Contribution of FOV Updating and Reacquisition to Estimates of Cortical Surface Measures in PROMO MPRAGE

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Target Audience: MR scientists and neuroscientists involved in structural image analysis of non-compliant subjects.

Purpose: Prospective motion correction techniques are becoming increasingly available to improve the quality of high resolution anatomical MRI. One such technique that uses motion estimates from navigator data, PROMO[1], has been used with the MPRAGE sequence and was previously shown to reduce errors in cortical surface reconstructions of moving subjects[2,3]. The PROMO technique has two parts: 1) updating the slice, phase, and frequency encoding/field of view (FOV) every MPRAGE TR and 2) reacquisition of k-space data in which excessive motion occurred between navigators acquired immediately before and after the k-space segment. The rescanning of data adds extra scan time, increasing with increased subject movement, which is undesirable for pediatric or patient studies where scan time is limited. In this study, we investigate the contribution of the FOV update and reacquisition parts of PROMO in reducing errors of cortical surface reconstructions from subject motion, with the goal of minimum overall scan time.

Methods: Data were acquired on 5 healthy young adult subjects at 3T with a 32-channel coil using a PROMO enabled 3D MPRAGE sequence and the following scan parameters: TE/TR=3.4/8 ms, IR=1150 ms, fa=7°, FOV=256 mm, 1x1x1 mm, ARC (parallel imaging factor)=2, scan time=6:48. The subjects were instructed to perform a figure-eight motion with their nose when cued, yielding 10 s of movement 5 times during the scan. Data were acquired under four conditions during intentional motion: full PROMO motion correction; FOV update only; reacquisition only; no PROMO. Data were also acquired with no subject motion for reference. All data sets were processed and values of mean cortical thickness, total cortical area, and total cortical volume of each lobe were calculated from regional values extracted using FreeSurfer 5.3[4]. The accuracy of each measure for each experimental condition was calculated as the average normalized percent difference from the no movement condition measure: $\%Difference=sum(100\%*d_i)/N$, where d_i is the difference between the condition and no move scan, normalized by the no move scan, and N is the number of subjects.

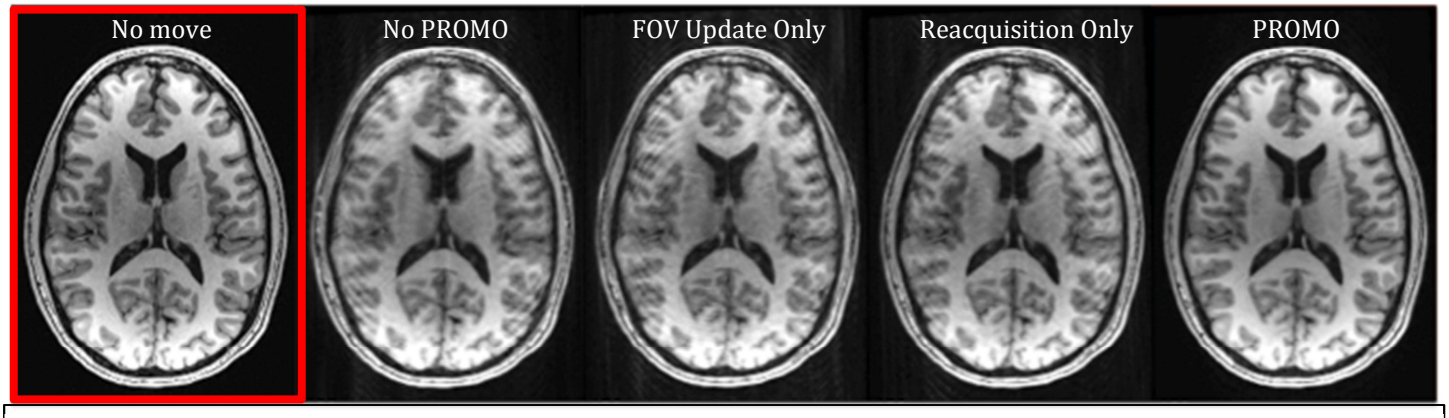

Fig 1: MPRAGE data acquired without motion (red box) and with motion under different experimental conditions.

Results: The within-subject motion was consistent between the experimental conditions. The range of translation and rotation from all subjects was ~1-10mm and ~1-20°, respectively. The additional time needed for reacquisition ranged from 0:51 to 1:57 (min:sec). In the representative raw images in Fig. 1, one can appreciate the reduction of artifacts obtained when PROMO is fully applied, compared to either part alone. Fig 2A-C shows the calculated accuracy of cortical reconstruction measures in the right hemisphere. Utilizing full PROMO produced more accurate measures in cortical thickness, volume, and area then either part alone. In addition, Fig. 2 shows that using either part of PROMO produces more accurate measures then not using PROMO. For cortical thickness, the reacquisition part seems to play a greater role. Similar results were obtained for the left hemisphere lobes (data not shown).

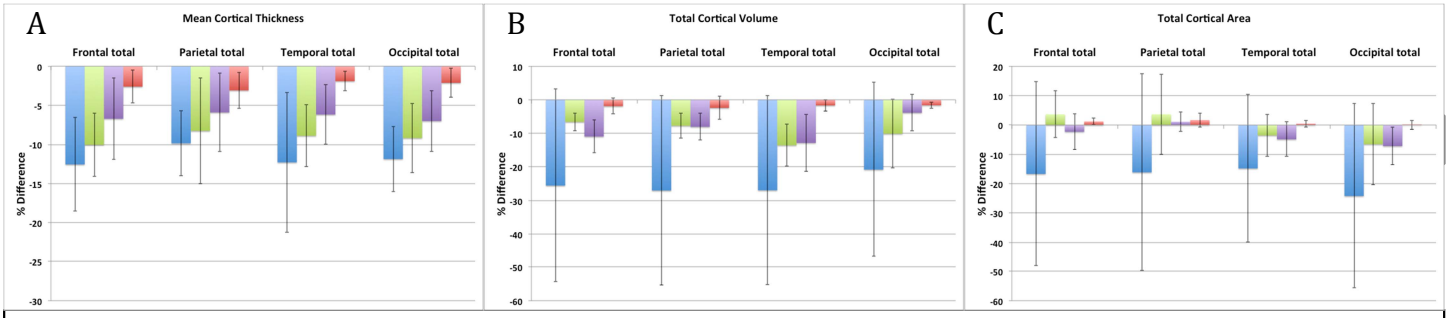

Fig 2: Plots of the average % difference of cortical measures compared to no movement.

Discussion/Conclusions: The accuracy of cortical thickness, volume, and area was improved when either part of PROMO was applied. Utilizing full PROMO provided even greater accuracy of cortical reconstruction than either part alone. These results indicate that when using the PROMO technique for high-resolution structural data acquisitions, allowing for reacquisition will greatly improve accuracy of the results. It is advised that the extra time needed to rescan data be planned for in studies where PROMO acquisitions are utilized.

References: [1] White, et. al., MRM, 63:91-105, 2010. [2] Brown, *et. al.,* NeuroImg, 53:139-145, 2010. [3] Sarlls, *et. al.,* OHBM, p.745, 2014. [4] Fischl, et. al., Neuron, 33:341-355, 2002.