

Introduction

We demonstrate the feasibility of determining visual evoked potentials (VEPs) during fMRI acquisition periods. Previously, it has been shown that event-related potentials (ERP's) can be recorded in periods of no gradient switching (Krugger et al. 2000). Our results indicate the possibility to transfer a standard EEG experiment in an fMRI environment without any restrictions.

To evaluate the influence of MR-artifacts we compare VEPs for 3 different modalities:

1. During MR-Scan Periods
2. During Interscan Periods
3. Outside the MR-Scanner

Methods

Functional MRI was performed with a Siemens Vision 1.5 Tesla scanner. A T2*-weighted BOLD sensitive gradient echo planar imaging sequence was used (TE 60 ms, flip angle 90°, voxel size 3x3x6 mm³).

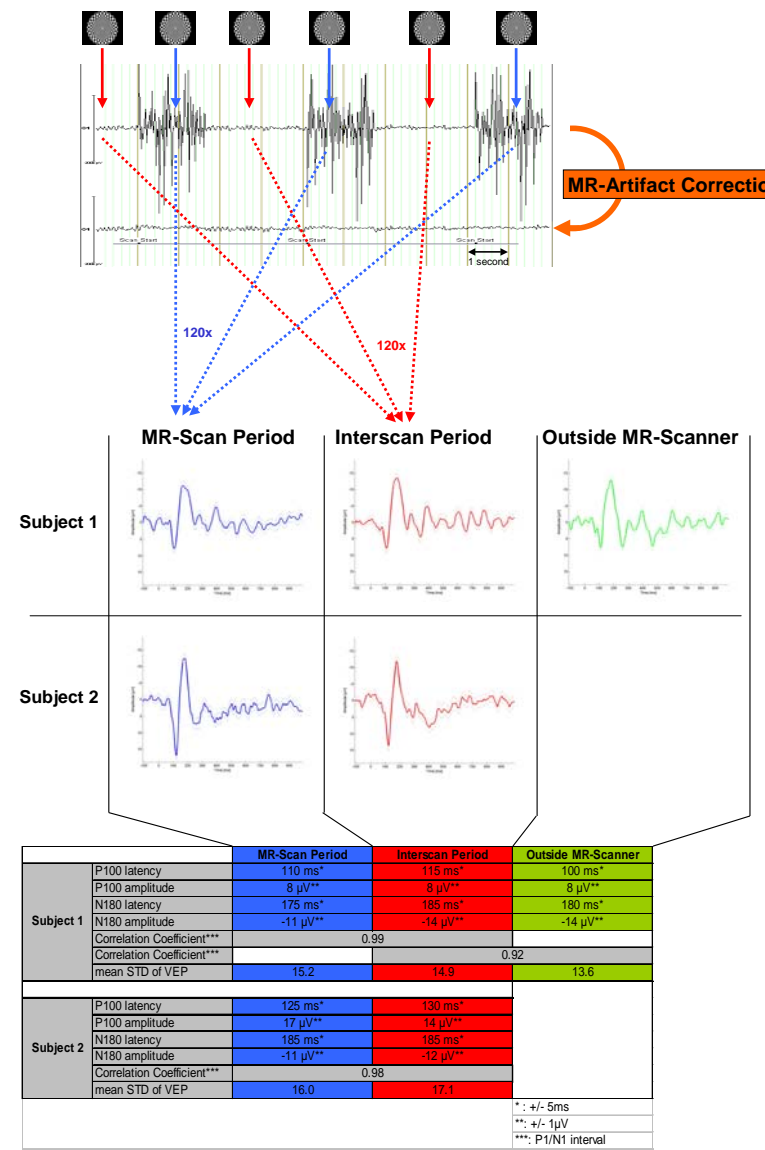
120 scans were recorded with a repetition time of 4.2 s (volume acquisition time: 2.1 s).

EEG recording was performed using a 32-channel MR-compatible EEG (Brain Products) with a large dynamic range to capture both low-amplitude EEG and large MR-artifacts. Sampling frequency was 5000 Hz. VEPs were analysed from recordings of electrode O2 (10/20 system)

Paradigm: One stimulus (reversing checkerboard) was presented per MR-scan and per interscan period.

Stimulus onset varied randomly between 100 ms and 800 ms after MR-scan onset or onset of the interscan interval

MR artifact correction was performed by a simplified version of an algorithm proposed by Allen et al. (2000) (see formula): A template (B_n) was calculated by a weighted (w) sum of k adjacent artifacts. This template was then subtracted from the actual contaminated interval A_n . We used all ($k=120$) artifacts weighted with $w=1$ to calculate one template B , that was subtracted from each artifact contaminated interval A_n .



$$B_n = \frac{\sum_{i=0}^k w^i A_{n-i}}{\sum_{i=0}^k w^i} \quad C_n = A_n - B_n$$

Algorithm for artifact removal:
 A_n : Artifact contaminated intervals
 B_n : Template
 w : Weighting factor
 k : Number of averaged artifacts

Results

Latencies and amplitudes of the P100 and N180 from all three modalities showed no significant differences (see Table). The VEP's during MR-Scanning periods were highly correlated with those recorded in non-scan periods.

As a measure for the signal to noise ratio we examined the standard deviation averaged over the time points. There is no remarkable difference in those values comparing the scan and nonscan potentials. As expected the VEP recorded outside the MR-scanner showed a slightly better signal to noise ratio.

Discussion

According to our data, real simultaneous recording of VEPs and fMRI-BOLD signal is feasible.

Since no significant differences were found we conclude that it is possible to use stimulus trials within acquisition periods for VEP analysis. The efficiency of combined EEG fMRI experiments can thus be increased

It should be noted though that the MR-artifact filter cuts higher frequencies. Therefore the analysis of finer structures of ERPs is hindered after applying the filter used in this study.

References

Krugger et al. 2000: Recording of the Event-related Potentials During Functional MRI at 3.0 Tesla Field Strength. Magn Reson Med. 2000 Aug;44(2):277-82.
 Allen et al. 1999: A method for removing Imaging Artifact from Continuous EEG Recorded during Functional MRI. NeuroImage 12, 2000.