

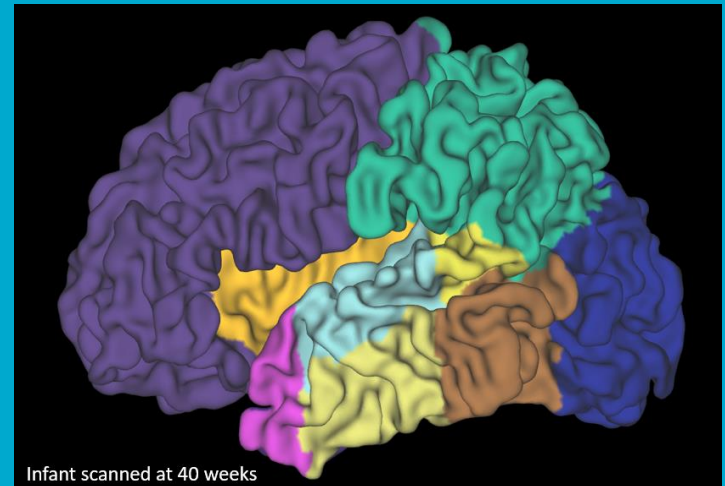
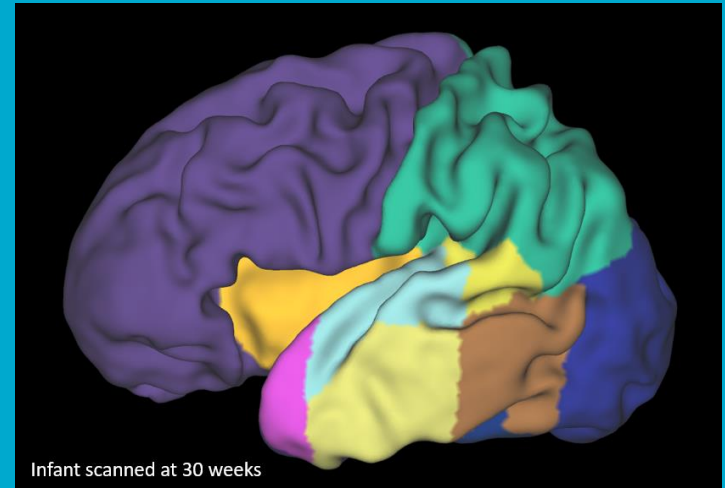


Australian e-Health
Research Centre

Improved prediction of outcomes in preterm infants

Alex Pagnozzi | 11/07/2023

Australia's National Science Agency



Preterm birth



- 8.5% Australian babies born <37 weeks*
- 1.6% Australian babies born <32 weeks*
 - 5-10% are later diagnosed with CP
 - Greater risk of cognitive, language, behavioural and motor problems

*Australian Institute of Health and Welfare: Mothers and Babies, 2016

Early Diagnosis of CP



Accurate prognosis is needed for selection of best possible interventions and result in best possible outcomes

The PPREMO study

- Cross-sectional cohort study of infants born <32 weeks
- Brain MRI and motor / neurological assessments at 30-32 weeks and at term equivalent age
- Follow-up assessments at 3 months, 12 months, 24 months CA
- Currently >270 infants recruited (including PREBO)
 - One of the world's largest and most comprehensive studies of preterm infants with advanced MRI (3T) early in life

