

Adults with dyslexia demonstrate space-based and object-based covert attention deficits

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ABSTRACT

Performance on a covert visual attention task is compared between a group of adults with developmental dyslexia (specifically phonological difficulties) and a group of age- and IQ-matched controls. 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. Visual field processing differences were found, in that the group with dyslexia showed higher costs when shifting attention between objects in the left visual field, and when shifting attention within objects in the right 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.

INTRODUCTION

Adults and children with dyslexia have demonstrated impairments on a number of selective visual attention tasks, and the performance deficits have been shown to be related to the degree of reading difficulty (e.g., Brannan & Williams, 1987; Buchholz & McKone, 2004; Vidysagar & Pammer, 1999).

Evidence has also indicated an asymmetry of attentional distribution between the two visual fields, reflecting impairments of right parietal function. For example, adults with dyslexia have demonstrated a left visual field (LVF) "mini-neglect" for stimuli (Hari, Renvall & Tanskanen, 2001). Children with dyslexia have been shown to omit a greater number of targets presented in the LVF in a visual search task (Fowler, Riddell & Stein, 1990; also see Eden, Stein & Wood, 1993), and have been shown to have problems with target eccentricity when stimuli are projected to the LVF (Facoetti & Molteni, 2001).

In the present study, the attentional abilities of adults with dyslexia were examined using the precuing methodology of Egly, Rafal, Driver & Starrveveld (1994). The aim was to investigate visual field differences in this group, and to determine if these differences were related specifically to particular space-based or object-based components of visual attention.

Two major views dominate our understanding of how covert visual attention selects information for further processing. The space-based view holds that attention is directed to a specific area in space, while the object-based view contends that information about particular objects is selected independently of the objects' spatial location.

METHOD

Experimental group: Eight adults reporting a history of reading difficulties, and who currently met the criteria of dyslexia as determined by the Dyslexic Adult Screening Test (DAST: Fawcett & Nicolson, 1998). These adults exhibited difficulties in phonological processing.

Control group: Eight adults with no history of reading difficulties, and who did not meet criteria for dyslexia. The two groups did not differ with regard to age or IQ.

Stimuli

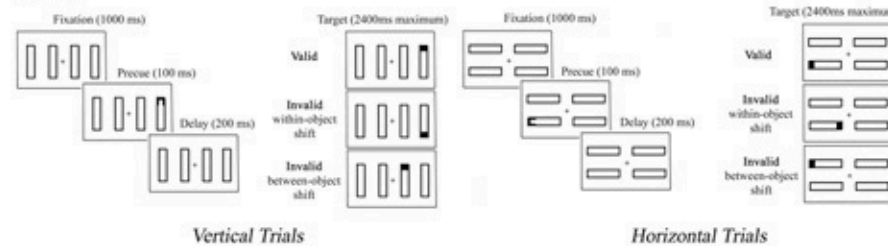


Figure 1: Trial sequences of valid and invalid trials for both vertical and horizontal rectangles (60% valid, 20% invalid, 10% cue-no target, 10% target-no cue; total 960 trials).

RESULTS

Cue Type: Both groups demonstrated the expected faster RTs for valid-cue trials compared to invalid-cue trials and no-cue trials. The group with dyslexia showed consistently longer RTs than the control group.

Valid-cue condition: For both groups faster RTs were associated with stimuli presented close to fixation compared to those presented more peripherally. (see Figure 2). The group with dyslexia demonstrated longer overall RTs than the control group.

Invalid-cue condition*: Both groups demonstrated the expected lower mean costs for within-object shifts compared with between-object shifts of attention. Note that compared to the control group, the group with dyslexia showed significantly greater RT costs for the between-object shifts of attention in the left visual field, and within-object shifts of attention in the right visual field (see Figure 3).

The group with dyslexia demonstrated significantly greater RT costs when shifting attention away from fixation, and lower RT costs when shifting attention toward fixation (see Figure 4).

*NI: Response time costs were calculated by subtracting valid-cue RT means from invalid-cue RT means (cue position being the same) for each condition.

CONCLUSIONS

The ability of adults with dyslexia to covertly orient attention following a precue is generally intact in both hemispheres.

However, adults with dyslexia demonstrate difficulties with both the space-based and the object-based components of covert visual attention. They especially have difficulties with engaging stimuli at the periphery, a finding which is consistent with previous research with children (Brannan & Williams, 1987; Facoetti & Molteni, 2001).

Fluent reading requires learned left-to-right and right-to-left shifts of covert attention away from a central fixation point. These shifts need to be maintained long enough for some processing of the written word to occur before overt recognition takes place. Clearly the results of this study have shown differences in the pattern of covert orienting of attention between adults with dyslexia and those without, which could have negative effects on these requirements of reading listed above. Future research is needed to investigate the relative importance of each apparent attentional difficulty to reading ability.

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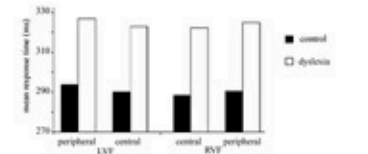


Figure 2: Mean response time to valid-cue trials as a function of visual field and position relative to fixation.

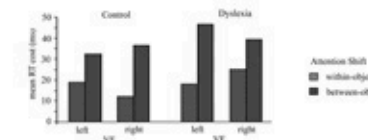


Figure 3: Mean RT costs for invalidly-cued targets as a function of visual field and type of attention shift from cue location.

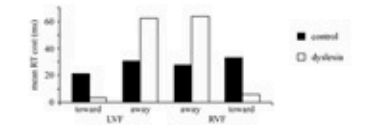


Figure 4: Mean response time costs for invalidly-cued targets as a function of visual field and direction of attention shift relative to fixation.