University of Amsterdam

Visual specialization for words in dyslectic and typically reading children

Fraga González,G. [1], Žarić, G. [4], Bonte, M. [4], Blomert , L. [4,†],Tijms, J. [1,3], Van der Molen, M.W. [1,2]

[1] Department of Psychology, University of Amsterdam, The Netherlands
[2] Cognitive Science Center Amsterdam, The Netherlands
[3] IWAL Institute, Amsterdam, The Netherlands
[4] Department of Cognitive Neuroscience, University of Maastricht, The Netherlands

Introduction

Fluent readers develop expertise to decode visual information to access a series of speech sounds, and word meanings during reading. **Dyslexia** is a disorder in the neural network for reading, with dysfluent reading as its most persistent symptom (Gabrieli, 2009)

Alongside a core phonological deficit, **impairment in fast visual word processing** might contribute to the persistent lack of fluency in dyslexia (Helenius, Tarkiainen, Cornelissen, Hansen, & Salmelin, 1999).

Functional **neuroimaging** studies suggest a **Visual Word Form Area** (VWFA) in left occipito-temporal regions **specialized for print** reading (McCandliss, Cohen, & Dehaene, 2003). **Electrophysiological** data suggest that **early N1 responses** at around 200 ms are sensitive to word-likeness of stimuli and reading expertise (Maurer et al.,2003).

Further, **longitudinal** studies suggest an inverted 'U' development in early word-specific activations after the first years of reading and atypical activation patterns in dyslectics (Maurer et al., 2011).

Goals

- **Compare** early visual responses in normal readers and dyslectics in school grade 3.
- Explore the **sensitivity** of visual ERPs using letter-like symbols as contrast stimuli to known words.
- Find **correlations** between word specific ERP responses and reading fluency measurements.

Methods

Participants
40 dyslectics :
(age 9 ± 0.41).Grade 3
20 normal readers:
(age 8.78 ± 0.35). Grade 3.

ERP experiment
Block design:
8 blocks
(2 x 2 string types x 2 lengths)
40 trials per block
Trial length: 700ms
Inter-trial interval (ITI): 1350ms
Stimuli:
Words (CELEX database) and *symbol strings* (letter-like).
Either short (4-5 characters) or long (6-7 characters).
Task:
Button press when stimuli immediate repetitions are detected (4 per block).

ERP analysis
Biosemi ActiveTwo system
64 scalp electrodes
Epoch:(-500 to1550 ms)
Artifact rejection:
Manual and ICA
Reference: average.
Filter: 1-30 Hz
Statistics:
Repeated Measures ANOVA
Electrodes in analysis:
P9,P7,P5,P10,P8,P6,PO7
PO3,PO8,PO4,O1,O2

Behavioral measurements
3DM:
- Letter-Speech sounds discrimination./identification
- Word reading (HF,LF,Pseudo)
- Spelling

One Minute Test
Text reading

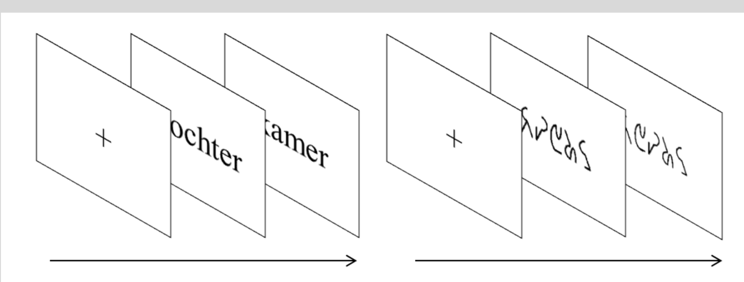

Figure 1. Word and symbol string stimuli (examples) visually presented in blocks

Results

Words elicited **larger amplitudes** of P1 and N1 than symbol strings in both groups. P1 *latencies* for words were also significantly shorter than for symbols (see figure 2).

