

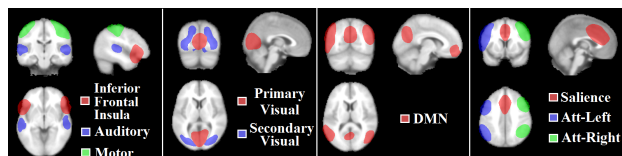
# Ultra-fast fMRI using MREG improves subject specific extraction of Resting State Networks

Burak Akin<sup>1</sup>, Hsu-Lei Lee<sup>1</sup>, Nadine Beck<sup>1</sup>, Jürgen Hennig<sup>1</sup>, and Pierre Levan<sup>1</sup>

<sup>1</sup>Medical Physics, University Medical Center, Freiburg, Germany

**Target audience:** Researchers who are interested in fast fMRI sequences and resting-state network analysis.

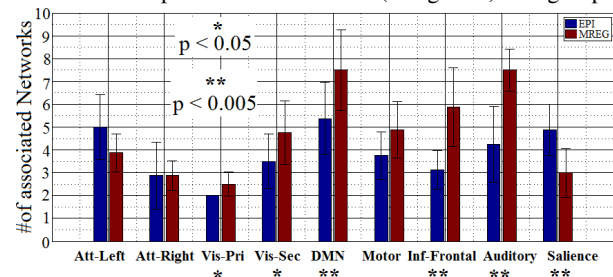
**Purpose:** Resting-state networks are becoming an important tool for the study of brain function. The advent of novel fast fMRI sequences has led to improved physiological noise correction and high sensitivity in the statistical analysis of fMRI data [1,2]. The aim of this study is to compare an ultrafast imaging technique called MR-encephalography (MREG)[3] with the standard EPI sequence in terms of capability to extract out resting state networks.



**Figure 1:** RSN masks are defined by thresholded ( $Z > 2$ ) group ICA maps.

TR=0.1s. TE=20ms, FA=15° and the same voxel size as EPI [3].

**Post-processing and analysis:** For both EPI and MREG datasets, typical preprocessing steps (motion correction, spatial smoothing) are carried out using FSL (www.fmrib.ox.ac.uk/fsl). Then physiological confounds and trends are linearly regressed out from the time courses. All images are then co-registered to standard MNI space. Both individual (using FSL) and group ICA (using GIFT: <http://mialab.mrn.org/software/gift>) are performed separately for each of the



**Figure 2:** Number associated network results for EPI and MREG

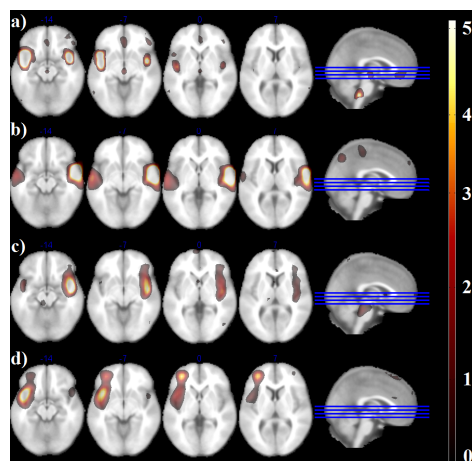
## Materials & Methods

**Acquisition:** 8 healthy volunteers (3F, 5M) underwent two consecutive 10-minute resting-state scans with EPI and MREG sequences. Data was acquired with a 3T Trio TIM scanner (Siemens Healthcare) with 32-channel head coil. Cardiac and respiratory time courses were recorded during the scan to retrospectively remove them as confounds later on [4]. The EPI sequence used parameters TR=2.5s TE=30ms, FA=90°, and an isometric voxel size of 4mm. The MREG sequence is acquired with a single-shot trajectory with the following parameters

**Results & Discussion:** Among 9 identified group network classes (Fig. 1), MREG mostly resulted in a higher number of associated individual networks than EPI and also statistically significant in 5 network groups (Fig. 2). In Figure 3, an activation map of a superior-temporal network is shown as a representative result. The EPI dataset resulted in only a single bi-lateral network (Fig.3a)). In contrast, MREG resulted in three bi-lateral networks associated with the group mask (Fig. 1). Networks shown in Figure 3c) and 3d) also bring additional frontal-temporal connectivity information. On the other hand, a reduced number of individual networks in frontal regions in the MREG datasets could be explained by the signal dropout due to increased sensitivity to susceptibility artifacts in MREG data (Fig.4). Nevertheless, recent work of ours using a stack of spirals trajectory should mitigate this issue [6].

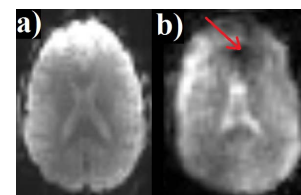
**Conclusion:** In this study, it was aimed to compare EPI with MREG with respect to the well accepted ICA methodology for extraction of resting-state networks. The 25-fold increase in sampling rate of MREG relative to conventional fMRI resulted in improved sensitivity and a higher number of components associated with standard resting-state networks in individual subjects. Compared to EPI, MREG might thus greatly improve analyses of intra- and inter-network connectivity.

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**Figure 3:** Group map shows superior-temporal networks, a)EPI, b)MREG-1 c)MREG-2 d)MREG-3

**References:** [1] Posse, et al. "Neuroimage" 61.1 (2012): 115-130. [2] Jacobs, et al. "Neuroimage" 2013(in press) [3] Zahneisen, Benjamin, et al. "Magnetic Resonance in Medicine" 68.2 (2012): 484-494. [4] Glover et al. "Magnetic Resonance in Medicine" 44.1 (2000): 162-167 [5] Damoiseaux, J. S., et al. "PNAS" 103.37 (2006): 13848-13853. [6] Assländer, et al. "Neuroimage" (2013)



**Figure 4:** Single EPI (a), and MREG (b) image, hypo intense region showed with a red arrow.