George et al. *BMC Pediatrics* (2015) 15:123
DOI 10.1186/s12887-015-0439-z



STUDY PROTOCOL

Open Access



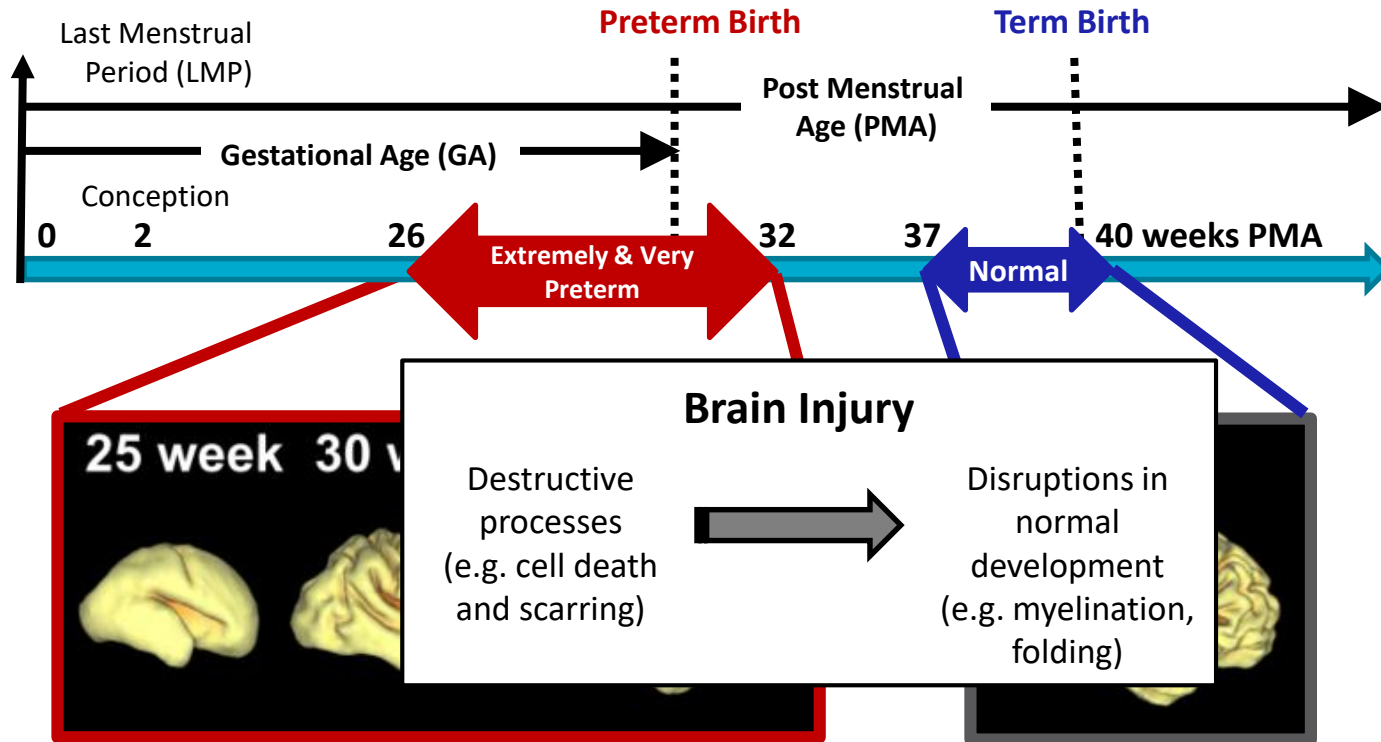
PPREMO: a prospective cohort study of preterm infant brain structure and function to predict neurodevelopmental outcome

Joanne M. George^{1*}, Roslyn N. Boyd^{1,8}, Paul B. Colditz², Stephen E. Rose³, Kerstin Pannek^{1,3}, Jurgen Fripp³, Barbara E. Lingwood², Melissa M. Lai², Annice HT Kong², Robert S. Ware^{4,5}, Alan Coulthard^{6,7}, Christine M. Finn¹ and Sasaka E. Bandaranayake⁸



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Preterm birth & brain development

