

# Effect of scanner and head coil on diffusion MRI measures of the brain

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**Introduction.** Quantitative assessment of diffusion parameters computed from diffusion weighted MRI data is commonly employed in studies into pathology of the human brain. To obtain sufficient power, large groups of subjects may have to be included. Acquiring data on multiple sites with different scanners is often required to obtain sufficient numbers. Alternatively, longer inclusion periods in the order of years on one site are needed, during which scanner hardware replacement may occur. Differences in scanner hardware affect the measured data in several ways, including signal to noise ratio (SNR) [1], magnetic and RF field homogeneity and shimming. Variations between scanners of 7% in Fractional Anisotropy (FA) and 4% in Apparent Diffusion Coefficient (ADC) were reported, compared to 9% and 2% within scanner over time [2]. Head coils with more channels may experience a different sensitivity pattern and pick up a lower signal further away from the coil elements. The goal of this study was to compare diffusion parameters between three scanners of one vendor with the head coils used in daily practice on the particular scanners.

**Materials & Methods.** Data were acquired on 3.0 Tesla Philips Intera, Achieva and Ingenia scanners (Philips Healthcare, Best, The Netherlands), equipped with 8-, 32- and 16-channel phased array head coils respectively. 13 consenting subjects enrolled in the study, of which 7 subjects were scanned on all three scanners. Diffusion weighted images (DWIs) were acquired, scanning parameters were TE/TR=84/7250 ms; half scan 0.8; data matrix 112x112; voxel size 2.0x2.0x2.0 mm<sup>2</sup>; diffusion sensitivities of b=0 and b=1000 s/mm<sup>2</sup>; 6 averages of the b=0 scan; 46 gradient directions; 60 continuous slices (no slice gap); SENSE factor of 2 in the AP-direction; scanning time 7 minutes. Adaptive RF shimming was not applied. Acquisition was repeated after repositioning of and repeated planning on the participants. Pre-processing of the DTI data was performed using in-house developed software, written in Matlab (The MathWorks, Natick, MA). Head motion and deformations induced by eddy currents were corrected for by an affine registration of the Diffusion Weighted Images (DWIs) to the non-diffusion weighted image. The gradient directions were corrected by the rotation component of the transformation. Rician noise in the DWIs was reduced by an adaptive noise filtering method [3]. Diffusion tensors were estimated in a non-linear least squares sense. From the tensors, Fractional Anisotropy and Mean Diffusivity maps were computed. The SNR was computed by dividing the average non-diffusion weighted image S0 by the root mean squared residual of the tensor fit. All data were non-rigidly registered to standard space. Relative difference maps intra- and inter-scanner were computed as follows:  $2(A - B)/(A + B)$ , with A and B being the first and second scan for intra-scanner comparison or scans of two sites for inter-scanner comparison.

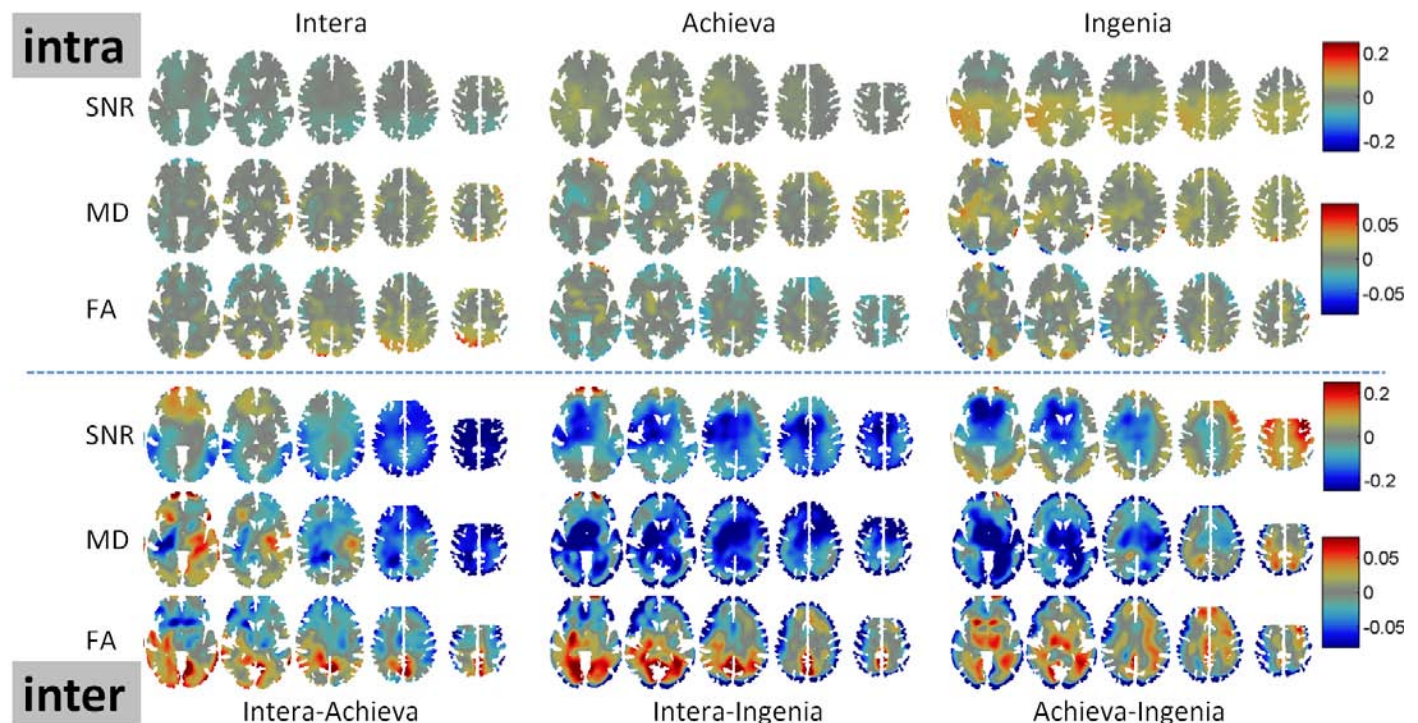


Figure. Intra- and inter-scanner relative difference maps of Signal to Noise Ratio (SNR), Mean Diffusivity (MD) and Fractional Anisotropy (FA) for Philips Intera, Achieva and Ingenia scanners. Color bars denote relative numbers (0.2 = 20%)

**Results.** In general, intra-scanner differences were smaller than inter-scan differences by an estimated factor of three. Deviations were largest for SNR, up to 20%, while MD and FA changes were limited to 8% maximum. An intra-scanner decrease in SNR of 10% was seen for the Ingenia scanner, mainly in the posterior part of the brain. No distinct relation between intra-scanner maps was observed. Inter-scanner differences in SNR were positively related to differences in MD and negatively to differences in FA. The Achieva scanner, equipped with a 32-channel head coil, cranially shows a higher SNR compared to the other two scanners which gradually decreases to a lower SNR in caudal regions. The Ingenia-scanner (16-channel head coil) globally shows a higher SNR compared to the Intera-scanner (8-channel head coil). Differences in SNR show a similar positive pattern in MD and negative pattern in FA.

**Discussion and Conclusion.** Changing scanner hardware and head coil significantly affects SNR, MD and FA, compared to repeated scanning using an identical configuration. Inter-scanner differences are comparable to earlier findings. Future work will be on predicting inter-site variation in MD and FA based on SNR differences.

**References:** [1] J.A.D. Farrell, JMRI 26 (2007) 756. [2] R.J. Fox, AJNR 33 (2012) 695. [3] M.W.A. Caan, MICCAI (2010) 167.