

### Background and Research Question

- Phonological processing deficit is a hallmark of Autism Spectrum Disorder (ASD)<sup>1</sup>.
- The left arcuate fasciculus (AF) has been linked with poor phonological awareness and reading skills<sup>2</sup>.
- It is yet unclear whether, or how, this translates to children with ASD.
- Research Question:** Is neuroanatomical deviation in white-matter associated with phonological deficits in children with ASD? If so, how do such structural anomalies affect children's reading ability?

### Methods

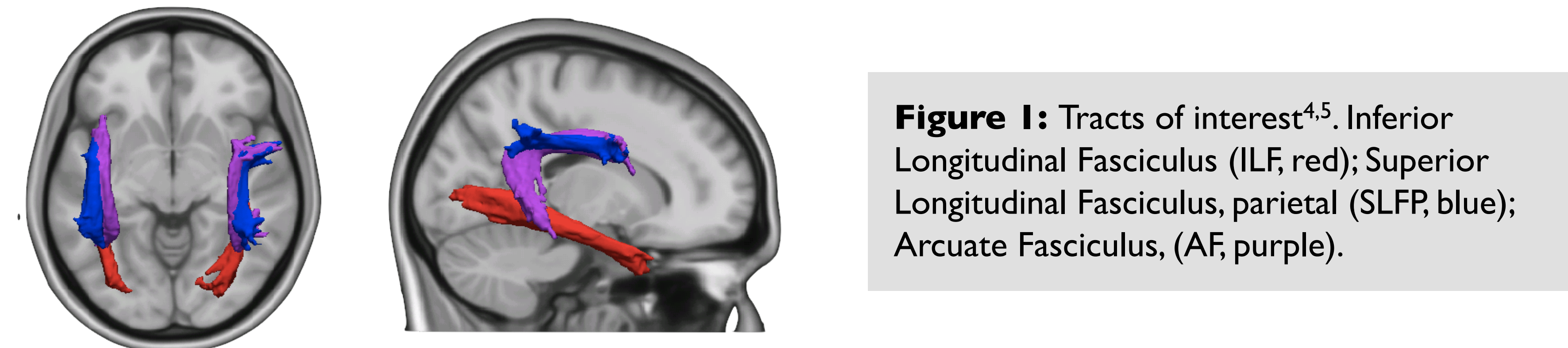
- Participants:** The two groups did not differ significantly based on age, IQ and gender ratio.

Group	Age	IQ	Gender ratio (F:M)
ASD (26)	11.27(3.43)	108.7(15.02)	0.37
TD (20)	10.33(3.57)	110.15(14.27)	0.43

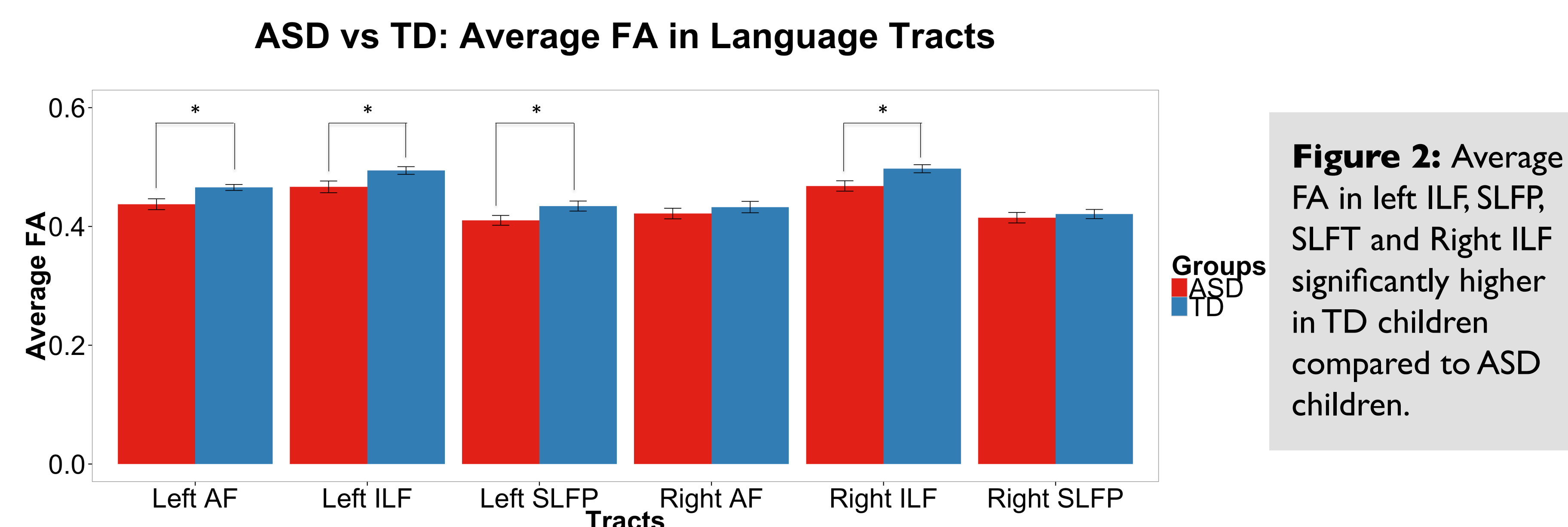
- Imaging:** T1-weighted anatomical and diffusion-weighted images were acquired on a Siemens Tim Trio scanner.
- Behavior:** Tests of phonology (Comprehensive Test of Phonological Processing; CTOPP and Children's Test of Nonword Repetition; CNRep) and reading (Test of Word Reading Efficiency; TOWRE).

