

# The impact of temporal signal fluctuations and susceptibility-related echo time shifts on BOLD sensitivity: an assessment in patients with brain pathologies at 7 T

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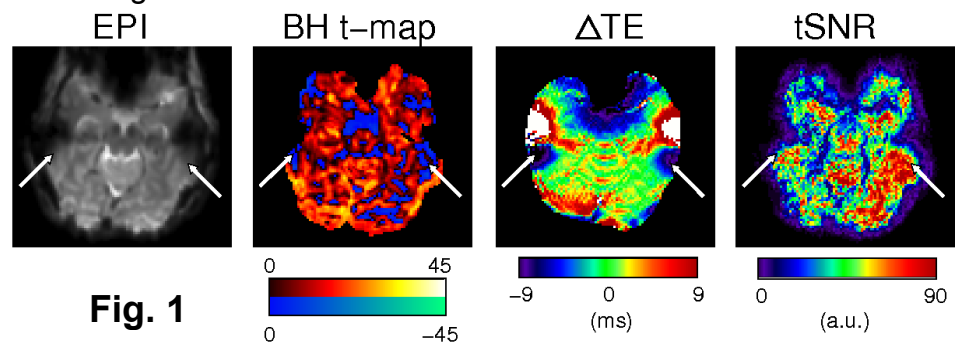
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**Purpose:** To investigate the scale and significance of variations in local echo time ( $TE_{local}$ ) and temporal SNR (tSNR) in EPI at 7 T in healthy volunteers and patients, focusing on pathologies and postoperative cavities frequently encountered in presurgical mapping.

**Introduction:** Gradients in  $B_0$  caused by tissues with differing magnetic susceptibilities lead to regional variations in the effective TE, which modifies BOLD sensitivity (BS). In the commonly used BS metric, namely tSNR<sup>[1]</sup>, changes in  $TE_{local}$  are not considered, but may be significant, especially at high field close to air cavities and near gross brain pathologies.

**Methods:** Three healthy volunteers and 11 patients with brain tumors, postoperative cavities and venous malformations participated in the study. Measurements were performed at 7 T with a 32-channel head coil. tSNR was estimated from a 5 min run of resting state EPI with effective  $TE=22$  ms. Maps of  $\Delta TE = TE_{local} - TE$  were derived from the phase of a multi-echo GE scan<sup>[2]</sup>. One healthy volunteer performed 10 runs of a breath-hold (BH) task. The t-map from this experiment served as a gold-standard BS measure<sup>[3]</sup>.

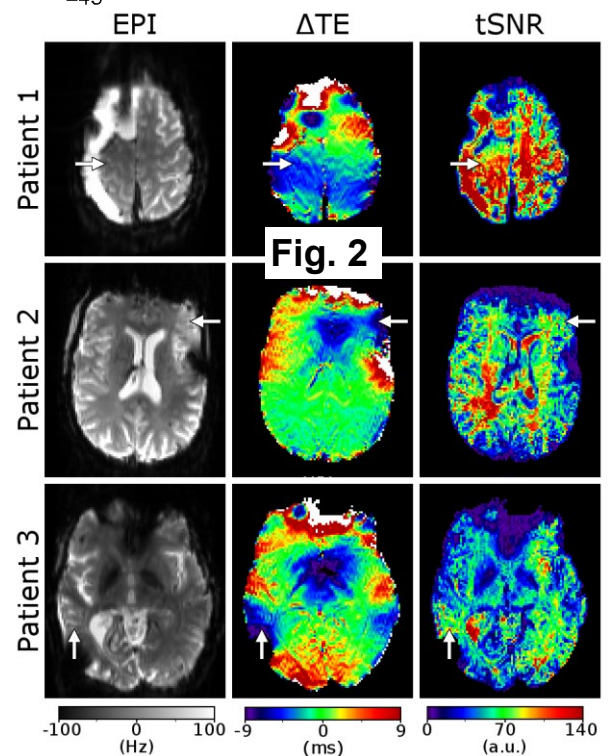
**Results:** Fig.1 shows the correspondence between the gold-standard BS measure (BH t-map),  $\Delta TE$  and tSNR map. Regions close to the auditory canals with strongly negative  $\Delta TE$  (at arrows) have high tSNR and EPI signal, but low BH t-values, indicating very low BS.



**Fig. 1**

In all subjects, a strong reduction in TE was found close to the ear canals and sinuses: from 22 ms to 11 ms. In some patients, regions of particular interest in presurgical planning were affected, with reductions in the TE to 13-15 ms. These included the primary motor cortex (Patient 1), Broca's area (Patient 2), and auditory cortex (Patient 3), as shown in Fig.2. These regions were characterized by high tSNR (>70).

**Conclusions:** Examining tSNR but ignoring regions of reduced  $TE_{local}$  would erroneously suggest BS sufficient to map BOLD signal changes, causing false negative results. It is thus important to consider both tSNR and  $TE_{local}$  in order to reliably estimate BS and to facilitate identification of potential false negative results. This is particularly true at high fields (7 T) and in patients with large pathologies.



**Fig. 2**

**Refs:** [1] Parrish et al., MRM 2000:44(6),925-932.

[2] Deichmann et al., NeuroImage 2002:15(1),120-135. [3] Kastrup et al., MRM 1999:42(3),608-611.