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Successful Recording of Visual Evoked Potentials in a 9.4T Static Magnetic Field

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Introduction

Simultaneous recording of electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) has shown a number of advantages that make this multimodal technique superior to fMRI alone. Recording these multiple measures is advantageous for many aspects of cognitive neuroscience, pharmacological studies, sleep studies or evoked potential studies. Here, we explore the possibility of recording visual evoked potential (VEP) in a 9.4T static magnetic field. The pulse artefact is considered to be the most challenging source of EEG data contamination in recordings performed at ultra-high fields [1] . See figure 1.

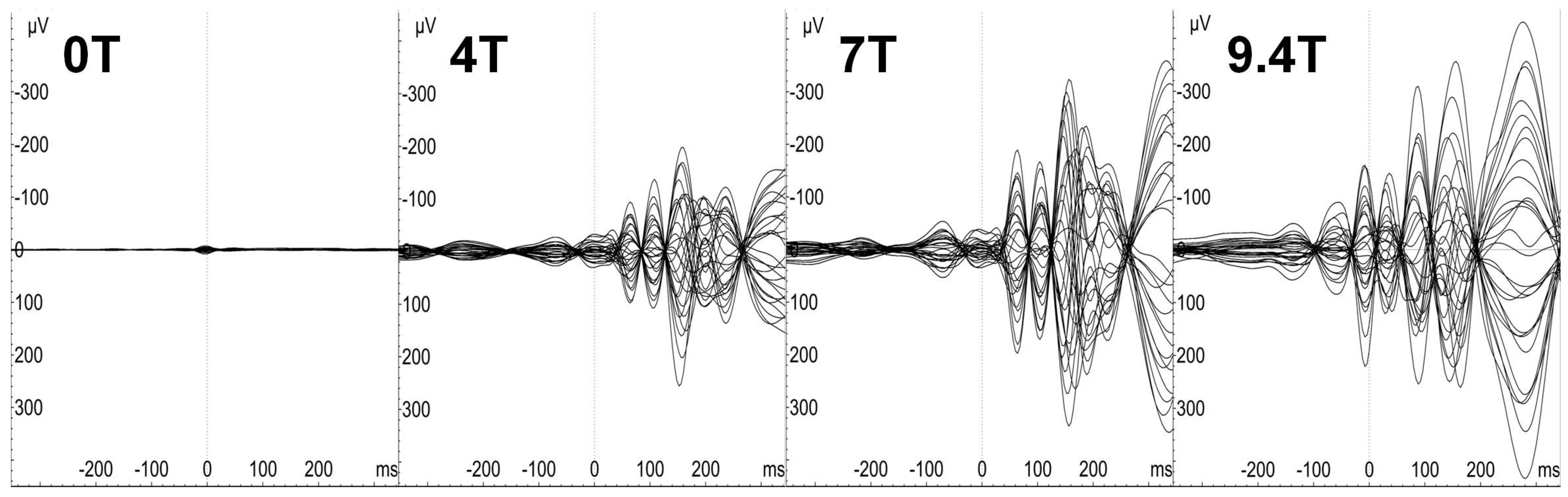

Figure 1. Pulse artefact at different magnetic fields. EEG signal is averaged around the heart-beat event

Methods

EEG data were recorded from 15 healthy volunteers (10 male, 5 female), mean age of 34.5 (SD 12.6) years. EEG data were recorded from each subject outside of the scanner (0T) and inside a Siemens 9.4T human whole-body scanner (Siemens Medical Systems, Erlangen, Germany) using a MR compatible EEG system. Visual stimuli were presented separately and recorded at 9.4T and 0T. The stimuli consisted of 200 flashes of white light with an intensity of 12 cd/m2, duration of 500 ms and ISI between 2 – 4 s.

EEG data were first down-sampled to a rate of 250 Hz, filtered at 0.16 – 20 Hz and re-referenced to Fz. The data recorded at 9.4T were corrected for ballistocardiogram (BCG) artefact by the means of independent component analysis (ICA), where the components were visually inspected and those activities which were related to heartbeat events were excluded. Data were then segmented around the event markers, 50 ms before and 250 ms after the stimulus. The segmented data were later subjected to extended infomax ICA using the Runica algorithm.

The presence of VEPs was evaluated at Oz channel. The resulting independent components were inspected for topography, evoked signal, and consistency across single trials to determine event related potential components [2].