### Analysis

- Imaging:** All images were corrected for eddy currents and motion; registered to the subject's T1 and MNI; and used to generate maps of Fractional Anisotropy (FA). TRACULA<sup>3</sup> was used to reconstruct white matter pathways.
- Behavior:** A phonological ability score was calculated as the average of z-scores from CTOPP and CNRep.
- A) Are there structural differences in language-related white-matter tracts between TD and ASD groups?
- B) Are structural differences between TD and ASD related to phonological ability?
- C) Are the relationships between structure and behavior distinct between TD and ASD?

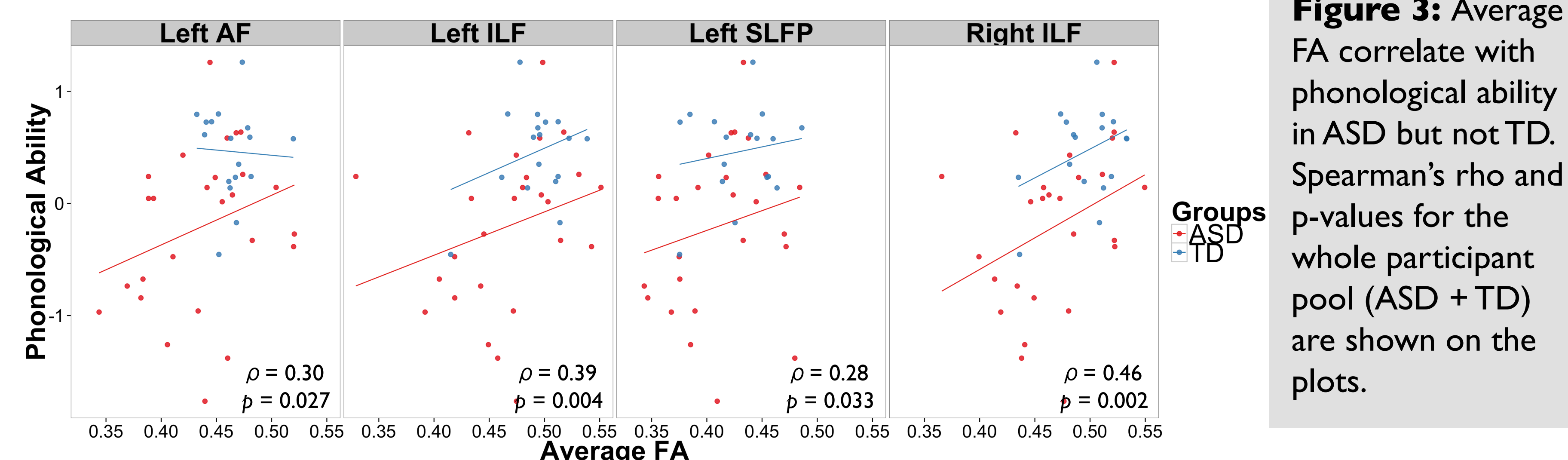


**Figure 1:** Tracts of interest<sup>4,5</sup>. Inferior Longitudinal Fasciculus (ILF, red); Superior Longitudinal Fasciculus, parietal (SLFP, blue); Arcuate Fasciculus, (AF, purple).



