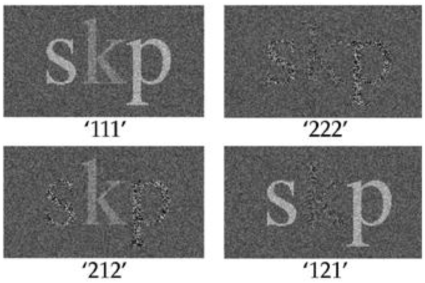
VISION
RESEARCH
An International Journal for Functional Aspects of Vision



Biochemistry & Cell Biology • Molecular Biology & Genetics
Anatomy, Physiology, Pathology & Pharmacology • Optics, Accommodation & Refractive Error
Circuitry & Pathways • Psychophysics • Perception • Attention & Cognition
Computational Vision • Eye Movements & Visuomotor Control

ISSN 0042-6989 | Volume 48 | Number 6 | March 2008

Available online at www.sciencedirect.com
ScienceDirect
Vision Research 48 (2008) 850–852
Vision Research
www.elsevier.com/locate/visres

Letter to the Editor

Visual target detection is not impaired in dyslexic readers

Abstract

In two previous studies we assessed a difficulty of dyslexic readers with letter string processing by using variants of the partial report paradigm, e.g., Averbach and Coriell [Averbach, E., & Coriell, A. S. (1961). Short-term memory in vision. *Bell Systems Technical Journal, 40*, 309–328] which requires report of a letter name in response to a position cue. The poor dyslexic performance was interpreted as evidence for a visual-attentional deficit of dyslexic readers. In the present study, we avoided verbal report by using a task which only required the detection of predefined targets (letters or pseudoletters) in strings. On this purely visual task, the dyslexic readers did not differ from non-impaired readers. This finding speaks against a basic visual-attentional deficit; rather it suggests that the dyslexic deficit on partial report paradigms stems from a problem in establishing a string representation which includes position and name codes.

Keywords: Developmental dyslexia; Target detection; Visual attention; String processing

1. Introduction

In two previous studies (Hawelka, Huber, & Wimmer, 2006; Hawelka & Wimmer, 2005, both this journal) we examined whether the slow, laborious reading of developmental dyslexic readers is due to a limitation in the number of letters which can be processed in parallel. We used variants of the partial report task (Averbach & Coriell, 1961) which presented strings of digits and consonant letters and required report of a single element in response to a position cue. The critical measure was the presentation time threshold required for reliable report. In support of the deficient simultaneous visual processing hypothesis, dyslexic readers exhibited substantially prolonged thresholds. Combined over groups, presentation time thresholds were reliably associated with number of eye movements during reading. Further evidence for a reduced visual attentional span in dyslexic readers comes from a series of studies by Valdois and colleagues (Bosse, Tainturier, & Valdois, 2007; see Valdois, Bosse, & Tainturier, 2004 for a review).

A problem of the report tasks was recently noted by Shovman and Ahissar (2006), who pointed out that the memory representations required for correct performance have to include the names of the string elements, so that the long presentation time thresholds of the dyslexic readers may reflect slow activation of name codes. In this perspective, performance on the "visual attentional span tasks" does not reflect a problem with parallel processing of visual elements but a problem with verbal coding. In support of this, Shovman and Ahissar (2006) indeed did not find a dyslexic deficit in a visual task without verbal involvement.

The present study used a visual target detection task introduced by Mason (1982) to avoid the involvement of verbal processes. The task—similar to the report tasks—presented strings of letters, but participants only had to indicate whether a predefined target was included. Because no verbal report is required, we considered the detection task a purer measure of visual attention than our previous tasks. Furthermore, an additional condition presented strings of not nameable pseudoletters.

2. Method

As schematically displayed in Fig. 1, a trial started with the presentation of the to-be-detected element (i.e., the *probe*) for 600 ms above the mid-position of the upcoming 5-element string which was presented for 2200 ms. Contrary to the original version of Mason (1982), the probe remained on the screen during string presentation. Participants were instructed to press the space bar of a keyboard when the string included the target ($N = 100$ per string type) and not to respond otherwise ($N = 50$ per string type). We used strings consisting of 5 letters and 5 non-nameable pseudoletters. Half of the strings presented letters in lower-case and half in upper-case. The pseudoletters were created (High Logic Font Creator 5.5®)

0042-6989/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.visres.2007.11.003

