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High-resolution human 7T functional MRI: feasibility and specificity

Author Block: *I. Kahn[1,2], C. J. Wiggins[2], G. Wiggins[2], K. L. Miller[3], T. Benner[2], B. Fischl[2], L. L. Wald[2], R. L. Buckner[1,2], B. C. Dickerson[2,4];
[1]HHMI, Harvard Univ, Cambridge, MA, [2]Martinos Center, MGH, Charlestown, MA, [3]Center for Functional MRI of the Brain, Oxford, Oxford, UNITED KINGDOM, [4]Neurology, Brigham & Women's Hospital, Boston, MA.

Robust high-resolution functional MRI will greatly expand the potential of human imaging including measurement of columnar activation patterns and differentiation of small subcortical regions. Here we demonstrate the feasibility of high (3T) and ultra-high (7T) field strength, multiple channel phased array imaging. The validation flickering (7.5hz) checkerboard paradigm consisted of a partial-field (wedge-shaped) stimuli allowing for selective stimulation of topographically-specific portions within early visual areas. Imaging was performed using a Siemens Trio 3T system with gradient performance of 40 mT/m and 200 mT/m/s, and a Magnex Scientific, Siemens and MGH built 7T system with a head gradient set capable of 100mT/m and 800mT/m/s. On the 3T system, the signal was received with a standard Siemens 12-channel phased array TIM coil or an in house 32-channel phased array coil. On the 7T system, the signal was received with an 8- or 32-channel phased array coil, and excitation was achieved with a detunable birdcage transmit coil, produced in house, which was tuned for each subject to ensure a good power match. A standard EPI sequence was used on the 3T system and a custom 3D multishot EPI sequence was used to image a transverse volume at isotropic resolutions of 1, 2, and 4 mm every 5.4 sec. EPI data were acquired over multiple runs. Reconstructed raw EPI data demonstrated adequate sensitivity BOLD resolution and gray/white contrast for anatomical localization directly from 1- and 2-mm EPI data. The signal- and contrast-to-noise ratio was estimated across different MR systems, receiving coils, and resolutions, indicating that signals can be detected with 1-mm voxel acquisitions in the vicinity of cortical gray matter. Furthermore, selective activation consistent with known mapping of visual topography was detectable at all resolutions. These results indicate that it is feasible to use high and ultrahigh-field MR systems equipped with large 32 channel phased array receive coils to study high-resolution functional organization.

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