INTRODUCTION

Neuroimaging studies addressing the pathophysiology of developmental dyslexia in alphabetic languages have focused primarily on reading and phonological processing. To date, there has been no objective assessment of the consistency of these findings. Accordingly, we submitted spatial coordinates from nine papers (14 experiments) to two Activation Likelihood Estimate (ALE) meta-analyses [Ref 1], to identify regions most likely exhibiting more brain activation in controls compared to dyslexics, and vice versa.

METHODS

Criteria for Inclusion in ALE Meta-Analysis
- Paradigms involved processing of visually presented words, pseudowords or letters in the subjects’ native, alphabetic language.
- Participants were post-pubertal teens and adults.
- Stereotactic Talairach/MNI coordinates of local maxima from a direct comparison between normal readers and dyslexics were reported.

Nine Papers Met Criteria [Refs 3-11]
1. Paulesu 1996 decision (rhyme)
2. Grünling 2004 decision (rhyme)
3a. Rumsey 1997 decision (phonological/orthographic)
3b. Rumsey 1997 explicit (phonological/orthographic)
4a. Brunswick 1999 decision (ascender)
4b. Brunswick 1999 explicit (reading)
5. Paulesu 2001 explicit/decision
6. Georgiewa 1999 explicit/transformation
7. Ingvar 2002 explicit reading
8. McCrory 2005 explicit reading
9. Flowers under explicit reading review

Controls > Dyslexics
96 foci from 9 publications (14 experiments).

Dyslexics > Controls
75 foci from 6 of the 9 publications (10 experiments).

Activation Likelihood Estimate Parameters:
- 10,000 Randomizations to estimate null distribution
- Spatial smoothing = 14.1 mm FWHM
- ALE Threshold = 0.00485, FDR = 0.0001 [Ref 2]

RESULTS

Controls > Dyslexics
ALE maps identified consistent hypoactivation in dyslexia in the left hemisphere in two extrastriate areas within BA 37, superior temporal sulcus, inferior parietal cortex, inferior frontal gyrus, precuneus and thalamus. Consistent right hemisphere hypoactivation was found in the fusiform and superior temporal gyri.

Table 1: Nine clusters of suprathreshold voxels for Controls > Dyslexics, MNI coordinates of each local maximum, ALE values of each maximum, and the % influence each contrast contributed to a given ALE value.

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Cluster Criteria</th>
<th>Estimated Coordinates of Local Maximum</th>
<th>MNI Coordinates of Local Maximum</th>
<th>% Influence from Studies</th>
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<tbody>
<tr>
<td>1</td>
<td></td>
<td>X Y Z</td>
<td>MNI X Y Z</td>
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<td>9</td>
<td></td>
<td>X Y Z</td>
<td>MNI X Y Z</td>
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</tbody>
</table>

Figure 1: ALE map for Controls > Dyslexics in the axial planes of each local maximum (subject left = image right).

Figure 2: Volume rendered ALE map for Controls > Dyslexics

- The left posterior inferior temporal/fusiform gyrus (BA 37) cluster was the largest, and had two local maxima.
- The left posterior inferior (BA 37) and superior temporal (BA 22) clusters were the most robust findings, each having contributions from 3 papers (4 contrasts).
- Four tasks from one paper (Rumsey et al., 1997) contributed to a right superior temporal gyrus (BA 21) finding.

REFERENCES

2. Laird et al., 2005. ALE meta-analysis: controlling the false discovery rate and performing statistical contrasts. Hum Brain Mapp 25(1), 155-164.