Microstructural development of human primary and nonprimary auditory cortex during the perinatal period

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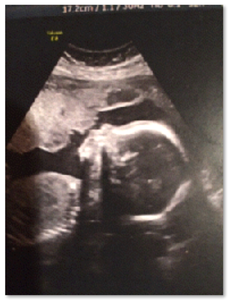
Introduction



The human auditory system undergoes a period of rapid neurodevelopment *in utero*.

Postmortem histology has provided insight into the structural maturation of auditory cortex during this period. Neuroimaging can reveal structural maturational processes *in vivo*.

Aim

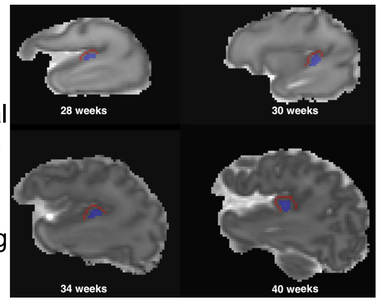
To characterize the maturational timeline of auditory cortex during the perinatal period.

To compare maturational timelines for primary (pAC) and nonprimary auditory cortical (nAC) regions.

To examine the effect of preterm birth on auditory cortex maturation.

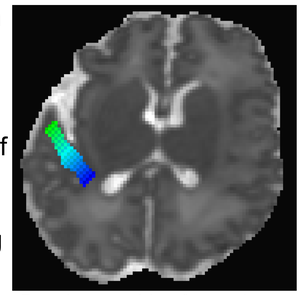
Method

- Usable data collected for 90 preterm infants (birth gestational age <30 weeks) who underwent MR imaging up to 4 times during NICU stay, from 26 to 42 weeks PMA



Regions of interest located in Heschl's gyrus at different ages

- Multi-shell acquisition at 48 directions
- Maturation of gray and adjacent white matter along the axis of left hemisphere Heschl's gyrus measured *in vivo* using diffusion weighted image analysis



Putative transition from primary to nonprimary auditory cortex

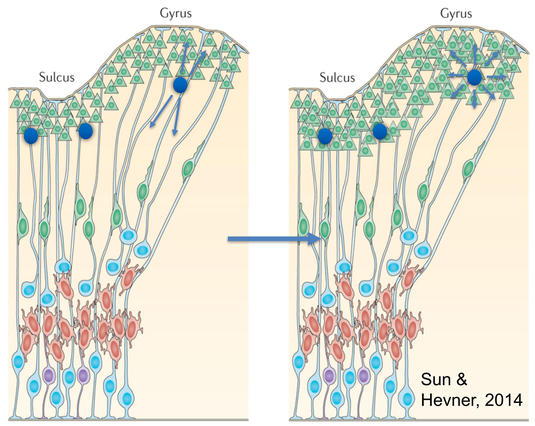
Diffusion MRI and Cortical Maturation

Diffusion MRI measures random motion of water molecules within tissue.

Parameters obtained include: fractional anisotropy (FA) and mean diffusivity (MD).

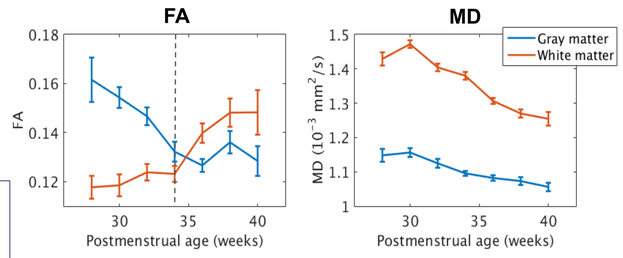
isotropic anisotropic

Human cortex



In developing *gray* matter, FA starts high (due to the radial structure of radial glia) and *decreases* with time; MD also *decreases* with time due to increasing neuron density and decreasing water content.

In developing *white* matter, FA starts low and *increases* with time due to myelination and precursors to myelination; MD *decreases* with time due to increasing cell density and decreasing water content.



