Cross-Validation of Brain Parenchymal Volumes between SPM5 and SIENAX

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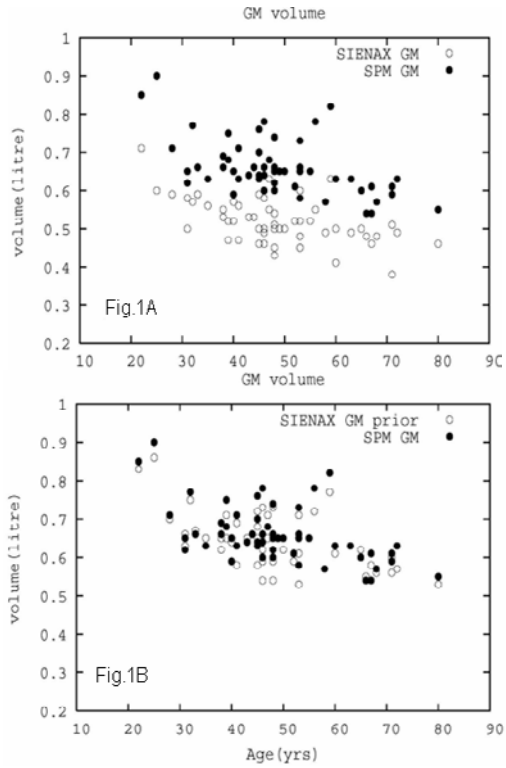
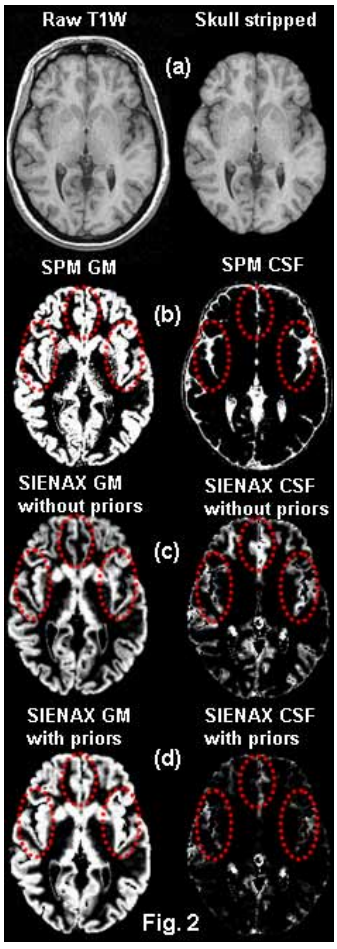
Introduction: Global and compartmental volumes of brain parenchyma are often used as clinical observations or statistical covariates. To achieve such quantification, brain voxels must be classified as grey-matter (GM) or white matter (WM), and summed in volume units. Several automated segmentation tools can be used for this purpose, but they have not been validated against external criteria, such as detailed post-mortem analyses, or against each other.

Methods: We used SPM5[1] and SIENAX 2.4 (FSL3.3)[2] to derive volumes of grey (GM) and white (WM) matter in 56 healthy subjects (26 females, 30 males, mean age 49±13, range 22-80) participating in a genetic study. All of the parameters, except the priors in SIENAX, were set to default values. MRI was performed with a GE 1.5T Signa, using SPGR (TR/TE/TI/FA 28/6/0/40) and acquired an axial slab of 104 slices yielding reconstructed voxel dimensions of .94 x .94 x1.50 mm. After segmentation, compartmental volumes in native space were computed by summing the intensities of segmented images. SPM and SIENAX volumetric results were compared to each other, as well as their age regressions. Statistical analyses consisted of product-moment linear regressions and appropriate ANOVA and ANCOVA models.

Results: Both methods yielded significant correlations with age in the expected directions, and estimates of parenchymal volumes were highly correlated (r=0.72, p<.0001 for GM, r=0.80, p<.0001 for WM). However, without use of priors in SIENAX, GM was significantly higher with SPM (0.66 ± .07 Vs 0.52 ± .06 L, p<.0001) and WM was significantly higher with SIENAX (0.48 ± .07 Vs 0.46 ± .07 L, p<.0001). Fig.1A shows individual GM volume for all 56 subjects; the age regression can easily be discerned, as well as the underestimation of GM volume by default SIENAX. Visual examination of segmented images suggested that SIENAX misclassified GM as CSF mostly in deep cortical regions such as the insula and cingulate gyrus as shown in Fig.2c, where regions of interest are outlined by red dotted lines. With the use of priors in SIENAX as shown in Fig.1B and Fig.2d, both methods achieved excellent agreement (r=.95, p<.0001): GM and WM volumes were found to be 0.64 ± .07 L and 0.47 ± .07 L. respectively.



Discussion: The volumes we measured with SPM5 and SIENAX (with priors) were in good agreement with the literature, indicating the validity of our procedures.[3,4,5] We conclude that SIENAX requires priors for accurate volumetric estimates in a single contrast T1W modality. Investigators using SIENAX at its default settings, which do not include use of priors, are likely to obtain absolute values that are inaccurate (underestimated GM, overestimated WM and CSF), and further confounded by gender interaction, although age regressions are preserved.



References:

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