Bilateral Frontal Aslant Tract's Relation to Verbal Fluency in Young Children With and Without ADHD

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Introduction

Attention-deficit hyperactivity disorder (ADHD) is a disorder typically diagnosed in early childhood, and is characterized, in the majority of children, by deficits in executive function (EF). There is a well-known comorbidity between ADHD and speech-language disorders (McGrath et al, 2008; Efron & Sciberras, 2010). In this study, we examined the relationship between a recently discovered bilateral language pathway, the Frontal Aslant Tract (FAT), and phonemic and semantic scores on the NEPSY in 196 children with (n=100) and without (n=96) ADHD using diffusion weighted imaging. The FAT is a long association fiber pathway (Catani et al, 2012) in the frontal lobe that is thought to play an important role in verbal fluency and speech production (Dick, Bernal, & Tremblay, 2014). The FAT is most commonly thought to connect the inferior frontal gyrus (pars opercularis (Op) and pars triangularis (Tri)) to pre-supplementary motor area (pre-SMA) and supplementary motor areas (SMA) (Broce et al., 2015; Catani et al, 2013). **We examined whether the FAT differentially predicts verbal fluency in children with and without ADHD.**

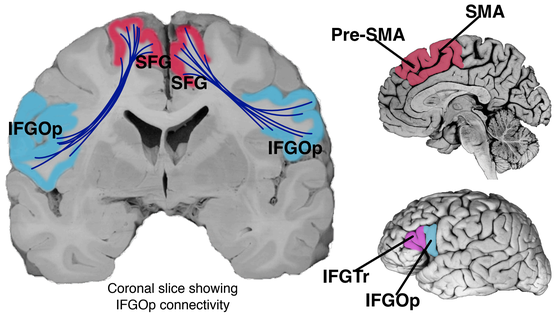
Method and Analysis

Participants: 196 children (137 males; age range = 4-7 years; *M* age = 5.6 years). There were 96 children in the control sample and 100 within the ADHD sample.

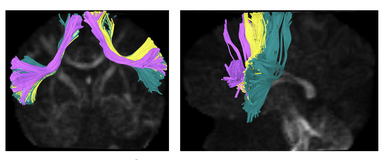
Assessments: Language was assessed using NEPSY-II semantics and phonetics measures, which require a child to list as many objects as they can think of starting with a certain letter or in a category within 60 seconds.

General Design and Parameters: DSIStudio was used to reconstruct DTI and HARDI images from a 3T scanner, b=500, 1000, 2000, 3000, 1.7 x 1.7 x 1.7 mm voxel size with 102 directions.

Approach and Reconstruction: Four regions of interest (ROI) were identified on each individual participants anatomy: inferior frontal gyrus (*pars opercularis* and *pars triangularis*), pre-supplementary motor area (pre-SMA) and supplementary motor area (SMA). Tracking was terminated when the relative QA for the incoming direction dropped below a preset threshold or the track exceeded a 40° turning angle.



Coronal slice showing IFGOp connectivity



Sample subject

Pre-SMA <--> IFGOp
Pre-SMA <--> IFGTr
SMA <--> IFGOp
SMA <--> IFGTr

Analyses: We related the generalized fractional anisotropy (GFA) of the bilateral FAT to the NEPSY verbal fluency measures using robust multiple regression. We controlled for age, sex, wholebrain FA, parental income, and movement in the scanner, and used Winsor outlier correction. Group (ADHD vs. Control) was entered as a moderator.

