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Successful Recording of Auditory P300 in a 9.4T Static Magnetic Field

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Introduction

One of the advantages of ultra-high field magnetic resonance imaging (MRI) is the possibility of imaging at increased spatial resolution with electroencephalography (EEG) during rest and different tasks. Simultaneous measurements lay the foundations for an EEG-informed, single-trial analysis approach to the fMRI data. Here we explore the feasibility of recording evoked potentials which resemble very early stages of cognitive processing such as the P300 in a 9.4T static magnetic field.

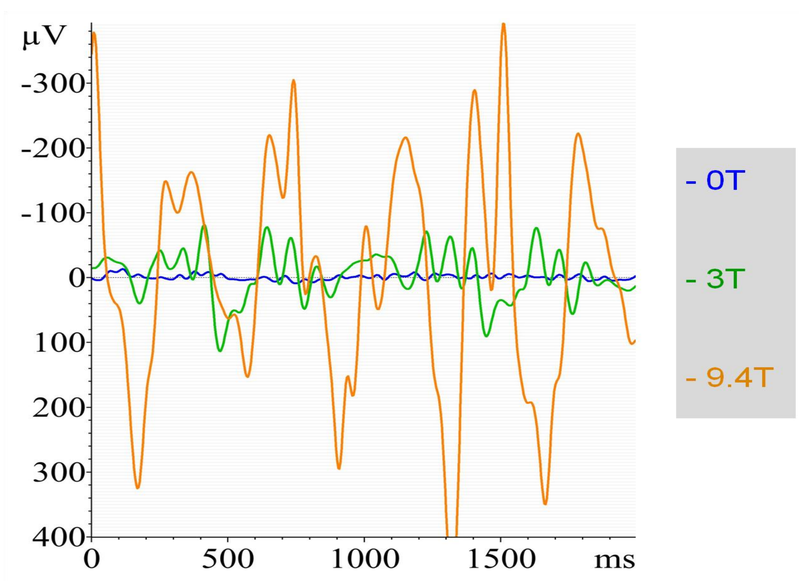

Figure 1. Raw signal appearance of 2 seconds of EEG recording at various magnetic fields: 0T, 3T and 9.4T.

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. An auditory oddball paradigm was presented and delivered via headphones. Subjects were presented with a series of high (1000 Hz) "task relevant" target tones and lower (500 Hz) "task irrelevant" tones of 50 ms duration, 85 dB, and inter-stimulus interval between 2 and 14 s. Target probability was 20%.

EEG data were first down-sampled to a rate of 250 Hz, filtered at 0.16 – 20 Hz and re-referenced to average. The data recorded at 9.4T were corrected for ballistocardiogram (BCG) artefact (Figure 1) 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 450 ms after the stimulus. The segmented data were later subjected to extended infomax [1] ICA using the Runica algorithm. The presence of VEPs was evaluated at Cz channel. The resulting independent components were inspected for topography, ERP signal, and consistency across single trials to determine event related potential components [2].

Results

Independent components representing clear P300 peaks were found in all 15 subjects at 0T. However, in the 9.4T scanner data from 12 subjects yielded clear ERPs. Paired t-test showed no significant difference in the latencies of the auditory P300 recorded at 0T and at 9.4T static magnetic fields; $t(14) = 1.474$, $p = 0.163$. There was no significant difference in the amplitude of the auditory P300 recorded at 0T and at 9.4T static magnetic fields; $t(14) = -2.084$, $p = 0.056$.

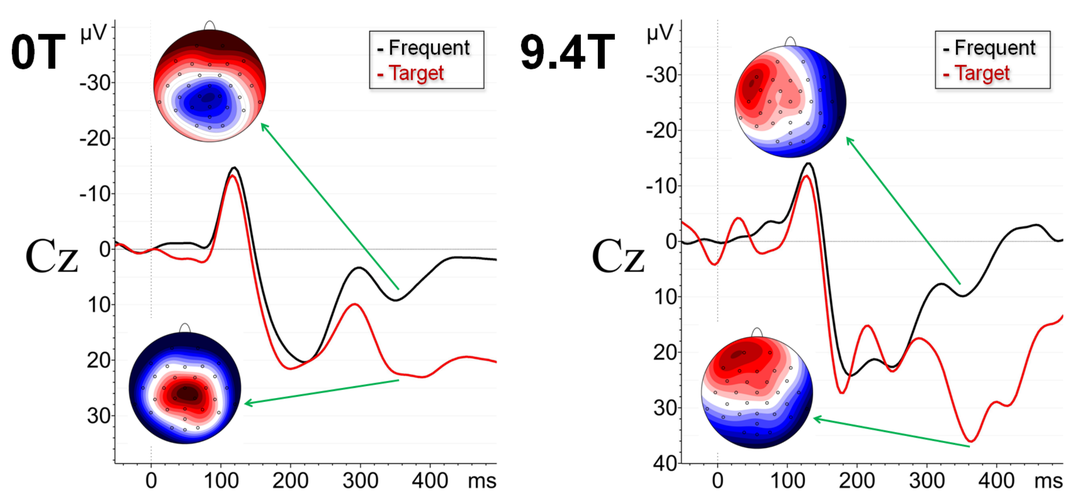

Figure 2. Example of auditory evoked potentials at 0T and at 9.4T recorded from one subject.

Discussion

The results of this study confirm the feasibility of recording the P300 at 9.4T static magnetic fields. Our results show that the latencies of the evoked potentials do not differ significantly between 0T or 9.4T static magnetic fields. This finding supports the assumption that the speed of very early cognitive processing is not altered by the 9.4T static magnetic field.

References

[1]Bell et al. (1995) Neural Comput. 7, 1129–1159.

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