

ORAL SESSION: Early Development

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Oral Sessions

Presentations

Tracking white matter development in the human fetus

During the third trimester of human gestation, rapid neurodevelopment occurs which is underpinned by fundamental developmental processes including neuronal migration, cellular organisation, cortical layering and myelination. In addition, white matter bundles are established and lay the foundation for an efficient network of structural connections. Disruptive processes in this juncture such as maternal stress and preterm birth can lead to abnormal white matter development and adverse consequences for later cognitive function and behaviour (1–3). However, there is limited understanding about the normal developmental trajectory of white matter in the healthy fetal brain, which is critical to act as a reference for studies of prematurity or neurodevelopmental abnormalities. Using state-of-the-art high resolution multi-shell diffusion-weighted magnetic resonance imaging (dMRI) collected as part of the Developing Human Connectome Project (dHCP) we aimed to characterize the in-utero maturation of white matter microstructure in 114 foetuses (gestational age range 22 to 37 weeks). We hypothesized that maturation within specific white matter tracts would be reflected in significant developmental changes in proxy measures of the underlying microstructure (fractional anisotropy (FA) and mean diffusivity (MD)).

Presenter

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Perinatal imaging
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High temporal resolution longitudinal observation of fetal brain development. A baboon pilot study

Cortical morphology has emerged as potential provider of useful biomarkers for the diagnosis of developmental pathologies or psychiatric disorders. Unfortunately, the very large inter-subject variability of the cortex is a strong limitation to the definition of normality intervals and to the detection of pathological abnormalities. It is therefore a critical challenge to understand how this variability emerges throughout development. Most folding patterns are already formed at birth and do not change during childhood and adolescence [1]. The pre-natal period is therefore critical, and we need to observe the developmental history of cortical folding with two constraints. First, morphogenesis needs to be observed longitudinally in order to not confound individual developmental history and the emergence of inter-individual variability. Second, because of the fast rate of change and the lack of knowledge on the timing of critical events, morphogenesis needs to be observed at a high temporal resolution. Here we present a pilot for a study that aims at observing and quantifying cortical development under these two constraints. Since it is not possible to perform such study on human subjects, this has been done with a female baboon (*Papio Anubis*).

Presenter

Olivier Coulon, Université Aix-Marseille/CNRS - Institut de Neurosciences de La Timone Marseille, N/A
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The Developing Human Connectome Project: functional connectivity across the perinatal period

The Developing Human Connectome Project (dHCP) is an Open Science project providing the first large sample of neonatal fMRI data with high temporal and spatial resolution. This data enables mapping of intrinsic functional connectivity between spatially distributed brain regions under normal and adverse perinatal circumstances, offering a framework to study the ontogeny of large-scale brain organisation in humans across this critical period of development. Here, we characterise in unprecedented detail the maturation and integrity of functional resting-state networks (RSNs) at normal term age in 337 infants (including 65 born preterm), addressing two key questions: i) Are higher-order RSNs such as the default-mode network (DMN) instated with adult topology in the neonatal period? Some find analogues of these at term-equivalent age (TEA) (Fransson et al., 2007; Doria et al., 2010; Smyser et al., 2016) while others locate their origin in later infancy or early childhood (Gao et al., 2015). ii) What is the effect of preterm birth on RSN development? Various alterations in the complexity, scope, strength and efficiency of functional connectivity in preterm-at-term infants have been reported (Doria et al., 2010; Toulmin et al., 2015; Ball et al., 2016; Smyser et al., 2016), but the majority of studies lack the large numbers of control subjects required to characterise these effects with precision.

Presenter

Michael Eyre, King's College London London, London
United Kingdom

Discovering developmental patterns and regionalization of cortical myelin during the first two years

The cortical myelination process during infancy is important for later cognitive maturation [1,2,3], yet has not been well understood due to lack of high-quality MRI data and adequate processing techniques for infant brains. To fill this gap, we compute the first spatiotemporal dynamic maps of cortical myelin, by leveraging the UNC/UMN Baby Connectome Project (BCP) and tailored image analysis techniques. Meanwhile, based on the development of cortical myelin, we divide the cerebral cortex into a set of distinct regions.

Presenter

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CHAPEL HILL, NC
United States

The subgrouping structure of newborns with heterogenous brain-behavior relationships

The existence of heterogeneity/subgroups in infants and older children based on single-domain brain or behavioral characterizations has been previously characterized^[1,2]. However, few attempts have been made to explore the presence of heterogeneity at the brain-behavior relationship level. Such a hypothesis posits that different subgroups of infants may possess qualitatively different brain-behavior relationships that could ultimately lead to divergent developmental outcomes. In this study, we aimed to explore such relationship-level heterogeneity and delineate the subgrouping structure of newborns with differential brain-behavioral associations.

Presenter

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Brain Function in the Pre-Adolescent Brain: Results from the ABCD Study.

The Adolescent Brain Cognitive Development Study (ABCD; www.ABCDstudy.org) is a 10-year longitudinal study of 11,880 children recruited at ages 9 and 10. A battery of neuroimaging tasks are administered biennially to track neurodevelopment, assess the impact of numerous genetic, psychological and environmental influences on development, and identify individual differences in brain function that precede or follow outcomes of interest in this cohort. This study reports cortical and subcortical analyses of the ABCD task fMRI battery at the study's first acquisition time point. We focus on: a) the patterns and magnitude of brain activity as predicted by prior research

in adolescent samples; and b) the reproducibility of activation patterns, including an assessment of group-level consistency as a function of sample size.

Presenter

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