Coupling of the sensorimotor cortical activation explored by blood-oxygenation-level-dependent signal navigated and traditional magnetic evoked potential recordings

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Introduction

The blood-oxygenation-level-dependent (BOLD) signal in functional magnetic resonance imaging (fMRI) reflects associated hemodynamics for a specific motor task. Motor evoked potentials (MEPs) represent the excitability of the motor cortex. Recently the MEP recording can be visually guided by the BOLD signal in fMRI. However, the two methods may represent diverse physiological mechanisms[1,2].

Objectives

To study the coupling of the sensorimotor cortical activation observed in fMRI BOLD signals and measured by traditional MEP recordings.

Materials & Methods

Ten healthy, right-handed subjects (7 men, mean age: 34.6 ± 7.6 years) participated in this study. Functional imaging was acquired by using a 3.0T GE MR scanner with a single-shot EPI sequence. The subjects were requested to perform simple, repetitive abduction movement at right index finger while they saw a go-signal appeared on the projection screen and to take a rest during no-go signal periods. Transcranial magnetic stimulation (TMS) was delivered through a focal figure-of-eight stimulating coil. The coil was held tangential to the scalp with the handle pointing backwards and ~45˚ away from the midline. Twenty single TMS trials were measured with a randomly varying intertrial interval ranging from 7.5-12.5 s at four coil positions. The electrophysiological optimal (EO) position was determined as the site where TMS at a slightly suprathreshold intensity produced consistently the largest MEPs in right first dorsal interosseus (FDI). The site was marked on the scalp to assure a constant placement of the coil throughout this session. The other three positions were determined by a frameless MR-navigation system (Visor^{TM}).

The maximal BOLD signals at left primary motor cortex (BM1), left primary sensory cortex (BS1) and the lateral margin of the BOLD activity (BL) were targeted by the guidance of the navigation system. Two TMS intensities which were adjusted to produce MEPs of about 0.5 mV (low intensity) and 1 mV (high intensity) in peak-to-peak amplitude in the right FDI muscle were tested. In total 8 recording sessions including 4 positions and 2 intensities were completed by a randomized order for each subject. The mean MEP amplitude of each session was analyzed by a two-way repeated measures analysis of variance (rmANOVA) with the within-subject factors of POSITION and INTENSITY.

Results

All subjects demonstrated a clear BOLD signal in the left sensorimotor cortex with response to the right finger movement. RmANOVA of the MEP amplitudes revealed significant main effects of POSITION and INTENSITY, and a significant interaction between POSITION and INTENSITY. The post-hoc analysis revealed a significant MEP difference between the four positions except EO-BM1 and BS1-BL at high intensity stimulation (all $p<0.01$). At low intensity stimulation, the MEP difference is significant only at the positions of EO-BL and BM1-BL (both $p<0.02$).

Conclusion

Findings suggest that the coupling of the BOLD signals and the MEPs can be TMS-intensity dependent. A distinct localization of the BOLD signal in M1 or S1 by the TMS-navigation system may significantly vary the MEP findings under a high TMS-intensity condition.

References

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