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 children[1]. 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 brain[2].
- In children with RD, reduced functional connectivity is observed during reading tasks and resting states relative to typical readers[3].

However, less is known about how such differences are linked to specific aspects of reading versus more generalized cognitive subskills also known to be impaired in RD.

Research Question

How do measures of resting-state connectivity relate to individual differences in specific aspects of reading such as decoding, rapid naming, and comprehension, versus other cognitive abilities such as mathematics?

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 Automatized Naming (RAN)

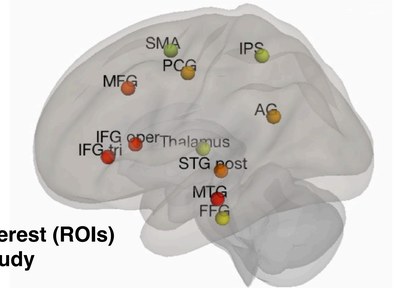
Timed naming of array of letters

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 children[4].

Data were preprocessed and analyzed using CONN-fMRI toolbox for SPM in MATLAB.



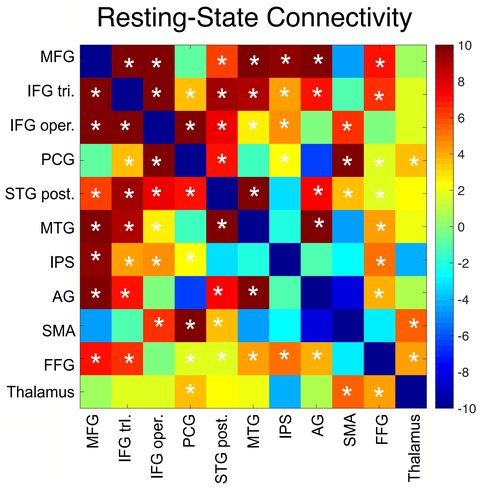
Regions of Interest (ROIs) used in this study

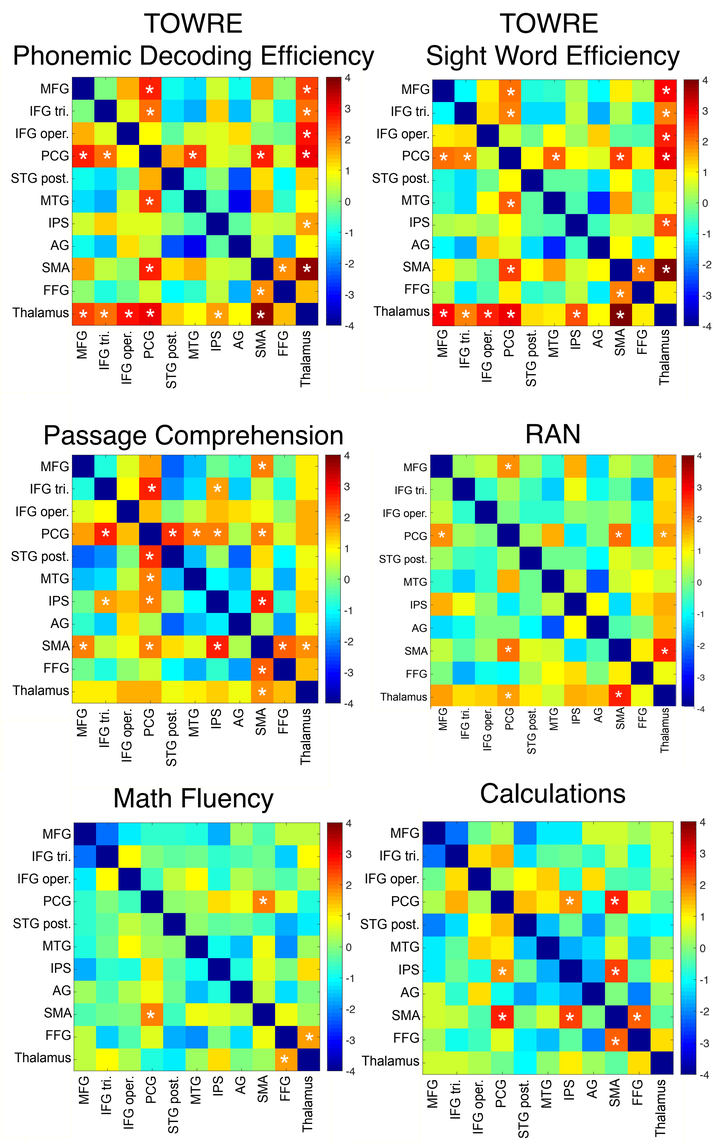
Results

Correlations between behavioural measures (* = $p < .05$)

	1.	2.	3.	4.	5.	6.
1. Calculations	-					
2. Math Fluency	*0.70	-				
3. Passage Comprehension	*0.58	*0.37	-			
4. Sight Word Efficiency	*0.39	*0.37	*0.64	-		
5. Phonemic Decoding	*0.43	*0.31	*0.72	*0.90	-	
6. Rapid Naming	*0.25	0.21	*0.37	*0.71	*0.72	-

Resting-state connectivity between ROIs was examined using a regression model (below). Behavioural measures were then added to the model to examine how scores on those measures related to resting-state connectivity between all ROIs (right).





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[4,6] which overlap with areas of the reading network.

References

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