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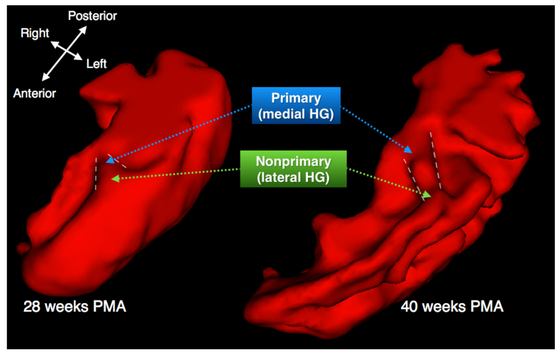
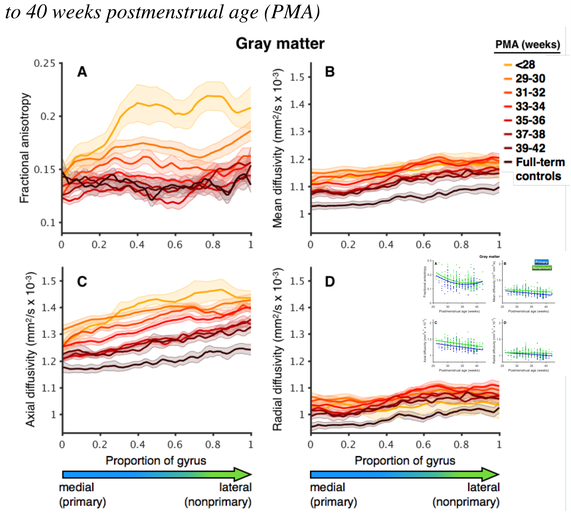
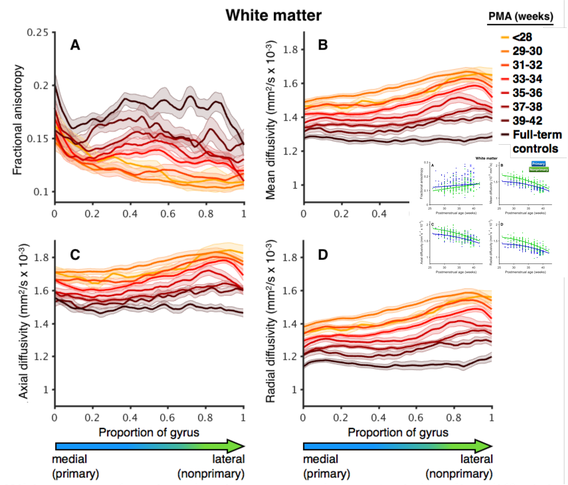
Results



Development of Heschl's gyrus (HG) macrostructure from 28 weeks to 40 weeks postmenstrual age (PMA)

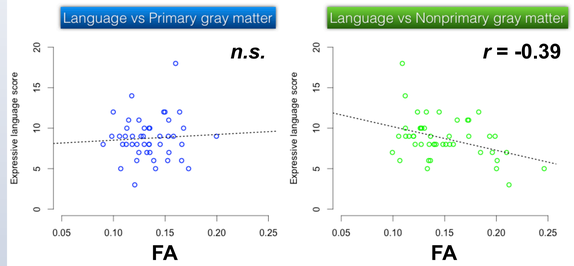


Gray matter fractional anisotropy and mean/axial/radial diffusivity changes along Heschl's gyrus by age group



White matter fractional anisotropy and mean/axial/radial diffusivity changes along Heschl's gyrus by age group

Results (continued)



Relationship between gray matter maturation in infancy (as measured by FA) and language development at age 2 years.

Conclusions

pAC matures in advance of nAC.

As a result, nAC exhibits more rapid maturational changes in diffusion measures from 26 to 42 weeks PMA than pAC.

Premature birth is associated with higher diffusivity values in pAC and nAC at term age, consistent with a delay in maturation of cortical microstructure in preterm infants.

A rapid maturation rate during the perinatal period may render nAC white matter more vulnerable to disruption or injury.

nAC (but *not* pAC) maturation in infancy is associated with language development at age 2.

References

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