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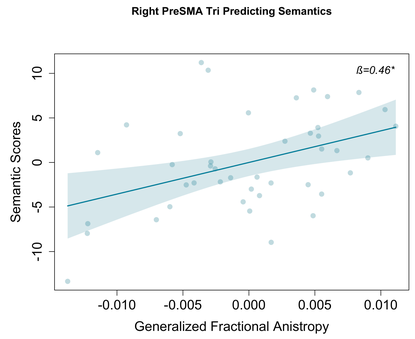
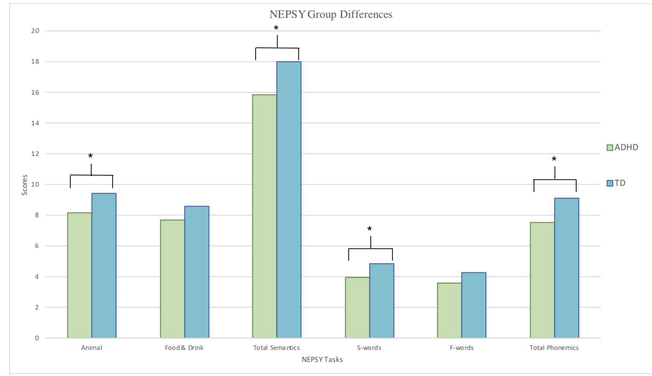
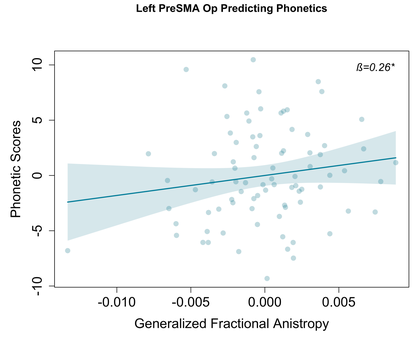
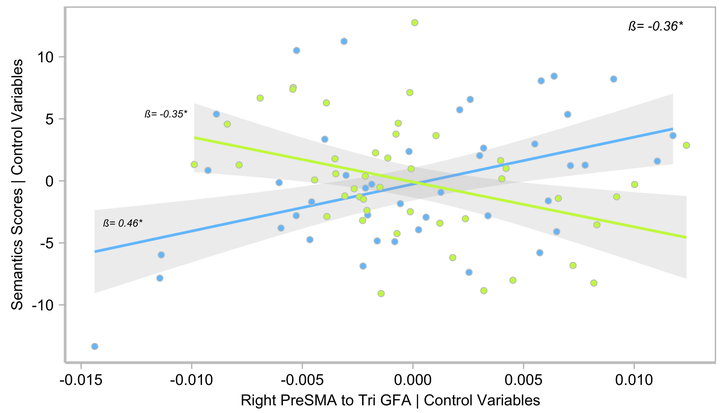
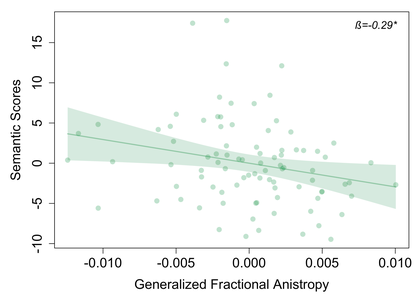
Results











Overview of Findings:

- Children in the control group outperformed the ADHD group on most fluency tasks, as seen in bar graph above.
- Since total semantics and phonemics were the primary findings, further analyses focused on those measures.
- In control group (blue plots on left), the greater structural integrity of the right FAT predicted better semantic scores, while left FAT predicted phonemics.
- In ADHD group, FAT predicted worse performance on semantics.
- ADHD diagnosis moderates relationship between right FAT and semantics.

Summary

We successfully tracked the FAT in 195 out of 196 children. Similar to our previous findings, we saw that, in the control group, right FAT segments predicted better semantic scores, while the left FAT segments predicted better phonemic scores. In contrast, we saw the right FAT segments predicted *worse* semantic scores in the ADHD group. We discovered that the relationship between the FAT and verbal fluency was moderated by ADHD diagnosis. In particular, the control group displayed improved performance predicted by increased GFA in the right FAT, but the ADHD group showed the opposite pattern. These findings imply that the bilateral FAT might be an important biomarker for speech dysfunction in children with ADHD.