

A comprehensive evaluation of regional cortical thickness in a large cohort of healthy controls: gender and field strength dependence

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Introduction:

Age-dependent changes in global and regional cortical thickness (Cth) provide crucial information about normal brain development and how it is affected by neurologic disorders. MRI is most commonly used for estimating the cortical thickness in vivo. Ideally, Cth should not depend on extrinsic factors such as type of MRI scanner or the field strength. However, studies based on a relatively small sample size, indicate that cortical thickness is influenced by both scanner type and field strength (1). Most of the published cortical thickness measurements were performed at 1.5T. With increased use of 3T scanners, there is a critical need to measure Cth at 3T and compare the results obtained at 1.5T. In this study we evaluated the effects of both intrinsic (gender) and extrinsic (field strength; 1.5T and 3T) factors on the measured Cth in 300 normally aging brains.

Field strength (N; Age ± SD)	Male (149; 45.7 ± 15.6)	Female (151; 44.8 ± 14.3)
1.5T (151; 46.7 ± 14.7)	75; 47.1 ± 13.4	76; 44.7 ± 15.7
3T (149; 44.6 ± 14.9)	74; 44.2 ± 15.7	75; 44.9 ± 12.8

Methods:

3D T1-weighted MR images on 300 normal controls (Refer Table 1) accessed from various publicly available databases was used for Cth measurements. All the sub-groups were age-gender- and field strength matched to ensure a valid comparison. All the images were processed with the Freesurfer pipeline (2). Average global and regional cortical thickness differences between males vs. females and 1.5T vs. 3T were evaluated. Regression analysis was performed in order to determine differences in aging trends for male vs. female and 1.5T vs. 3T. A multiple comparison Monte-Carlo simulation with 5000 iterations was performed to make inferences at $p = 0.001$ at an FDR of $p < 0.05$.

Results:

The average global Cth did not show significant dependence on either gender or field strength. However, regional Cth in precentral, temporal pole and transverse temporal regions showed gender dependence. In these structures the Cth is up to 0.1 mm thicker in females than in males. These differences were found to be more pronounced at 1.5T than at 3T. The same regions were found to be up to 0.2 mm thicker in females than in males at 1.5T whereas at 3T, the maximum difference was only about 0.07 mm. The male vs. female difference maps at 1.5T and at 3T are summarized in Fig. 1. Regional Cth differences in parahippocampal, entorhinal, superior and transverse temporal and posterior cingulate were a much larger (up to 0.25 mm) at 3T than at 1.5T. The effect of field strength on Cth was comparable for both males and females.

Regression analysis showed larger dependence of Cth on age in males compared to females in fusiform, inferior temporal, parahippocampal, insula at 1.5T, but not at 3T. As an example, the regression plots for the right inferior temporal region in Figure 2.

Discussion and Conclusions:

To the best of our knowledge this is the first comprehensive study on a large sample that investigated the effect of gender and field strength on measured Cth on a large sample size. Significant gender differences on Cth were seen in precentral, temporal pole and transverse temporal regions at 1.5T. Our results at 1.5T are consistent with other

Table 1: Demographic information on 300 normal controls

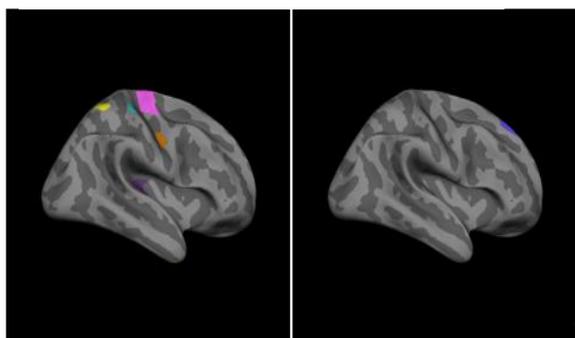


Figure 1: Lateral views of right hemisphere thickness difference maps between males and females at 1.5T (left) and 3T (right)

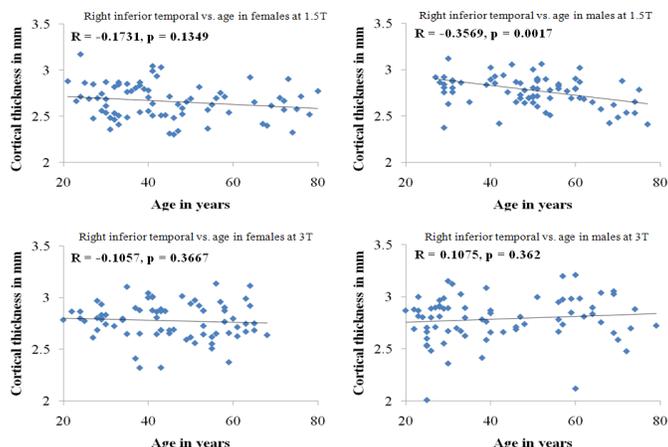


Figure 2: Regression plots for right inferior temporal region in females and males at 1.5T and at 3T

published studies that have reported thicker inferior parietal and posterior temporal regions in females than in males (3) and thicker superior frontal, precentral, postcentral regions reported in females than in males (4). We did not find such significant differences at measured Cth at 3T. A possible reason for this effect might be that the improved SNR and image contrast at 3T allows more robust calculation of cortical thickness. Our results indicate that when investigating factors affecting the measured cortical thickness, field strength has a larger effect than gender. The effect of field strength on cortical thickness has not been reported on a large subject pool.

In summary these results show that the effect of field strength is more important than gender in the estimation of cortical thickness and that the interpretation of Cth and its age dependence should take into account the field strength at which these measurements are performed.

References:

- 1) Han et al Neuroimage 2006; 180-194,
- 2) <http://surfer.nmr.mgh.harvard.edu/fswiki>,
- 3) Sowell et al Cerebral Cortex 2007; 1550-1560,
- 4) Lv et al Neuroimage 2010; 373-382