White Matter Maturation In Early Brain Development

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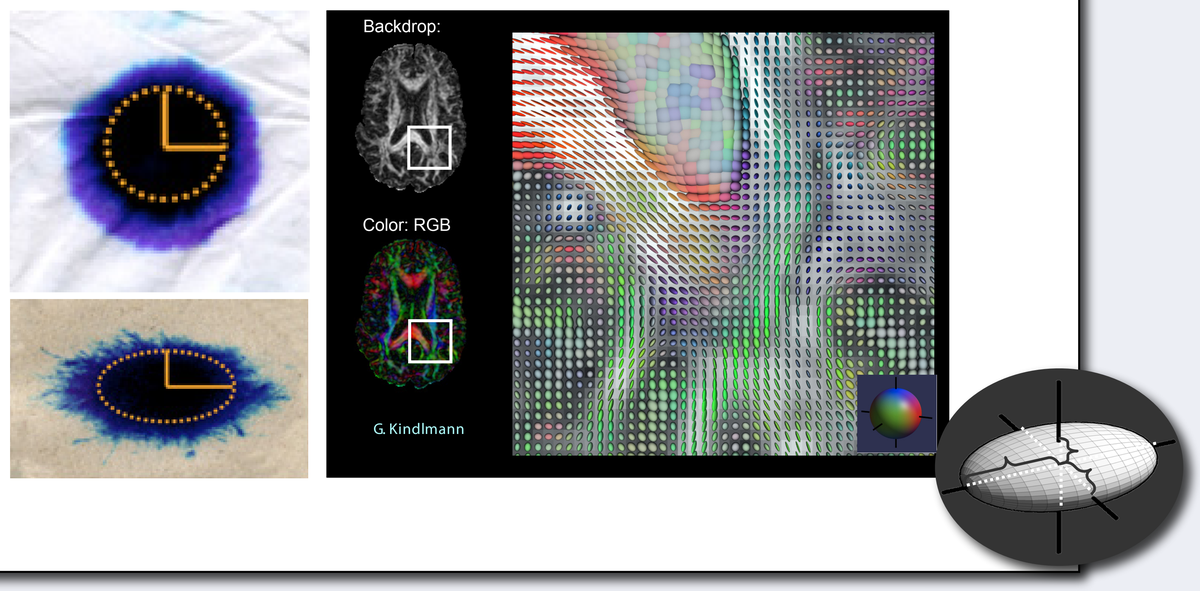
Motivation

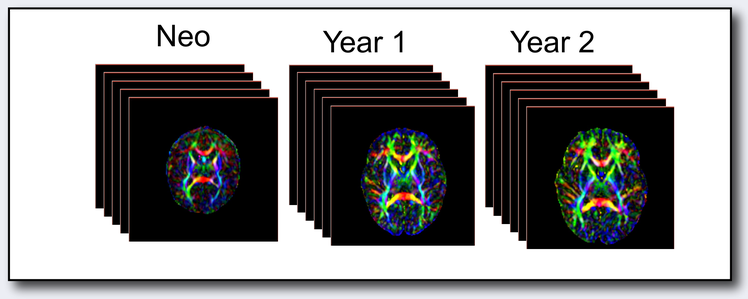
- Understanding of human brain development is of significant scientific and clinical importance
- Better understanding -> early diagnosis -> early therapy -> improve outcome

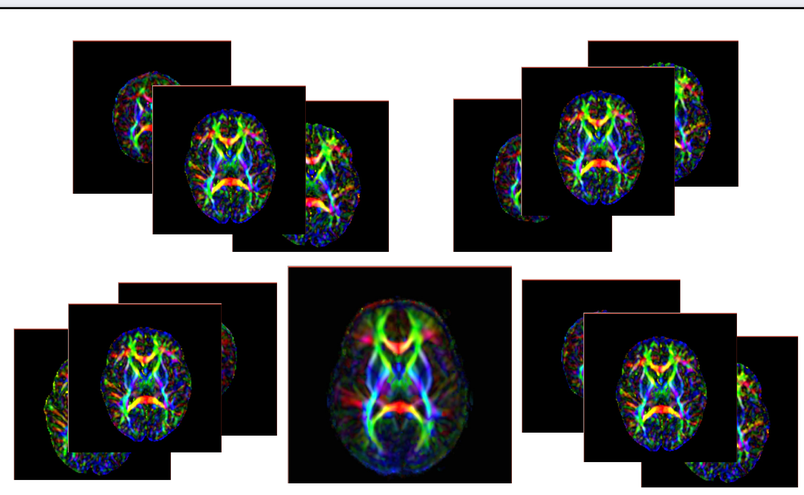
Method

- White matter tracts/regions are attributed to characteristic cognitive functions.
- Diffusion Tensor Imaging (DTI) reflects the underlying white matter connectivity.
- Characterizing longitudinal patterns of tissue properties in white matter regions has excellent potential to explain pattern of change in disease.