Results

Independent components representing clear VEPs were found in all 15 subjects at 0T. However in the 9.4T scanner, data from 10 subjects yielded clear VEPs. Paired t-test showed no significant difference in the latencies of the visual P100 recorded at 0T and at 9.4T static magnetic fields; $t(14) = -0.546$, $p = 0.594$. There was no significant difference in the amplitude of the visual P100 recorded at 0T and at 9.4T static magnetic fields; $t(14) = -2.12$, $p = 0.052$.

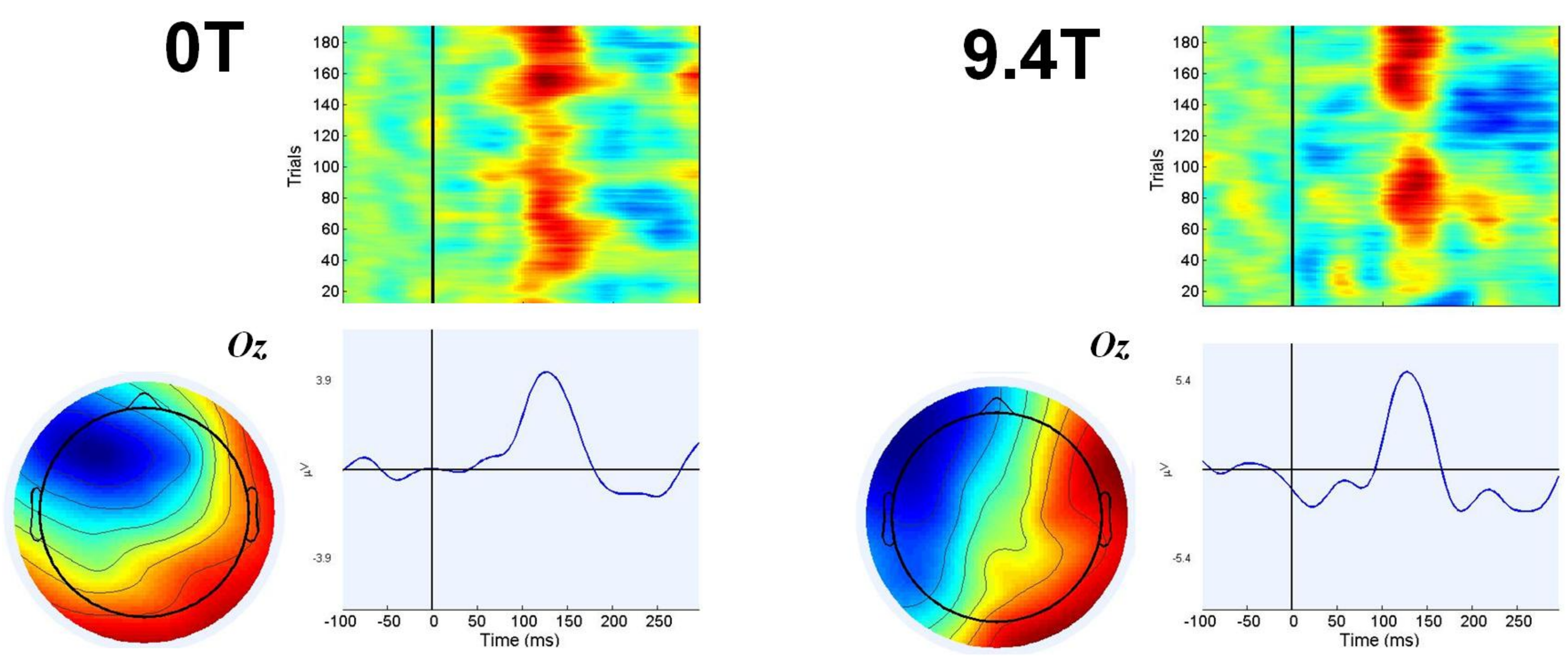

Figure 2. Example of visual evoked potentials at 0T and at 9.4T recorded from one subject. The plot over the ERP signal shows the consistency of the response across the trials.

Discussion

The results of this study confirm the feasibility of recording evoked potentials at 9.4T. ICA proved to be effective in removal of the BCG artefacts and also for identifying VEPs. Our results show that the latencies of the VEPs do not differ when the stimulation was performed at 0T or 9.4T static magnetic fields. This finding supports the assumption that the speed of primary sensory perceptions is not altered by the 9.4T static magnetic field.

References

[1] Debener et al. (2008) Int. J. Psychophysiol. 67, 189–199.

[2] Makeig et al. (1997) Proc. Natl. Acad. Sci. U. S. A. 94, 10979–10984.