Altered Structural and Functional Connectivity in Late Preterm Preadolescents

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Target Audience
Researchers who are interested in brain development, connectomics and those who model brain network topology using DTI and fMRI methods.

Purpose
Long-range corticocortical and thalamocortical connections form the basis for the default mode network (DMN) and other brain networks. These networks undergo critical periods of development during the third trimester of fetal gestation. Preterm birth is a risk factor for injury to the developing white matter and it is not known how such injury affects the long-term development of these networks or network topology. We hypothesized that preadolescent children who were born preterm would have a decrement in long-range inter- and intrahemispheric connectivity, and concomitantly, a decrease in the overall efficiency of their functional connectome.

Methods
The participant population consisted of a community sample of pre-adolescent twin pairs (ages 9-13 years) born late preterm (>32 weeks) and at full term recruited from a developing region in northeast Brazil (Montes Claros, pop. ca. 410,000) as part of an ongoing longitudinal international collaborative research program investigating the genetic and environmental influences relating prematurity, long-term neurocognitive functioning and health outcomes.

MRI scanning was performed on a Philips 1.5T Achieva system. DTI scans were acquired with the following parameters: TR = 6000 ms, TE = 90 ms, slice thickness = 2 mm, matrix = 112 X 112, FOV = 22.4 X 22.4 cm, b value = 1000 s/mm^2; 32 diffusion-encoding gradients. Pre-processing included motion and eddy current correction and slice dropout removal according to routines written in FSL. Diffusion tensor components were computed and fractional anisotropy (FA), axial diffusivity (AD), and radial diffusivity (RD) maps were spatially normalized into MNI space. Only voxels with FA > 0.2 and white matter mask with FA > 0.9 were retained for further analysis in order to minimize false positive errors.

Conclusion
This is the first study, to our knowledge, to apply multimodal DTI and fMRI to examine the longitudinal impact of preterm birth on the preadolescent connectome. Prior research has demonstrated that the white matter adjacent to the anterior horn and trigone of the lateral ventricles, regions that contain a number of crossing fiber bundles including those containing fibers connecting the DMN hub regions to other cortical and subcortical hubs, is exquisitely vulnerable to injury in preterm infants. Here, using voxelwise DTI analyses, we demonstrated that preterm birth was associated with differences in the tissue microstructure of these regions in a sample of preadolescent children. Furthermore, these changes were associated with decreased interhemispheric connectivity of the posterior DMN hub regions, and concomitantly, with decreased cost-efficiency in the network topology of the functional connectome.

References:

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