Different T1 relaxation brain ageing patterns over the human lifespan: frontal vs. posterior brain (75 subjects)

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Introduction: : Evolution of the brain during life can be divided in three time periods: an initial period of maturation characterized by increasing myelination and brain growth, an intermediate adulthood period characterized by relative stability, and an ageing period marked by ventricular enlargement, brain atrophy, and white matter (WM) and gray matter (GM) tissue deterioration. Furthermore, these three brain evolution periods exhibit specific regional trends (**Ref.**1, 2).

Purpose: To compare the T1 relaxometric properties of the brain (GM and WM) by partitioning the brain into frontal cerebrum, posterior cerebrum and cerebellum with the goal of detecting possible tissue micro-architecture differences.

Materials and Methods: 75 subjects (45 males, 30 females, age range 0.5-87 years, average age 39.0 years) were enrolled for this study: 29 volunteers and 46 patients who were referred to MRI for various clinical reasons. All subjects were imaged with the mixed-TSE pulse sequence (**Ref.** 3) by using a 1.5T MR scanner (Philips Medical Systems, Cleveland, OH). The brain was segmented from the whole head data set using a dual-clustering segmentation algorithm. We further divided the whole brain into 6 segments: right and left frontal cerebrum, posterior cerebrum and cerebellum segment. All segmentation algorithms were programmed by MathCAD 2001i (Mathsoft, Cambridge, MA) (**Fig.** 1). Bisecting planes were user defined by selecting three points in more than one slice. First, the right and left hemispheres were divided. Then the frontal and posterior segments were defined with the coronal plane encompassing both sides of the internal auditory canals. Finally, the posterior cerebrum and cerebellum segments were defined with a transverse bisecting plane positioned at the top of the tentorium cerebelli. T1 relaxation time histograms of all segments were generated and further modeled with Gaussian functions. Peak values for segmental WM and GM were derived from the histograms and plotted as functional of age (**Fig.** 2).

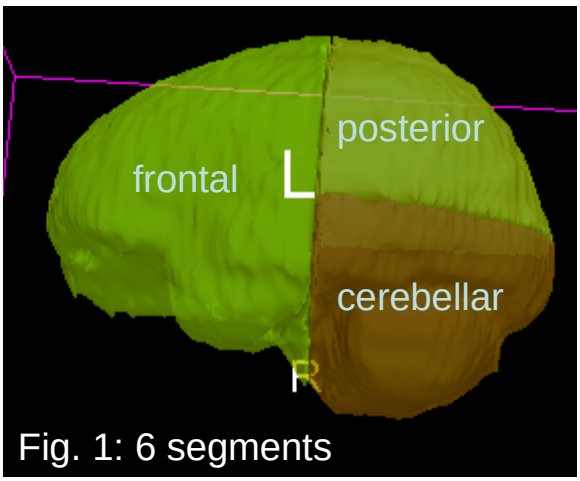

Fig. 1: 6 segments

Results: As shown in **Fig.** 2, T1 of frontal GM was consistently and bilaterally longer than T1 of posterior GM (posterior cerebrum as well as cerebellum), by about 10% for all ages studied. Furthermore, the T1 of frontal WM was shorter than T1 of WM in the posterior segments also over the full human lifespan: this effect was however not as pronounced or consistent as the GM effect (**Fig.** 2).

Conclusion: Different frontal *vs.* posterior cerebra and cerebella T1 relaxation brain ageing patterns have been demonstrated in the 0.5 to 87 age range, for both GM and WM. In particular, T1 relaxation mechanisms in frontal GM are weaker than in posterior GM over the full human lifespan, possibly suggesting differences in frontal *vs.* posterior tissue micro-architecture and/or hydration level. To the best of our knowledge, this is the first time that frontal *vs.* posterior brain tissues have been shown to exhibit different T1 relaxation properties over the full human lifespan. These findings could be useful for developing brain ageing T1 standards and for diagnosing clinical conditions affecting brain development.

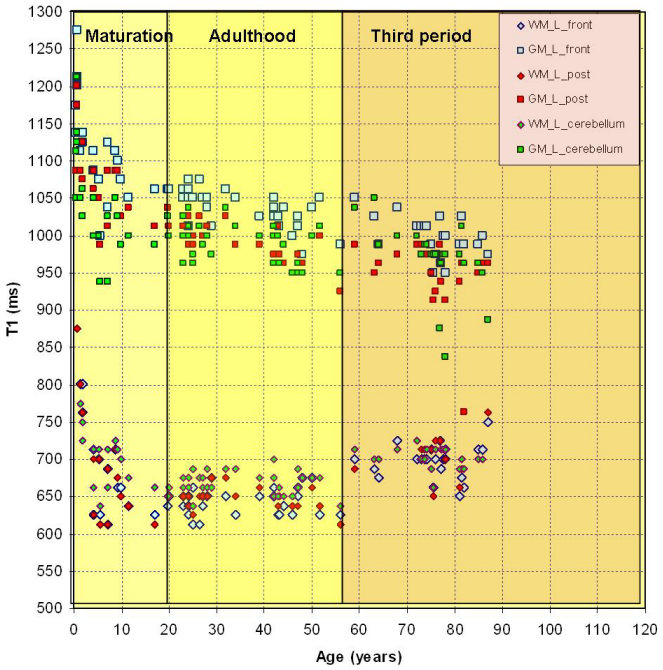

Fig. 2: Peak T1 relaxation times of 6 segments vs. age.
Note that the T1 relaxation times of the frontal GM are longest for all ages. (light blue square).

References

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