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INTRODUCTION

Inconsistent evidence of localized structural differences related to linguistic variables in neurotypical readers:

- Increased grey matter (GM) thickness in left posterior medial regions in resilient vs. poor readers (Welcome et al., 2011).
- Increased GM thickness in left angular gyrus as a function of increased print exposure (Goldman & Manis, 2013).
- Increased GM thickness in LIFG & bilateral STG associated with improved phonological processing (Lu et al., 2007).

BUT

- Reduced GM thickness in right fronto-parietal regions associated with greater processing speed (Lu et al., 2009).
- Reduced GM thickness in left lateral dorsal frontal and left lateral parietal regions associated with improved vocabulary ability (Sowell et al., 2004).

Most investigations have examined a restricted range, either of participants (e.g., university students), or of variables measuring individual differences in language-relevant cortical areas.

CURRENT GOAL

Examine connections between cognitive abilities and grey matter thickness in a non-clinical population.

- We used a community-based sample, rather than a convenience sample of university students (N = 39, 17 females, age 16 – 24).
- We used an extensive battery of cognitive assessments, including WMC, vocabulary, oral and reading comprehension, phonological processing, reasoning, and print exposure.

Hypotheses: Increased grey matter thickness may be associated with greater comprehension and/or phonological ability (e.g., Goldman & Manis, 2013); however, reduced grey matter thickness may result from greater phonological, naming, or vocabulary ability (e.g., Lu et al., 2007; Sowell et al., 2004).

METHOD

- Participants completed a behavioral assessment battery comprised of 16 measures covering a broad range of cognitive abilities.
- Battery data was submitted to a Principal Components Analysis.
- A 1x1x1 mm high-resolution, three-dimensional T1-weighted sagittal acquisition was acquired (MPRAGE pulse sequence; TE: 3.66 ms; TR: 2530 ms; FA: 7 degrees; FOV: 256x256 pixels; slice thickness 1 mm; 176 slices).
- General linear model analyses were carried out with the FreeSurfer image analysis suite (http://surfer.nmr.mgh.harvard.edu).
- Clusterwise correction for multiple comparisons was applied during the analysis (Hagler et al., 2006).


RESULTS: INDIVIDUAL DIFFERENCES

Broad range of cognitive abilities in the community sample, e.g.:

- Following Kaiser’s stopping rule (1960) and a scree test (Cattell, 1966), we extracted four varimax-rotated factors explaining 76% of the variance.
- These factors align with those identified as important in our previous work (e.g., Braze et al., 2007; Kuperman & Van Dyke, 2011).

- ID variables, factors, and highest factor loadings:

  PHONOLITICAL ABILITY 27%
  - CTOPP – Phonological awareness (72)
  - Gray Oral Reading Test – fluency (52)
  - Pseudohomophone ID (79)
  - TOWRE (Nomwords) (73)
  - WJ-3 Word Attack (86)
  - WJ-3 Word ID (68)
  - WASI Matrix Reasoning (.59)

  COMPREHENSION ABILITY 25%
  - Magazine Recognition Test (.78)
  - Peabody Picture Vocabulary Test (.84)
  - PIAT – Reading Comprehension (.70)
  - PIAT – Listening Comprehension (.62)
  - Stanford Fast Reading (.69)
  - WJ-3 Reading Fluency (.58)

  PROCESSING SPEED 15%
  - CTOPP – Rapid Letter Naming (.88)
  - TOWRE (Words) (.76)

  WORKING MEMORY 9%
  - Listening Span (WMC) (.89)

RESULTS: MRI

Initial results indicate that COMPREHENSION ABILITY is associated with cortical thickness of pars opercularis (BA 44). Higher comprehension ability is correlated with reduced grey matter thickness (p = .041).

In addition, we also observed a GM thickness x PHONOLITICAL ABILITY x WORKING MEMORY interaction (p = .0482) in pars opercularis, also indicating that higher ability was associated with reduced GM thickness.

CONCLUSIONS

- Higher comprehension ability, phonological ability, and WMC were associated with GM thinning, rather than GM thickening. This is consistent with developmental accounts of cortical thinning in areas associated with skilled and/or mature performance, e.g., motor skills (Sowell et al., 2004).
  - BUT: Thinning was not observed in Broca’s Area in Sowell et al. (2004).
- BA 44 is associated with critical higher-level language functions (e.g., sound-to-articulation mapping, Saur et al., 2008, 2010; processing non-adjacent elements in syntactically complex (Friederici, 2011) and non-canonical input (Braver et al., 2011). It has also been associated with conflict resolution ability (January et al., 2008; Novick et al., 2005).
  - Suggests that language-relevant cortical structures continue to mature well into adolescence/young adulthood.