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Faculty of Psychology and Neuroscience

Gains in letter-speech sound integration in children with dyslexia: a six-month longitudinal study

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Introduction

Dyslexia is a disorder in the neural network for reading, with dysfluent reading as its most persistent symptom (Gabrieli, 2009).

Individuals with dyslexia are at severe risk for adverse academic, economic, and psychosocial consequences, because of their inability to attain society's literacy demands.

Successful interventions in dyslexia show that reasonable levels of reading accuracy may be attainable (e.g. Tijms, 2007), but no effective cure for the lack of reading fluency is available yet.

It was further shown that automating letter-speech sound pairs takes years to develop in normal readers, despite the fact that they 'know' which letter goes with which sound (Froyen et al, 2009).

Moreover, 9 year old dyslexic participants show deficit in the late crossmodal electroencephalographic (EEG) response (600-750ms) to the letter-speech sound pairs (Žarić et al., 2014).

Objective

Explore the plasticity of the network by means of intervention expressed in behavioral and ERP parameters.

Correlate neural changes with reading-related cognitive and behavioral changes.

Methods

Participants:
17 9 year old children with dyslexia (age range: 8.2-9.9).

Stimuli: Dutch phonemes /a/ and /o/
And letter "a".

Mismatch negativity (MMN) paradigm:
Standard 83%; Deviant 17% (**Fig. 1**)

3 conditions:
- Auditory (Au)
- Two audiovisual conditions with different stimulus onset asynchronies (SOA):
Audiovisual SOA 0ms (Av0)
Audiovisual SOA 200ms (Av200)

3 blocks per condition
288 trials per block
Trial onset asynchrony 1750ms

EEG recordings: 64 active channels
Biosemi system
EEG analysis:
Two time windows of interest:
100-250ms (MMN) and 600ms-750ms (Late Negativity - LN)

Repeated measures ANOVA on mean amplitudes (across 50 ms centered on the individual peak latency) in fronto-central electrodes (Fz, FCz, Cz, F3, F4, FC3 and FC4) covering the maximal MMN and LN responses.

Behavioural measures

1. *3DM (Blomert & Vaessen, 2009):*
   - Letter-speech sound identification
   - Letter-speech sound discrimination
   - Spelling
   - Word reading (high and low frequency words and pseudowords)
2. One minute test
3. Text reading

Intervention:

- 17 weeks, 34 sessions, 1 on 1 computer-assisted reading intervention program, guided by a tutor
- Explicit training of letter-speech sound mappings within the context of reading practice

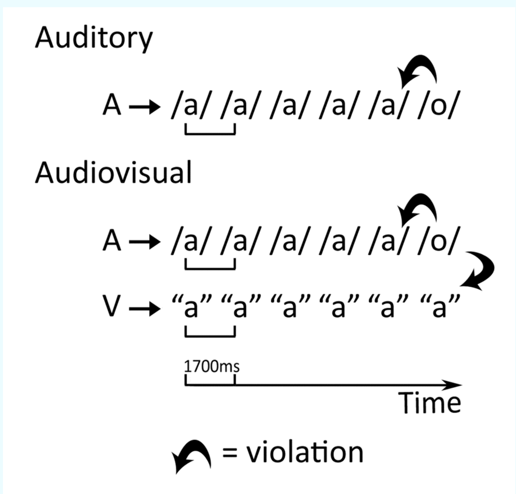

***Figure 1**: Mismatch negativity paradigm for investigating letter-speech sound integration*

Results

Behavioral improvements on word reading accuracy and fluency, as well as spelling (**Fig. 2**).

