Tract Profiles of White Matter Properties: Automating Fiber-Tract Quantification

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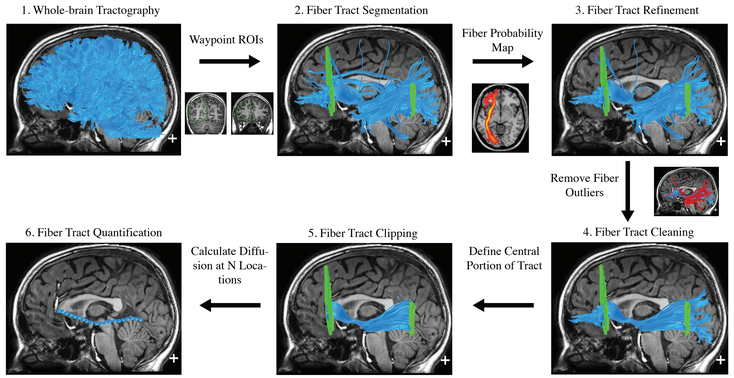
- Introduction -

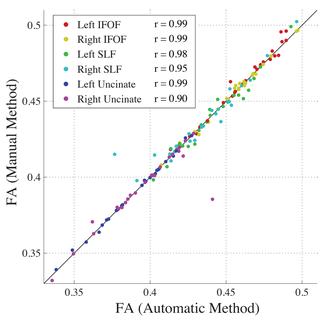
- A major goal of clinical neuroimaging research is to make measurements that can accurately diagnose or characterize clinical conditions and predict clinical outcomes
- Achieving this goal requires an efficient procedure to (1) identify equivalent brain structures in healthy controls and individual patients and (2) measure biological properties of the structures that are sensitive to clinical abnormalities
- We develop open source software for Automated Fiber-tract Quantification (AFQ) in individual brains from diffusion imaging data

- Methods -

AFQ Automated Fiber Tract Segmentation Proceedure



AFQ Produces Reliable Results

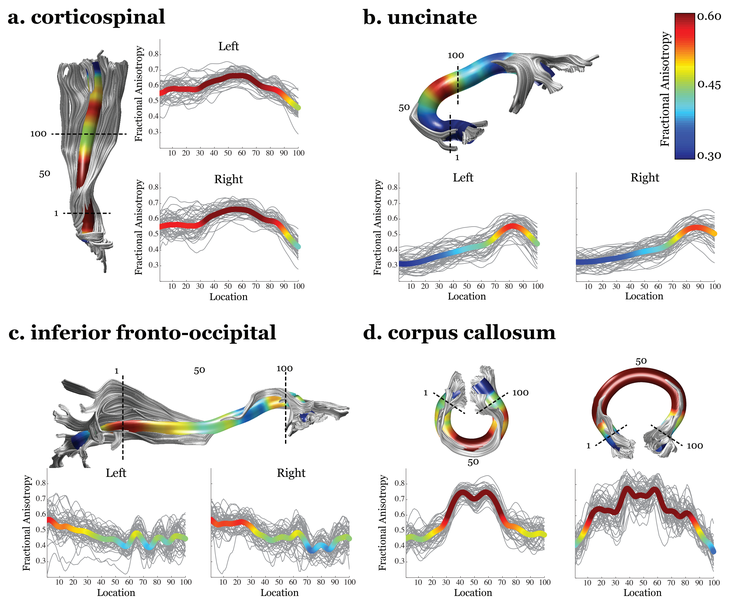


- AFQ can accurately identify fiber tracts in children born preterm with white matter injury
- AFQ automated segmentations are consistent with time consuming manual segmentations
- AFQ results are reliable in an individual over time (r = 0.93)

Subjects and Data

- Subjects: N = 48 typically developing children, N = 27 children born prematurely. Ages 9 - 16 years
- DWI data: 3T GE Signa Excite, 2x2x2 mm voxels, 30 diffusion directions (b = 900), 4 repeats
- Behavioral tests: Woodcock Johnson (reading), WASI (IQ)

