fMRI on Primates with Custom Taylored RF Coils

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Introduction

Functional magnetic resonance imaging (fMRI) is now successfully established in non-human primates [1]. Due to its availability, fMRI is likely to complement or replace invasive physiological techniques in the near future. The development of novel hard- and software is critical to maximize its usefulness in novel research applications. In this contribution, we report on functional imaging on primate visual cortex using custom-tailored radio frequency coils with increased signal to noise in (f)images of the monkey brain.

Subjects & Methods

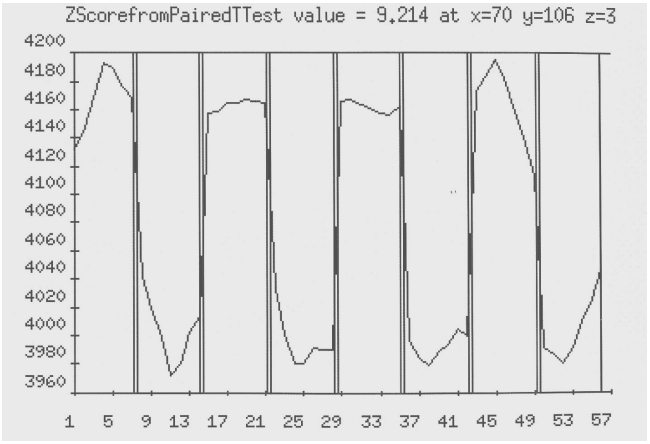
9 rhesus monkeys, each weighing between 5.5 and 10 kg, served as subjects in the present investigation. The animals were cared for in strict compliance with international (European Community, EUVD 86/609/EEC) guidelines, and the full experimental preparation, including the anesthesia protocol, is described elsewhere [1]. All experiments were conducted with a 4.7 Tesla MR system (Bruker Instruments, Ettlingen, Germany), with a 40 cm diameter vertical bore shielded magnet.

Several sets of customized radio frequency (rf) coils were optimized (1) for sensitivity at the visually evoked blood oxygen level dependent (BOLD) responses in the visual cortex or (2) for signal homogeneity over the whole monkey brain. These included adapted transceive- as well as electronically decoupled transmit/receive coil systems that were used together with manufacturer-supplied control hardware.

The coils were constructed from 12 mm wide 0.5 mm thick fine-silver stripes or 2 to 4 mm diameter fine silver wire with inserted ceramic capacitors. The prototype wire networks were attached to a cylindrical acrylic former (120 mm diameter) which was mounted on a rotating base (axis = 'z') in order to spatially decouple the transmit coil from the receive coil. The proton surface coil, **A** (110 mm diameter), B_1 in 'x/y', is a type 'double D' structure with rf-current feeding points at the common base. This coil can be used either as a transmission/reception coil or, using the electronic decoupling network, as the transmission coil when utilizing the small subcutaneous or implanted reception coil, **B** (22 mm diameter), for highly localized studies. A different t/r coil, **C**, built for homogeneity over the whole monkey brain is a Helmholtz type, dual saddle coil composed from two barrel-shaped diametrically opposed surface coils (120 mm diameter).

Results

Due to the sensitivity advantage of this coils (**A**, **C**) of ~3-4, as compared to a large transmit receive coil, anatomical images were obtained with higher resolution without compromising signal to noise ratio (SNR). Detailed functional brain maps were obtained within the monkey brain using a variety of visual paradigms. The surface coil, **B**, positioned over the visual cortex provided additional signal gain (~4, as expected due to the size). The time-course of this functional data are obtained with high consistency as shown below for a single voxel of 32 nanoliters volume.



Discussion/Conclusion

FMRI neurophysiological studies in anesthetized and awake animals benefit dramatically in increased SNR which allows for higher spatial and/or temporal studies when customized coils are utilized.

Literature

N.K. Logothetis et al [1999] *nature neuroscience* 2(6):255-262