Delineation of human primary auditory cortex on the basis of a combined T1 and T2 weighted MR contrast

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The delineation of cortical areas in the human brain currently relies on parcellation schemes obtained from a small number of post-mortem brains using architectonic methods. However, the precision to localize cortical areas in single subjects is limited due to large anatomical differences between subjects. Therefore alternative approaches are useful e.g. paradigms to functionally localize specific brain regions in individual brains. Such approaches have been very successful in the visual system using retinotopic mapping. In the auditory modality such routine methods are not available although there is some success using high resolution tonotopic mapping at 7 Tesla in defining two primary auditory cortex (PAC) areas (Formisano et al. (2003) Neuron 40, 859-69). An anatomical imaging approach has recently been made by mapping the longitudinal relaxation rate (R1), of gray matter in auditory cortex (Sigalovsky et al. (2006) Neuroimage 32, 1524-37). This resulted in highest R1 values mostly in posterior Heschl's gyrus consistent to the location of PAC in architectural studies. The basis for such an approach is that the gray matter of primary areas is more strongly myelinated than of secondary areas.

We developed a method to anatomically identify PAC using combined T1 and T2 weighted imaging with 0.7 mm isotropic resolution at 3 Tesla to create an artificial contrast that is specifically sensitive to the effects of an increased myelination of the cortex. Fourteen subjects were scanned with standard MPRAGE and TSE sequences in ~30 min. Segmentation and cortical surfaces was generated by FreeSurfer. Each vertex was associated with a feature vector formed by gray values of the MPRAGE and the TSE scan averaged along gray matter profiles orthogonal to the cortical surface. We then calculated the difference in probabilities that a vertex belongs to the inside or outside region of PAC (Fig. 1). To prevent effects of overall shading, we used a restricted area, FreeSurfer's label for Heschl's gyrus, as initial inside region. The adjustment of this region was done in an iterative fashion which does not require any user interaction. This resulted in a compact region on the medial two thirds of Heschl's gyrus in all hemispheres. Strong hints for the validity of this method are (1) the close correspondence to the maximum probability map for area Te1 (based on Morosan et al. (2001) Neuroimage 13, 684-701.) and (2) the appearance of the motor cortex in datasets with little overall shading. However, we regularly found clearly false positive labelling of small areas (1-2 voxels) which may be related to blood vessels. Furthermore, the results depend on the accuracy of the segmentation and any error may result in misclassification. Future studies will show how well this area corresponds to tonotopic maps obtained at high resolution fMRI at 7 Tesla.

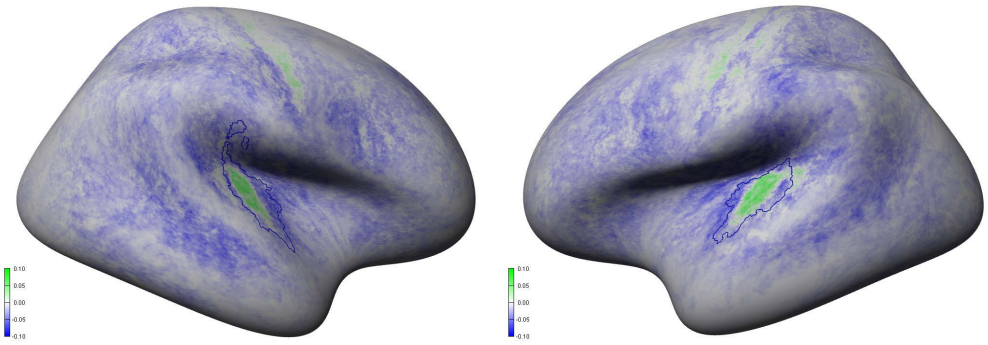

Fig. 1.: Likelyhood-difference map averaged across all subjects. Green areas suggest regions with higher myelin content. The blue line represents the maximum probability map (MPM) for area Te 1.