

# Tonotopic columns and cortical depth dependent modulations in human A1: preliminary results.

Federico De Martino<sup>1,2</sup>, Michelle Moerel<sup>1</sup>, Rainer Goebel<sup>1</sup>, Kamil Ugurbil<sup>2</sup>, Elia Formisano<sup>1</sup>, and Essa Yacoub<sup>2</sup>

<sup>1</sup>University of Maastricht, Maastricht, Netherlands, <sup>2</sup>Center for Magnetic Resonance Research, Minneapolis, Minnesota, United States

**TARGET AUDIENCE.** High-resolution fMRI community. Auditory neuroscience.

**PURPOSE.** Columnar and layer specific modulations (by task manipulation) of fMRI activity in primary auditory cortex.

**INTRODUCTION.** Using high field high-resolution functional measurements in vivo, the columnar organization of striate and extra striate visual areas in humans has been imaged [1-3]. Similarly, cortical depth dependent functional responses have been recorded from visual and motor areas of the human brain [4-7]. While a model of tonotopic columns in A1 has been proposed based on animal literature [8], direct evidence of such organization in humans is not available. Similarly, the role of different cortical layers to the formation of our auditory percept [8, 9] is still based on inferences from animal data. Here we report our preliminary results on the investigation of the vertical (i.e. columnar) and horizontal (cortical depth dependent) functional responses in human primary auditory cortex. We measured T<sub>2</sub> weighted (3D GRASE) [10] functional responses to frequency sweeps (arranged in six different frequency ranges) while the subject was performing either an auditory discrimination task or a visual discrimination task. Our preliminary results show that the medial portion of Heschl's gyrus is organized in tonotopic columns and that superficial layers are modulated by the increased feedback during the auditory discrimination task compared to the visual one.

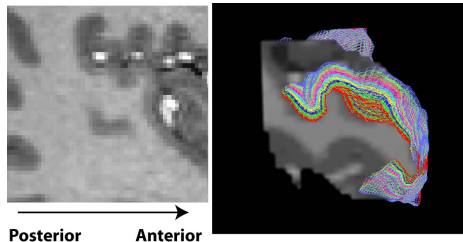


Figure 1

**MATERIAL AND METHODS.** Measurements were performed at 7T (Siemens, Erlangen,

Germany) using a custom 9 channel receive array and a separate open half-volume quadrature transmit coil. Our preliminary results are recorded from one healthy volunteer, the recording of additional sessions from other subjects is ongoing. T<sub>1</sub> and proton density weighted (3D-MPRAGE)

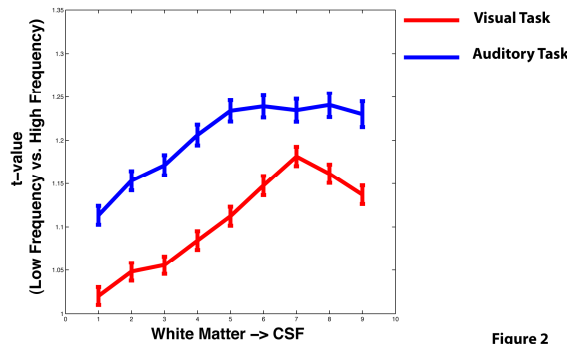
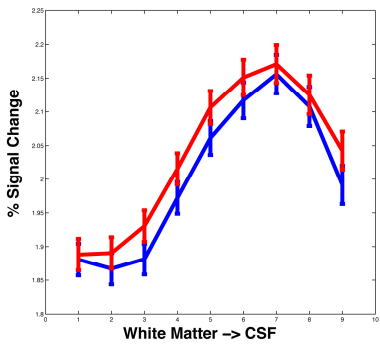


Figure 2

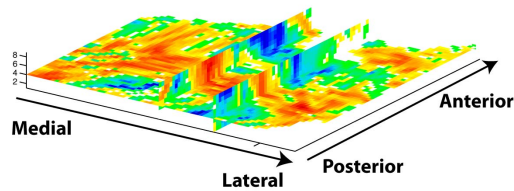


Figure 3

to low and high frequencies (t-scores), we observed a smaller difference between the two tasks at 30% cortical depth and an increased difference (with the auditory task showing higher t-scores) in deep and superficial layers (Figure 2). Visualizing the tonotopic map on the flattened anatomical 3D grids of the Heschl's gyrus revealed a clear vertical (columnar) arrangement of preferred frequency (figure 3).

**DISCUSSION.** The modulation of the difference between the functional response to low and high frequency tones in superficial gray matter (figure 2), highlights the possibility of measuring the effect that feed-forward (visual task) and feedback (auditory) information has on the functional properties of primary auditory cortex. Our preliminary results show that superficial layers are characterized by a better frequency specificity when subjects are attending to the acoustic properties of the stimuli. Furthermore, we have shown here that tonotopic maps in the human primary auditory cortex have a clear columnar arrangement.

**ACKNOWLEDGMENTS.** Work supported in part by the National Institutes of Health (R01 EB000331, P30 NS057091, P41 RR08079, P40 NS057091). The 7 T magnet purchase was funded in part by the WM KECK Foundation.

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