Fx3MRI: simultaneous fMRI scanning in an open system

F. G. Hoogenraad[1], E. A. Moore[2], F. de Graaf[1], F. Visser[1], J. W. de Jong[1], M. Stoesz[3], A. L. Moerland[1]

[1]Philips Medical Systems, Best, The Netherlands, Netherlands, [2]Philips Medical Systems, London, UK, United Kingdom, [3]Philips Medical Systems, Cleveland, Ohio, United States

Introduction

Functional MRI experiments are normally performed to define functional areas in the individual subject or patient. Scanning of multiple brains during one fMRI experiment is difficult as a result of the limited access in normal high-field cylindrical systems. As such, performing experiments of human interaction whereby all participating subjects are scanned, remains elusive.

Montague et al[1] performed an experiment whereby two individuals – lying in two different scanners – were able to hear and see each other. They investigated this type of "hyperscanning" with a simple game of deception. In this game the asynchronous interaction between volunteers was analyzed using special soft- and hardware for the two volunteers to communicate over the Internet. However, this fMRI experiment suffered from some Internet latency, and interaction between subjects was done only through screens.

In our experiment we wanted to see whether it was possible to perform fMRI with 3 subjects simultaneously in an open MRI scanner, operating at 1.0 Tesla.

Methods

All scanning was performed on a vertical field magnet 1.0 Tesla super conducting Panorama MRI scanner (Philips Medical Systems, Best, The Netherlands). A special table was made to facilitate multiple subjects in the scanner, as the standard table only allows for a single subject. Three subjects were placed supine, in a triangular pattern, with their heads in the scanner isocenter and their feet towards the corners of the triangle. The integrated body-coil was used for both transmission and reception of RF.

Surveys were run to verify the position of the 3 subjects. Standard coronal single-shot GE-EPI images were used for the fMRI experiment. It was run with 80x80 matrix and a large FOV of 330 mm to include all three brains. A slice thickness of 5.0 mm was used with a gap of 0.5 mm. The echo-time was set to 70 ms in order to provide enough BOLD contrast at this low field strength[2]. The TR was set to 3 seconds while 100 dynamics were scanned. Two paradigms were used: finger tapping of the dominant hand, or bilateral finger tapping. In both cases a block paradigm of [10rest – 10active] was used. Analysis was done using standard software (IViewBOLD, R1.5). The coronal images with 3 brains were analyzed as if it were a single subject scan. Cross correlation analysis was applied using a threshold of 0.40 clustering of 2 pixels and smoothing with a Gaussian filter, FWHM of 1.5 pixels.

Results

The 3 subjects did fit without difficulty in the isocenter (Fig 1). The single-shot GE-EPI images showed good quality with a SNR ranging from 9 to 12 in the various subjects. Only minor motion was detected in the fMRI runs.

In the dominant-hand finger tapping experiment activation could be detected in all three subjects (Fig 2). The activation for the various subjects was seen in different slices for the 3 subjects (Fig 2). For the bilateral fMRI experiment functional activity was also found in 2 of the 3 subjects (Fig 3). The signal changes in the various areas of activation ranged from 3% to 7%.

Figure 1: the setup of 3 different subjects in one open scanner

Discussion

To our knowledge these are the first results of simultaneous detected BOLD activation in multiple subjects in one scanner. It is shown that simple paradigms can produce functional activation results in these multiple subjects, even at this low field strength.

The variation in SNR and detection of BOLD activity may be caused by the slightly off-center placement of the subject, and the non-symmetric loading of the integrated body coil. It will be useful to use other types of coils like large phased-array body coils to improve in SNR. Also, the applied analysis did not include any motion correction, and this may have had a small effect on the final result. Other approaches like interleaving one set of slices for each individual subject, using a smaller FOV, may also improve the final fMRI image quality.

The results of this experiment show that fMRI – at 1.0 Tesla – on 3 subjects is feasible. Although the sensitivity is not as high as today's high-field systems it does allow for experiments, which are otherwise impossible. General human interaction, and communication may very well be studied with these fMRI experiments. For example, fMRI experiments on Siamese twins may benefit from the above setup, as long as the applied paradigms produce strong responses.

1 Montague, P. R. et al., *Neuroimage*, 16, 1159, 2002 **2** Hoogenraad F. G. C. et al., Proc. *ISMRM*, Vancouver, 1997, p.735

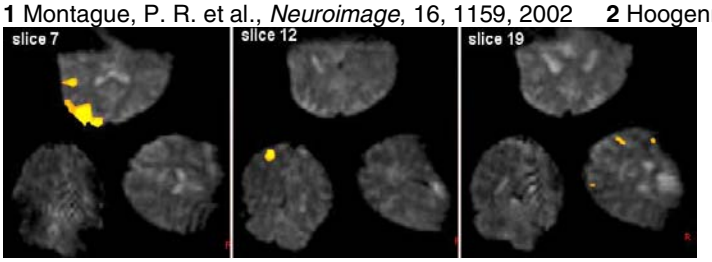

Fig2: activation of finger tapping in the dominant hand

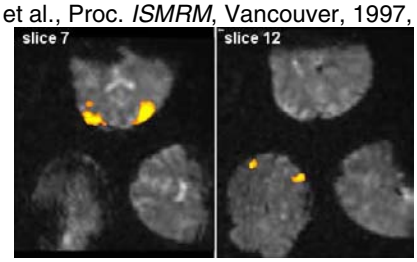

Fig3: activation of the bilateral experiment