Dyslectics showed larger **word-specific N1 amplitudes** than the normal readers at the left parietal electrodes (see figures 2 and 4). Significant group effects at P1 or P2 were absent.

Further**, correlations** were found in the dyslectic group, between the N1 word-symbol amplitude difference and reading fluency scores (HF and LF word reading, One Minute Test); together with negative correlations with reaction times in spelling task (see figure 5).

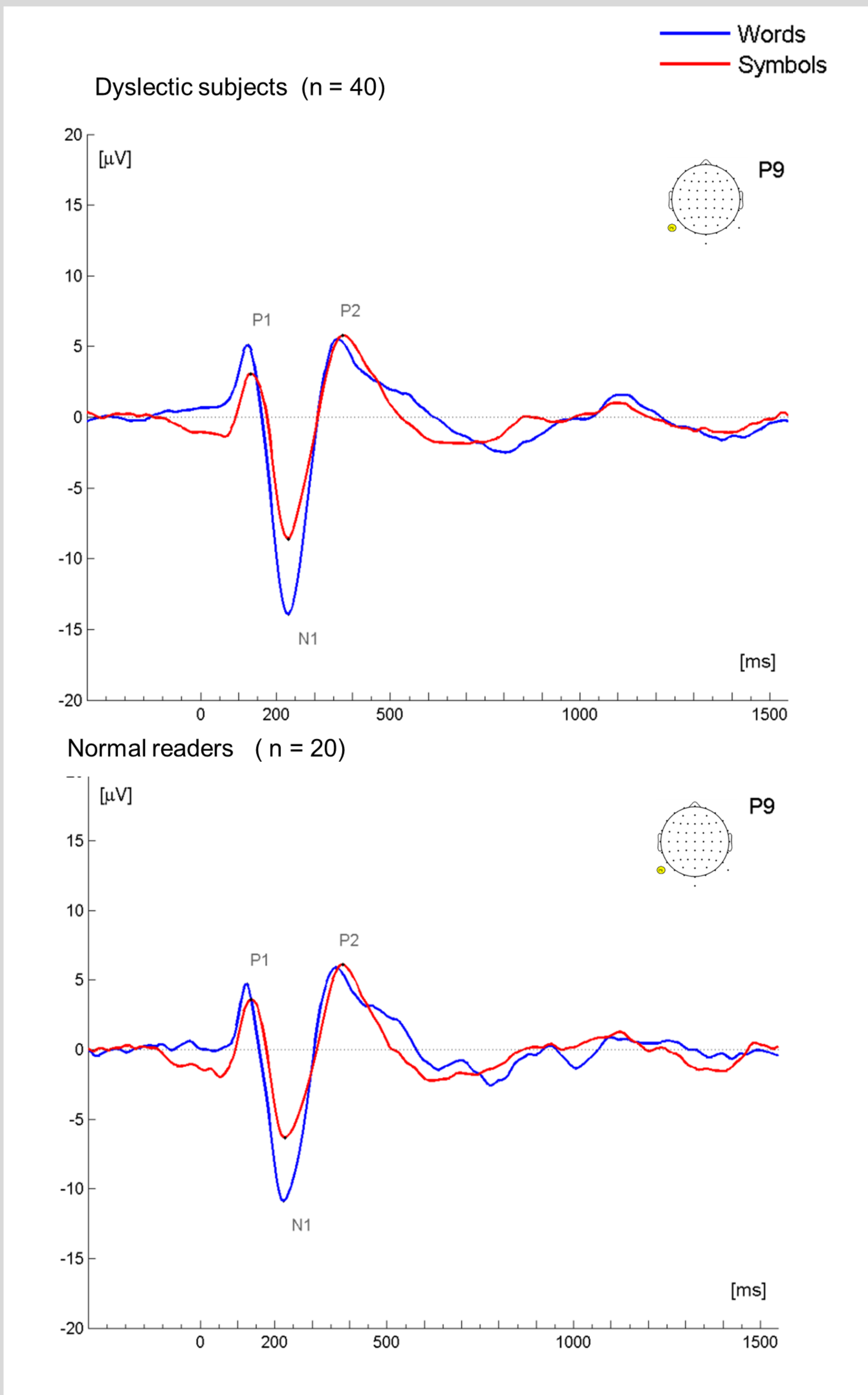

Figure 2. Group ERPs for word and symbol stimuli at P9.

