Lexical and Phonological Frequency Effects in Developmental Dyslexia
Evidence from Auditory MEG Data

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I Introduction

- Most individuals with diagnosed dyslexia have a phonological processing deficit, which has led to the Phonological Representation Hypothesis of Dyslexia. Individuals with dyslexia have poorly specified phonological representations and/or difficulties in accessing these representations.
- Assuming weaker phonological representations in dyslexia, atypical neural encoding of phonological neighbourhood (NP) during auditory word access is expected. However, it is unclear how a deficit in learning phonological associations affects processing at the lexical level (word form frequency; WF).
- Research on NP and WF effects in dyslexia has concentrated on visual processing and found conflicting evidence, ranging from virtually no processing differences to differences in localization, atypical word repetition effects, and differences in evoked power.
- The link between behavioural phonological deficits and the neural basis of phonological-lexical access in dyslexia remains unclear.

Research Question
Does the phonological deficit in dyslexia modulate how phonological-statistical information is encoded during auditory word access?

At what level?
(1) at the Phonological Level: Phonological Neighbours
(2) at the Whole Word Level: Word Form Frequency

II Methods
Participants
17 without reading problems, 14 diagnosed with dyslexia, matched in age (12-44, M=26.1) and general IQ (M=119.5)

Behavioural Tests of Phonological Skill
(a) Phonological awareness test (PECO: N out of 40)
(b) Nonword reading test (accuracy/time*100)
→ Combined into Phonological Composite Score: z(a) + z(b) / 2

Procedure
- MEG recordings
- Participants listened to Spanish nouns (N=120)
- Occasional decision as to whether word was animate or inanimate

Analysis
1. Single-subject regression of the epoched data (-100–700ms):
   (1) Phonological Neighbourhood (Phonological Level)
   (2) Written Word Form Frequency (Whole Word Level)
2. Averaging of Event-Related Regression Coefficients (ERRCs) within pre-defined time-windows (90-650ms)
3. Correlation of ERRCs and Phonological Composite Score

III Results

1. Single Regression of the Epoched Data
- (1) Phonological Neighbours
  - Control
  - Dyslexia Diagnosis
- (2) Word Form Frequency
  - Control
  - Dyslexia Diagnosis

2. & 3. Correlation of Averaged ERRCs and Phonological Composite Score
(1) Phonological Neighbours x Phonological Score
   Left Hemisphere
   Right Hemisphere

   → Correlation between NP and Phonological Score in the left and right hemispheres 90-400ms post stimulus-onset

(2) Word Form Frequency x Phonological Score

   → Correlation between WF and Phonological Score in the right hemisphere 200-500ms post stimulus-onset, but only for subjects with diagnosed dyslexia

IV Discussion

(1) At the Phonological Level
- Better phonological skills are correlated with stronger encoding of phonological neighbourhood in the brain throughout the time course of word processing, especially in the left hemisphere.
- This correlation holds regardless of dyslexia diagnosis, but dyslexics tend to have lower phonological skills (lower Phonological Composite Score) and as such weaker encoding overall.

(2) At the Whole Word Level
- Better phonological skills are associated with stronger encoding of word frequency in the right hemisphere in mid-late time-windows, but only for people with diagnosed dyslexia.
- Stronger encoding of word form frequency in the right hemisphere could be a dyslexia-specific mechanism, compensating weaker phonological form encoding in the left hemisphere.

Phonological deficits are linked to weaker neural encoding of phonological information and compensatory encoding of word form frequency during auditory word access
→ in line with the Phonological Representation Hypothesis of Dyslexia.