Higher maternal education is related to greater executive functions and decreased functional connectivity between cognitive control networks and reading related regions in children with reading difficulties.

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Introduction

- Reading difficulty (RD or dyslexia) is characterized by deficits in language processing and executive functions (EFs) [1].
- EFs include cognitive abilities underlying learning such as working memory, inhibition and switching, as well as attention [2]
- Networks such as Dorsal Attention (DAN) and Ventral Attention (VAN) are involved in basic orienting attention and Fronto-Parietal (FP) and Cingulo-Opercular (CO) are involved in executive control [3].
- Children can have RD also due to environmental effects of inadequate resources, lack of stimulation or motivation [4]. Socioeconomic status (SES) consists of household income, maternal education, and occupation [5].
- Maternal education is associated with parent-child interaction and cognitive developmental outcomes [6].

Aims

To determine the relations between maternal education and basic abilities related to reading (such as EFs) in children with RD and typical readers (TRs) using behavioral and neurobiological measures.

Methods

- Forty-six children, 25 RD (x=9.76±1.42; F=13) and 21 typical readers (TRs) (age=10.05±1.47; F=6).
- No history of attention deficits, neurological or psychiatric disorders.
- Maternal education was collected as a construct of SES.
- All participants had intact non-verbal intelligence (IQ) ≥85 (TONI-4) [7].
- RD participants scored <25th percentile on two or more reading tests [8].

Behavioral Measures

Executive functions:

- BRIEF Inhibition [9]
- CPT detectability [10]
- TEA-Ch Sky Search Dual Increment Task [11]
- DKEFS Color Naming Inhibition/Switching [12]
- DKEFS Verbal Fluency: FAS [12]

Behavioral Data Analysis:

- Compared EFs measures between RD and TRs using independent t-tests.
- To determine the correlations between EFs measures with maternal education for RD and TRs, controlling for non-verbal IQ.
- Data is corrected for multiple comparisons.

Neuroimaging Acquisition and Analysis:

- 25 RD and 21 TRs participated in two 5 minute resting state scans: 430 whole brain scans per resting state imaging sequence.
- Imaging data were acquired using a 3T Phillips Ingenia Scanner. T1 weighted images were acquired for each participant with TR/TE of 700/30 msec.
- The data were preprocessed using SPM12 and then processed using the CONN: functional connectivity toolbox.
- Defined ROIs comprising these networks (DAN, VAN, FP, CO) using anatomic locations from the WFU-pick atlas tool [2, 13].

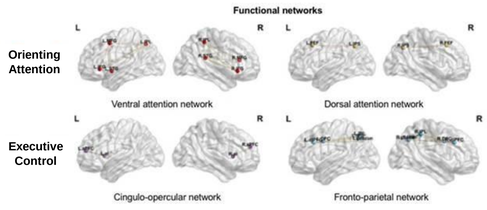

Figure 1. Visualization of orienting attention (ventral and dorsal attention) and executive control (cingulo-opercular and fronto-parietal) networks on a glass brain.

- Seed-to-voxel analysis was performed by calculating correlations of BOLD time-series of each seed to those of all the voxels in the brain, controlling for non-verbal IQ.
  - Each network was weighted equally as a seed.
- Maternal education was used as a covariate of interest.

Results

Behavioral Measures:

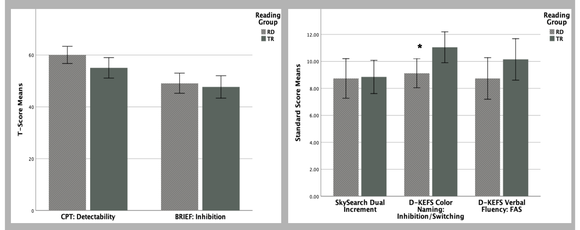

Figure 2. Mean differences in EFs measures for children with RD and TRs (*P<0.05).

Higher maternal education is related to greater EFs abilities in children with RD and TRs.

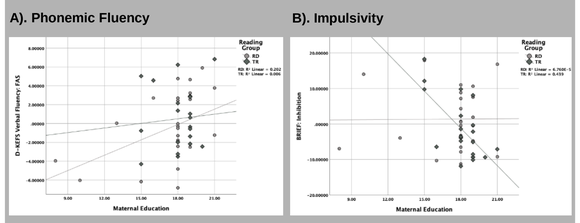

Figure 3. Correlations between EFs measures and maternal education for children with RD and TRs controlling for non-verbal IQ.
(A). Phonemic fluency [RD: *P<.05, r=.448], **(B).** impulsivity [TRs: *P<.05, r=-0.646]. BRIEF impulsivity for TRs survived multiple comparisons *P<.01

Cognitive control networks connectivity and voxels within reading related regions:

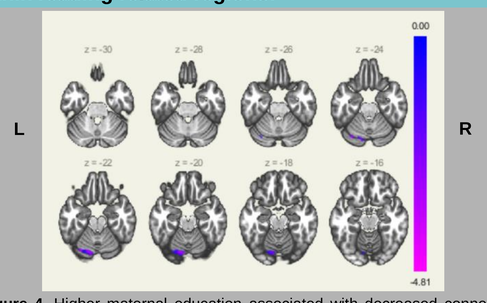

Figure 4. Higher maternal education associated with decreased connectivity between DAN and a cluster of voxels within the left cerebellum, left fusiform gyrus, and left lingual gyrus for RD>TRs. The Fig. is presented in neurological orientation (left on left, right on right) *P<.05, FDR-corrected.

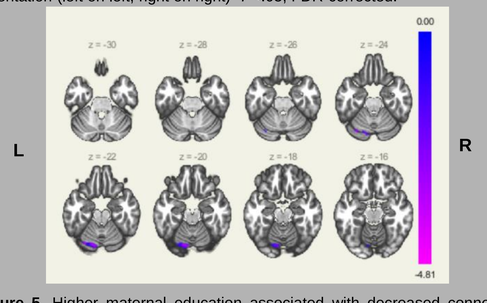

Figure 5. Higher maternal education associated with decreased connectivity between FP and a cluster of voxels within the left cerebellum, left fusiform gyrus, and left lingual gyrus for **RD>TRs**. The Fig. is presented in neurological orientation (left on left, right on right) *P<.05, FDR corrected.

Discussion

- Children with RD whose mothers' have higher educational attainment performed better on tasks that probe phonemic fluency.
- TRs whose mothers' have higher educational attainment had reduced impulsivity.
- Children with RD with mothers who have higher educational attainment may rely less on top-down networks related to EFs.
- Results point at maternal education having different roles in cognitive control for children with RD and TRs during reading.
- Higher maternal education may be a compensatory mechanism for children with RD by engaging abilities that support reading (EFs).

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