

A Twin-Head Coil for Studying Two Brain Interaction with fMRI

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Introduction

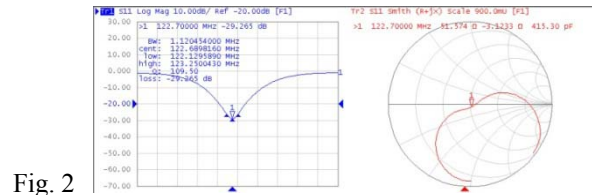
One of the major functions of the human brain is to mediate interactions with other people. Until recently, studying brain social interactions has not been possible due to the lack of measurable methods to observe two interacting minds simultaneously. We have developed a novel twin-head MRI coil that can scan two subjects' brains simultaneously while the subjects are socially interacting in one MRI scanner. Meanwhile, an even-odd mode scheme for decoupling two quadrature coils (not surface coils) is validated.

Method

The twin-head coil is made from two identical birdcage coils (1) for providing local homogeneous excitation. Since diameter of scanner bore is 60cm and diameter of homogeneous spherical region (where static magnetic field deviation is less than 1.5ppm) is 50cm, the diameter of each birdcage coil is set to 25.5cm. Each birdcage has four rungs, each rung is 21.59cm long and 2.54cm wide. Each coil was separately tuned as band-pass birdcage. The capacitor on each end-ring section is 82pF; the capacitor on both end of each rung is 11pF plus trimmer.

Although two birdcages can be placed side-by-side in any orientation, an unique orientation, where four rungs are located at 45°, 135°, 225°, and 315°, is optimal for decoupling, because its horizontal and vertical components correspond to odd and even mode. The even-mode, by nature, is decoupled. In its composite field, the middle plane that separates two coils acts as a virtual "magnetic wall". The field pattern and S11 response of even mode are shown in Fig.1A and Fig. 2A. The odd-mode, however, is strongly coupled. The field pattern and S11 response of odd mode are shown in Fig.1B and Fig. 2B. Since only odd-mode fields from two coils need to be decoupled, the circular polarized field decoupling is reduced to linear polarized field decouple. A decoupling interface (2) was designed and built based on the two coils are loaded with two heads. The S11 and Smith chart of decoupled coils are shown in Fig. 3.

The block diagram of interface between coil and scanner is shown in Fig. 4. It is configured as 1-ch transmit and 2-ch receive system. Note that decoupling interface is only used between two odd-mode ports on coils; and one transmit signal is split to two ways for two birdcages.



Results

A prototype twin-head coil was built and tested on a Siemens Tim Trio 3T scanner. The coil installation and two subjects' placement are shown in Fig. 5 A and B. A MR image set was acquired by MPRAGE sequence with TR 2.5s, TE 2.5ms, TI 900, FOV 500mm, sampling matrix 448x224, flip angle 7, BW 170. The image of two heads from two different subjects is shown in Fig. 6.

Conclusions

A unique twin-head coil that enables conducting fMRI studies for two interacting people was built; and in vivo images from two living human subjects are successfully acquired. On the technical development, an even-odd mode scheme was proposed and validated for decoupling two strongly-coupled quadrature coils, which, unlike surface coils, has not been thoroughly studied.

References

- (1) J. Tropp, J. Magn. Reson. 82:51, 1989, (2) R. Lee, et al, Magn. Reson. Med. 48:203, 2002.

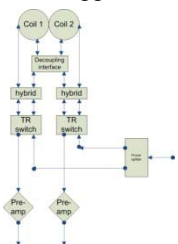


Fig.4

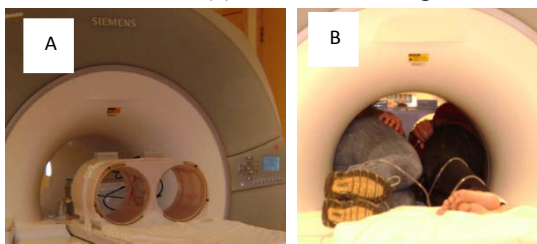


Fig.5

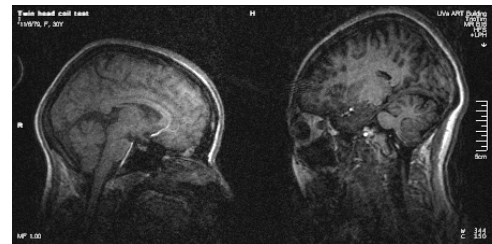


Fig. 6