Cortical Thicknesses Determination from High Resolution MPRAGE and MP2RAGE Data at 7 T

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Introduction:

Cortical thickness analysis from magnetic resonance imaging (MRI) has been proposed to investigate various neurological and psychiatric diseases, such as depression [1], Alzheimer's disease [2] and autism [3]. However, current imaging methods are mostly using moderate resolution of 1 mm and corresponding inevitable partial volume effects. 7 T MRI allows for higher resolution, but suffers from B_1 inhomogeneity. Correction of MPRAGE images, either by division by a GE image or using MP2RAGE was proposed [4, 5]. In this study, a comparison of the cortical thickness estimation from high resolution (0.7 mm isotropic) MPRAGE and MP2RAGE MRI is presented.

Methods:

Each of four subjects was scanned four times on different days. T1-weighted 3D-data were acquired on a 7 T MRI (Siemens Healthcare, Erlangen, Germany) with a 32 channel head coil using MPRAGE (TR=2300 ms, TE=2.5 ms, TI=1050 ms, FA 5°, GRAPPA=2) divided by GE image (TR=1650 ms, TE=2.5 ms, FA 5°, GRAPPA=2) and MP2RAGE (TR=5000 ms, TE=2.5ms, TI=899 ms, FA 5°, GRAPPA=2) (**Figure 1**) All images were processed as following:

1. Intensity normalization and skull stripping with FreeSurfer.
2. Tissue segmentation FSL (FAST toolbox) or SPM8
3. Voxel-based regional cortical thickness calculation with ARCTIC (3D Slicer) to subdivide the cortex into 24 regions
4. Surface-based cortical thickness calculation with FreeSurfer
5. Statistical analysis for cortical thickness (ANOVA: 4 subjects, 4 repeats, 2 acq. methods, 3 segmentations)

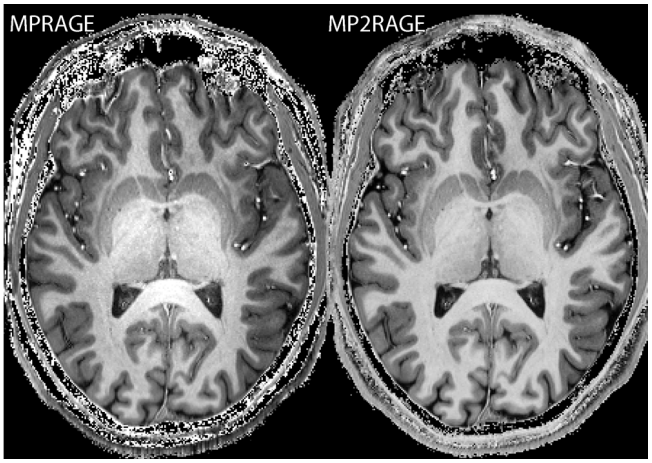

Figure 1: 7 T MRI T1-weighted MPRAGE divided by GE (left) and MP2RAGE (right) with 0.7 mm isotropic resolution.

Results:

As **Figure 2** shows, the measured cortical thickness estimated using SPM8 and FSL with MPRAGE was thinner than with MP2RAGE. Significant differences in cortical thickness between MPRAGE and MP2RAGE were determined with FSL ($p<0.005$) and SPM ($p<0.062$) while only FreeSurfer resulted in indistinguishable values ($p<0.986$). The variance across subjects and repeated measures are similar for all the processing methods and not significantly different.

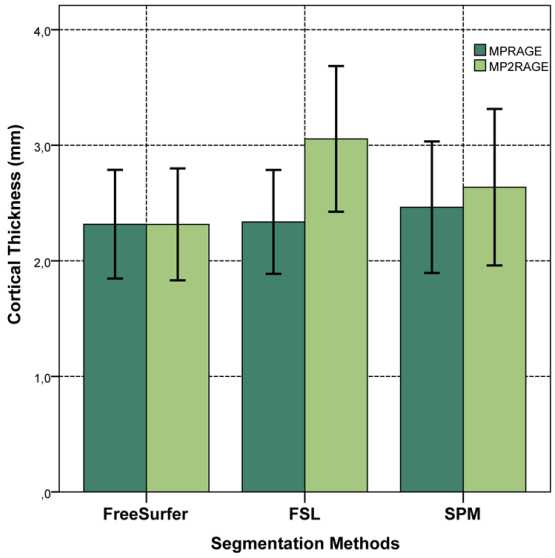

Figure 2: The mean values of cortical thickness determined by FreeSurfer and ARCTIC (3D Slicer) using the segmentation from FSL and SPM.

Discussion/Conclusion:

In this study, we successfully processed high resolution (0.7 mm isotropic) MPRAGE and MP2RAGE images at 7 T after removing inhomogeneity and estimated the cortical thickness by SPM8, FSL and FreeSurfer. FreeSurfer yielded most robust results independent of the acquisition method, but down-samples onto a 1 mm grid. For SPM8 and FSL systematic differences in cortical thickness between MPRAGE and MP2RAGE were detected. This variation is most likely caused by small differences in the contrast between the sequences and a resulting segmentation bias (**Figure 1**). Moreover, the difference in cortical thickness between MPRAGE and MP2RAGE, as determined by SPM, was smaller than with FSL (**Figure 2).**

Acknowlegments:

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References:

[1] Taki et al., J Affect Disord, 2005 Nov;88(3):313-20
[2] Querbes et al., Brain, 2009 Aug;132(Pt 8):2036-47
[3] Hardan et al., Am J Psychiatry, 2006 Jul;163(7):1290-2
[4] Moortele et al., NeuroImage, 2009 Jun;46(2):432-46
[5] Marques et al., NeuroImage, 2010 Jan 15;49(2):1271-81