High resolution fMRI of the human auditory cortex at 7 Tesla

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Introduction

The parcellation of the human auditory cortex (AC) into functional fields is essentially unclear. Based on comparative evidence from non-human primate auditory cortex a large number of fields are expected. At present the only potential correlates of different AC fields in fMRI studies are multiple foci of activation. However, besides the large anatomical variability of folds of the human temporal lobe (which requires the analysis of each individual brain), the small size of auditory fields is a major problem. So far, only few attempts with fMRI were made to separate fields of the core region and the medial and lateral belt regions. Using high (1.5 mm isotropic) resolution fMRI at 7T we characterized the location of small clusters of activation in relation to anatomical landmarks. A further aim was to evaluate potential task-dependent modulation of activation especially in primary AC and to replicate recent findings (1) on the mirror-image tonotopic organization of primary AC.

Methods

Data from eight subjects (5 female, 3 male, ages 23-35) were acquired on the 7 Tesla system (Siemens, Erlangen) at the MGH in Boston using a TEM volume head coil. A single shot gradient echo EPI sequence (TE = 20 ms; FA = 90°; TR = 8 s; FOV = 192 x 192 mm^2; matrix = 128 x 128; 6/8 phase partial fourier; BWTH = 2298 Hz/pixel; echo spacing = 0.48 ms) was used to acquire 86 volumes (9 slices à 1.5 mm, 0.375 mm gap) in each of two functional runs of 11 min 18 s. The horizontal slices were positioned using a 3 D anatomical dataset (MPRAGE) and covered the superior temporal lobe in both hemispheres. Acoustic stimuli were pure tones of 125 ms duration presented at 4 Hz in blocks of 22 s. Each block consisted of alternating tones (ABAB scheme) of either 440 Hz and 1245 Hz or 1245 Hz and 3520 Hz. During the first part of the session the subjects just had to listen to the stimuli. In the second run they were instructed to detect target tones (4 in each block) which were one semitone lower than the standards. The perceived scanner noise (120 dB peak SPL) was attenuated by using earplugs (24 dB at 1 KHz) and ear muffs (> 20 dB above 100 Hz, 30 dB above 2.5 kHz) in which the MRI compatible electrodynamic headphones were integrated (2). The loudness of the pure tones were equalized and adjusted to a comfortable level during the silent periods between the EPI shots. Stimulus blocks were presented at variable offsets (0, 2, 4, 6, 8 s) to the 8 s regular EPI intervals to reconstruct the entire time course of the BOLD-response (3). Functional images were analyzed using Brain Voyager 2000™. Following 3D motion correction, linear trend removal and high pass filtering of the functional data statistical maps were obtained using a General Linear Model (GLM) and analyzed in a region of interest approach for each individual subject.

Results & Conclusion

Fig. 1 shows that the pattern of activation in auditory cortex (AC) is similar to the strip-like activation obtained at 3 Tesla (4). However, more detailed separation of small clusters of activation is possible, especially within the two strips along Heschl's gyrus (one on the antero-medial and one on the postero-lateral part). Furthermore, in some subjects clear clusters of activation can be observed on planum polare anterio-medial to Heschl's Gyrus. This suggests that the classical distinction between medial belt, core and lateral belt regions in non-human primates can also be found in humans by using high resolution fMRI at 7 Tesla. Quantitative results will be presented at the poster.

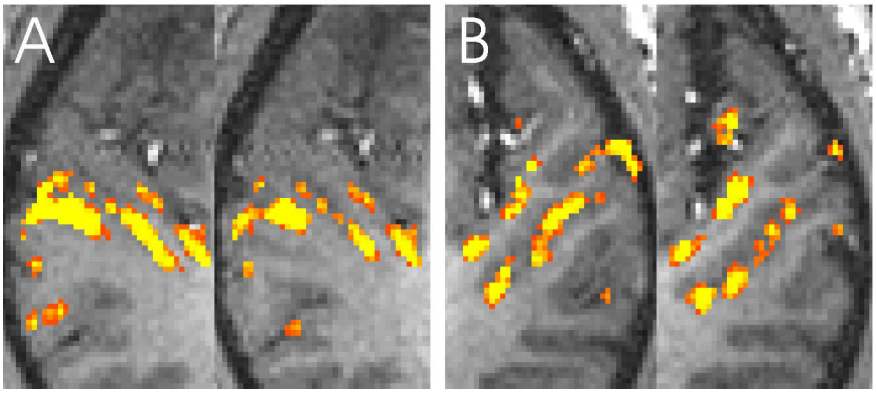

Fig. 1.: Pattern of activation in right **(A)** and left **(B)** auditory cortex of a single subject. Note the separate clusters of activation along both sides of Heschl's gyrus.

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