High Field fMRI of the Parahippocampal Region

A. de Greiff[1], E. R. Gizewski[2], and M. E. Ladd[1]

[1]Research Center for Magnetic Resonance, University Duisburg Essen, Essen, NRW, Germany, [2]Department of Diagnostic and Interventional Radiology and Neuroradiology, University Hospital Essen, Essen, NRW, Germany

Introduction

Functional imaging of the amygdala, hippocampus, and the parahippocampal (PHC) region is of great interest in neurological and psychological science. A common stimulus for robust PHC activation is a virtual walk [1]. Due to the sensitivity of BOLD contrast imaging sequences to susceptibility, these regions suffer from imaging artifacts even at lower field strength. Since these artifacts increase with field strength, it is not clear whether these examinations benefit from high field scanners such as 7 Tesla.

Methods

We examined 4 healthy volunteers with a 7T whole-body scanner (Magnetom 7T, Siemens, Erlangen, Germany). Data acquisition comprised a 3D MPRAGE for anatomical overlays and two sets of 110 and 165 functional images, respectively. We used single shot gradient echo EPI sequences to acquire a 64x64 matrix with an echo time (TE) of 28 ms. In one run we achieved whole brain imaging using 38 slices, 3.6 mm slice thickness (ST), and 230 mm field of view (FOV) with a repetition time (TR) of 2840 ms. In a second session (pseudo randomized) we reduced the number of slices to 18, ST to 2.0 mm, and FOV to 160 mm, accepting aliasing artifacts. This led to a minimum TR of 1800 ms. Prior to examination, subjects designed a virtual walk comprising five destinations in a familiar area. The examination itself comprised of active blocks of 10(15) scans initiated with preconcerted key words alternating with an equally long backward counting condition initiated by a number. Data post processing comprised realignment, normalization, and Gaussian smoothing with different filter widths. Voxel-by-voxel statistical estimation was based on the general linear model utilizing a boxcar function convolved with a canonical hemodynamic response function and its temporal derivative [2].

Results

Whole-brain measurements revealed, aside from widespread parietal activation and the frontal eye fields, a robust bilateral activation of the PHC region with local maxima at MNI-coordinates -28 -32 -22 mm and 26 -36 -22 mm. In accordance with previous examinations, we found a slight dominance of the left hemisphere, but with a low lateralization index of 0.15±0.04. The activated areas in the PHC showed an overlap to 1.5T results of more than 86% in all subjects (mean 93% ± 4%). A comparable statistical power to 1.5T could be achieved with less than half the measurements. The small FOV experiments could confirm these results, but aliasing disturbed the realignment, so that restive subjects were difficult to analyze. The high signal-to-noise ratio (SNR) could be used to define limited periods of little motion which is not an option at 1.5T.

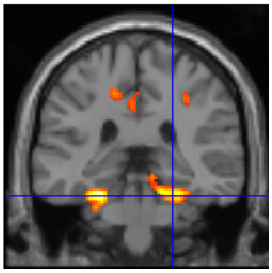

Fig. 1 Robust bilateral activation of PHC

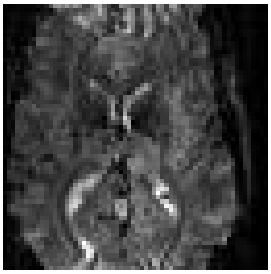

Fig. 2 Aliasing artifacts due to the reduced FOV

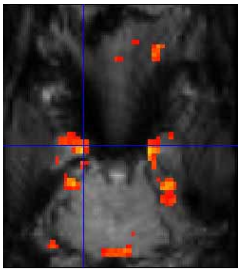

Fig. 3 Axial activation map with reduced FOV

Discussion

The results show that functional activation of the PHC can be revealed at 7T. The higher SNR can be used to shorten the examination or to increase spatial resolution, as our results with narrow Gaussian filter smoothing clearly indicate. However, spatial accuracy under the influence of susceptibility artifacts has to be discussed critically. Parallel imaging and segmented EPI sequences will be needed to minimize artifacts and misplacement [3].

References

[1] Jokeit et al., Neurology. 2001 Nov 27;57(10):1786-93.
[2] Friston,et al., NeuroImage. 1995 Mar;2(1):45-53.
[3] Poser et al., Magn Reson Med. 2006 Jun;55(6):1227-35.