SENSE fMRI at 3 Tesla for the study of the hippocampus

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INTRODUCTION:

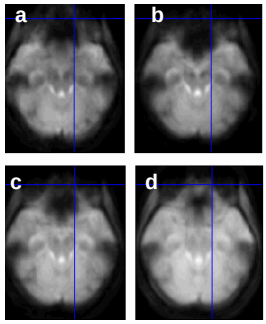
High-field fMRI studies suffer from susceptibility and deformation artifacts which degrade image quality, particularly in some brain areas such as in the hippocampus or around the frontal sinuses. This is problematic for many activation studies. Sense techniques allow the decrease of the echo train length, thus reducing the TE and, therefore, related artifacts [1]. In addition, sensitivity to BOLD contrast depends on T2* of the blood at a given magnetic field and thus on TE [2]. In the present work, we investigated the relationship between the choice of TE, the sensitivity to BOLD contrast and the susceptibility artifacts, in a visual memory task which is believed to engage hippocampal areas. The aim was to find the best acquisition protocol for a range of activation studies.

METHODS:

Eight normal subjects (mean age 27.2y ± 4.02), right handed, underwent four fMRI block-design experiments. Each experiment consisted in 80 dynamics, i.e. 10 blocks of 8 repetitions each. Blocks alternated between two different tasks, i.e. picture encoding (experimental task) and covertly counting from 1 to 10 (baseline). In picture encoding, subjects were presented with line drawings of familiar objects, 8 for each block. At the end of each experiment, subjects were presented with old and new drawings in random order, and were asked to identify those they had previously seen. Scans were performed on a 3T Intera Philips body scanner (Philips Medical Systems, Best, NL) using a sense head coil. Sense was used in three of the four scans, with reduction factor (RF) = 2. Acquisition parameters for the GE EPI pulse sequence were chosen as follows: TR=3700ms, voxel size=2.5x2.5x4mm, TE was 20, 30, 40, and 40ms, for sense20, sense30, sense40 and nosense40 scans, respectively. The order of acquisition of the 4 experiments was counterbalanced across subjects. Data were analysed using SPM2 [3], first on a single subject level, then on a group study level. Second-level statistics were obtained from conjunctions between individual effects.

RESULTS:

Visual inspection of the images confirmed the relative better quality of EPI using sense and TE=20ms. A good quality and minimal artifacts were also obtained with TE=30ms (fig.1).



Statistical group analysis revealed a common pattern of activation for all modalities, which included in particular visual associative areas, bilaterally. The bilateral dorso-lateral prefrontal cortex, including Broca's area on the left hemisphere was also activated in all four acquisition modalities (fig2). In addition, the medial temporal lobe (hippocampus) was bilaterally activated in sense30 and sense20, but not in sense40 and nosense40.

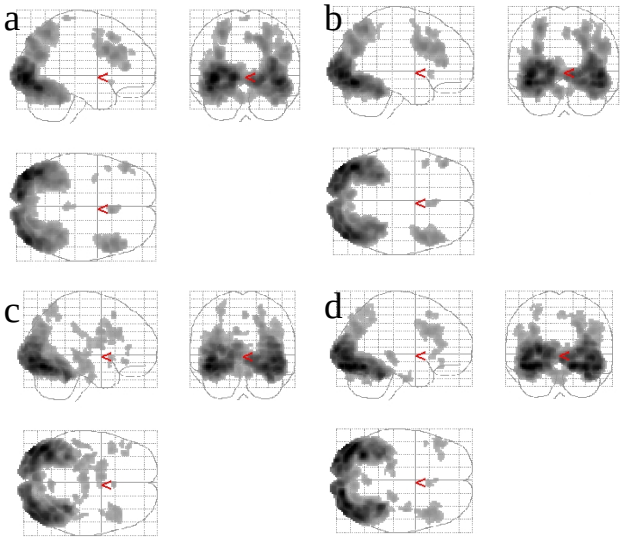


Fig1-2a) nosense40; b) sense40; c) sense30; d) sense20

DISCUSSION:

Picture encoding activated a bilateral network of visual associative, temporal and frontal areas. Activations in the hippocampus were found in some modalities, but not in all: the greatest effect size was found using sense and a TE=30ms. In sense20, the hippocampal activations are slightly less significant from a statistical point of view, probably because the acquisition was not performed at the maxima of the hemodynamic response function. In scans where a TE=40ms was used (with and without sense), activations in the hippocampus are probably cancelled by the loss of signal due to susceptibility artifacts. This study demonstrates that TE=30ms using sense technique with a RF= 2 is an optimal compromise between BOLD sensitivity and susceptibility artifacts.

REFERENCES:

[1] KP Pruessmann et al, MRM, 1999;42:952-962; [2] Fera et al. JMRI, 2004; 19:19-26; [3] http://www.fil.oin.ucl.ac.uk/spm