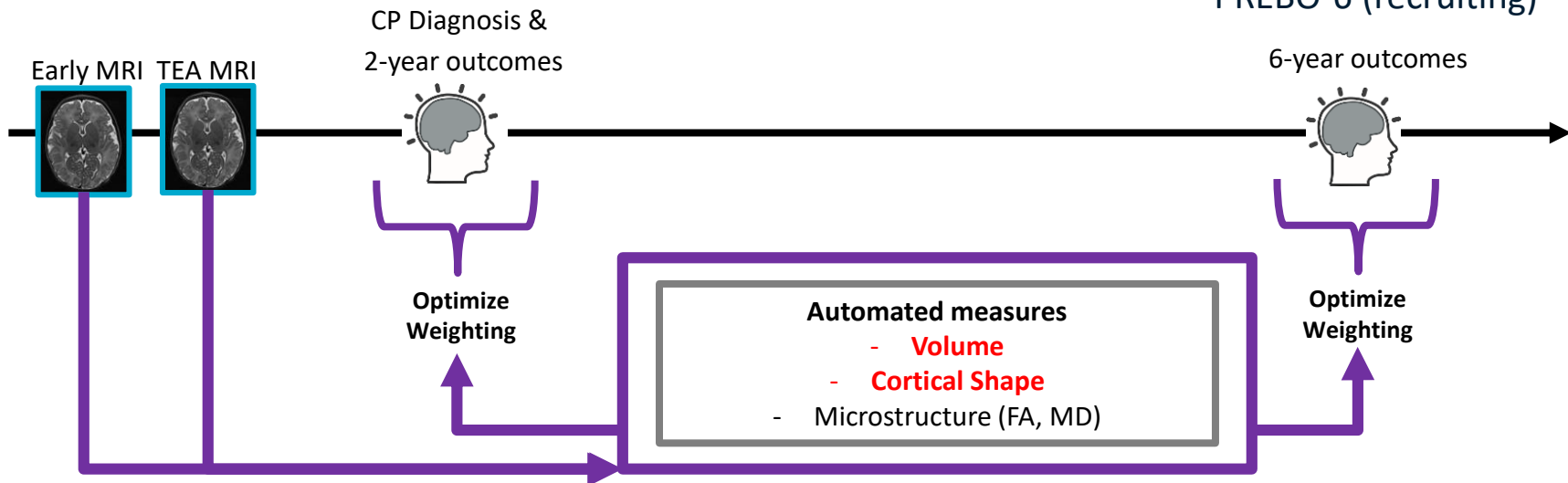


https://en.wikiversity.org/wiki/Fundamentals_of_Neuroscience/Development

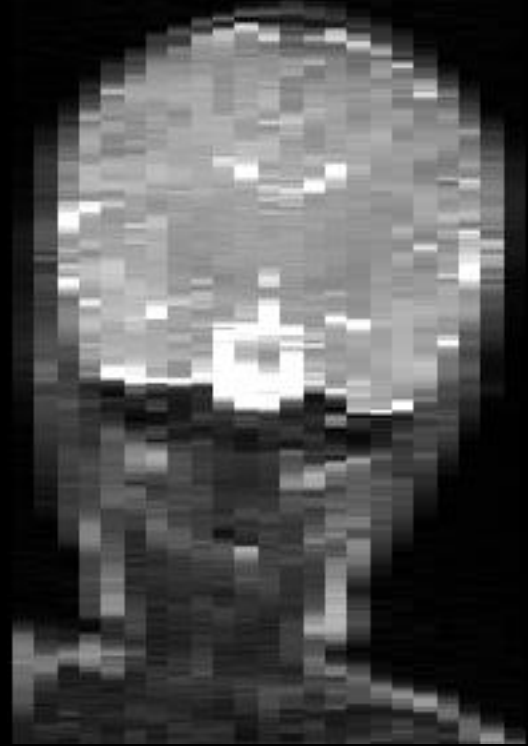
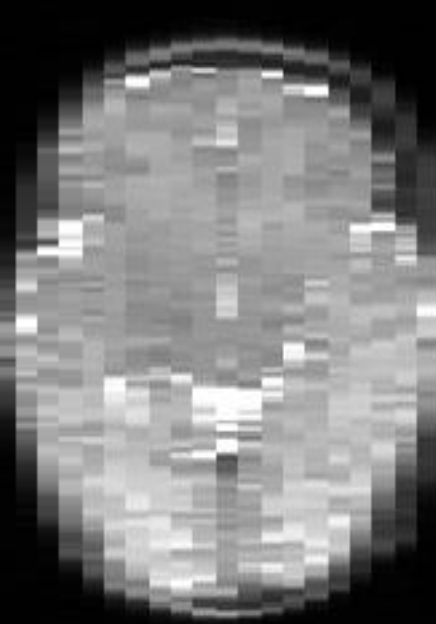
Early Diagnosis of CP

PPREMO/PREBO

PREBO-6: Prediction of childhood Brain Outcomes in infants born preterm using neonatal MRI and concurrent clinical biomarkers

