Repeated Measures Performance of Whole-Brain Echo-Planar Spectroscopic Imaging at 4 Tesla

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Introduction

While increased sensitivity provided by high magnetic fields can benefit volumetric whole-brain echo-planar spectroscopic imaging (3D EPSI) in several ways, the gain in measurement repeatability and reproducibility compared to EPSI performed at lower fields, i.e. 1.5T [1], has not been thoroughly investigated. Here, a test/retest study is presented for 3D EPSI of normal human brain at 4 T focusing on repeatability.

Methods

3D EPSI was used on a 4 T Bruker MedSpec system with TR/TE/TI=1780/45/280 ms and an effective voxel size of 2 ml [2,3]. Three healthy female volunteers (mean age=30 yrs.; range=24–41 yrs.) were scanned twice (average interscan interval=4.7 days; range=4–6 days) with identical protocols, including T_1-weighted MPRAGE. Data were processed as described previously [2], with quality assessment based on fitted metabolite linewidth to reject poor-quality data [3]. For each subject, metabolite maps were transformed into the space of the first time-point 3D EPSI data by rigid intra-subject registration [4] using the T_1-weighted MRI data. Regions of interest (ROIs) were defined bilaterally in the frontal, parietal, occipital, and temporal lobe, and in the cerebellum. For each ROI, mean metabolite areas and their coefficients of variation (CV = standard deviation divided by the mean) were calculated for N-acetylaspartate (NAA), Creatine (Cr), and Choline (Cho). Data from an interleaved 3D EPSI water reference acquisition were used for normalization of metabolite areas in institutional units ("metabolite intensities").

Results and Discussion

In Fig. 1 are shown metabolite intensities (mean and standard deviation), averaged over the two time points and over the ROIs, for each of the three subjects. The left and right hand sides of each panel (one panel per ROI for each metabolite) show data from the left and right hemisphere, respectively. Using the same layout, Fig. 2 shows the mean coefficient of variation for the three subjects. Variability in metabolite intensities between subjects may be due to biological variability, as well as partial volume errors due to differences in manual definition of the ROIs. Ignoring differences in relaxation times between 1.5 T and 4 T, metabolite intensities at 4 T from left frontal white matter show reasonable agreement with results at 1.5 T [1]. Coefficients of variation, ranging from 2% to 16%, are, on average, lower than in [1], indicating reasonable repeatability of the method at 4 Tesla.

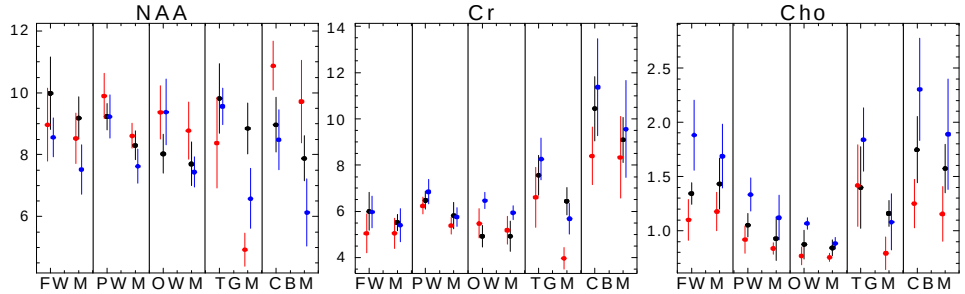

Figure 1: Metabolite intensities (a.u.) for three subjects (color-coded). ROIs are defined as FWM/PWM/OWM: frontal/parietal/occipital white matter; TGM: temporal gray matter; and CBM: cerebellum.

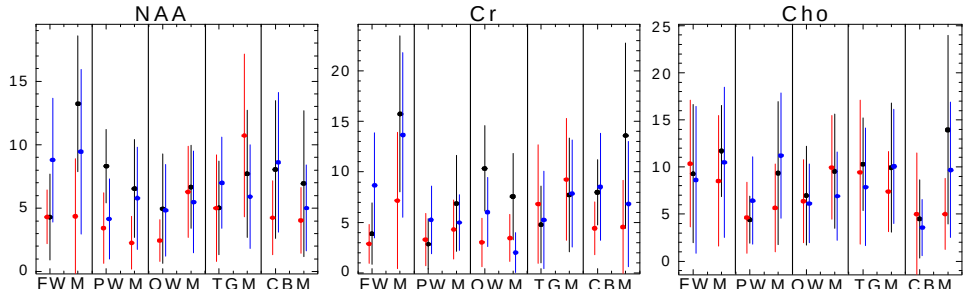

Figure 2: Coefficient of variation (%) for three subjects, as in Fig. 1.

Conclusions

This study demonstrates that whole-brain 3D EPSI acquisitions at 4 Tesla are reasonably reproducible. In future work, data from additional subjects, over a wider age range, and additional time points will be acquired. Reproducibility will be addressed by registering data from all subjects into one common space and by accounting for tissue composition, which will also help reduce inter-subject variability due to definition of the ROIs.

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References: [1] Alger JR et al., ISMRM 2006, p. 3229. [2] Ebel A et al., MRM 54:697 (2005). [3] Ebel A et al., MRI 25:377 (2007). [4] Studholme C, http://www.colin-studholme.net/software/software.html.