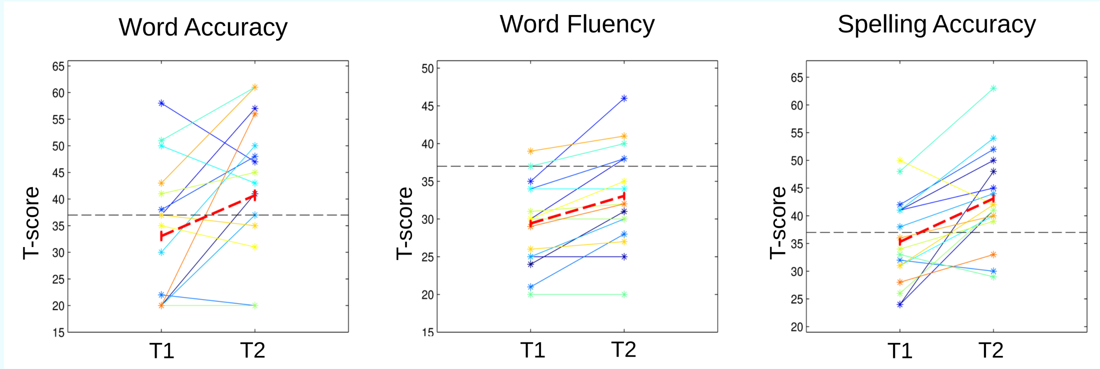

***Figure 2**: Individual and group improvements on standard scores of behavioral tasks showing significant difference between the two measurements (T1 and T2). Thick red dashed line – group improvement, Black dashed line – 10th percentile; thin lines – individual subjects.*

Normal auditory MMN/LN change detection responses to spoken vowels /a/ and /o/ together with reduced letter-speech sound integration at T1 (**Fig. 3**).

Significant relation between individual differences in reading fluency and the latency of the MMN in the simultaneous crossmodal condition (AV0). AV0 MMN latency also predicted reading fluency at the second measurement (T2) and gains in reading fluency from T1 to T2 (**Fig. 4 A, B and C**).

Moderate improvements in the neural integration of letters and speech sounds over a 6 months period including schooling and training, with earlier (and enhanced) crossmodal effects in the LN window (**Fig. 3**).

Earlier LN latency at T2 correlated significantly with higher behavioral accuracy in letter-speech sound coupling (**Fig. 4 D**).