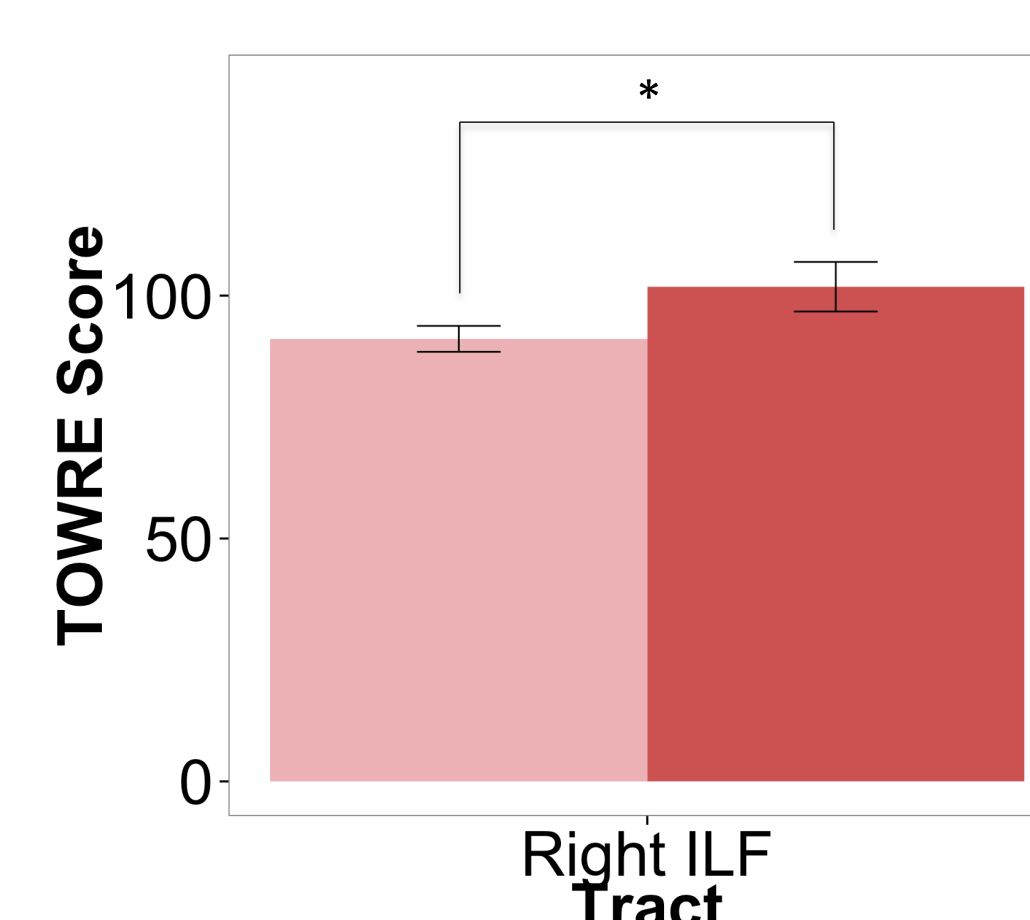
**Figure 2:** Average FA in left ILF, SLFP, SLFT and Right ILF significantly higher in TD children compared to ASD children.

