A real-time event-related hyperscan-fMRI software system

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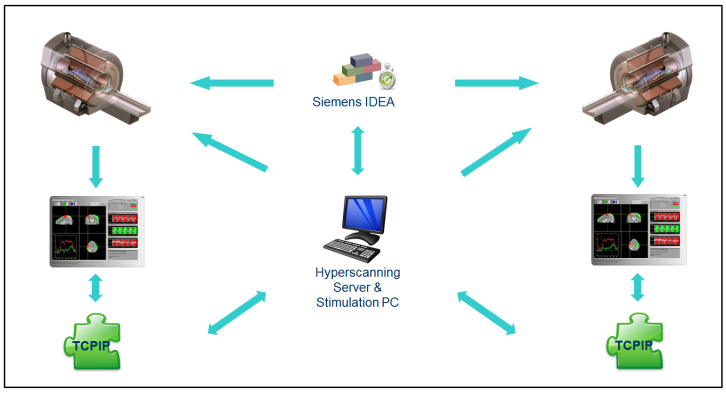
Purpose

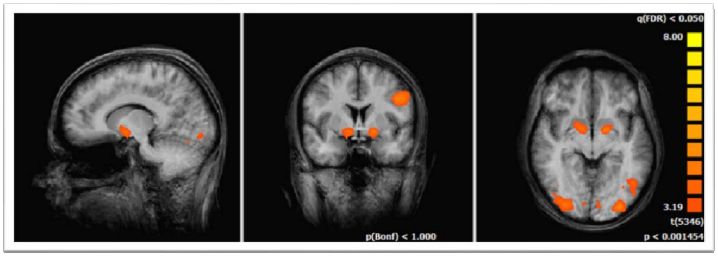
In the overwhelming number of fMRI experiments data acquisition is performed after the experiment. In contrast, real-time fMRI(rt-fMRI) offers new techniques to apply unique paradigms. The main advantage is the direct feedback to the subjects which may then influence their own brain activity (neurofeedback) or the potential to serve as MR-based human-brain-interfaces. Neurofeedback can be exploited to develop and optimize strategies to increase neural responses [1]. RtfMRI also enables to analyze important questions underlying social interactions. Typical situations in daily life include competition and cooperation where often in time strategies are changed depending on the behavior of the partners. If these strategy changes are performed unpredictably during the social interaction process rtfMRI will be indispensable to monitor and analyze the brain activation. An interesting extension is whether the partners may have explicit knowledge about the mutual brain activations. To allow experiments with synchronous real time fMRI we developed a software system that connects two (or more) MR-scanner in real-time, feeds back measures of the brain activation of both volunteers to each of them while additionally providing the capability to change the paradigm depending on the activation patterns of both volunteers. Here we present the first results of a feasibility study connecting a 3T and a 7T-scanner. However, the advantage of establishing a direct communication in real-time may turn into a disadvantage if one of the partners would try to communicate indirectly with the other partner (for example by testing the reactions of the other player by manipulating the own activation). As in the first step we wanted to analyze the basic conditions and results of a comptetion/cooperation paradigm we decoupled the mutual presentation of the results by including a time shift between the presentation of the resutls to each other.



Method

A self-developed MATLAB-based rt-fMRI software system was used to control the stimulus presentation, data analysis, and communication with the scanner system [2]. The software processed the data and classified the brain activation. The results were sent to an SSH server which is accessible from both scanner environments [3]. Hyperscanning-rtfMRI was performed with 12 healthy volunteers after giving written consent according to the local ethics committee. Measurement parameters were: TR: 2000ms, TE: 21ms (7T) / 27 ms (3T), matrix-size: 64x64, 31 slices (3T) / 20 slices (7T), resolution 3x3x4mm³. The participants were trained prior to scanning to control a ball on a stimulus screen by the brain activity of the motor area. In the main experiment the ball had to be placed in a particular location. Three task types were distinguished: single runs (each volunteer tried only to reach a specified target region without seeing the ball of the partner), competition (who hits the target-region better; both saw the own ball as well as the ball of the partner), cooperation (both participants must reach the same target region; both saw the own ball as well as the ball of the partner). If the task was fulfilled one partner (or in the cooperation part both partners) received a financial reward.

Results and conclusion



The combination of rt-fMRI and hyperscanning could be realized successfully. The detection and assessment of motor activity was reliable. The condition where one subject received payment while the other partner did not receive payment led to strong activation in the left and right basal ganglia similar to results of other groups[4]. The experimental setting showed that a standardized setup to perform social fMRI in real time is feasible.

Acknowledgments

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References:

1. Weiskopf et al., 2004, IEEE
2. Hollmann et al., 2006, Proceedings ESMRMB
3. Mönch et al, 2008, Proceedings ISMRM
4. Fliessbach et al, 2007, Science