Realising the benefits of structural and functional MRI at ultra-high-field

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Title of project or programme

Title of PI Realising the benefits of structural and functional MRI at ultra-high-field

Principal Investigators of project/programme grant

Title	Forname	Surname	Institution	Country
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- United Kingdom

Source of funding information

Medical Research Council

Total sum awarded (Euro)

2388784.65

Start date of award

30-06-2010

Total duration of award in months

60

The project/programme is most relevant to

- Parkinson’s disease

Keywords

Research abstract in English

Ultra-high-field has delivered the expected improvement in sensitivity which we have exploited to increase the spatial resolution of structural and functional MRI (fMRI). In structural imaging, we are now fast approaching a resolution limit set by subject movement, which we aim to overcome by developing a motion tracking system. The limited performance of whole-body gradient systems poses

a further restriction on achievable resolution. We will therefore exploit the potential of a novel insert gradient coil set to produce higher gradients at the threshold for peripheral nerve stimulation. Static (B0) and radiofrequency (B1) magnetic field inhomogeneities remain significant challenges at 7T; we will develop new B0-shimming strategies and explore multiple transmit and travelling wave approaches for achieving B1-uniformity. Susceptibility effects contribute to enhanced contrast at 7T, but can be difficult to interpret. We will therefore develop quantitative methods for susceptibility mapping and relate the resulting maps to tissue iron content. We will also develop chemical exchange saturation transfer (CEST) techniques as a measure of myelination. We will validate these techniques using post mortem specimens and use them in vivo, together with more conventional MR contrast parameters, to detect boundaries between functional domains, to distinguish between white matter ischaemic and MS lesions, improve detection of cortical MS lesions and to measure iron content in the subcortical nuclei of patients with Parkinson's disease. The improved spatial resolution we aim to achieve for fMRI will allow us to investigate the fine-grained functional organisation of the auditory cortex and to probe columnar organisation in other sensory areas. We will also develop improved methods of measuring haemodynamic parameters and use these to refine methods of calibrating the BOLD response at 7T. In linearity studies we will compare cerebral metabolic rate of oxygen (CMRO2) derived from the BOLD signal and other haemodynamic parameters with 13C MRS measurements of energy metabolism. We will also compare them to measures of electrical activity (MEG and EEG). We have already established a close correlation between electromagnetic and MR measures; we now wish to examine this relationship across different frequency bands and, using 1H and 13C MRS, relate it to the levels and turnover of excitatory and inhibitory neurotransmitters. We will develop muti-modal (MEG/EEG and EEG/fMRI) methods for this purpose. These methods will also be used to distinguish between network models of motor learning, and to compare the 'salience' network between control subjects and schizophrenics in whom it may be deficient.

Lay summary
In which category does this research fall?

- Basic research