Reading Intervention Duration and Brain Activation Changes Before and After Treatment: A meta-regression study

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INTRODUCTION

- Reading disability (RD) is the most common disability in school-aged children and affects about 7% of the population, many of whom receive remedial intervention.1
- Neuroimaging studies of reading intervention generally find one of three profiles: 1) Normalization - pre-to-post activation changes are observed in canonical reading areas such that children's brain activation during reading comes to resemble that of typically developing children.5,6 2) Compensation - pre-to-post changes are observed in brain areas not typically associated with reading, particularly in right hemisphere homologues of the reading network and areas associated with executive function.7,8 3) Mixed Results - A mixture of normalization and compensation is observed.9,10
- While intervention is generally considered to have positive outcomes, the specific features of intervention programs that lead to these positive outcomes are not well understood.
- Several studies, including a recent meta-analysis, have found that neither number of weeks nor total hours of intervention predict intervention outcomes.11,12,13,14 1) In contrast, other studies have found that duration of intervention does predict significant differences in pre-to-post intervention reading gains.15,16,17

The goal of the current study was to use a meta-regression analysis to explore whether pre-to-post brain activation changes were related to intervention duration (number of weeks/hours).

METHODS

- First, we conducted a systematic review and meta-analysis of reading intervention studies that featured pre- and post-intervention fMRI imaging for participants with or at-risk for RD (Perdue et al., In Prep).
- We conducted two exploratory meta-regression studies in which we considered the total number of hours and total number of weeks of intervention as possible predictors of brain activation changes.
- For the hours analysis: we used a binary definition of longer and shorter interventions Longer =>100 total hours; Shorter <=100 total hours
- For the weeks analysis: we coded total number of weeks continuously.
- Our reporting threshold was set to p<0.005, uncorrected and a voxel size>=10.

RESULTS

- Total Hours of Intervention: 7 studies were included in the regression analysis

<table>
<thead>
<tr>
<th>Author</th>
<th>N</th>
<th>Analysis Contrast</th>
<th>Voxel-wise Threshold</th>
<th>Number of foci</th>
<th>Hours</th>
<th>Weeks</th>
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</thead>
<tbody>
<tr>
<td>Eden, 2004</td>
<td>19</td>
<td>Post vs. Pre for intervention group &gt; non-intervention RD group</td>
<td>p &lt; .001, unc.</td>
<td>15</td>
<td>112.5</td>
<td>8</td>
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<td>Gebauer, 2012</td>
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<td>Post vs. Pre in training group</td>
<td>z &gt; 2.0</td>
<td>7</td>
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<td>Heim, 2015</td>
<td>33</td>
<td>Post vs. Pre in RD intervention group</td>
<td>p &lt; .05, FWE-corrected</td>
<td>2</td>
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<td>Meyer, 2008</td>
<td>35</td>
<td>Good vs. Poor readers at post-intervention</td>
<td>p &lt; .002, unc.</td>
<td>5</td>
<td>100</td>
<td>24</td>
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<tr>
<td>Nugiel, 2019</td>
<td>21</td>
<td>Post-intervention fMRI correlation with reading gain score</td>
<td>uncorrected z-map provided</td>
<td>&lt;100</td>
<td>16-32</td>
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<tr>
<td>Partanen, 2019</td>
<td>29</td>
<td>Poor readers &gt; Good readers at Post vs. Pre</td>
<td>z &gt; 2.3</td>
<td>1</td>
<td>24 or 189</td>
<td>12</td>
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<tr>
<td>Richards, 2006</td>
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<td>Post vs. Pre in orthographic treatment group</td>
<td>z &gt; 2.4</td>
<td>5</td>
<td>14</td>
<td>3</td>
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<tr>
<td>Shaywitz, 2004</td>
<td>25</td>
<td>Follow-up &gt; Pre in RD experimental intervention group</td>
<td>p &lt; .05</td>
<td>7</td>
<td>105</td>
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<tr>
<td>Temple, 2003</td>
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<td>Post vs. Pre in RD group</td>
<td>p &lt; .005, unc.</td>
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<td>46.5</td>
<td>5.58</td>
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<td>Yamada, 2011</td>
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<td>Post vs. Pre in at-risk group</td>
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<td>41</td>
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- Total Weeks of Intervention: 9 studies were included in the regression analysis

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DISCUSSION

- Longer interventions (coded by weeks and hours) were associated with greater compensatory activation.
- Our analysis of total hours of intervention shows that longer interventions (<100 hours) increased activation in the R STG while shorter interventions (>100 hours) increased activation in the L MOG. This result might indicate that longer interventions provide more training for right hemisphere homologues which may help supplement activity in canonical L hemisphere reading areas.
- Our analysis of total weeks of intervention reveals an increase in activation along the R STG and R Occipito-temporal regions, again suggesting that increasing intervention duration may increase engagement of RH compensatory regions.
- Across both analyses (hours and weeks), we saw increased activation in R STG. This suggests that this region may play an important role in reading remediation, possibly by providing an alternate route for phonological processing.25,26

REFERENCES

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- Yamada, 2011
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