319

Neuroanatomy of depressive patients with sexual dysfunction: functional MRI

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320

fMRI data analysis on schizophrenic patients under auditory stimuli. A comparison between the General Linear Model (GLM) and Independent Component Analysis (ICA)

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Introduction: General Linear Model (GLM) is prevailing in fMRI (functional Magnetic Resonance Imaging) analysis. This approach, based upon a model of the time course and an hemodynamic response estimation, is limited on studying task-related areas. ICA (Independent Component Analysis), a data-driven method in which no a priori assumptions are needed about the time course reference, has been shown to be an accurate tool for fMRI analysis . We compared ICA to GLM fMRI results for task-related analysis, auditory stimuli in patients with schizophrenia and chronic auditory allucinations.

Subjects and Methods: fMRI studies were carried out on 24 schizophrenic patients. Eighty dynamics covering the whole brain were acquired under two different auditory verbal stimuli. The stimuli had an ABAB task design and were performed twice: with and without emotional content.

GLM analysis was performed using SPM 2.0 (FIL, London, UK), and ICA using Fastica 2.2 (HUT-CIS, Helsinky, Finland). Pre-processing steps were applied throughout SPM: motion correction, coregistration, normalization, spatial smoothing (FWHM 4.0mm) and high-pass temporal filter (T=128 s). After statistical analysis, z statistic images were thresholded using corrected (family wise error) p=0.05. Independent components (IC) were calculated in a 30-dimensional subspace using PCA (Principal Component Analysis). To threshold task-related IC, a combination of temporal cross-correlation (r>0.7) and potential spectral density properties of the main frequency area were used.

Results: ICA returned task-related activation maps almost identical to the ones using GLM (fig.1). We had no 'false negative' area between ICA and our reference GLM (area>20 voxels). In addition, other non-task related IC (transiently task-related, quasiperiodic, slowly varying) were returned.

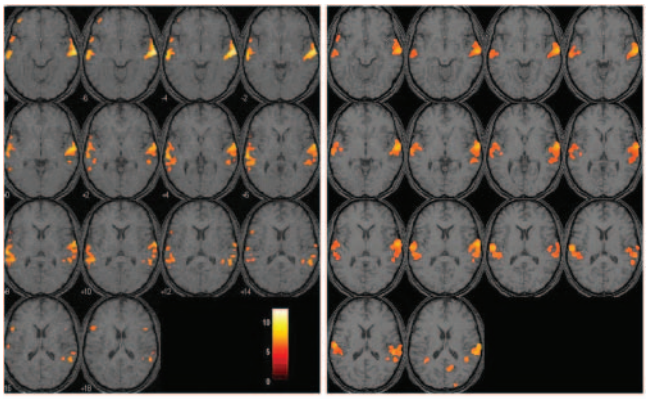

Fig.1: Mapping of task-related independent components. The left ones are GLM results, and the rigth ones are from ICA.

Discussion: ICA and GLM results fit quite well, showing the robustness and the spatial accuracy of the ICA method. Moreover, ICA can also be used to distinguish between non-task related components, movements and other artifacts, and should be considered to improve the fMRI preprocessing [2]. Further research and increment in the number of analysed patient will focus on how to combine both methods for a more performant analysis.

321

The impact of susceptibility gradients on EPI and spiral MRI for BOLD fMRI

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Introduction: BOLD fMRI requires pulse sequences sensitive to the BOLD effect. Geometric precision is also very important. Finally, rapid data collection is highly desirable. Much published work uses EPI although more recently spiral MRI has been introduced. This technique allows faster acquisition, is less sensitive to motion[1], and is more temporally stable[2]. Both sequences suffer geometrical errors and loss of sensitivity in variable susceptibility areas.

We hypothesize that spiral MRI is better suited for BOLD fMRI in regions of high susceptibility changes and test this by constructing a general simulation framework which allows isolating the effects of susceptibility gradients. The simulations were then validated experimentally.

Methods:

Simulations: A finite elements type of simulation is performed for each sequence and activation state. Activation is mimicked by extending T_2^* and detected by a pixel-wise t-test. The t-score is used as a measure of the strength of activation and the centroids of activated areas are determined to allow testing the geometrical fidelity.

Experiments: A five cycle paradigm of paced finger-tapping was used and activation determined using SPM99. Sadato *et al* used PET to determine the position of S1/M1[3] and their coordinates were used as reference.

Results:

Simulations: The simulations show EPI to be more sensitive than spiral MRI. Both lose sensitivity where the susceptibility gradient increases, however, the EPI images show a substantial deterioration of geometrical precision whereas spiral MRI primarily suffers a loss of sensitivity, which can be remedied by using more experiment time.

Experiments: Spiral MRI is significantly more sensitive than EPI