# Functional MRI on an open 1.0 T MRI scanner: a comparison with a state-of-the-art 3.0 T MRI scanner

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*Introduction*

Open MRI scanners are designed for imaging specific patient groups that cannot be routinely scanned with conventional MRI scanners, e.g. obese patients, claustrophobic patients, and young children. It has not yet been tested whether functional MRI (fMRI) can be performed on an open MRI system, which thus would be available for research and clinical fMRI applications for these specific patient groups. The maximum available magnetic field strength of open MRI systems is currently 1.0 T, while the majority of fMRI studies has been conducted on MRI systems of 1.5 T or higher. A limited number of studies shows that fMRI is feasible at a magnetic field strength of 1.0 T using closed MRI systems, though (1,2). Therefore, we investigated the feasibility of fMRI on an open 1.0 T MRI scanner by comparing the results with fMRI on a state-of-the-art 3.0 T MRI scanner.

*Materials and Methods*

Twelve young healthy adults were scanned in both an open 1.0 T MRI scanner and a 3.0 T MRI scanner. Gradient-echo echo-planar images were acquired for all subjects while performing a motor paradigm and a cognitive paradigm (Table 1). No attempt was made to choose identical sequence parameters; in both cases optimal protocol settings were used. The motor paradigm consisted of block design with rest and fingertapping with the right hand. The cognitive paradigm consisted of a block design with neutral, aversive, or attractive pictures that were shown to the subjects. Each paradigm was performed five times by each subject at five different echo times (TEs; 40 ms, 50 ms, 60 ms, 70 ms, and 80 ms at open 1.0 T; 20 ms, 25 ms, 30 ms, 35 ms, and 40 ms at 3.0 T). All scans were reconstructed to voxel size 3.0x3.0x3.0 mm and analyzed using SPM5. Maximum statistical t-scores were determined per TE for the relevant brain areas (motor cortex, visual cortex, amygdala, orbitofrontal cortex (OFC)) for the individual scans and at a group level. They were used to compare the BOLD sensitivity between different TEs. Next the overall highest t-scores per brain area were compared between the two scanners, both at individual and at group level.

| Table 1: Sequence parameters for open 1.0 T and 3.0 T | | |
|---|---|---|
| | open 1.0 T | 3.0 T |
| TE | 40-80 ms | 20-40 ms |
| TR | 3200 ms | 2600 ms |
| # slices | 27 | 40 |
| matrix | 64x64 | 96x96 |
| voxel size | 3.4x3.4x4.5 mm | 2.3x2.3x3.0 mm |
| SENSE | no | yes |
| coil | 4 channel | 8 channel |

*Results*

For the open 1.0 T scanner, a TE of 70 ms resulted in the highest t-scores in the activated brain areas for both paradigms, which thus appeared to be most favorable for fMRI on this system. For the 3.0 T, the highest t-scores per brain area varied among the different TEs. This suggests that the currently used TE range is optimal for fMRI on the 3.0 T system and not one specific TE, which is in line with a previous study (3). On both scanners intersession differences appeared to affect t-scores to a large extent, as has been shown before (4).

Comparison of the maximum t-scores per brain area for the individual scans demonstrated that the mean maximum t-scores were significantly lower on the open 1.0 T than on the 3.0 T scanner in the motor cortex, visual cortex, and OFC, but not amygdala.

At a group level, the t-scores were generally lower for the open 1.0 T than the 3.0 T scanner (Table 2, Figure 1 and 2). However, the overall highest t-scores in the group analyses did not differ significantly between the open 1.0 T and the 3.0 T scanner for each relevant brain area, except for the right OFC.

| Table 2: Maximum t-scores group analysis | | | | |
|---|---|---|---|---|
| | Motor cortex (left) | | Amygdala (right) | |
| TE (1.0T/3.0T) | open 1.0 T | 3.0 T | open 1.0 T | 3.0 T |
| 40 ms / 20 ms | 9.9 | 17.7 | 5.2 | 8.1 |
| 50 ms / 25 ms | 13.7 | 13.7 | 5.5 | 5.5 |
| 60 ms / 30 ms | 10.0 | 17.6 | 2.0 | 5.0 |
| 70 ms / 35 ms | 19.1 | 18.8 | 5.6 | 7.1 |
| 80 ms / 40 ms | 10.1 | 21.2 | 5.4 | 5.6 |

*Conclusion*

The optimal TE for fMRI on an open 1.0 T MRI system is around 70 ms. Intersession differences affect BOLD sensitivity on an open 1.0 T scanner, however, to a similar extent as on a state-of-the-art 3.0 T MRI scanner. FMRI on an open 1.0 T MRI scanner is feasible for studies that are designed to analyze data at a group level, though not optimal for studies on single subjects.
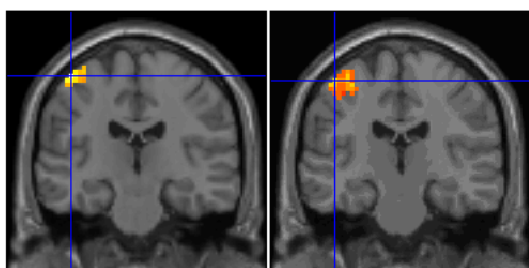


Figure 1. Left motor cortex activation at group level for open 1.0 T (left, TE=70ms) and 3.0 T (right, TE=40ms), (p<0.05, family-wise error corr.)
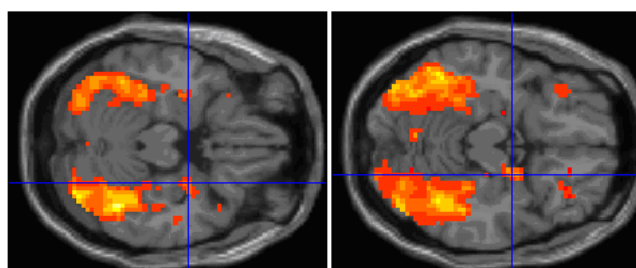


Figure 2. Right amygdala activation at group level for open 1.0 T (left, TE=70ms) and 3.0 T (right, TE=20ms), (p<0.001, uncorr.)

*References*
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