Resting-State fMRI Connectivity for Reading and Nonverbal Ability in Children With and Without Reading Disability

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Introduction

Reading disability (RD) affects approximately 10% of otherwise typically developing children1. Many challenges remain in understanding the cause of RD. The present study uses resting-state fMRI, a neuroimaging technique that measures spontaneous patterns of neural activity as an index of grey matter connectivity.

- In adult readers, individual differences in single-word reading ability are correlated with resting-state functional connectivity in the brain2.
- In children with RD, reduced functional connectivity is observed during reading tasks and resting states relative to typical readers3.

Method

Participants
58 children (30 female) ages 9 to 11 (mean 10.9 years). 13 were previously identified with a reading disability.

Behavioural Measures
Test of Word Reading Efficiency (TOWRE-II)
- Sight Word Efficiency: reading list of words quickly and accurately
- Phonemic Decoding Efficiency: reading list of nonwords quickly and accurately

Woodcock Johnson III Tests of Achievement
- Passage Comprehension: reading comprehension
- Calculations: untimed mathematical calculations
- Math Fluency: timed simple arithmetic
- Rapid Automated Naming (RAN)
- Timed naming of array of letters

MRI Data Acquisition
A high-resolution anatomical and an 8-minute resting state fMRI scans were acquired using a Siemens 3T Prisma scanner.
- Regions of interest were identified based on a meta-analysis of brain areas implicated in fMRI studies of reading in children4.
- Data were preprocessed and analyzed using CONN-fMRI toolbox for SPM in MATLAB.

Results

Correlations between behavioural measures (\( * p < .05 \))

<table>
<thead>
<tr>
<th>Behavioural Measure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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</thead>
<tbody>
<tr>
<td>1. Calculations</td>
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<tr>
<td>2. Math Fluency</td>
<td>1.70 -</td>
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<tr>
<td>3. Passage Comprehension</td>
<td>1.38 -</td>
<td>1.37 -</td>
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<td>4. Sight Word Efficiency</td>
<td>1.36 -</td>
<td>1.37 -</td>
<td>1.64 -</td>
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<td>5. Phonemic Decoding</td>
<td>1.43 -</td>
<td>1.31 -</td>
<td>1.72 -</td>
<td>1.06 -</td>
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<td>6. Rapid Naming</td>
<td>1.25 -</td>
<td>0.27 -</td>
<td>1.37 -</td>
<td>1.71 -</td>
<td>1.72 -</td>
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Resting-state connectivity between ROIs was examined using a regression model (below).

Resting-state connectivity was observed during reading tasks and resting states relative to typical readers.

Conclusions

We used resting state functional connectivity to decompose the role of reading network subregions on individual differences in reading and cognition.

Key Findings:
- Increased connectivity between the thalamus and cortical areas of the reading network (particularly frontal areas) related to better sight word reading and decoding.
- Increased connectivity within areas of the reading network (particularly temporal and parietal areas) was associated with better reading comprehension.
- Increased connectivity between the thalamus and frontal regions related to more fluent and accurate rapid naming.
- Individual differences in mathematics was correlated with connectivity in areas that are implicated in studies of numerical cognition, which overlap with areas of the reading network.

References


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