Early Microstructural Maturation in the Human Perisylvian Regions

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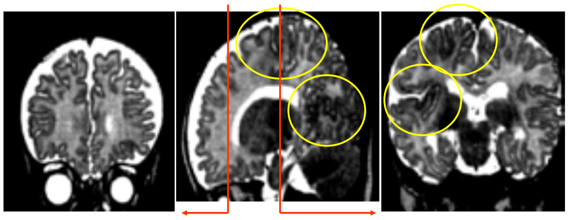
Introduction

We aimed at a better understanding of the early maturational events in the language areas. It could bring critical insight on language acquisition. During brain development, MRI T2-weighted signal decreases in the cortex due to a decrease of water content related to maturation. Based on normalised T2w signal, we here defined a maturation index and applied it to the perisylvian regions.



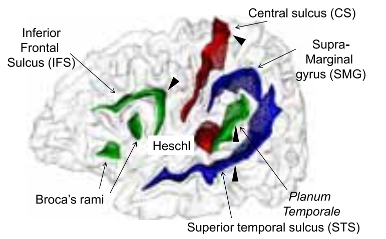
Dark areas (in *yellow* circles) in a 9-week-old infant MR image

Infant database

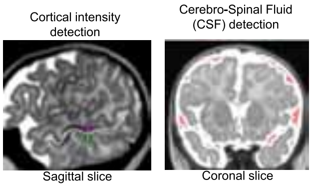
- 14 infants from 3 to 16 weeks of age
- T2 fast spin-echo sequence
- 1,5 T MRI system
- Axial + coronal + sagittal scans
- Slice resolution: 0.8 x 0.8 x 2mm

Method

Manual Drawing of Structures of interest



Defining a normalized maturation index (MI)



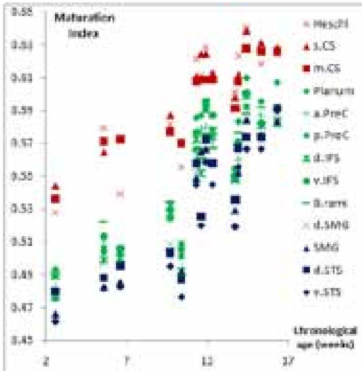
$$MI_{dorsal} = 1 - \frac{\text{Signal of dorsal cortex}}{\text{Signal of CSF}}$$

$$MI_{ventral} = 1 - \frac{\text{Signal of ventral cortex}}{\text{Signal of CSF}}$$

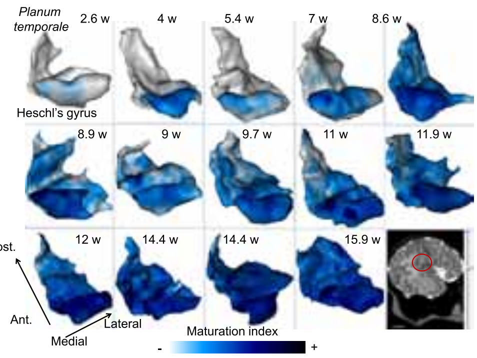
Results: Index variations with age

Perisylvian structures grouped by maturation level

- mature group
- intermediate group
- Immature group

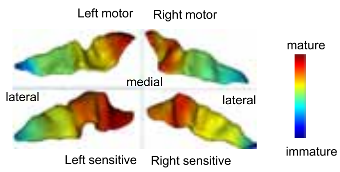


Left Heschl's gyrus and *planum temporale*



Sensitive and motor cortices

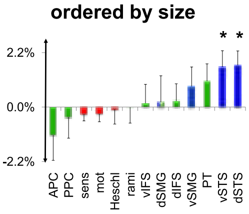
vSTS:	STS ventral lip;
dSTS:	STS dorsal lip;
dSMG:	Cortex dorsal to SMG;
dIFS:	IFS dorsal lip;
vIFS:	IFS ventral lip;
B.rami:	Broca's rami;
mCS:	CS motor lip;
sCS:	CS somato-sensitive lip



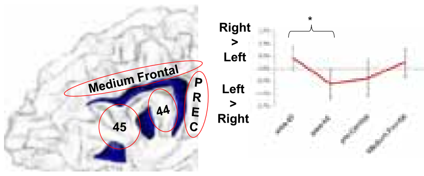
Results: Index asymmetries

APC:	Anterior to precentral sulcus
PPC:	Posterior to precentral sulcus
sens:	Somato-sensitive cortex
mot:	Motor cortex;
rami:	Broca's rami;
vIFS:	IFS ventral lip;
dSMG:	Cortex dorsal to SMG;
dIFS:	IFS dorsal lip;
PT:	*Planum temporale*
vSTS:	STS ventral lip;
dSTS:	STS dorsal lip;

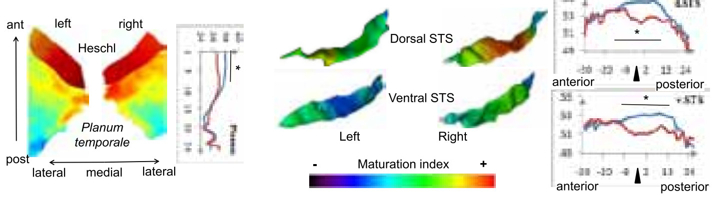
Asymmetry coefficients ordered by size



Significant asymmetry gradient between areas 44 and 45 in Broca regions



Maturation lag of the left temporal cortices (*red curves*) behind the right (*blue curves*)



Conclusion

We detected Heschl's gyri and central regions as the most mature regions, as it can be expected from primary cortices.

Less expectedly, inferior prefrontal regions were nearly as mature as the *planum temporale* and significantly in advance relatively to the STS. It suggests that Broca's region might be a key actor of language learning.

By contrast, the left superior temporal sulcus showed a delayed maturation which could offer the native language a longer time-window to shape the linguistic representations.