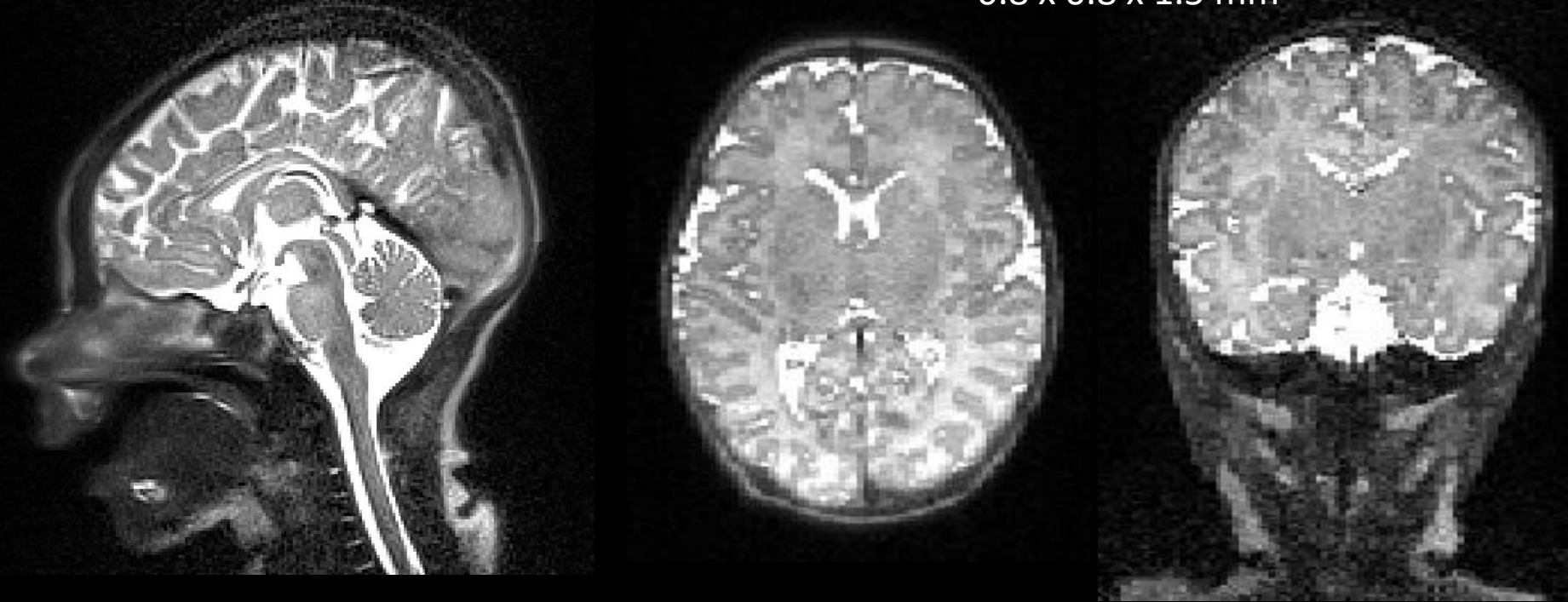


Technical challenges: image quality



Technical challenges: image quality

0.8 x 0.8 x 1.5 mm



Technical challenges: head motion

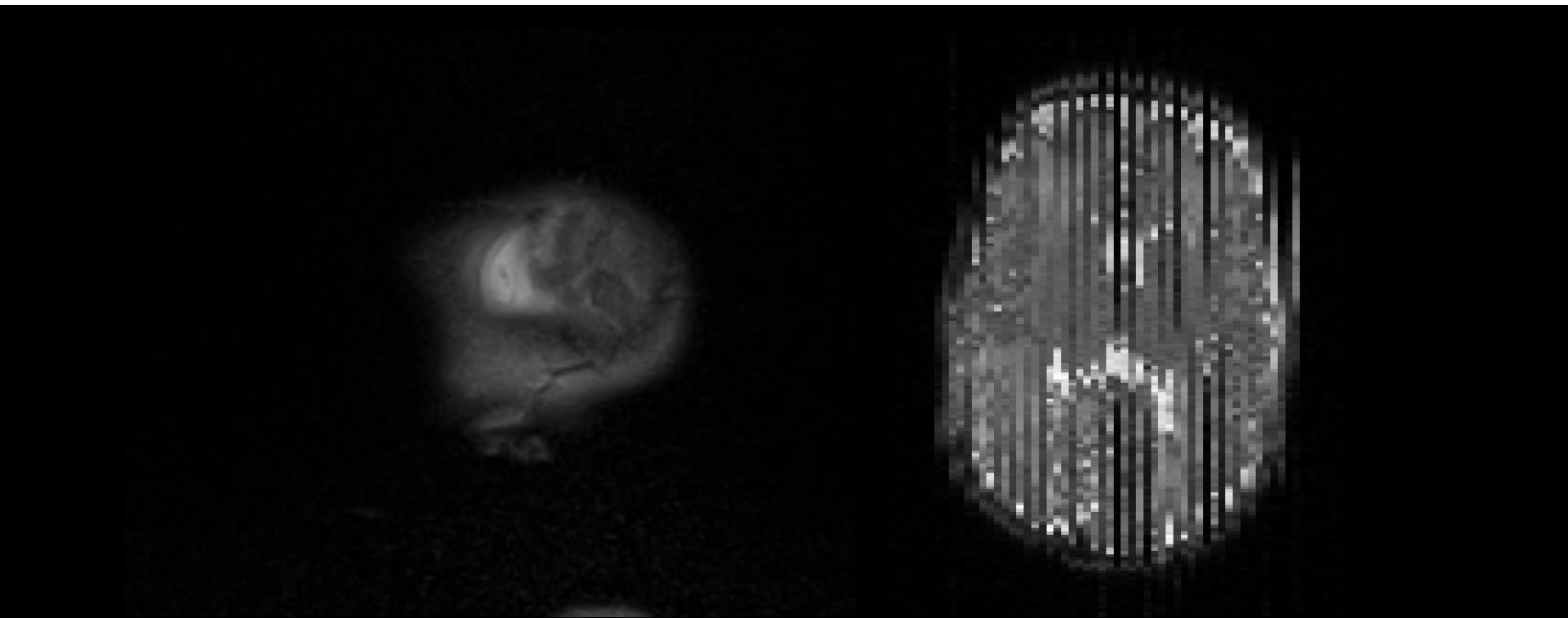