Develop normative model of maturation pattern along time as is reflected in the DTI

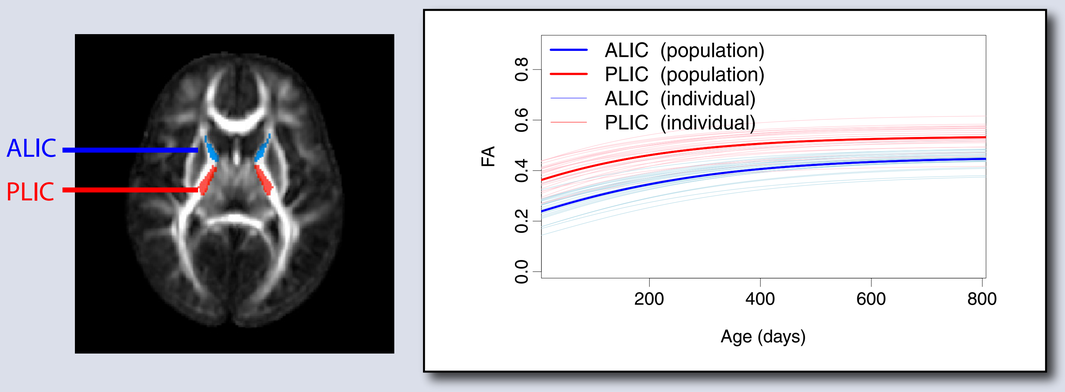




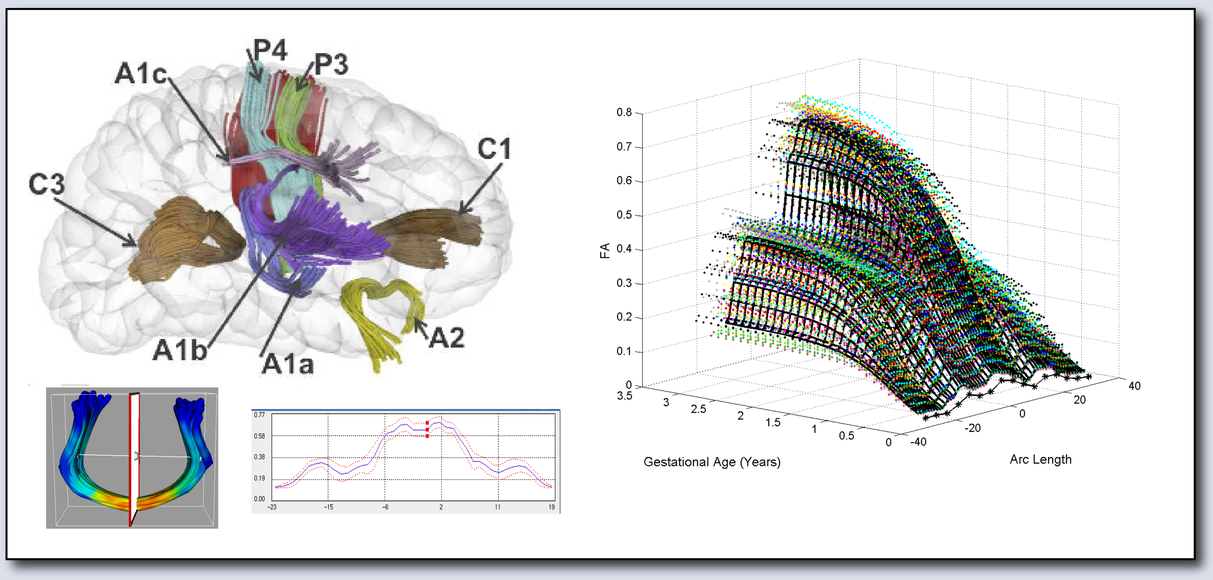
Coregistration of time (age), and subjects.

Normal Development

Modeling of typical diffusion changes over time.
Modeling of growth trajectories for individuals and population.



