PROspective MOtion Correction (PROMO) Results in Improved Image and Segmentation Quality of High-Resolution MRI Scans of Children

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Artifacts due to patient motion can be a significant impediment to the acquisition and analysis of high-resolution structural MRI data. Motion artifacts will particularly impact studies that rely on the ability of MRI to elucidate subtle changes in cortical thickness or subcortical volumes. While all subject populations are susceptible to such artifacts, these problems are especially severe with young children, who frequently have difficulty remaining still during the time required to collect high-resolution data. Although methods exist to limit the severity of motion artifacts, many can only correct for motion that occurs in plane and oftentimes require a significant increase in scan time. In contrast, PROspective MOtion correction (PROMO) [1] provides the ability to account for both in plane and through plane motion, thereby greatly reducing motion artifacts, and does so with only a minimal increase in scan time (depending on the degree of subject motion). To demonstrate the efficacy of PROMO, a small cohort of children (ages 9-12) were scanned with PROMO enabled or disabled. The resulting scans show a noticeable improvement in both image quality and FREESURFER segmentation quality with PROMO enabled.

Methods: A total of nine child subjects (range 9-12 years old, mean 10.75) were recruited for this study, which was conducted with approval of the Institutional Review Board.
Imaging: A total of four T1-weighted scans were acquired for each subject, using a previously described sequence [2]. All scans were performed on a 1.5 T Signa HDx system (GE Healthcare Technologies, Milwaukee, WI) with an 8-channel phased-array head coil. PROMO enabled and disabled scans were collected in an alternating pattern. Subjects were instructed to remain as still as possible throughout the examination.
Intensity correlation and segmentation reliability calculations: For each subject, the two scans acquired with PROMO were co-registered and the RMS difference in voxel intensities was calculated. Each scan was then run through FREESURFER's automated segmentation routine. The number of voxels assigned the same segmentation label for both scans was divided by the total number of voxels assigned to that structure, giving the percent volume overlap of all segmented structures of interest. The same calculations were performed on the pair of scans with PROMO disabled for comparison.

Results: Scans acquired with PROMO enabled showed qualitatively fewer motion artifacts and significantly greater percent volume overlap for automated segmentations than those acquired without PROMO (Figure 1).

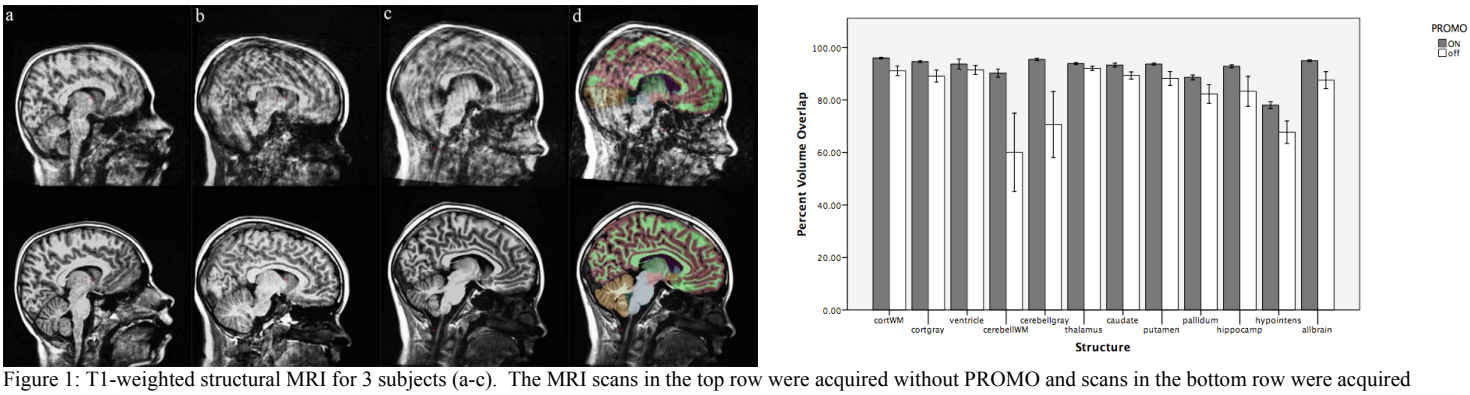

Figure 1: T1-weighted structural MRI for 3 subjects (a-c). The MRI scans in the top row were acquired without PROMO and scans in the bottom row were acquired with PROMO. (d) Freesurfer segmentation of one subject (c). Percent volume overlap of automated volumetric measurements performed with PROMO on versus off (e).

Discussion and Conclusion: Scans obtained with PROMO enabled show visibly fewer motion artifacts and the quality of the segmentation derived from the PROMO scan is noticeably superior. PROMO shows promise as a tool for research scientists and clinicians working with subjects and patients prone to movement, such as children. The improvement in image quality and greater reliability in segmentations and volumetric measurements allow for the possibility of detecting small effects that might not otherwise be observable.

[1] N. White et al. ISMRM 2007. [2] A. Shankaranarayanan et al. ISMRM 2007.