Is B1-Correction for Neuroanatomy Necessary?

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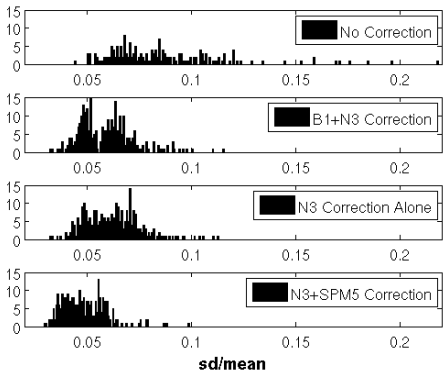
Introduction: B1-inhomogeneity correction for neuro-MR images is a common option provided by system vendors on new systems. Low resolution images acquired with the body coil and head coil are used to correct shading artifacts, particularly for phased array designs. For multi-center drug trials and disease studies subject enrollment capacity rather than MRI acumen generally drives site selection. Thus, the availability of onboard B1-correction cannot be assumed. The Alzheimer's Disease Neuroimaging Initiative Study (ADNI), for example, acquires additional scans to allow off-line B1-correction. This introduces complexity in protocol design and implementation as well as increasing data management burden. The purpose of this abstract is, using data acquired according to the ADNI protocol [1], to examine two questions: Is B1-correction necessary? And does mixing B1-corrected and uncorrected data negatively impact data homogeneity after other common offline image preprocessing steps? **Materials and Methods**: A collection of 256 MP-RAGE scans was acquired with the ADNI protocol. Subjects were from a population of elderly persons. Acquired on GE, Philips, and Siemens 1.5T scanners, images were processed as follows. All scans were corrected for gradient warping (3D) unless done on the scanner. Data acquired on Philips scanners had on-board (CLEAR) B1-correction, independent of head coil type used in data acquisition. Data acquired on GE and Siemens scanners had B1-correction done in post-processing for scans acquired with phased array head coils. Quadrature (birdcage) coil images on Siemens and GE scanners were not B1-corrected. All data were passed through the N3 inhomogeneity correction suite [2,3] including an approximate brain mask and subsequently all post-N3 images were processed through the SPM5 unified segmentation[4]. Unified segmentation was carried out using same mask as N3 and included a template and tissue probability maps generated from scan of 400 elderly, half of whom were clinically diagnosed as having Alzheimer's Disease, with the rest being cognitively normal. For each subject a brain mask was generated and eroded by two passes of a 3x3x3 kernel to obtain a sample of voxels with high white matter content. The histogram of image intensities for voxels within the eroded mask was fitted as in [5] to obtain a centroid and width for each image. The ansatz being that inhomogeneity will spread the intensity distribution leading to increases in the ratio of width to centroid, i.e. smaller values are better. In addition to automated analysis corrected images from 100 data sets were visually assessed images for inhomogeneity (Figure 2). **Results**: All images showed decreased white matter inhomogeneity with N3 and SPM. Pair-wise analysis of data processed through N3+SPM compared to data processed with B1+N3+SPM were not significantly different. Images with B1+N3 correction were slightly more homogeneous than N3 correction alone ($p<0.0001$ for pair-wise comparison). For phased array images the Bland-Altman plot comparing B1+N3+SPM with N3+SPM is tightly clustered with a few outliers. Negative differences are consistent with greater homogeneity without B1-correction. Human rater assessment uniformly agreed with the relative ratings obtained from the distribution fitting technique. **Conclusion**: B1-correction in post processing adds complexity to protocol design and data management. For the 1.5T systems tested adequate image inhomogeneity corrections create final results are equivalent with or without B1-correction. **References**: 1) Jack, Jr. et al, JMRI 27(4):685-691. 2) Sled et al, IEEE TMI 17:87-97. 3) Boyes et al, Neuroimage 39(4):1752-1762. 4) Ashburner & Friston, Neuroimage 26:839-851. 5) Gunter et al, JMRI 18(1):16-24.



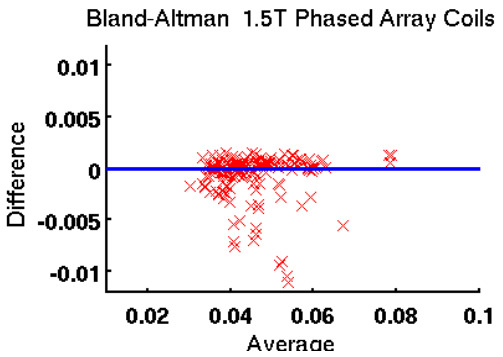


Figure 1: Histograms of sd/mean for white matter in 1.5T images are shown left; bimodality in the B1+N3 histogram is due largely to the mixture of images acquired with phased array and quadrature head coils. The histogram of B1+N3+SPM5 correction is not statistically or visibly different than the N3+SPM5 is not shown. The Bland-Altman plot comparing B1+N3+SPM5 and N3+SPM5 for data acquired with phase array head coils reveals good agreement between the two correction schemes.

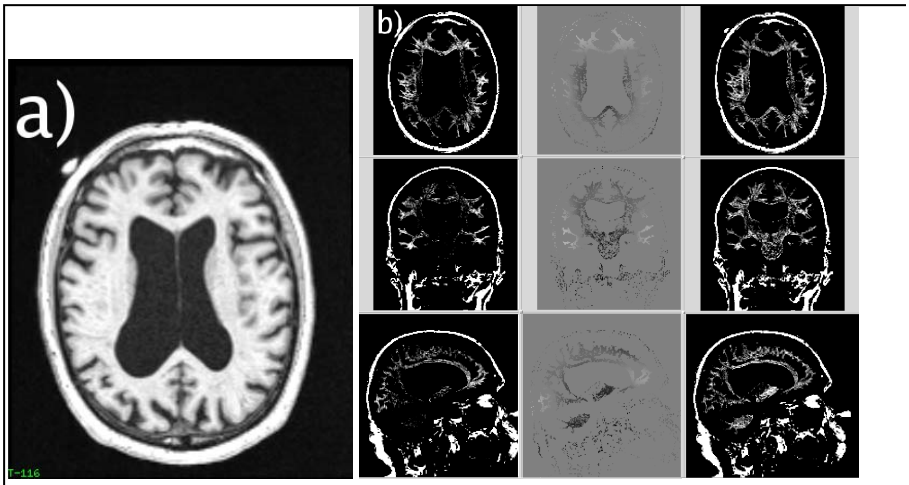


Figure 2: Representative image from visual assessment; a) the full grey scale range is shown; b) a composite of N3 (left column), N3+SPM(right column), and the difference between them (center column) where window levels have been adjusted to highlight voxels in the range of white-matter. A residual inhomogeneity (inner dark, outer bright) is observed on the N3-only image and not on the N3+SPM5 corrected image. (The scan was chosen at random and is typical.)