Mapping Brain Development in Infants and Young Children Using MPnRAGE T1 Relaxometry

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BACKGROUND

- Human brain development is rapid, nonlinear throughout the first years of life[1,2]
- Quantitative relaxometry offers unique opportunity to understand developmental patterns of brain tissue microstructure.
- MPnRAGE[3] is a 3D radial, self-navigated technique for high quality, motion-robust T1-weighted structural imaging and quantitative T1 relaxometry, making the technique well-suited for pediatric populations.
- MPnRAGE studies to date are limited to adults and older children[4,5].
- **Objective: To develop an optimized and age-appropriate MPnRAGE acquisition and apply this to a cohort of infants and young children to evaluate changes in T1 relaxation times during the first years of life.**

METHODS

- 47 children (Mean Age: 51.4 months, age range: 2 months – 9.75 years years; 15 Female; 32 Male)
- Imaged at Waisman Center on GE 3t MR750 scanner using a 32-channel head RF array (Nova Medical, Wakefield, MA).
- Children under 4 years of age imaged during natural, non-sedated sleep (~14 min); children over 4 years imaged awake (~9 min),
- Age and study-specific templates were created using MPnRAGE T1w images and ANTs9 (Fig. 1).
- Mean qT1 values extracted and plotted against age.

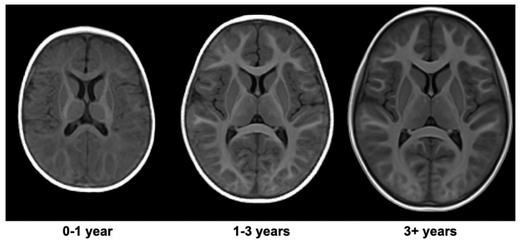
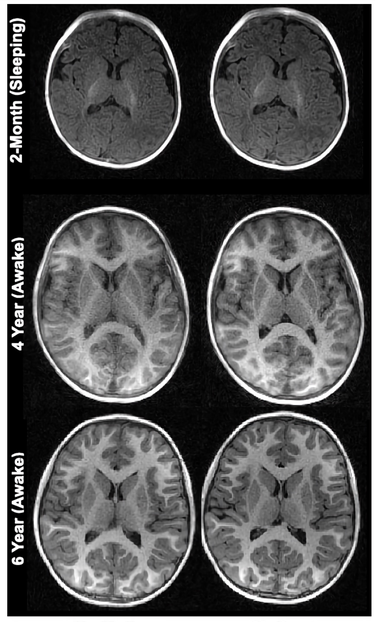


Fig. 1: Representative axial slices of MPnRAGE Population Templates.

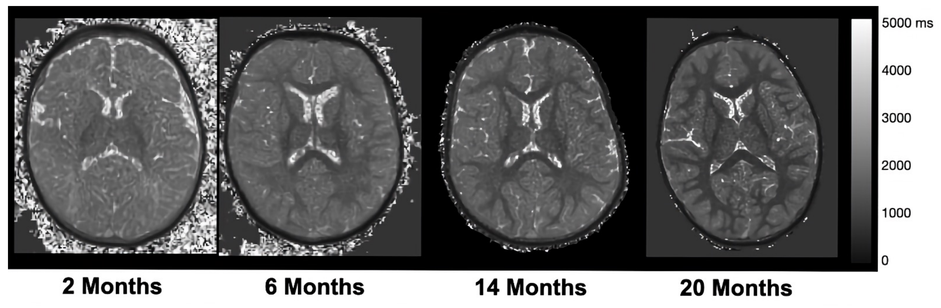
RESULTS

Fig. 2. Representative slices of MPnRAGE T1-weighted images with and without motion correction. Motion corrected T1w images highlight ability of MPnRAGE to provide motion-robust images across infancy and childhood.



MPnRAGE enables high-resolution, motion-robust structural T1w and quantitative T1 relaxometry imaging in infants and young children

Fig. 4. Bar Graph of top gene ontological (GO) biological processes associated with DMP genes, ordered by statistical significance, with x-axis bar length indicates # of DMP-associated genes.



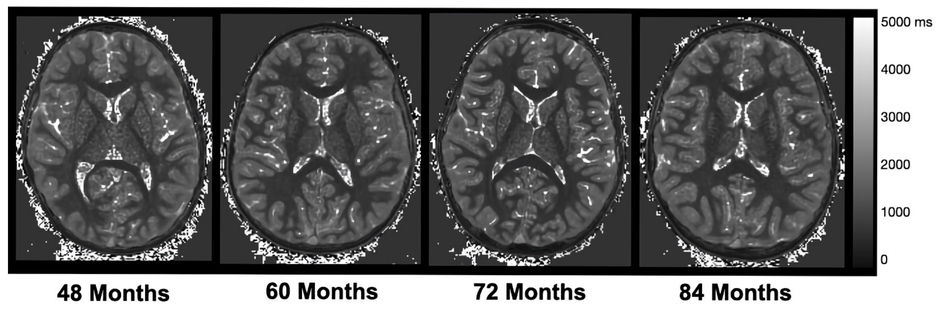
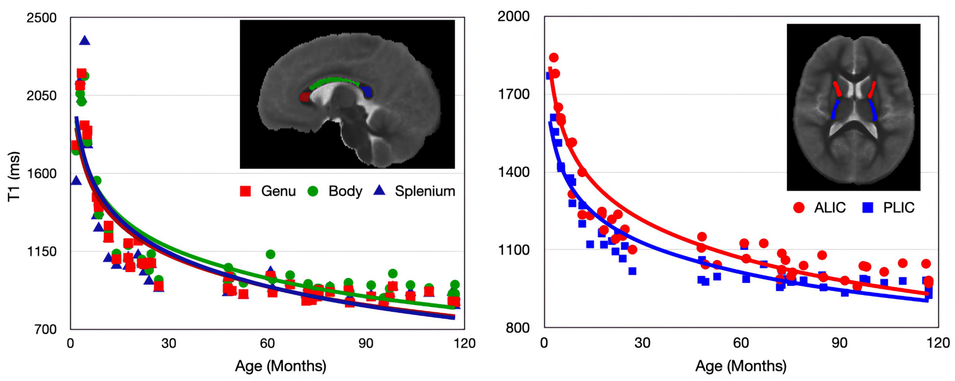


Fig. 3. Age related patterns of MPnRAGE qT1 for the genu (red) body (green) and splenium (blue) of the corpus callosum and anterior (red) and posterior (blue) limbs of the internal capsules. Logarithmic models were fit to age related patterns.



- With increasing age, T1 across much of the gray and white matter are rapidly decreasing, reflecting underlying changes in myelination and free water content.
- MPnRAGE T1 follows spatiotemporal pattern consistent with existing literature, extending from deep to superficial brain regions in a posterior to anterior pattern.

CONCLUSIONS

- We demonstrate high resolution and whole brain coverage, while the self-navigated, retrospective motion correction significantly improves image quality in the presence of intra-scan motion.
- Age-related patterns of qT1 followed a logarithmically decreasing shape, highlighting the rapid microstructural development during the first years of life.
- Technique may help advance the use of quantitative imaging in pediatric and other challenging populations
- Future work will investigate alternative acoustic noise reduction strategies and comparisons with existing methods.

ADDITIONAL KEY INFORMATION

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