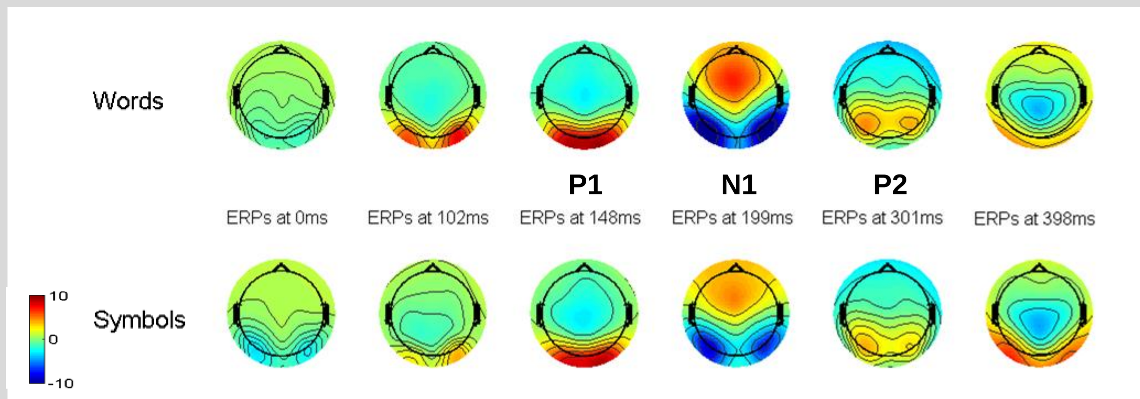

Figure 3. Topographical maps showing the course of neural activity following stimulus presentation. Posterior activations and polarity are visible at peak latencies.

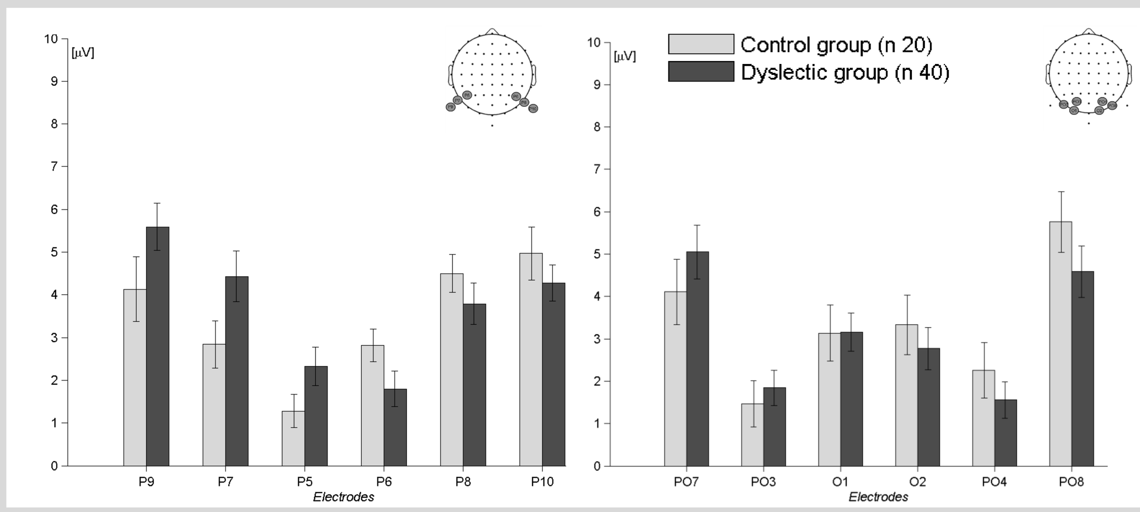

Figure 4. Mean N1 word-symbol difference in amplitude (peak-baseline) at parietal (P9,P7,P5,P10,P8,P6), parieto-occipital (PO7,PO3,PO4,PO8) and occipital (O1,O2) electrodes (see location in scalp maps). Error bars show standard errors of the sample.

