

Atypical processing of phonotactic probability and syllable stress in dyslexic adults: an MMN study

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Introduction

- Efficient sensory processing and skill acquisition are facilitated by our knowledge of **regularities** in the **timing (temporal structure)** and **content (formal structure)** of events in our environment, allowing us to formulate **predictions** of upcoming sensory input.
- In the context of speech perception, these predictions can be made at the level of **phonotactic probability** and **syllable stress (Fig 1)**.
- The **mismatch negativity (MMN)** is sensitive to **phonotactic regularities**, but not **rhythmic regularities** in Dutch speakers [1,2]
- Dyslexic readers** exhibit behavioral impairments in **phonological** and **rhythmic processing** [3], and a reduced MMN sensitivity to **phonotactic probability** [4,5], however these features are typically studied in isolation.

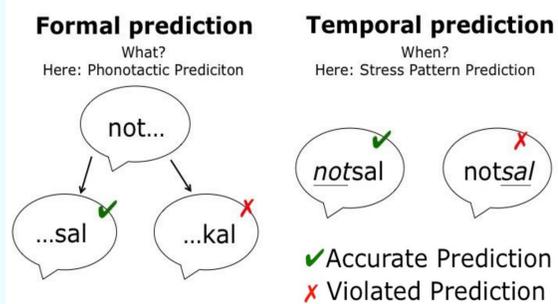


Figure 1: Formal and temporal predictions in speech perception.

Methods

Participants: 35 native Dutch speakers (21 typical readers [1], 14 dyslexic)
Passive oddball paradigm (Fig 2)

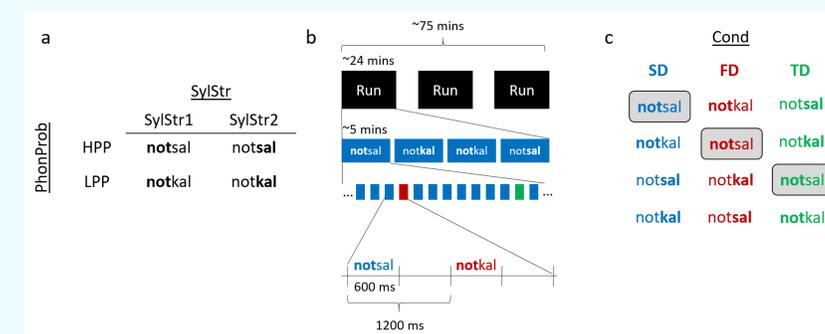


Figure 2: Experimental design, adapted from [1]. Stimuli consist of Dutch pseudowords varying in phonotactic probability (**PhonProb**) [2] and syllable stress (**SylStr**). SD = Standard, FD = Formal deviant, TD = Temporal deviant.

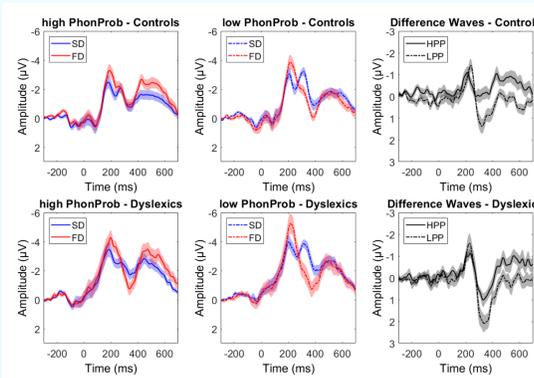
EEG recording: 63 passive electrodes, acquired with BrainVision Recorder

Analysis: PhonProb x SylStr x Group ANOVA on MMN mean amplitude (+/- 25ms around individual peak) and latency in frontocentral ROI

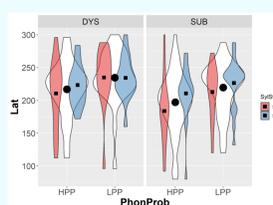
Hypotheses

- The **MMN** is sensitive to **phonotactic** but not **rhythmic regularities** of speech stimuli (see [1]):
 More predictable structures show facilitated change detection, indexed by shorter peak latencies or larger peak amplitudes.
- This sensitivity is **reduced/atypical** in individuals with **dyslexia**

Results Formal Deviants

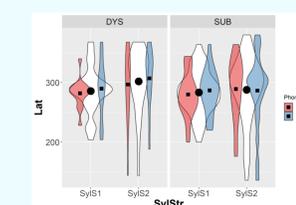
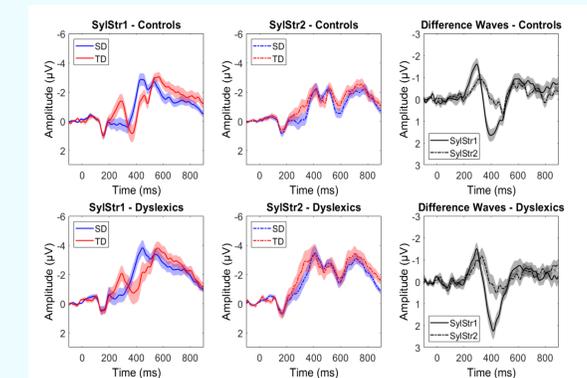


MMN latency: main effects of Group and PhonProb:



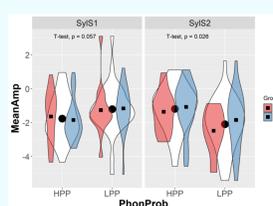
- Dyslexic readers (DYS)** show **later MMN** than controls (SUB).
- High PhonProb deviants (HPP)** elicit **earlier MMN** than low PhonProb deviants (LPP).

Results Temporal Deviants

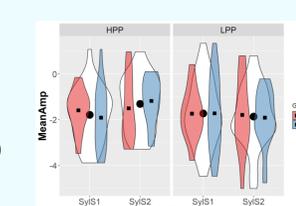


No significant main effects or interactions for MMN latency for temporal deviants

MMN amplitude: interaction PhonProb x SylStr:



- Low PhonProb deviants (LPP)** elicit **larger MMN** than high PhonProb deviants (HPP), only for **second syllable stress (SylS2)**



No significant main effects or interactions for MMN amplitude for temporal deviants

Summary & Outlook

- MMN** is sensitive to **phonotactic regularities**, but not **rhythmic regularities** in Dutch speakers [1]
 - Dyslexic readers** show a **later MMN** compared to typically reading controls, suggesting slower processing of phonotactic regularities
 - PhonProb x SylStr** interaction on MMN amplitude.
 - Pattern of modulation (**larger MMN** for **less** probable items) suggests a “**violation**” response, rather than facilitated change detection: irregular stress pattern may disrupt automatic phonological processing.
- Next steps:** Investigate **oscillatory mechanisms** underlying formal and temporal predictions through time-frequency analysis.

References

[1] Emmendorfer, A. K., Correira, J. M., Jansma, B. M., Kotz, S. A., Bonte, M. (2020). *Scientific Reports* [2] Bonte, M. L., Mitterer, H., Zellagui, N., Poelmans, H., & Blomert, L. (2005). *Clinical Neurophysiology*. [3] Goswami, U. (2011). *Trends in cognitive sciences*. [4] Bonte, M. L., Poelmans, H., & Blomert, L. (2007). *Neuropsychologia*. [5] Noordenbos, M. W., Segers, E., Mitterer, H., Serniclaes, W., & Verhoeven, L. (2013). *Neuroreport*.