

ACROSS-SESSION REPRODUCIBILITY OF DTI DERIVED METRICS MEASURED AT 3T: PHARMACOG CONSORTIUM

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PURPOSE: PharmaCog is an industry-academic European project aimed at identifying reliable biomarkers that are sensitive to disease progression in patients with Mild Cognitive Impairment [1]. Here we present work aimed at implementing standardized procedures to acquire and analyse longitudinal multi-site diffusion 3T MRI data for anatomical connectivity characterization. Previous multi-site 3T DTI MRI studies evaluating across-session reproducibility are limited to few sites [2] or to long dedicated acquisitions with multiple DTI averages [3]. In this study we evaluate and compare across-session test-retest reproducibility of fractional anisotropy (FA), mean diffusivity (MD), axial and radial diffusivities (AD, RD) across different 3T MRI sites, on a group of healthy elderly subjects, using a single DTI acquisition that is part of a protocol aimed at studying other anatomical and functional parameters.

METHODS: Eight 3T MRI sites participated across Italy, Spain, France and Germany. MRI systems include one GE HDxt, two Philips Achieva and five Siemens (two TrioTim, one Verio, one Allegra, and one Skyra) scanners. Most systems used 8 RF channel receive coils, except for the Allegra (birdcage) and Skyra (20 channels) systems. The acquisition protocol (35 min in total) included a single DTI acquisition: b-value= 700 s/mm², 5 b0 volumes, 30 gradient directions, 2x2x2mm³, acceleration factor 2 (GRAPPA, SENSE and ASSET in Siemens, Philips and GE systems, respectively), axial slice acquisition. After local ethics approval each site recruited 5 local healthy volunteers in the age range of the clinical population (55-80 years), who were scanned in two sessions a week apart. Data analysis of each DTI volume included eddy current and motion correction followed co-registration to an ICBM atlas and estimation of FA, MD, AD and RD from a full-brain voxel-based track-based spatial statistics (TBSS) analysis [4]. Each site's FA maps were projected into a common WM skeleton using randomized 5000 permutations. Atlas-based white- and gray-matter ROIs were defined for each subject and session by linear co-registration of the JHU-ICBM-1mm atlas to each subject's space. Across-session reproducibility analysis was done on each subject evaluating test-retest absolute differences relative to the mean on ROI labels. The ROI analysis was focused on the corpus callosum (body, genu and splenium), fornix, corticospinal tract (left/right), inferior and superior lateral fasciculi (left/right). Each site's reproducibility mean was the average across subjects.

RESULTS: We found that the absolute reproducibility errors of FA, MD, AD and RD in white matter ROIs were highly consistent across structures, metrics and 3T MRI sites, and was mostly within the range 2-3 %. To summarize the results, Figure 1 shows for each MRI site the reproducibility errors of FA, MD, AD and RD when averaged across the 10 white matter ROIs. A strong site effect was evident for one MRI site.

DISCUSSION: Within the limitations of the study (40 elderly subjects, 5 per MRI site, 8 MRI sites), we found considerable consistency and good reproducibility of DTI-derived metrics, in general consistent with previous studies [2, 5]. One particular site showed higher reproducibility errors relative to the other ones. For this site only two of the five subjects had full brain coverage in the test-retest DTI data, which apparently resulted in higher variability of the results. These effects, which are being further investigated, do not seem to be related to the scanner itself but to the protocol implementation at that site.

CONCLUSIONS: A multi-site 3T MRI protocol for brain DTI analysis was implemented in eight sites covering four countries. Preliminary test-retest reproducibility results show good consistency with the literature. This study is ongoing to better understand possible sources of variability as well as to include reproducibility measures in gray matter, such as the hippocampus.

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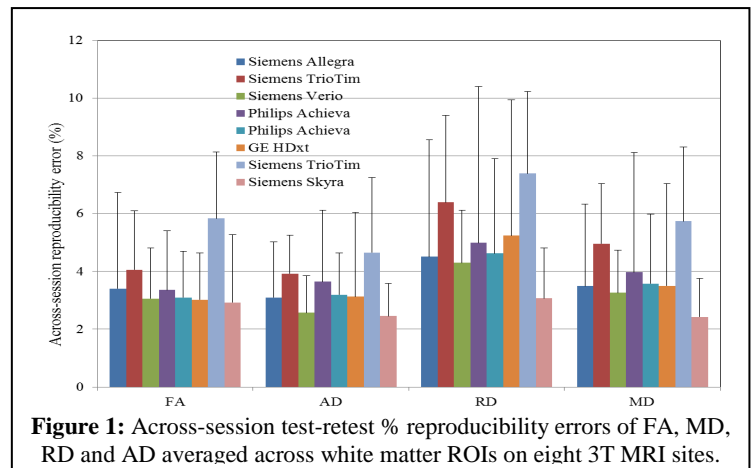


Figure 1: Across-session test-retest % reproducibility errors of FA, MD, RD and AD averaged across white matter ROIs on eight 3T MRI sites.