INTRODUCTION

Previous work has shown that task-related signal changes in response to perception of visual motion are weaker in dyslexics compared to typical readers in area V5/MT [5,7]. This observation is consistent with psychophysical data indicative of a magnocellular deficit in developmental dyslexia. Measures of perceptual processes have the advantage that they can be assessed in pre-readers, whereas pure reading ability is not directly assessed prior to formal schooling. This raises the potential of using the neural responses elicited during visual motion perception as an early marker for reading disability.

We explored the possibility of classifying subjects as dyslectic or non-dyslectic based on the functional magnetic resonance imaging (fMRI) profile elicited during the performance a visual motion task. We compared the discriminability of linear discriminant analysis (LDA) [10,13], decision tree classification (“dree”) [3,4], and single regions of interest (ROIs). We also compared two metrics: the average fMRI signal change versus the average Z value within a region of interest (ROI).

METHODS

Subjects: 12 adult dyslexic subjects (ages 18-44 years) and 14 matched nonimpaired readers (ages 20-55 years). Difference in mean reading skill was significant; not so for age (Table 1).

Scanning parameters: Multi-slice transverse EPI scans acquired on a 1.5 Tesla Siemens Vision scanner. TR/TE = 40 ms/3500 ms, 64x64 acquisition matrix, 230 mm FOV, 40 non-interleaved 3.0 mm slices, 0.6 mm gap; 3.6 mm3 voxel size.

Tasks: Subjects viewed (1) moving dots and indicated the direction of the motion; (2) stationary dots and indicated which visual field had a higher dot density; and (3) a fixation cross [7].

Data analysis: fMRI scans were motion corrected [14], high-pass temporal filtered, and spatially smoothed with an 8mm Gaussian filter. A statistical contrast between tasks #1 and #2 was computed, generating a Z map for each subject. The two groups were then contrasted using “Stoutt’s Method” [11]. The resulting Z map was thresholded (False Discovery Rate = 0.05 [9]), defining 19 clusters of contiguous suprathreshold voxels [8]. Four of the clusters were in the orbits bilaterally or in the left and right lateral ventricles posteriorly, and were therefore removed from further analysis. The remaining 15 clusters were used as ROIs. An fMRI metric was generated by computing either (a) the mean fMRI signal change or (b) the mean Z value, for each subject and ROI: LDA and dree were used to classify subjects based on the fMRI metrics. Single ROIs were also tried as classifiers. The leave-one-out method was used for cross-validation, to estimate sensitivity, specificity, and % correctly classified.

RESULTS

Table 2 shows sensitivity/specificity/number correctly classified, for LDA and dree.

Table 3 shows the same information, but this time for the single ROI classifiers.

SUMMARY

• LDA had superior performance to dree, perhaps due to the relatively low prediction accuracy of decision trees in general [2].

• The simple single ROI classifiers did surprisingly well compared to LDA and dree.

• Neither of the two metrics (mean fMRI signal change vs. mean Z value) seemed to have a decided advantage, although mean fMRI signal change resulted in slightly better sensitivity overall (not statistically significant).

• The accuracy of these results is comparable to classification studies using neuroanatomical data in dyslexia [12] and functional brain imaging data in neurological disorders [1,6].

Further refinement and extension to pediatric populations could lead to an fMRI-based tool for detecting the potential of using the neural responses elicited during visual motion perception as an early marker for reading disability.

We thank Christian Borghelt (Otto-von-Guericke-University of Magdeburg) and Habtom Ressom (Georgetown University Medical Center) for their kind assistance. This work was funded by NICHD (HD37890, HD40095), NIMH (MH6500), and the Latham Trust. This poster is available online at http://csi.georgetown.edu/publications/DyslexiaClassificationPoster-HBM2006.pdf

REFERENCES