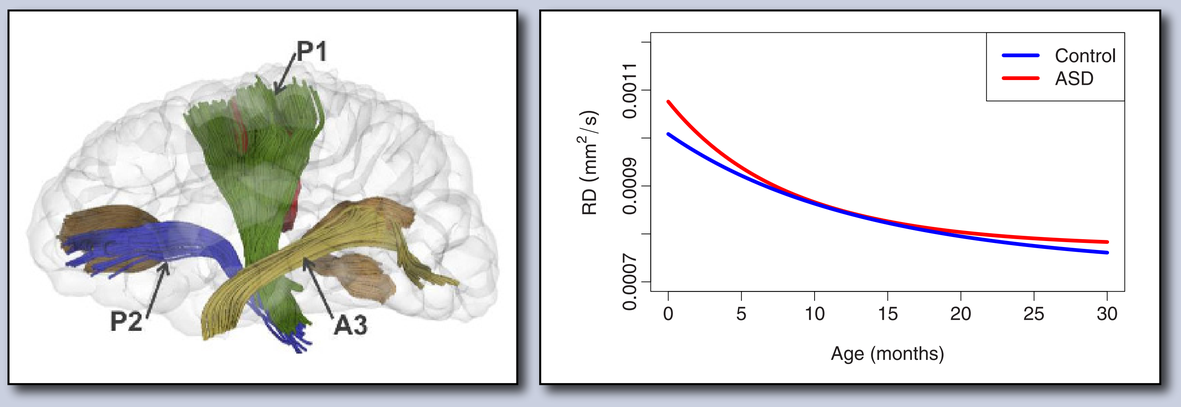
Difference in regional growth pattern of ALIC (anterior limb of internal capsule) shown in blue vs. PLIC (posterior limb of internal capsule) shown in red.



Diffusion changes along genu tract over time (shown by C1 in the above image).

Autism

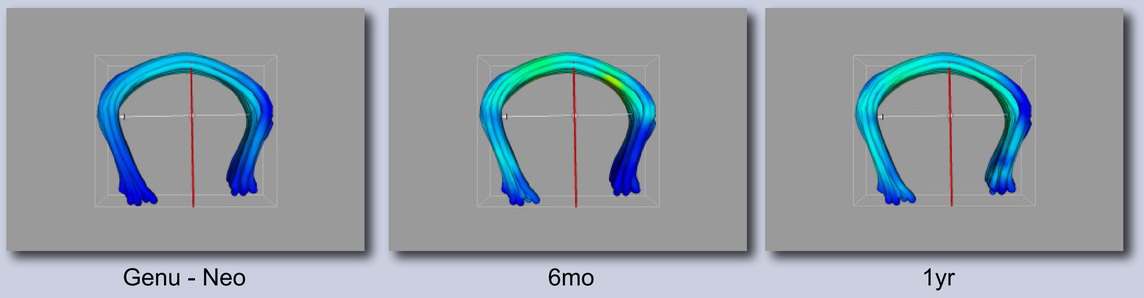
Autism spectrum disorder (ASD) is a developmental disorder,
usually characterized by difficulty in social interactions and/or repetitive behavior.



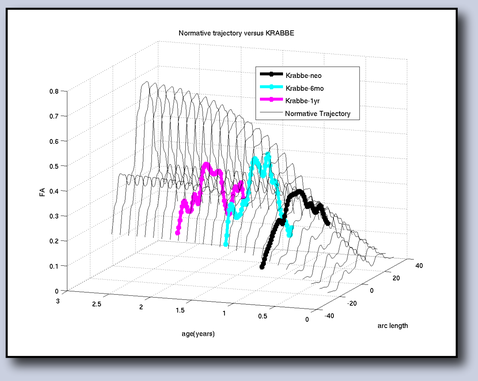
Above plot shows the comparison of typical developing brain vs. children diagnosed with autism spectrum disorder in the inferior longitudinal fasciculus tract (denoted as A3 in the left image). The ASD group has a higher RD (measure of diffusion perpendicular to white matter tract) value compared to the control group. The ASD group also shows a sharper decline in RD value at early age compared to the control group.

Krabbe's Disease

Degenerative disorder, affects the myelin sheath of the nervous system.
Often fatal within the first two years without a very early bone marrow transplant.



Genu - Neo | 6mo | 1yr



The plot to the left compares the genu tract from a typically developing brain vs. a child diagnosed with Krabbe's disease.

While a normal development shows increasing FA (a measure of directional diffusion) values over the first few years, the Krabbe's subject exhibits a decline of FA along the genu tract.

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