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.

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

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

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.

Develop normative model of maturation pattern along time as is reflected in the DTI
Coregistration of time (age), and subjects.

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

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.

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.

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.