Reduced fMRI signal sensitivity in motor areas when cued by MRI-compatible apparatuses

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Introduction

Nowadays, many researchers studying in neural mechanisms of human behaviors make use of FMRI as an experimental tool duo to its non-invasive quality and suitable for combining with various tasks. During experimental processes, instructions may be delivered by distinct modalities such as goggle, projector, headphone or tapping by the experimenter, according to task necessity and brain sites to be studied (1) (2). However, there is less research exploring whether these MRI-compatible apparatuses would affect BOLD signals in imaging acquisition process. In this study, we will propose the influence of MRI-compatible apparatuses when performing a motor task. Activation volumes in motor cortex and SNR values will both provide evidences.

Methods

Five right-handed volunteers (two females and three males) participated in this study. The task was presented in alternating 30-s periods of rest and movement, repeating 4 times. In movement conditions, subjects performed grasp-release with right hand at the frequency of 0.5 Hz. Every subject attended to three functional runs with cuing " go" and " stop" to trigger movement and rest epochs by three different kinds of modalities, including goggle, headphone and leg-tapping respectively. Moreover, the sequence of three runs was pseudo-randomized.

Imaging was performed on a 1.5T Magnetom Vision MRI scanner. 84 slices were acquired using single-shot gradient-echo EPI sequence (TR/TE/θ= 3000ms/60ms/90°, FOV=211mm, 64*64 matrix, slice thickness 5mm). In all functional runs, the MR signal was allowed to achieve equilibrium over four scans that were excluded from analysis. T1-weighted images were acquired for use as the anatomical overlay.

FMRI data were analyzed using SPM2 software (Wellcome Department of Cognitive Neurology, London, UK). In single subject analysis, images in one run were realigned and statistical map was obtained. The quantification of activation in motor cortical area was conducted by a region-of-interest (ROI) analysis. Voxels within ROI meeting significant difference in BOLD signal intensity (corrected $p < 0.05$) during movement compared with rest conditions were considered activated. Signal-to-noise ratio (SNR) was also computed. In averaging process, using fixed-effect model, all the images of one run across subjects were realigned, normalized and smoothed with a 5mm isotropic Gaussian kernel. Statistical parametric maps were obtained and voxels were considered significant at a threshold of $p<0.05$, corrected.

Results

The average of SNRs in three modalities was summarized in table1. Paired t-test revealed that the SNR of tasks cued by goggle was significantly larger than that of tasks cued by leg-tapping [$t(4) = 4.71$, $^{**}p<0.01$]. No significant differences appeared between goggle cues vs. headphone cues and between leg-tapping cues vs. headphone cues. ROI analysis showed that there were significant differences in activation volumes when compared headphone cues with leg-tapping cues [mean= 77.4 versus 107.6, $t(4) = 4.78$, $^{**}p<0.01$]. Activation volumes did not differ between leg-tapping cues vs. goggle cues [mean=107.6 versus 80.2] and goggle cues vs. headphone cues [mean=80.2 versus 77.4]. Figure 1 presented the average activation maps in three modalities.

Discussion

This study proposed FMRI BOLD signal sensitivity decrease when conducting movement task using MRI-compatible modalities, goggle and headphone. This implies that researchers who apply FMRI to their studies might take reduced sensitivity into consideration. Moreover, each FMRI lab may have its own apparatuses, and perhaps the result will be different from that of this study. Especially when the same brain sites or human functions were studied, researchers who use different apparatuses to deliver their instructions may attain distinct results. Also, the result of phantom with apparatuses may not apply to human beings directly.

References

1. Burton M. W., et al., *NeuroImage*, 2005, 647-661
2. Vigneau M., et al., *NeuroImage*, 2005, 694-705

Table 1

subject	SNR		
	goggle	headphone	leg-tapping
1	78.7	78.4	92.9
2	79.1	79.7	83.9
3	73.7	82.0	80.8
4	64.6	73.6	71.7
5	77.6	91.0	92.2
mean ± SD	74.8 ± 6.1	80.9 ± 6.4	84.3 ± 8.8

Figure 1