Early Exposure to Reading Relates to Leftward Structural Asymmetries Critical for Literacy Development in Pre-readers

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Introduction

- Home literacy experiences, such as shared reading, are important for children's language and reading development, especially before the start of schooling[1-4].
- Reading ability is supported by a primarily left-lateralized neural network[5]. Left-lateralization of regions important for language and reading development have been associated with behavioral measures of verbal and literacy skills[6,7].
- Positive associations have been observed between home literacy exposure (HLE) and left-hemispheric white matter microstructure and functional activation relevant for language ability[2,8].
- It remains unknown whether and how HLE is associated with hemispheric specialization in gray matter characteristics in regions important for language and reading development.

Methods

Participants: 112 pre-kindergarteners (55 females, age = 66.8 ± 5.7 months).

HLE: characterized through parental survey using the following three questions

- Age of child when first read to:
  1. Prenatal; 2. 0-3 months; 3. 3.1-6 months; 4. 6.1-9 months; 5. 9.1 or more months
- Total number of children's books in the home:
  1. 0-10; 2. 11-50; 3. 51-100; 4. 101-200; 5. 201-300; 6. 301+
- Amount of time at home that someone reads to the child each week:
  1. <1 hour; 2. 1 hour; 3. 2 hours; 4. 3 hours; 5. 4-5 hours; 6. 6+ hours

Processing of Structural MRI Data:

- Manual editing of FreeSurfer[9] surface segmentation as needed.
- Cortical thickness, volume, and surface area extracted for 11 regions in both hemispheres (Fig. 1).
- Left-lateralization index (LI) computed for each region:

$$LI = \frac{\text{Left-hemispheric measure} - \text{Right-Hemispheric measure}}{\text{Left-hemispheric measure} + \text{Right-Hemispheric measure}}$$

Statistical Analyses: Correlation analyses between each HLE measure and LI of cortical regions performed. Results were corrected for multiple comparisons (n=33).

Results

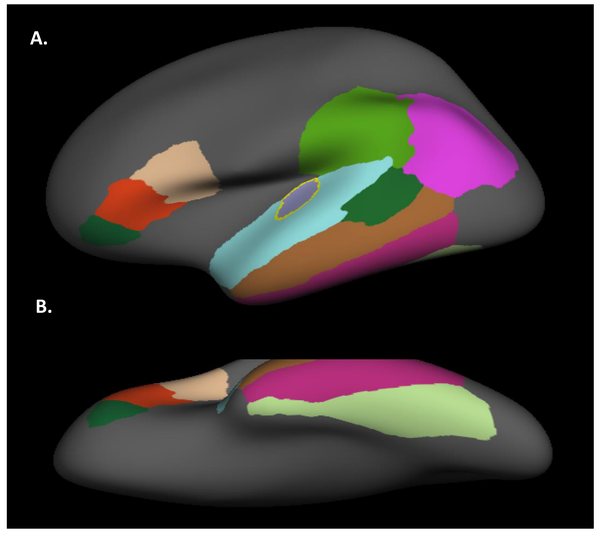

Figure 1. Sagittal (A) and ventral (B) view of language-relevant regions included in the current analyses.

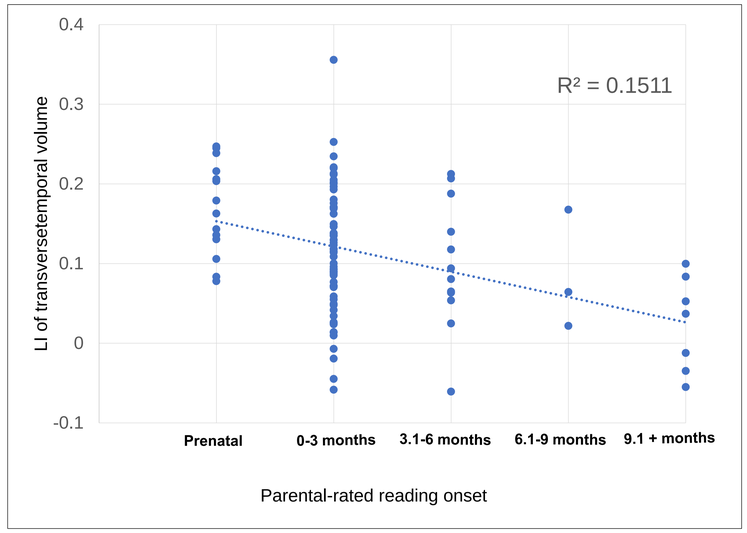

Figure 2. Significantly negative correlation between LI of transversetemporal volume and onset of shared reading (outlined in yellow in Figure 1).

- Shared reading onset negatively correlated with LI of transverse temporal (Heschl's) gyri for volume (r= -0.39, $p_{uncorrected} < 0.001$, $p_{corrected} = 0.003$).
- No other significant correlations observed.

Discussion

- The significant association between onset of shared reading and LI of Heschl's gyrus represents a structural correlate in gray matter characteristics for the previously observed positive association between HLE and children's language and reading development.
  - The left Heschl's gyrus (primary auditory processing area) has been implicated in speech perception in infants[10] and children with dyslexia have shown atypical rightward asymmetry of Heschl's when compared to controls[11].
  - Speech perception plays a critical role in the development of oral language and preliteracy skills (e.g. phonological processing) which are critical foundations of reading development[12,13].
- Though most parents began reading to their children in infancy (Fig. 2), small differences in month of onset were significantly associated with LI of Heschl's.

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