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Investigating the origin of individual differences in the response to electromagnetic field exposure

Background

A reliable effect of radio frequency electromagnetic fields (RF EMF), such as those emitted by modern telecommunications technology, is the increase of EEG power during waking and sleep (Borbély et al., 1999; Huber et al., 2000; Loughran et al., 2005; Regel et al., 2007; Schmid et al., 2011). Common features of these studies are the striking inter-individual differences in how subjects react to the field exposure. Why certain subjects show even converse effects of field exposure is unknown.

Objectives

We believe that understanding the origin of these individual differences may shed light on the biological mechanisms underlying the effects that RF EMF have on brain activity. Recent studies using pulse modulation with a single fundamental frequency provide evidence that electromagnetic field pulses may entrain and synchronize neuronal activity (Huber, unpublished observation; FSM supported project nr. A2008-08; Ozen et al., 2010). Thus, individual differences may be explained by the fact that such external fields cooperate with or compete against synaptically-mediated network activity. Such intrinsic network activity is to a large extent dependent on the architecture of the network.

Methods

Nowadays, state-of-the-art imaging techniques allow a quantification of the key elements of the network's architecture. In our project we propose an experimental design in which each of the 20 healthy male subjects is exposed twice to the same electromagnetic field (and to a spurious exposure) in a double-blind, randomized crossover design in order to explore the robustness of the RF EMF effects observed. After completion of the experimental part, anatomical Magnetic Resonance Images (MRI) will be collected. We will use state-of – the-art MRI protocols and analysis such as Diffusion Tensor Imaging (DTI), fiber tractography and improved volumetric analysis using Freesurfer to study key grey and white matter structures. Correlation analysis will then be used to explore the relationship between the reproducibly observed EEG effects and anatomical features.

Expected Results

The combination of techniques should reveal anatomical markers responsible for the individual differences in the EEG response to RF EMF exposure. Such observations would significantly contribute to a mechanistic understanding of how RF EMFs affect brain activity.