

Visual attentional processes in adults with
dyslexia

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Declaration

I, Judith Ann Buchholz, hereby declare that, except where acknowledged, this work is my own and has not been submitted for a higher degree at any other university or institution.

Judith Ann Buchholz

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Publications and presentations arising from this research

The findings from the experiments discussed in Chapters 5, 6, 8, 9, and 10 that have been published and/or presented are presented below.

Papers

1. Buchholz J.A., & Aimola Davies, A. (submitted). Characterising the attentional orienting deficits observed in adults with dyslexia. *Journal of Experimental Psychology: Human Perception and Performance*.
2. Buchholz J.A., & Aimola Davies, A. (in press). Adults with dyslexia demonstrate attentional orienting deficits. *Dyslexia*. Accepted Sept 11, 2007.
3. Buchholz J.A., & Aimola Davies, A. (2007). Attentional Blink deficits shown in Dyslexia depend on task demands. *Vision Research*, 47, 1292-1302.
4. Buchholz J.A., & Aimola Davies, A. (2006). Do Visual Attentional Factors Contribute to Phonological Ability? Studies in Adult Dyslexia. *Neurocase*, 12, 111-121.

5. Buchholz J.A., & Aimola Davies, A. (2005). Adults with dyslexia demonstrate space-based and object-based covert attention deficits: Shifting attention to the periphery and shifting attention between objects in the left visual field. *Brain and Cognition*, 57, 30-34.

Abstracts

6. Buchholz, J., & Aimola Davies, A. (2007). An attentional orienting deficit in adults with dyslexia. *Journal of the International Neuropsychological Society*, 13(Suppl 2), 72.
7. Buchholz, J., & Aimola Davies, A. (2007). An investigation of task constraints on attentional orienting in adults with dyslexia. *Australian Journal of Psychology*, 59(Suppl 1), 22.

Presentations

8. Buchholz, J.A., & Aimola Davies, A. An investigation of task constraints on attentional orienting in adults with dyslexia. Poster presentation at EPC Conference, Canberra, April, 2007.
9. Buchholz, J.A., & Aimola Davies, A. Adults with dyslexia demonstrate specific orienting deficits on the Attentional Network Test. Poster presentation at CNS Conference, San Francisco, 9th April, 2006.
10. Buchholz, J. A. & Aimola Davies, A. Adults with dyslexia demonstrate space-based and object-based covert attention deficits. Poster presentation at TENNET XV, Montreal, Canada, June 24 - 26, 2004.

Abstract

Deficits in sensory processing of visual and auditory stimuli, specifically that associated with the magnocellular/dorsal pathways, have been extensively reported in individuals with dyslexia (McArthur and Bishop, 2001; Stein, 2001). Furthermore, significant relationships have been reported between reading ability and performance on sensory processing tasks, both in the auditory and the visual modalities (Cestnick and Coltheart, 1999; Cestnick and Jerger, 2000; Talcott et al., 2002). However, a central role for phonological difficulties in reading difficulties independent of visual and auditory processing deficits has been demonstrated (Ramus et al., 2003b). The inconsistent results may be explained by individual differences in attentional processes (Marshall et al., 2001; Olson and Datta, 2002). While many studies have been carried out investigating attentional difficulties experienced by children with dyslexia, relatively few have examined these difficulties in adults with dyslexia (ADys). Furthermore, the relationship of these difficulties to the phonological deficits most often seen has yet to be fully explored. By determining the difficulties experienced by individuals with dyslexia, it may be possible to develop strategies to overcome them. This thesis primarily examines and compares processes of visual attention in adults with and without dyslexia. Each adult with dyslexia demonstrated phonological deficits consistent with this difficulty being a core deficit in dyslexia. A case-based approach, in addition to the usual group comparisons, has been adopted.

Chapter 1 provides background information to the nature of dyslexia, in-

cluding the difficulty of definition. Several theories of causality are also presented. In Chapter 2, the rationale behind the aims of this thesis is presented. Chapter 3 provides an explanation of, and the results from, the screening measures and analytical tools used in this thesis. These measures provide a comprehensive account of the cognitive and literacy abilities of the participants in the experiments that follow.