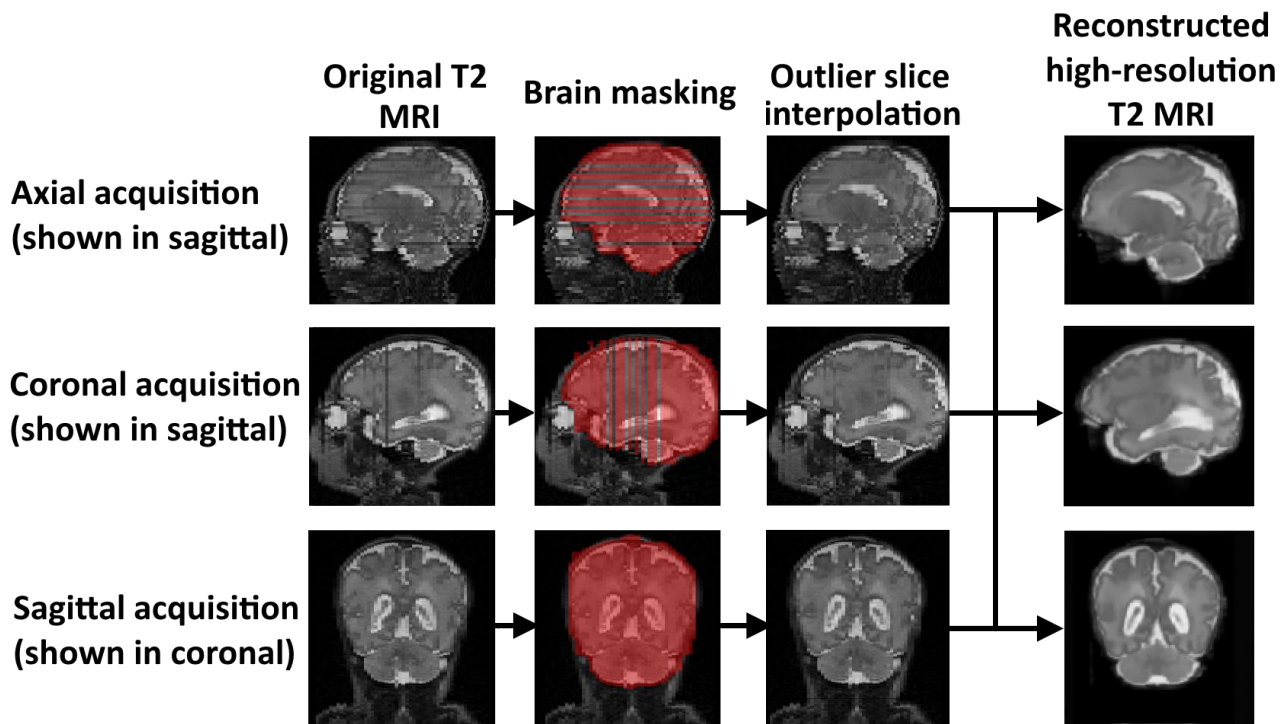
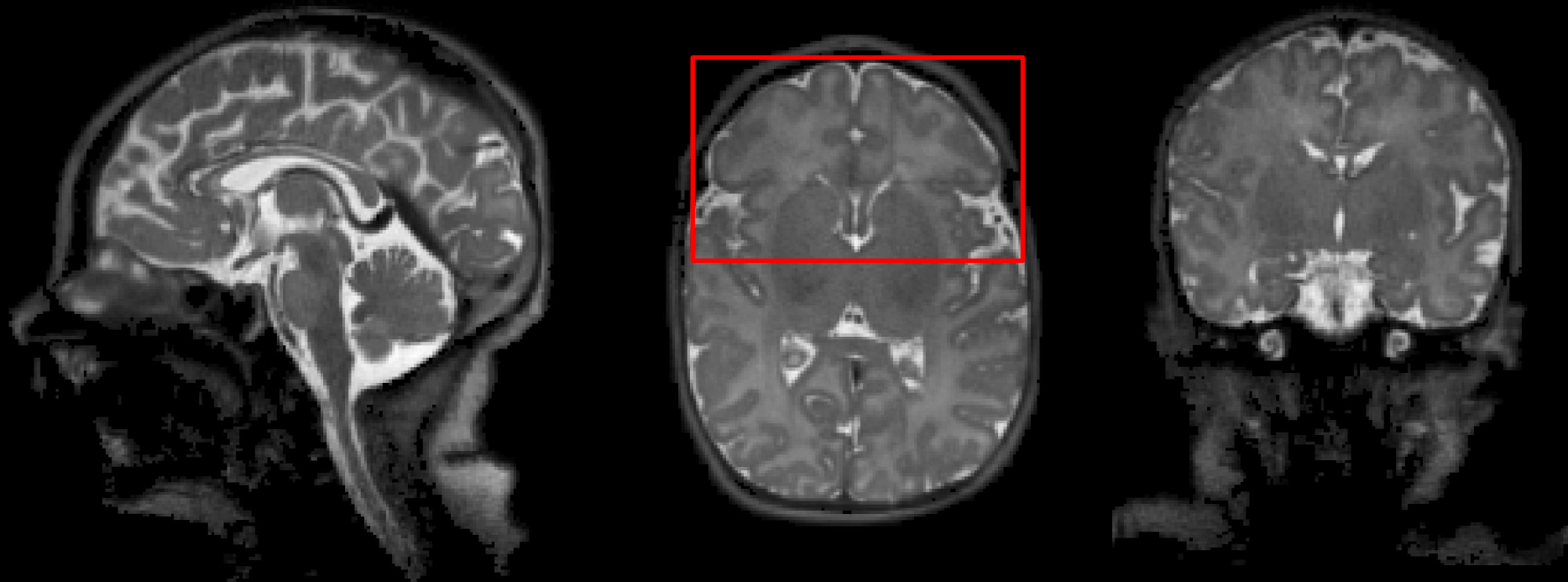