### Correlation between Phonological Ability and Language Tract FA

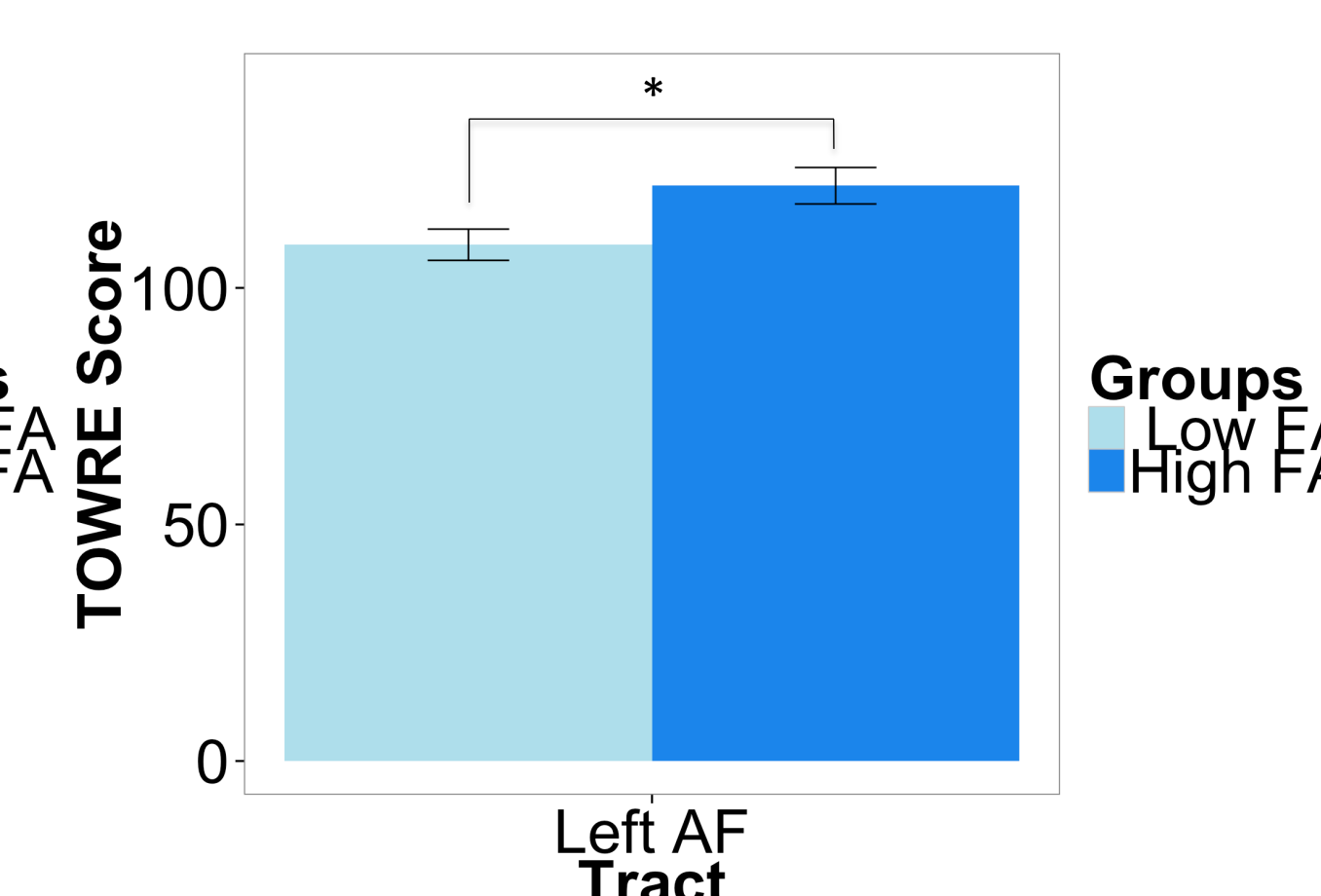


**Figure 3:** Average FA correlate with phonological ability in ASD but not TD. Spearman's rho and p-values for the whole participant pool (ASD + TD) are shown on the plots.

### Right ILF Distinguishes Reading Ability in ASD



### Left AF Distinguishes Reading Ability in TD



**Figure 4:** Average FA in right ILF ( $p=0.047$ ) distinguish ASD children with lower and higher reading abilities. Average FA in left SLFT ( $p=0.017$ ) distinguishes TD children with lower and higher reading abilities. None of the other tracts are associated with reading scores.

### Results

- A) Average FA was significantly higher in the TD group compared to the ASD group in left ILF ( $FDR-p=0.043$ ), left SLFP ( $FDR-p=0.043$ ), left AF ( $FDR-p=0.043$ ), and right ILF ( $FDR-p=0.043$ ).
- B) Overall, average FA values in all four tracts correlated with phonological ability. In ASD, average FA in left ILF ( $\rho=0.39$ ,  $p=0.028$ ), left AF ( $\rho=0.36$ ,  $p=0.033$ ), right ILF ( $\rho=0.39$ ,  $p=0.025$ ) correlated with phonological ability. In TD, none of the tracts correlated with phonological ability.
- C) In ASD, participants with higher-than-median FA in right ILF scored higher on the TOWRE assessment. In TD, participants with higher-than-median FA in left AF scored higher on the TOWRE assessment. Right ILF did not relate with behavior in TD and left AF did not relate with behavior in ASD.

### Conclusion and Discussion

- A) The ASD group exhibits lower FA in left AF, left SLFP and bilateral ILF, compared to TD.
- B) All four language tracts are associated with phonological ability. However, only the ASD group showed significant positive correlation between the tract FA values and phonological ability.
- C) Reading ability is further associated with the FA values of right ILF in ASD and the FA values of left AF in TD.
- Overall: White-matter structural abnormalities, especially in the right ILF, is associated with phonological and reading deficits in children with ASD.

### References

- [1] Kjelgaard, M. & Tager-Flusberg, H., *Lang. & Cogn. Proc.*, 2001.
- [2] Yeatman, J., Dougherty, R. et al. *J. of Cogn. Neuro.*, 2012.
- [3] Saygin, Z., Norton, E. et al. *J. Neurosci.*, 2013.
- [4] Yendiki, A., Panneck, P. et al. *Frontiers in Neuroinform.* 2011.
- [5] Hickok, G. and Poeppel, D. *Cognition*, 2007.
- [6] Glasser, M. and Rilling, J. *Cerebral Cortex*, 2008.