



**Introduction**

The opposing trends in cerebral development and decline suggest that there is an age when cerebral performance will reach a maximum indicating the end of cerebral maturation and the beginning of cerebral decline. Here, we examined myelin and cerebral performance trends in a large population of subjects covering 9 decades of human life-span.

**Methods**

**Subjects:** 831 subjects (348/485 M/F) from 79 families, ages 10-90  
**Imaging:** Hi-res (1.7x1.7x3 mm) SE-EPI, 55 dir (b=0,700)  
**FSL DTI Processing:**

- Tensor fitting: FDT
- Intersubject Normalization: TBSS
- By tract-measurements: JH-DTI atlas (Figure 1)

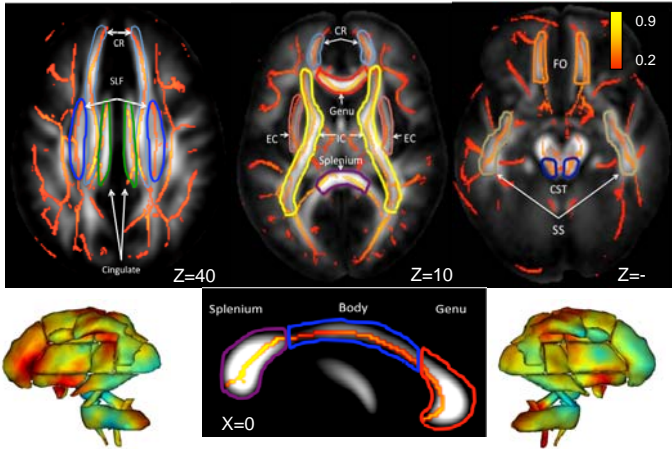


Figure 1. Average FA were calculated for 12 major WM tracts

**Results**

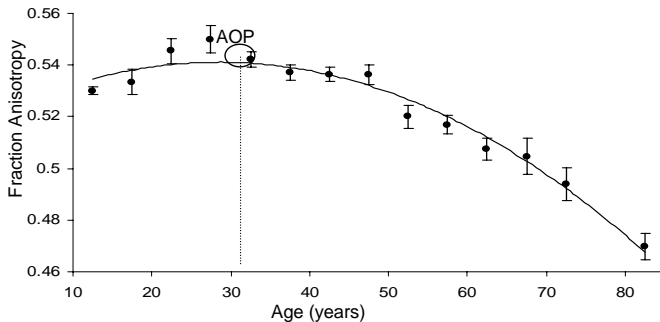


Figure 2. Whole-brain average FA values vs. age at 5-year intervals. Age at peak (AOP) is 32.1±5.9 years.

- FA measurements for all but one tract showed a quadratic trajectory
- The age of peak 23-39 y/o overlap with age of peak for cognitive function
- The rates of cerebral maturation and decline correlated (r=0.74, p<0.05)
- The rates of cerebral decline correlated with the age of peak