Image super-resolution



Motion artefact removal

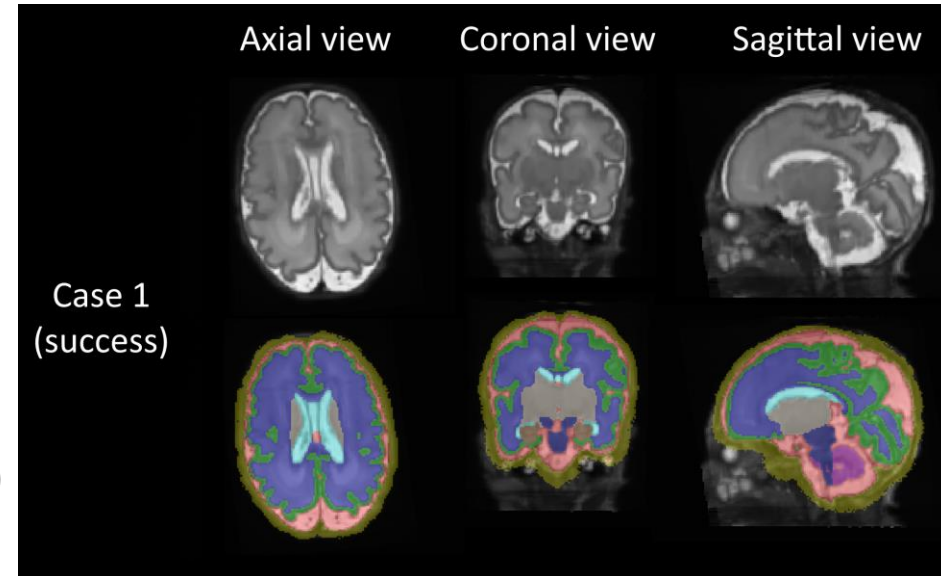


Quantitative measurements

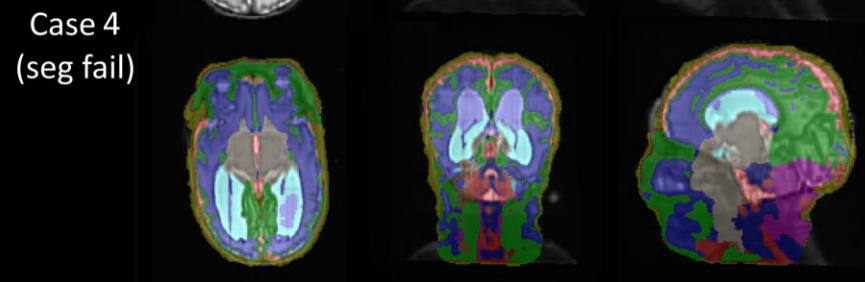
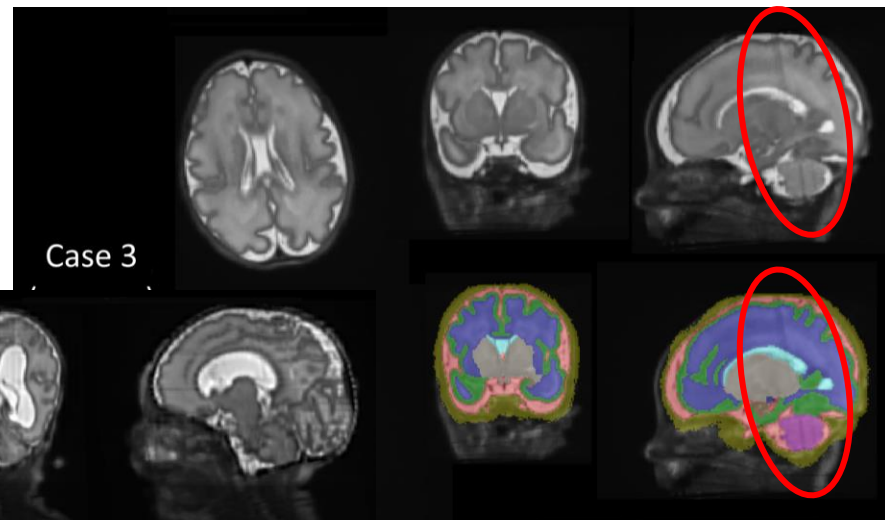
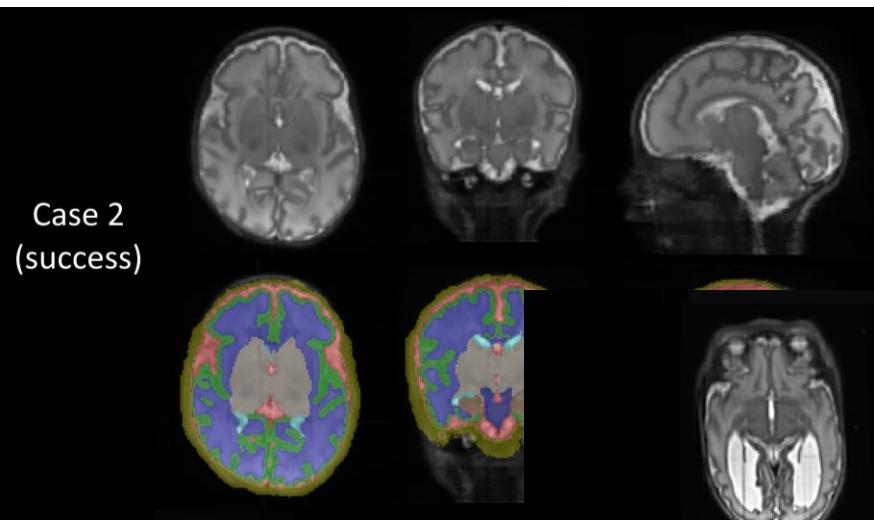
- The developing Human Connectome Project structural pipeline was used.
- 24 measures per MRI
 - 8 volumes (CSF, cortical GM, WM, ventricles, cerebellum, DGM, brainstem, hippocampi/amygdala)
 - cortical thickness (CT), sulcal depth (SD), surface area (SA) and gyrification index (GI) of each of the 4 lobes