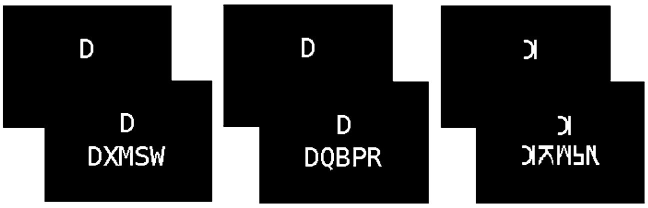


Fig. 1. Schematic illustration of the setup of the string processing task. The left and middle panels show letter string items with low and high visual similarity between target and distractors, respectively. The right panel shows a pseudoletter item in which the target was derived from ‘D’.

by cutting and rearranging the visual features of letters, so that the height, width and the visual complexity of the pseudoletter strings were the same as of the letter strings (see Fig. 1). Within the letter strings we varied visual similarity (using the similarity matrices of Boles & Clifford, 1989) between the target and the surrounding distractors with half of the letter strings consisting of visually similar letters. The high-similarity strings may pose specific difficulties when dyslexic readers suffer from basic visual impairments. Susceptibility to high letter similarity was found for acquired dyslexic readers by Fiset, Arguin, Bub, Humphreys, and Riddoch (2005). Of further importance is that the strings were word-like in the sense that their length (2.4° of visual angle with 75 cm viewing distance) corresponded to a 5-letter word in a normal reading situation (i.e., 12 pt font size and 30 cm viewing distance). The close proximity of the string elements may induce visual crowding effects in dyslexic readers, specifically for letter strings consisting of similar letters.

Participants were 18 dyslexic and 18 normal reading young, male adults recruited from two longitudinal studies (e.g., Wimmer, Mayringer, & Landerl, 2000). Participants had to score below percentile 10 and above 20 on a standardized reading speed test for inclusion in the dyslexic and control group, respectively. Slow reading speed was chosen as diagnostic criterion since it is the primary manifestation of dyslexia in the regular German orthography, in which even young dyslexic readers commit very few reading errors (e.g., Wimmer, 1993). The dyslexic participants did not differ from the typical readers on the Similarities, Object assembly and the Block design subtests of the German version of the Wechsler Intelligence Scale. They scored lower on the Vocabulary subtest ($M = 11.4$, $SD = 1.9$ vs. $M = 13.7$, $SD = 2.0$), but in the normal range ($M = 10$, $SD = 3$).

3. Results and discussion

There was no difference in the very low error rates between typical and dyslexic readers (less than 1% for each group).

The left panel of Fig. 2 shows the average detection times for each string type. Detection times reflected the expected task difficulty with shortest detection time for consonant strings with low letter similarity, followed by consonant strings with high letter similarity and slowest detection time for pseudoletters. The main finding is that the average reaction times of the dyslexic readers did not differ from those of the controls (main effect of group: $F < 1$). Particularly surprising was that they tended to respond faster than the typical readers to strings consisting of visually similar letters.

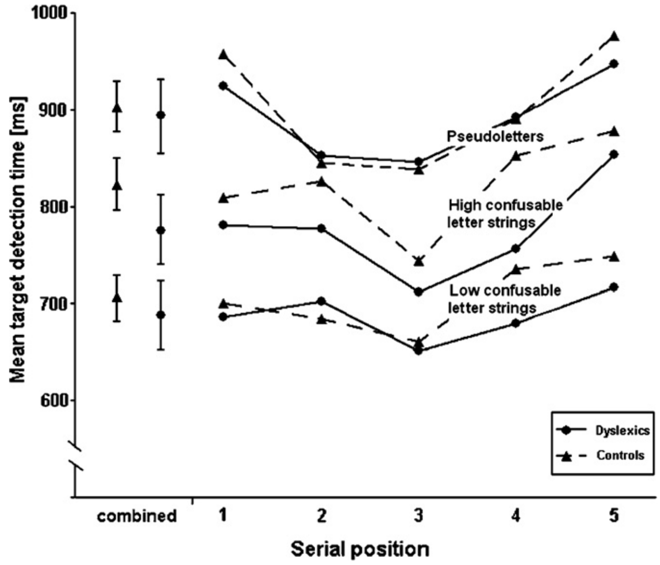


Fig. 2. Left panel: mean target detection times of the dyslexics and controls for the 3 string types averaged over the 5 string positions. Bars represent 1 *SEM*. Right panel: mean target detection times of the dyslexics and controls for each string type separately for string position 1–5.

The right panel of Fig. 2 provides information on position effects. For pseudoletter strings, the first and the final position exhibited higher detection times than the interior positions so that the position profile corresponded to a U-shape which reflects the acuity drop-off of the exterior letters of the centrally fixated string (Mason, 1982). For the letter strings, the position curves differed from the U-shape of the pseudoletters by exhibiting a relative advantage for the first position, resulting in a significant position by string type interaction, $F(8, 272) = 6.05$, $p < .001$. Importantly, group was not involved in any interaction with string type or position, all Fs < 1.68.