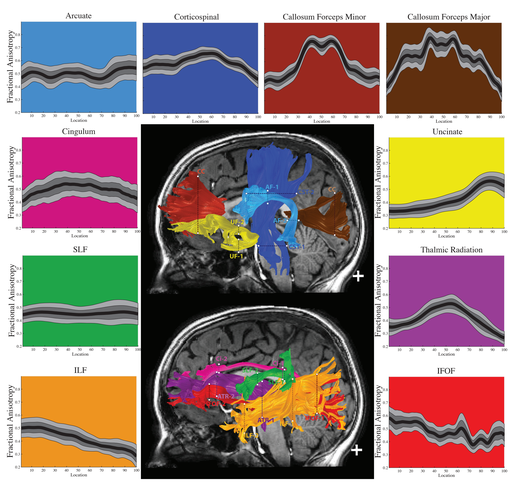
- Tract Profiles of White Matter Properties -



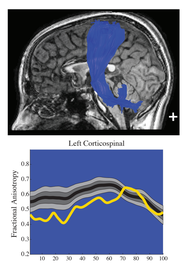
- A fascicle is like a highway: Populations of axons merge, diverge and cross the fascicle at distinct locations.
- Tract profiles have a consistent shape that reflects these local changes

- Detection of White Matter Abnormalities -

Standardized Tract Profiles

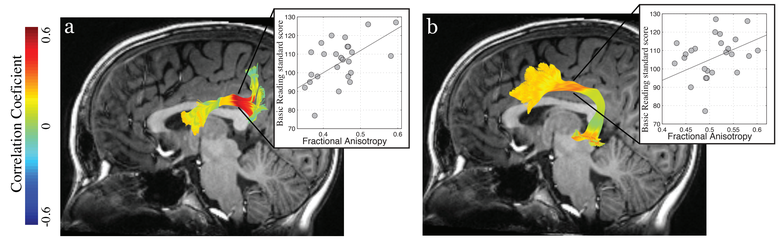


Analyzing the Individual: 12 year old with cerebral palsy



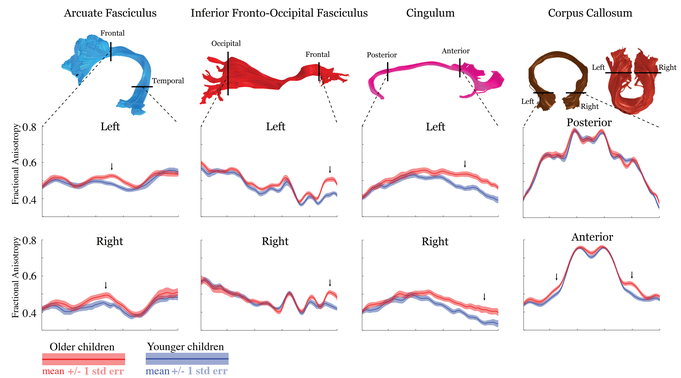
Abnormalities can be detected in patients by comparing their data with Standardized Tract Profiles

- Predicting Reading Outcomes -



- Preterm birth is associated with white matter injury and reading disability
- Spatially localized diffusion measurements on the left arcuate and superior longitudinal fasciculus predict reading proficiency in preterm children
- This analysis provides a framework for predicting an individual patient's outcome based on their deviation from normative measurements

- Tract Profile Development -



- Rate and timing of white matter development vary along the tract
- Might reflect the development of localized axons populations within the tract

- Conclusions -

- AFQ can localize abnormalities and predict behavioral outcomes in individual subjects based on diffusion weighted imaging data
- Tract Profiles are more sensitive to changes in tissue properties than are measurements of mean tract properties
- Future research will assess the sensitivity and specificity of "neuroprognosis" with AFQ for outcomes in autism, multiple sclerosis and dyslexia

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Open source software available at: https://github.com/jyeatman/AFQ
Documentation available at: http://white.stanford.edu/newlm/index.php/AFQ
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