a deficit in phonological processing (syllabic segmentation) and visual spatial attention as compared to children without risk. This is consistent with previous studies in both areas. This study provides further evidence that children that are at-risk for developmental dyslexia may be detected in the pre-reading stage. Identification is crucial as intervention has been shown to assist in remediation of related deficits.