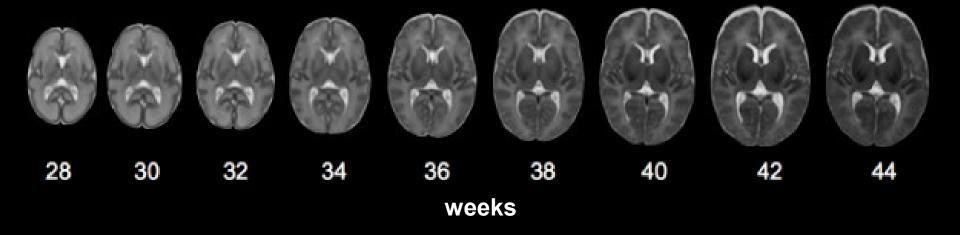# Developing brain

James Boardman FRCPCH PhD

MRC Centre for Reproductive Health

Centre for Clinical Brain Sciences

University of Edinburgh
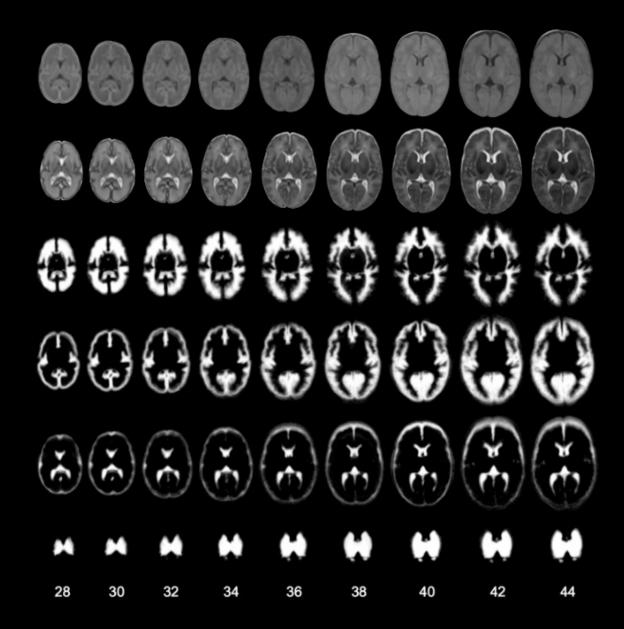

28 30 32 34 36 38 40 42 44

weeks

Current and potential uses of perinatal MRI

- Define typical / atypical phenotypes and trajectories
  - Disease specific eg preterm birth
  - Early life origins
    - Neuropsychiatric disease
    - Vulnerability / resilience to neurodegeneration and poor cognitive ageing

- Biomarker development
  - Identification of 'at risk' groups. Early intervention during a period of high neuroplasticity may attenuate impairment in later life
  - Evaluation of neuroprotective strategies in RCTs

- Need for age specific spatio-temporal templates for early life

- Imaging genetics

- Developing human connectome

Current resources

- Single centre collections to study specific populations
  - Usually cross-sectional
  - Neonatal specific registration and segmentation algorithms, and dMRI processing pipelines.
  - Most (not all) processing pipelines are 'in-house'
  - 'Normal' data are few

- Some multi-centre data sharing for processing but no banks

- Neonatal component of BRAINS bank being developed

- Some atlases: eg T1 and T2, with probability maps 29-44 weeks

28 30 32 34 36 38 40 42 44

Serag et al NeuroImage 2012

Challenges & opportunities

- Acquisition
  - Marked intra and individual variation in head size and shape in early life
  - Movement artefact
  - Rapid changes in tissue contrast over early months associated with myelination, decreases in brain water, changes in tissue density
  - Low contrast to noise ratio between GM and WM
  - Resolution difficulties eg cortical complexity
  - Scanner variation and standardisation of sequences, QA of data
  - Metadata: linkage to population data (birth records / educational outcomes); biological / genetic data; neuropsychological outcomes; and adult health outcomes over decades

- Analysis
  - Number and timing of observations required to model growth accurately?
    - Successful modelling between 1-2 years using Jacobian determinant maps (Aljabar et al NeuroImage 2008)
    - Frequent observations required in early neonatal life (Serag et al NeuroImage 2012)
  - What is the optimal method for spatial normalisation and does this vary over the life course?
  - Interoperability of sMRI / dMRI

- Representation
  - How to map labels between 3D coordinate systems over the life course
  - Shape characteristics may not represent functional neuroanatomy consistently across the life span

- Expected gains from a life course image bank
  - Expedite replication studies
  - Expedite biomarker development
  - Increased power for investigating of pathways to injury, maldevelopment and resilience at a critical time in development
  - More precise estimates of the effect of genetic contributions to brain injury
  - Agree and improve availability of age specific templates
  - Early detection of 'at risk' groups
  - Development of computational methods that have wider application eg motion correction