**Result (cont)**

Tract	Whole brain	CC	Cing	CR	CST	EC	IC	FO	SLF	SS
Average FA (FA units)	.52±.02	.66±0.04	.43±.02	.46±.02	.45±.004	.57±0.01	.55±.01	.52±.02	.43±.01	.42±.01
$\beta_{mat} \pm sd$ (p)	16.8±2.9*10 <sup>-4</sup> (2E-8)	31.9±3.5*10 <sup>-4</sup> (1E-8)	26.7±3.6*10 <sup>-4</sup> (2E-7)	13.5±2.6*10 <sup>-4</sup> (3E-7)	5.3±3.1*10 <sup>-4</sup> (0.003)	8.96±2.6*10 <sup>-4</sup> (0.0001)	8.9±2.4*10 <sup>-4</sup> (0.0003)	28.3±4.3*10 <sup>-4</sup> (1E-10)	10.9±2.7*10 <sup>-4</sup> (1E-4)	5.4±2.6*10 <sup>-4</sup> (0.04)
$\beta_{sen} \pm sd$ (p)	-.26±0.03*10 <sup>-4</sup> (1E-13)	.47±0.06*10 <sup>-4</sup> (1E-12)	.34±0.04*10 <sup>-4</sup> (1E-14)	.24±0.03*10 <sup>-4</sup> (1E-14)	.06±0.04*10 <sup>-4</sup> (3E-5)	.18±0.003*10 <sup>-4</sup> (1E-8)	.14±0.03*10 <sup>-4</sup> (1E-6)	.36±0.05*10 <sup>-4</sup> (2E-12)	.19±0.03*10 <sup>-4</sup> (1E-8)	.12±0.03*10 <sup>-4</sup> (1E-14)
$\beta_{mat} \pm sd$ (p)	156.04±68.0*10 <sup>-4</sup> (0.02)	198±123*10 <sup>-4</sup> (1E-11)	143±84*10 <sup>-4</sup> (1E-11)	43.8±58*10 <sup>-4</sup> (1E-11)	191±81*10 <sup>-4</sup> (2E-4)	68.5±39.0*10 <sup>-4</sup> (0.2)	127±56.8*10 <sup>-4</sup> (0.03)	167±97*10 <sup>-4</sup> (0.08)	89.6±62*10 <sup>-4</sup> (0.2)	48.8±38.8*10 <sup>-4</sup> (1E-4)
$\beta_{sen} \pm sd$ (p)	10.8±3.9*10 <sup>-4</sup> (0.01)	13.4±7.2*10 <sup>-4</sup> (1E-10)	14.6±4.9*10 <sup>-4</sup> (0.003)	3.2±3.4*10 <sup>-4</sup> (1E-3)	17.0±4.7*10 <sup>-4</sup> (3E-4)	4.0±3.4*10 <sup>-4</sup> (0.2)	7.6±3.3*10 <sup>-4</sup> (0.02)	9.5±5.7*10 <sup>-4</sup> (1E-1)	7.0±3.6*10 <sup>-4</sup> (0.05)	3.2±3.4*10 <sup>-4</sup> (0.3)
$\beta_{mat} \pm sd$ (p)	-14±0.1*10 <sup>-4</sup> (0.001)	.20±0.09*10 <sup>-4</sup> (1E-10)	-.18±.06*10 <sup>-4</sup> (0.001)	.06±.04*10 <sup>-4</sup> (1E-2)	.19±.05*10 <sup>-4</sup> (3E-4)	.05±.04*10 <sup>-4</sup> (0.2)	0.09±0.04*10 <sup>-4</sup> (0.02)	-.1±.07*10 <sup>-4</sup> (1E-1)	.08±.04*10 <sup>-4</sup> (0.07)	.02±.04*10 <sup>-4</sup> (0.6)
rF <sub>mat</sub> (p)	.49±0.5 (<1E-16)	.49±0.5 (<1E-16)	.45±0.0 (<1E-16)	.58±8.2 (<1E-16)	.17±5.5 (0.003)	.50±4.1 (<1E-16)	0.34±23.3 (<1E-16)	.37±6.7 (<1E-16)	.44±0.5 (<1E-16)	.40±0.7 (<1E-16)
Age of Peak ± sd (years)	32.1±5.9	33.8±6.3	39.4±5.8	27.9±5.7	N/A	25.6±7.7	31.7±9.3	38.9±6.6	28.8±7.6	23.1±1.6

Table 1. Results (value: sd (p-value)) of the quadratic modeling of the intersubject by-tract variability in FA values using general linear mixed effects model

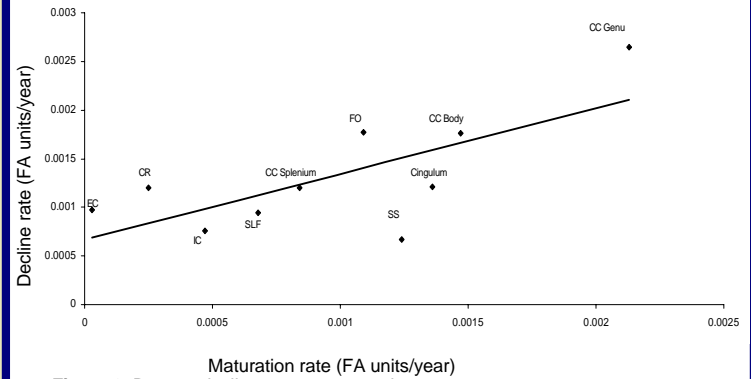


Figure 3. By-tract decline rate vs. maturation rate

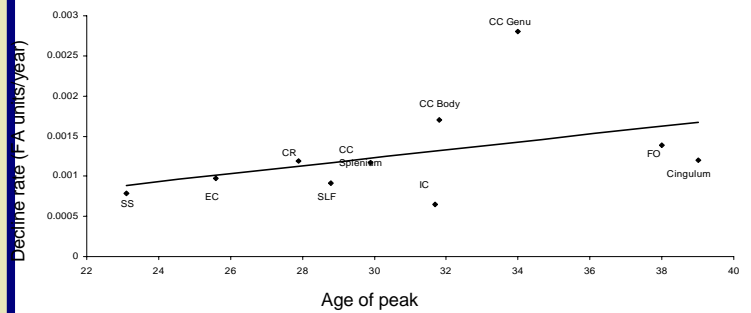


Figure 4. By-tract FA decline rate versus age of peak.

**Conclusions**

We carefully mapped the heterogeneity and heterochronicity of cerebral myelination trends in a large group of healthy subjects aged 11 to 90 years. We showed that the ages-of-peak (AOP) for the fractional anisotropy (FA) occur in the 3rd and 4th decades of life (23.1-39.4 years). The exception was the cortico-spinal tract that was seen to reach its adult myelination levels in childhood

**Acknowledgements**

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