Relationships between phonological working memory and language processing in adults with dyslexia

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Summary

- Phonological working memory (PWM) is the process of maintaining sounds important for speech and language in short term memory.
- Individuals with dyslexia often show a specific deficit in PWM, as measured by nonword repetition (NWR) tasks.
- We measured brain activation using fMRI while individuals with dyslexia and age-matched controls performed NWR (including control conditions with real words), as well as two functional localizers for the language processing and multiple demand (MD) networks.
- Though the dyslexia group performed significantly less accurately on NWR, traditional group averaging did not reveal any significant differences in brain activation.
- We tested for differences during NWR in functionally defined regions of interest in PWM, language processing, and MD networks, and only found group differences in MD regions.

Analyses and Results

Nonword Repetition: In-Scanner Behavior and Group Average Comparison

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Activity</th>
<th>Significant effects of:</th>
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<tbody>
<tr>
<td>Control</td>
<td></td>
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<tr>
<td>Dyslexia</td>
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</tbody>
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Do control and dyslexia groups have different magnitude responses in core phonological working memory regions?

We measured brain activation in functional regions of interest within the PWM, language processing, and multiple demand networks.

Do control and dyslexia groups have different magnitude responses in language processing regions?

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Do control and dyslexia groups have different magnitude responses in multiple demand regions?

We measured brain activation in functional regions of interest within the PWM, language processing, and multiple demand networks.

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Participants

- 23 adults with dyslexia (19 female, 4 male; age M = 23.34 ± 2.93) and 22 controls (12 female, 10 male; age M = 23.73 ± 4.13)
- Inclusion criteria for the dyslexic group: Standard scores of ≤ 85 without a diagnosis of dyslexia (≤ 90 for controls) and TOWRE scores of 23.34 ± 2.93 and 22 controls (12 female, 10 male; age M = 23.73 ± 4.13)

Methods

Task

- Nonword Repetition Design: fMRI Runs: 3 per session
  - 1-Syllable Nonwords
  - 4-Syllable Real Words
  - 1-Syllable Real Words (Rest)
  - 4-Syllable Nonwords (Rest)

Sparse-sampling fMRI acquisition

Functional Localizers

Language/Speech Task Design

- fMRI Runs: 2 per session, 16 blocks per run + rest, one 18-second audio clip per block
- Intact Speech
- Degraded Speech

Spatial Working Memory: Corsi Blocks

- fMRI Runs: 2 per session, 8 blocks per run + rest, 4 trials per block, Easy blocks lasted 18 seconds, Hard blocks lasted 27 seconds
- Easy - Three Item Sequences
- Hard - Six Item Sequences

Continuous-sampling fMRI acquisition

Fedorenko et al. (2010)

Linear Mixed Effects Model
Mean Activity = Word Type * Number of Syllables * Group + (1 | Brain Area)
Significant main effects of:
Word Type (p < 0.001)
Number of Syllables (p < 0.001)

Fedorenko et al. (2013)

Linear Mixed Effects Model
Mean Activity = Word Type * Number of Syllables * Group + (1 | Brain Area)
Significant main effects of:
Word Type and Number of Syllables (p = 0.04)

Scott & Perrachione (in press)

Linear Mixed Effects Model
Mean Activity = Word Type * Number of Syllables * Group + (1 | Subject)
Significant main effects of:
Word Type (p < 0.001)
Group (p < 0.001)
Significant interactions between:
Number of Syllables and Group (p = 0.001)
Word Type, Number of Syllables and Group (p = 0.04)