

# Age-related changes Analyzed using Whole-Brain Tissue Histogram: a DTI study of two different b values

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## Introduction

Diffusion Tensor Imaging (DTI) enables quantitative measurement and visualization of water molecular diffusion inside the brain. Mean Diffusivity (MD) and Fractional Anisotropy (FA) are two quantitative parameters characterizing diffusion; MD denoting the average diffusion independent of direction and FA denoting the degree to which diffusion is directionally dependent. Both parameters may be important for investigating age-related influences on DTI brain measurements. A few studies have previously been carried out within the field involving subjects of relatively large age spans, typically 10-90 years old. A more narrow range of age, with focus on late adulthood, has not yet been studied. Furthermore, to our knowledge, age-related studies of MD and FA based on different b values are still lacking.

## Aims

The objective of the present study was to investigate age-related changes on subjects in late adulthood by means of the DTI parameters MD and FA. Additionally, two different b values were to be used for comparisons between results of different diffusion weightings.

## Materials and Methods

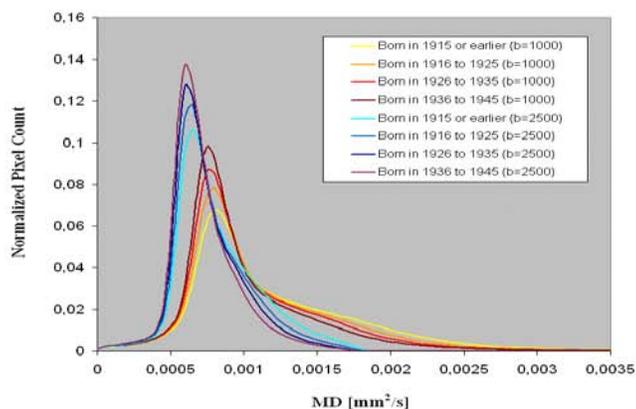
In total, 307 healthy subjects were examined, spanning the ages of 62-99 years, using a single shot spin echo EPI diffusion sequence applied in six directions using two different b values (1000 and 2500 s mm<sup>-2</sup>) on a 1.5 T Philips Gyroscan Intera (TE=104 ms, TR=6838 ms, Matrix=256×256×22). Post-processing of the images was based on FSL<sup>1</sup> tools and whole brain histogram analysis was carried out using in-house Matlab software.

## Results

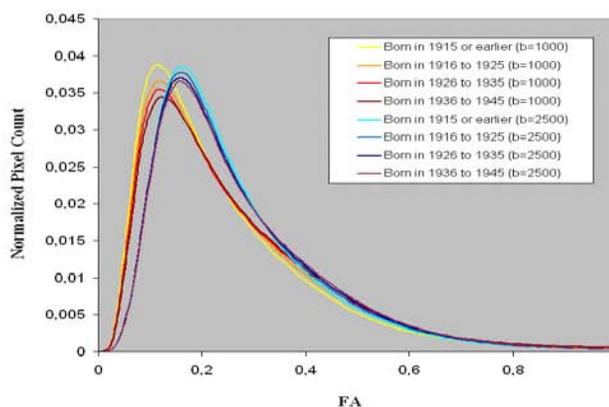
The results obtained from whole-brain tissue histogram were analyzed in terms of parameter peak height values and mean values. The analyses indicate moderate influence of age on diffusion as measured using parameter FA, while prominent influence was indicated using parameter MD. In general, the older the subject, the lower the peak height of MD and the larger the mean MD, as illustrated in Figure 1a. Differences in peak height of MD and in mean MD between the age-group histograms in Figure 1a reached statistical significance ( $P < 0.0001$ ) for both b values studied. In the case of the parameter FA, the opposite trend was observed, although not as prominent as for the MD values. The FA peak height increases while the mean FA decreases with increasing age as shown in Figure 1b. Differences in peak height of FA and in mean FA between the age-group histograms in Figure 1b were found with statistical significance ( $P < 0.020$  for peak height of FA and  $P < 0.024$  for mean FA) for b value 1000 s mm<sup>-2</sup>. However, statistical significance was not found for b value 2500 s mm<sup>-2</sup>. Additionally, the analysis showed significant differences between MD and FA histograms obtained using b values 1000 and 2500 s mm<sup>-2</sup> ( $P < 0.0001$  for mean MD, mean FA, peak height of MD and peak height of FA) (Figure 1a and 1b).

## Conclusions

This study shows increased mean MD and decreased peak height of MD with increasing age. Conversely, increased age was also related to decreased mean FA and increased FA peak height. The relation between diffusion parameter changes and for example age-associated memory impairment needs to be further explored. The pronounced differences between MD and FA histograms obtained using different b values agree with theories of diffusion as being multiexponentially dependent.



**Fig 1a:** Normalized Mean Diffusivity (MD) histograms of different groups of age and of two different b values (1000 and 2500 s mm<sup>-2</sup>).



**Fig 1b:** Normalized Fractional Anisotropy (FA) histograms of different groups of age and of two different b values (1000 and 2500 s mm<sup>-2</sup>).

<sup>1</sup> The FMRIB Software Library (FSL) is provided by The Oxford Centre for Functional Magnetic Resonance Imaging of the Brain (FMRIB).