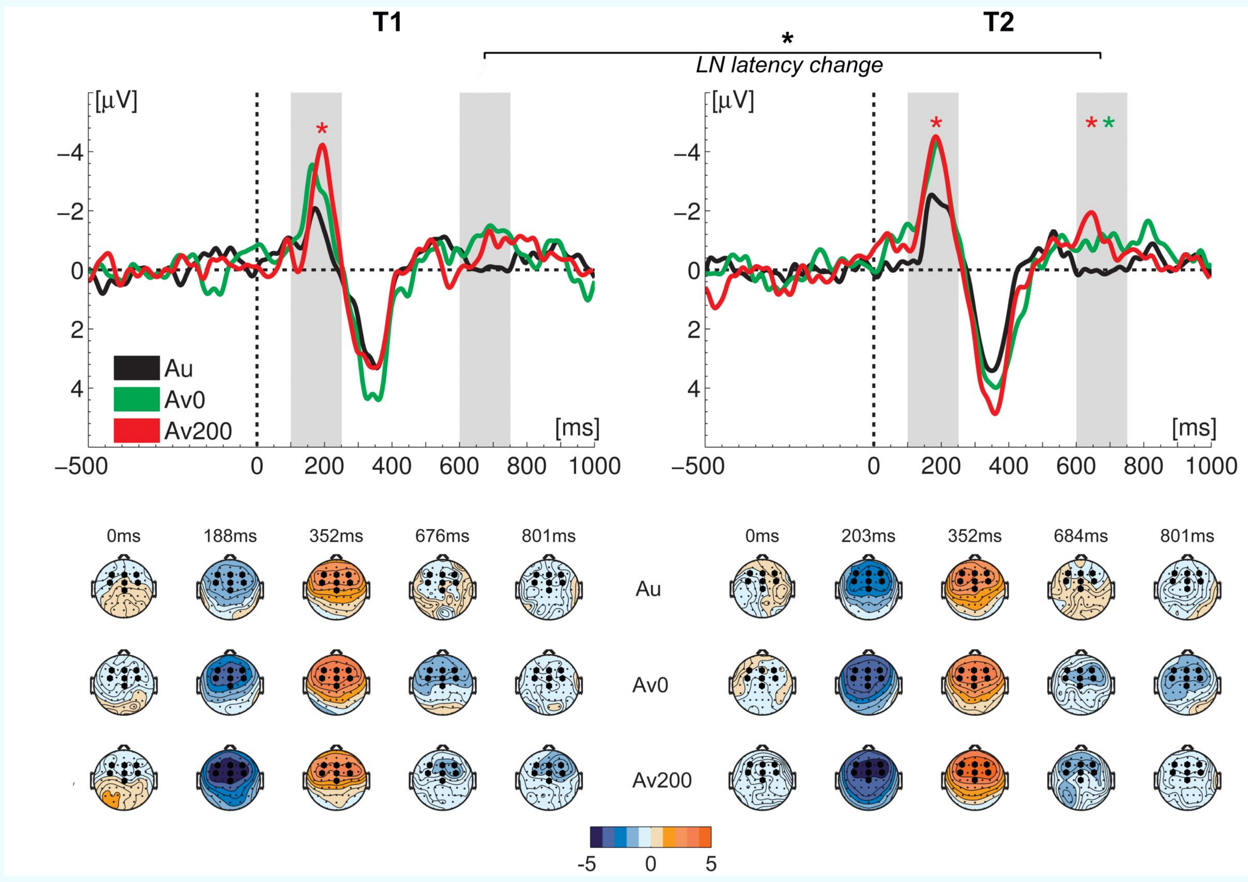

***Figure 3**: Difference waves (upper row) and topographical maps (lower row) at the two measurement times (T1 and T2).*

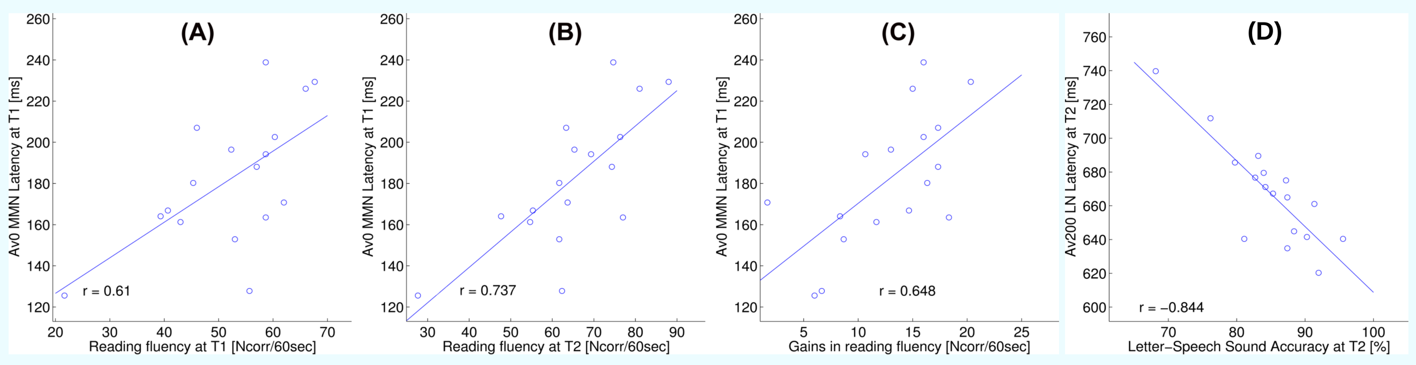

***Figure 4**: Correlations of MMN latency in the Av0 condition with the number of correctly read words (accuracy) in 3DM task and composite score of fluency (3DM, EMT, text) at T1, T2 and T2-T1 (A,B and C) and LN latency in the Av200 condition and letter-speech sound accuracy (L-SS id. Acc., L-SS disr. Acc, Spelling acc.) at T2 (D)*

Discussion

The present findings suggest that the reduced neural integration of letters and speech sounds in dyslexic children may show moderate improvement over a period with reading instruction and letter-speech sound training, particularly in the timing of later aspects of this integration (LN window).

Our findings additionally point to a less flexible early integration (MMN window), with individual differences in its timing predicting gains in reading fluency. Although further studies are needed, the timing of this type of crossmodal change detection responses may provide a biomarker that could contribute to a better prediction of reading gains and/or individual tailoring of dyslexia training/intervention strategies (Leppänen, 2013).

References

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