The developing human connectome project: A minimal processing pipeline for neonatal cortical surface reconstruction

Antonios Makropoulos ^{a,1}, Emma C. Robinson ^{a,b,1,2,3,4}, Andreas Schuh ^a, Robert Wright ^b, Sean Fitzgibbon ^c, Jelena Bozek ^d, Serena J. Counsell ^b, Johannes Steinweg ^b, Katy Vecchiato ^b, Jonathan Passerat-Palmbach ^a, Gregor Lenz ^a, Filippo Mortari ^a, Tencho Tenev ^a, Eugene P. Duff ^c, Matteo Bastiani ^c, Lucilio Cordero-Grande ^b, Emer Hughes ^b, Nora Tusor ^b, ... Daniel Rueckert ^a

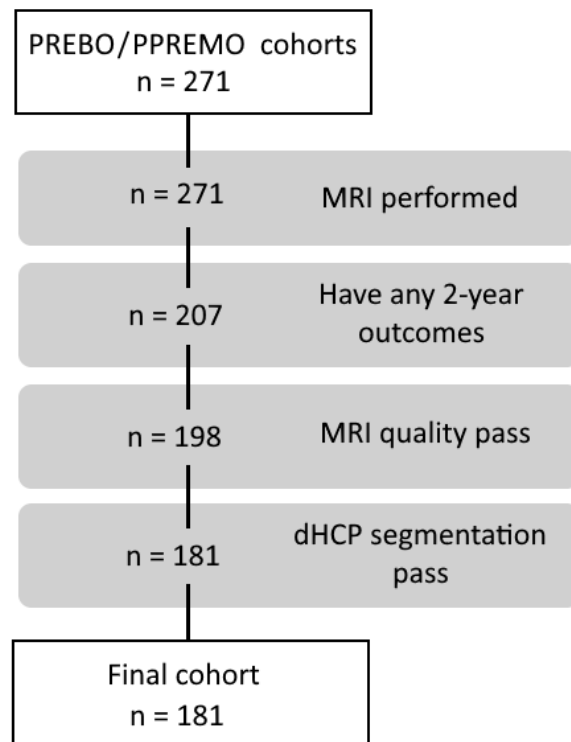


dHCP Segmentation Examples



Statistical analysis

- LASSO (Least Absolute Shrinkage and Selection Operator) regression
 - 24 MRI measures
 - Covariates: sex, gestational age at birth, PMA at MRI, socioeconomic status, GMs at 3 months CA, multiple measures of care
- 2-year outcomes include Bayley-III motor, cognitive and language composite scores, and NSMDA functional grade



Associations with developmental outcomes

Increased 2-year scores



Reduced 2-year scores

Model	Pseudo r^2 with MRI	Pseudo r^2 no MRI
M1: Bayley-III motor composite	0.757	0.465
M2: Bayley-III cognitive composite	0.546	0.431
M3: Bayley-III language composite	0.773	0.482
M4: NSMDA functional grade	0.660	0.492

parietal lobes

Sulcal depth of the frontal, temporal and occipital lobes



CSF volume



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Discussion

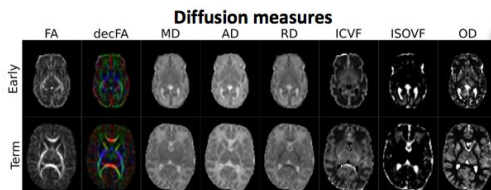
- What is the benefit (if any) of adding MRI at TEA to the prediction models?
- Are these biomarkers predictive of outcomes at 6 years of age (e.g. school readiness)?
- Super-resolution could benefit from more advanced motion detection/correction (slice-to-volume reconstruction) and replacement strategies

Automated reporting



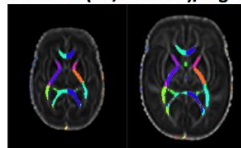
Diffusion MR Quantification Report

SUBJECT: BP *** **REPORT DATE:** Tuesday, 20th November, 2018
AGE at scan: 32.5 weeks (Early)
and 42.1 weeks (Term) (PMA)



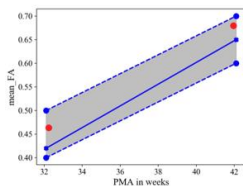
Diffusion maps at different time points

Measures (FA, MD etc.)/region



regional labels (JHU neonate atlas)

Regional FA/MD measures compared to population (e.g. cerebellum)



comparison to population





Thank you

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