High resolution BOSS fMRI at 1.5T

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INTRODUCTION.

Blood Oxygenation Sensitive Steady-state (BOSS) fMRI is a new method for obtaining functional contrast using refocused SSFP imaging [1,2]. In BOSS, the frequency sensitivity of refocused SSFP is used to detect changes in blood oxygenation based on the frequency shift of deoxyhemoglobin. In particular, strong functional contrast can be achieved due to the sharp phase transition near resonance [2]. Because it is based on refocused SSFP imaging, BOSS has high SNR efficiency and does not suffer from image warping or signal dropout. These factors make BOSS a strong candidate for high-resolution fMRI, an area of current research [3-7]. This work presents a feasibility study of high-resolution BOSS fMRI at 1.5T.

METHODS.

Imaging was done on a 1.5T GE Signa using a transmit/receive head coil. Shimming was targeted to the occipital lobe and the transmit frequency was matched to the resonance frequency of the calcarine fissure. BOSS fMRI experiments were performed at 2 high-resolution voxel sizes, 1.25x1.25x3 mm^3 and 1x1x2 mm^3. A different subject was used for the 2 experiments. Data was gathered on a single sagittal slice through the occipital pole (24 cm FOV). The sequence was timed to give an image every 2 seconds (1.25x1.25x3 mm^3) or 3 seconds (1x1x2 mm^3). A back-projected 10 Hz reversing annulus grating visual stimulus was presented in 15s on/off blocks for 2 minutes. This experiment was repeated 2 (1.25x1.25x3 mm^3) or 6 (1x1x2 mm^3) times. Analysis was performed using FSL [8]. Repeated runs were registered, averaged and processed using FEAT with cluster thresholding (cluster threshold Z>2.3, cluster significance threshold P<0.01).

RESULTS.

The activation maps for the experiments are shown in Figs. 2 (1.25x1.25x3 mm^3) and 3 (1x1x2 mm^3 data), overlaid on high-resolution T2-weighted structural images. In both experiments, activation is confined to the gray matter and is focused on the calcarine fissure. In each data set, the percent signal change due to activation was calculated for the voxel with greatest Z-statistic. The lower-resolution scan (1.25x1.25x3 mm^3) had a signal change of 9.1% and the higher-resolution scan (1x1x2 mm^3 data) had increased signal change of 15.7%. Previous work has reported increased signal change at smaller voxel size due to reduction of partial volume effects [4-7].

DISCUSSION AND CONCLUSIONS.

This work has presented high-resolution fMRI at 1.5T using BOSS fMRI. Using BOSS, we have achieved high-resolution fMRI at low field without special hardware. It is expected that these results may be improved upon at higher field and with the use of surface coils.

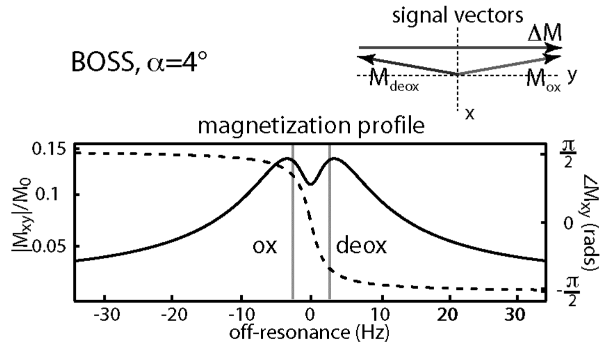

Figure 1. BOSS contrast mechanism. The SSFP phase profile causes deoxygenated blood to oppose oxygenated blood, creating signal dependence on blood oxygenation.

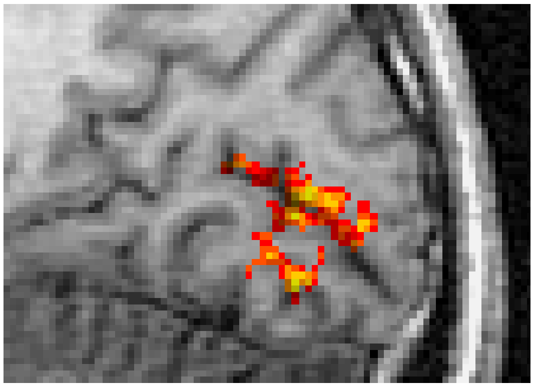

Figure 2. BOSS fMRI with voxel size 1.25x1.25x3 mm^3.

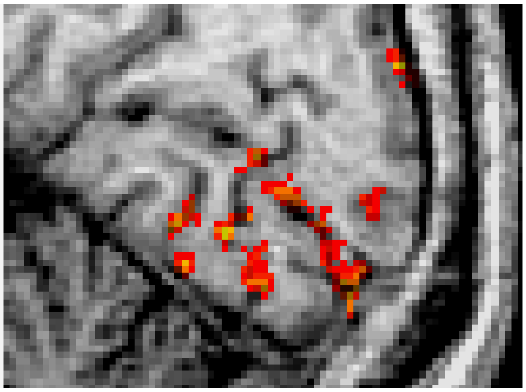

Figure 3. BOSS fMRI with voxel size 1x1x2 mm^3.

References

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