The absence of any dyslexic speed deficit on the present string processing task differs strikingly from the markedly prolonged presentation thresholds of the dyslexic readers which we found in the studies using the partial report tasks. Obviously, there are several differences between the present and our previous tasks. We already mentioned that the partial report task may have induced verbal coding of the string elements and dyslexic readers may have been speed impaired in activating these codes. Another possibility is that the prolonged presentation time thresholds stemmed from a problem of dyslexic readers with fast encoding of letter position (Enns, Bryson, & Roes, 1995; Jones, Branigan, & Kelly, in press; Pammer, Lavis, Hansen, & Cornelissen, 2004). Such encoding was required in the partial report tasks which used position cues for name report.

The present task avoided both name coding and position coding in string processing and found dyslexic readers to perform as accurately and quickly as non-impaired readers. This finding was surprising given the visual demands of the task. As noted, strings were presented in word-like format with close proximity of the string elements so that visual crowding may have affected performance, specifically for strings consisting of visually similar letters. Higher susceptibility for visual crowding in dyslexic readers was indeed found by Spinelli, De Luca, Judica, and Zoccolotti (2002), but apparently was absent for the present sample. The conclusion from the present finding is that the slow reading speed of German dyslexic readers cannot be traced to inefficient visual processing of letter strings.

Acknowledgments

This research was supported by the Austrian Science Fund (Grant No. I57-G14) as a part of an ESF-EUROCORES Project (05_ERCP_FP006). We appreciate the helpful comments of two anonymous reviewers.

References

Averbach, E., & Coriell, A. S. (1961). Short-term memory in vision. *Bell Systems Technical Journal, 40*, 309–328.

Boles, D. B., & Clifford, J. E. (1989). An upper- and lowercase alphabetic similarity matrix, with derived generation similarity values. *Behavior Research Methods, Instruments, & Computers, 21*, 579–586.

Bosse, M-L., Tainturier, M-J., & Valdois, S. (2007). Developmental dyslexia: The visual attentional span deficit hypothesis. *Cognition, 104*, 198–230.

Enns, J. T., Bryson, S. E., & Roes, C. (1995). Search for letter identity and location by disabled readers. *Canadian Journal of Experimental Psychology, 49*, 357–367.

Fiset, D., Arguin, M., Bub, D., Humphreys, G. W., & Riddoch, M. J. (2005). How to make the word-length effect disappear in letter-by-letter dyslexia. *Psychological Science, 16*, 535–541.

Hawelka, S., Huber, C., & Wimmer, H. (2006). Impaired visual processing of letter and digit strings in adult dyslexic readers. *Vision Research, 46*, 718–723.

Hawelka, S., & Wimmer, H. (2005). Impaired visual processing of multi-element arrays is associated with increased number of eye movements in dyslexic reading. *Vision Research, 45*, 855–863.

Jones, M. W., Branigan, H. P., & Kelly M. L. (in press). Visual deficits in developmental dyslexia: Relationships between non-linguistic visual tasks and their contribution to components of reading. *Dyslexia, 14*.

Mason, M. (1982). Recognition time for letters and nonletters: Effects of serial position, array size, and processing order. *Journal of Experimental Psychology, 8*, 724–738.

Pammer, K., Lavis, R., Hansen, P., & Cornelissen, P. L. (2004). Symbol-string sensitivity and children's reading. *Brain and Language, 89*, 601–610.

Shovman, M. M., & Ahissar, M. (2006). Isolating the impact of visual perception on dyslexics' reading ability. *Vision Research, 46*, 3514–3525.

Spinelli, D., De Luca, M., Judica, A., & Zoccolotti, P. (2002). Crowding effects on word identification in developmental dyslexia. *Cortex, 38*, 179–200.

Valdois, S., Bosse, M.-L., & Tainturier, M.-J. (2004). The cognitive deficits responsible for developmental dyslexia: Review of evidence for a selective visual attentional disorder. *Dyslexia, 10*, 339–363.

Wimmer, H. (1993). Characteristics of developmental dyslexia in a regular writing system. *Applied Psycholinguistics, 14*, 1–33.

Wimmer, H., Mayringer, H., & Landerl, K. (2000). The double deficit hypothesis and difficulties in learning to read a regular orthography. *Journal of Educational Psychology, 92*(4), 668–680.

Stefan Hawelka
Heinz Wimmer *
Department of Psychology and Center of Neurocognitive Research, University of Salzburg, Hellbrunnerstr. 34, A-5020 Salzburg, Austria
E-mail address: heinz.wimmer@sbg.ac.at (H. Wimmer).

Received 11 July 2007;
received in revised form 5 November 2007

* Corresponding author.