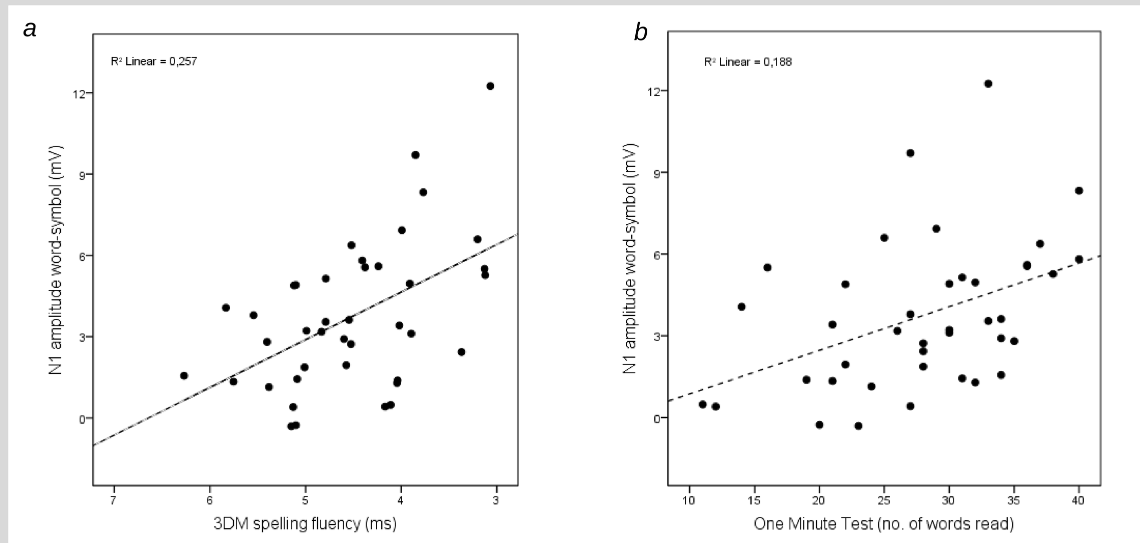

Figure 5. Linear regression between N1 amplitude word-symbol difference in left posterior electrodes (average of P9,P7,P5,PO7,PO3,O1) and behavioral fluency measurements: (a) Spelling RTs (b) Fluency in One Minute Test. Both show a positive correlation between N1 amplitude difference and fluency.

Discussion

In line with previous studies **N1** is found to be **sensitive** to string type. That is, N1 amplitude is enhanced to words relative to symbols. The enhancement of N1 amplitude is found for both groups.

The N1 word vs. symbol difference is larger for dyslectics compared to typical readers in contrast to previous findings reported by Maurer (2011).

The apparent discrepancy might be due to the **type** of **symbol** string; word-like in the current study vs. icon-like in the Maurer et al. study.

The current N1 data suggest a stronger reliance on **visual encoding** in dyslectics compared to typical readers. These data might be suggestive of a developmental delay in dyslectic children.

Finally, the **positive correlations**, albeit moderate, between N1 amplitudes and speed reading measures contribute to the validity of N1 vis-a-vis visual word processing.

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Correspondence to:
Gorka Fraga González

G.FragaGonzalez@uva.nl
www.uva.nl

Department of Developmental Psychology

T: *+3120 525 6828*

University of Amsterdam

Weesperplein 4
1018 XA, Amsterdam