Biomed Tech 2012; 57 (Suppl. 1) © 2012 by Walter de Gruyter · Berlin · Boston. DOI 10.1515/bmt-2012-4353

Acoustic noise control during auditory fMRI using a DSP system - first initial in vivo results

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Introduction

Acoustic noise cancellation during fMRI has been previously reported as a promising tool to enhance experiments using acoustic stimulation. However, publications investigating the different aspects of this technique, such as interference of stimulus with noise cancellation procedures, are rare. We implemented a template-based ANC system for online application and evaluated the effect of pausing adaptation of the algorithm during acoustic stimulation.

Methods

We implemented a FilteredX normalized Leaky Least Mean Squaresalgorithm on a DSP developer board. In addition, we employed two optical microphones and an MR compatible headset. The implemented algorithm continuously optimizes the attenuation by adapting filter coefficients independently for the left and right channel. We conducted fMRI measurements on a 3T whole-body MRI system using auditory stimulation with a single frequency tone at four different amplitude levels. The relative amplitude levels were 0, -8, -16 and -24 dB. The experiment was performed with active noise cancellation twice: one experiment, in which the adaptation of filter coefficients was stopped during acoustic stimulation and one experiment with continuous adaptation. In a third experiment no active noise cancellation was applied.

Results

Both experiments with stopping adaptation during stimulus presentation and with continuous adaptation show significant activation ($p < 0.05$, FWE) in the right auditory cortex (AC). No activation was found in the left AC with continuous adaptation. Without active noise cancellation, no activation was observed in AC.

Conclusion

Our fMRI experiment showed significant differences between continuously adapting noise cancellation compared to interrupted adaptation during stimulus presentation when using a self-developed real-time template-based noise-cancellation system. This finding may be the result that the algorithm attenuates the stimulus too quickly during stimulus presentation if adaptation is continuous. Future works will evaluate techniques that aim to slow down the adaptation during the presentation of acoustic stimuli.