Functional connectivity of the basal ganglia in the preterm brain is established by term age

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Background: The basal ganglia segregate into specific circuits identified through connectivity with the thalamus and anterior cortical regions (Alexander & Crutcher, 1986) mirroring the rostral-caudal organization of cortical networks (Verstynen et al, 2008). These circuits are structurally established during prenatal development and this normal development may be interrupted in infants who experience the environmental stress of premature birth, as basal ganglia volume is consistently reduced compared to term controls at follow-up (Peterson et al, 2000). Here we characterise the pattern of functional connections from basal ganglia to cortical networks in a large cohort of preterm infants.

Methods: Resting state fMRI data (TR=1.5s, TE=45ms, 256 volumes) were collected in 137 children born preterm (gestational age range 24-32 weeks) and scanned at term (post-menstral age range 38-52 weeks). Using group independent component analysis, we first defined cortical networks with dominant activity in anterior regions of the brain (from somato-sensory cortex onwards, Haber and Knutson 2010) and then segmented the basal ganglia into distinct parcels based on maximal functional connectivity with these networks across individuals.

Results: Patterns of connectivity from basal ganglia to cortical networks followed a rostral-caudal gradient (see figure). Across subjects, territories were clearly delineated and bilaterally consistent.

Conclusions: At term equivalent age, segments or bands of striatal and pallidal structures corresponded to the spatial pattern observed in invasive animal and non-invasive human experiments. These patterns seem to be established early, prior to the maturation of the cortical networks itself. The basal ganglia in particular are vulnerable to injury in prematurity with specific motor and cognitive problems arising during development. Characterising their connectivity at birth may help to predict later outcomes in those with perinatal brain injury.

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