**Functional Brain Imaging using T₁rho Dispersion**

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**Purpose:** To investigate T₁rho-dispersion as a contrast mechanism for functional brain imaging. T₁ρ-weighted imaging has recently been suggested to be sensitive to activity-evoked pH changes in the brain, while being relatively insensitive to blood oxygenation compared to conventional T₂*-weighted BOLD imaging[1]. Comparing T₁ρ- and T₂-weighted imaging (which can be regarded as a special case of T₁ρ where the spin-lock frequency is zero) allows us to determine the effect of the spin-lock pulse (the T₁ρ dispersion) while holding all other parameters constant.

**Methods:** A spin-lock prepared spin-echo EPI sequence was developed on a Philips 3T Achieva TX scanner. T₁ρ-weighting was produced by non slice-selective 90° SL→180° SL→90° magnetization preparation[2], where SL represents the spin lock pulses with a frequency of 500Hz and duration of 50ms each, (total spin-lock time 100ms). T₂-weighting (spin lock frequency of zero) was produced by setting the spin lock RF amplitude to zero. Data readout was using a single-slice spin-echo EPI technique with TE/TR=14/3000ms, matrix 84x84, 240mm FOV, 10mm slice thickness. The functional paradigm consisted of 5 epochs of (24s off/24s on) checkerboards flashing at a frequency of 15Hz. A total of 4 runs of T₁ρ- and T₂-weighted imaging were acquired from a single subject in two sessions, with the order of presentation counterbalanced between sessions. Data was analyzed with a general linear model using SPM8 with a canonical HRF[3].

**Results:** The baseline signal intensity with 500Hz T₁rho-weighting was approximately 40% higher than with T₂-weighting, consistent with appropriate spin-locking. Maximum signal intensity changes were ~2% and ~3% for T₁ρ- and T₂-weighting respectively. While the activation maps are similar (Figure 1a-c), consistent regions are observed in which the activation is significantly higher with T₂-weighting (cluster p<0.05, FWE corrected, Figure 1d). No regions were observed with significantly greater activation using T₁ρ-weighting.

**Discussion:** The subtle but consistent differences between the maps may be an indication of better spatial localization in the 500Hz T₁ρ-weighted data, consistent with a shift in weighting towards pH and away from BOLD contrast. However, the slice thickness used may partly obscure any improved localization.

**Conclusion:** Functional brain imaging using T₁ρ- and T₂-weighted imaging provide qualitatively similar maps, but with some regions of significant difference (T₁ρ-dispersion), perhaps due to differences in the contrast mechanism. Further work with an improved interleaved acquisition of different spin-lock frequencies will investigate whether T₁ρ-frequency dispersion can further disentangle pH and oxygenation-related contrast.


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**Figure 1.** Activity measured using (a) T2-weighting, (b) T₁ρ, (c) T2 and T₁ρ overlaid, and (d) T₁ρ-dispersion. All maps thresholded at p<0.001 (uncorrected). Top and bottom rows show data from different sessions but the same subject.