Chapters 4-10 present the findings of several experiments which have examined various aspects of attentional processing. In Chapter 4, visual selective attention is measured using a visual search paradigm. Both response time and accuracy of target detection as a function of set size were examined. A difficulty was demonstrated by the dyslexia cases only where searching involved a conjunction of stimulus features. However, while suggesting a compromised attentional system the nature of the visual search difficulties were not addressed in this experiment. For example, attention involves a number of processes, each of which may be responsible for the observed deficits in performance. Furthermore, the deficits may also be due to a slower attentional system, and/or relate to the processing of spatial and/or object information, and/or vary with visual field of presentation.

In Chapter 5, attentional dwell time is examined. The attentional blink (AB) refers to a deficit in the ability to identify a second target following a first target when both appear randomly within a rapid sequence of distractor items. Two tasks were completed which differed in the conceptual category of the target items (a red digit or letter) relative to the distractor items (all black digits). In the digit condition, all ADys cases showed a longer AB. In the letter condition, all participants showed improvement in accuracy compared to the digit condition, but three ADys cases continued to have longer AB compared to the control group. The results suggest that a) AB performance depends on task requirements, and b) the attentional system is compromised in dyslexia. However, examination of individual case performance suggests that prolonged attentional dwell time is not a core deficit in dyslexia.

Chapter 6 examines the space- and object-based components of attention using a spatial cueing paradigm. The group with dyslexia were generally slower to detect validly-cued targets. Costs of shifting attention toward the periphery when the target was invalidly cued were significantly higher for the group with dyslexia, while costs associated with shifts toward the fovea tended to be lower. Higher costs were also shown by the group with dyslexia for up/down shifts of attention in the periphery. A visual field processing difference was found, in that the group with dyslexia showed higher costs associated with shifting attention between objects in the left visual field. These findings indicate that adults with dyslexia have difficulty in both the space-based and the object-based components of covert visual attention, and more specifically to stimuli located in the periphery. However, Vecera (1994) found that object-based attention effects are sensitive to spatial manipulations. Thus, any difference observed between the control and dyslexia groups may merely reflect differences in space-based attentional orienting, rather than object-based attentional orienting.

An attempt to examine object-based attention in isolation was made in Chapter 7, using a methodology developed by Duncan (1984), which examines the accuracy of attending to two objects as opposed to one. The results of this experiment indicated a difficulty in processing rapidly presented stimuli in dyslexia. With respect to object-based processing, it appears that task difficulty may have been a confound. The results of the control group did not replicate those found by Valsangkar-Smyth et al. (2004), and performance was as poor as the dyslexia group.

In Chapter 8, a case study approach was taken to examine the role of visual attention and auditory memory processes in dyslexia. Individual data revealed that, although one adult with dyslexia showed overt visual attention deficits on a visual search task, and five showed auditory working memory deficits, the difficulty that all of the adults with dyslexia had in common was with covert shifts of attention toward and away from fixation. These results indicate that

deficits in overt visual attentional processing and working memory can be present with dyslexia, but neither is a necessary requirement. Overall, the results suggest that covert visual attention makes a significant contribution to phonological ability, which thus has implications for reading ability.

Chapter 9 examines the specificity of the attentional deficit observed in the previous chapters. Alerting, orienting and executive control of attention is investigated in five adult cases of dyslexia. Two spatial cueing tasks were employed. For the task requiring target detection, orienting difficulties were evident only in peripheral locations. While orienting attention to parafoveal stimuli was intact for this detection task, it was found to be impaired for the discrimination task. These results are discussed with respect to the methodological differences of the two tasks.

In addition to the unusual findings of Chapter 9, a specific attentional deficit has not been consistently demonstrated across studies of adults and children with dyslexia, possibly due to differences in methodology. In Chapter 10, three spatial cueing tasks were used to examine the effects of manipulating task variables, such as cue size, stimulus onset asynchrony (SOA), eccentricity and visual field of presentation, on attentional orienting. Visual orienting difficulties were observed when adjusting and maintaining attentional focus, but only under specific task conditions. Although increasing the size of the cue improved orienting performance, increasing stimulus onset asynchrony had a negative effect on this initial improvement. The poorest performance was observed at peripheral locations and in the right visual field. The observed difficulties may compromise reading since a difficulty in automatic orienting may affect the planning of eye movements, while a difficulty maintaining attention may hinder decoding due to increased distraction from nearby text. This study further highlights the need to consider task variables when designing attentional studies.

Finally, Chapter 11 provides a general discussion of the findings and their implications to dyslexia research.

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