**Walk through of ERP analysis**

**Simultaneous EEG and fMRI data**

As an example, simultaneous EEG (sampling rate is 5000Hz) and fMRI data (TR = 2s) of a healthy subject were recorded using a 64-channel MR compatible EEG system (Neuroscan, Charlotte, NC) and a 3-T MRI scanner (Discovery MR750, GE) in the Center for Information in Medicine of UESTC.

EEG data were primarily preprocessed (including artifact removal, down-sampled to 1000Hz, pass-band filtering (1-30Hz), re-referencing to average), and clean EEG data was provided. FMRI data were analyzed in an identical fashion, and preprocessed fMRI data were provided. The fMRI data preprocessing comprised slice time correction, 3D motion detection and correction, spatial normalization (3×3×3 mm3, EPI template) and spatial smoothing (8-mm full-width at half maximum (FWHM) of an isotropic Gaussian filter).

**Experimental task**

During the experimental task, two types of stimuli, target (downward-oriented triangle with thin cross in its center, label 2 in EEG data, ~35 trials) and standard (upward-oriented triangle with thin cross in its center, label 1 in EEG data, ~120 trials) were randomly presented, respectively. During tasks, all subjects were required to gaze at the center of the monitor. The appearance of a bold cross indicated the beginning of the experiment and also warned subjects to concentrate. After 250 ms, a thin cross appeared, alerting the stimulus onset. After 500 ms, the target or standard stimulus appeared (Fig. 1); at the same time, the subjects were required to press the key of ′3′ as quick and correct as possible when only the targets were presented.

C:\Users\Administrator\Desktop\figure 1.tif

Fig. 1: Experimental task.

**EEG-informed fMRI analysis (GLM)**

* **ICA analysis**

After loading EEG data (sub01-clean\_P3\_data.set), select ‘Tools->Run ICA’. The ICA algorithm is temporal informed-ICA (runica()). As an example, ICA analysis is applied on simultaneous EEG data (target events, label 2). The parameter settings are follows (Fig. 2):

**Select Channels**: Select EEG channels. Here we select 62 EEG channels. The labels of selected channels will be listed.

**Select Events**: Select interested events. Here we select target events (label 2). The labels of selected events will be listed.

**Epoch Time Range [min max] (msec)**: Use default epoch time range. Defaults are 200 msec before time-locking event (min ≤ 0) and 800 msec after time-locking event (max＞0).

**EEG Sampling Rate**: EEG sampling rate.

**Exclude Event in Bad Block (label 9999)**: Exclude events in the bad blocks? The label of bad block in NIT is ‘9999’.

**No**. **of ICs**: Number of ICA components. Default is number of EEG channels or number of retained PCs.

**Training blocks (extended-ICA)**: Perform tanh() "extended-ICA" with sign estimation N training blocks. If N > 0, automatically estimate the number of sub-Gaussian sources. If N < 0, fix number of sub-Gaussian comps to -N [faster than N>0] (default|0 -> off). Here, set is as 0.

**No. of PCs to retain**: Number of PCs to retain (i.e. retain first ? PCs). Here, we set it as 5.

**Stop Criterion**: Stop training when weight-change < this (default is 1e-6).

**Max Steps**: Max number of ICA training steps. Default is 512.

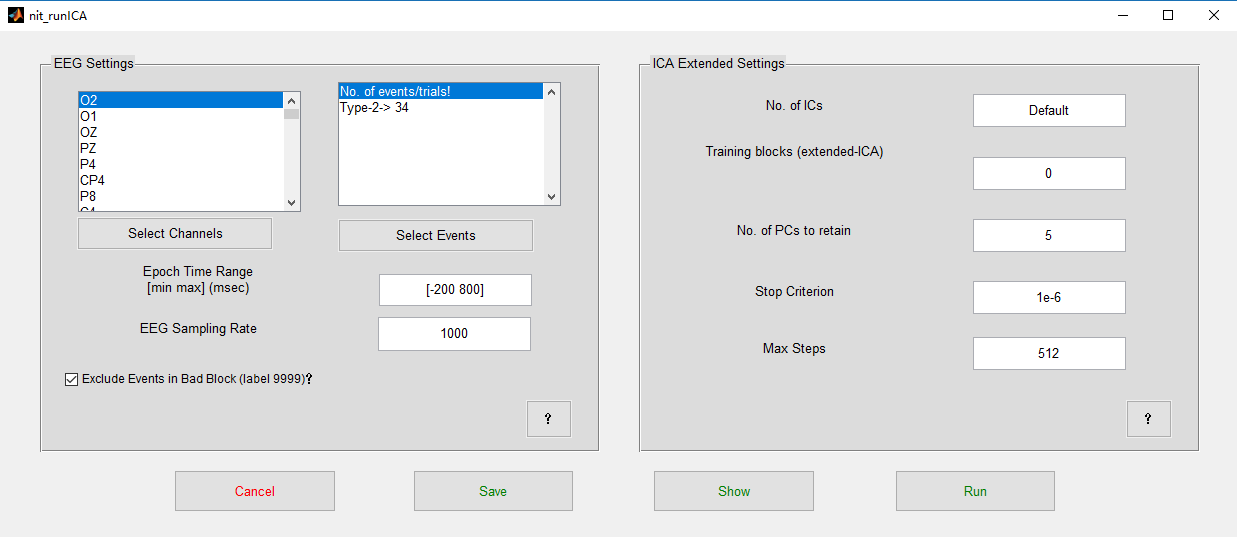


Fig. 2: The interface of ICA analysis.

Press button ‘Run’ to calculate (when calculating, the color of ‘Run’ will be red) ICA. The results (‘ICAresults’) will be first saved in the MATLAB work space. You can press button ‘Show’ to see the results of ICs (Fig. 3), and button ‘Save’ to save the ‘ICAresults’. If channel locations are contained in the EEG data, NIT will plot the topographies of ICs. Otherwise, NIT only plots the ICs as trials and an averaging wave.

F:\Works\work1\Software\Lab softwares\NIT_toolbox\Example_data\P300_EEG_informed_fMRI\example\IC5-P3.tif

Fig. 3: Results of ICA (P300 component) for subject 01. For an EEG independent component, the 1st row is topography, the 2nd row is trial image and the 3rd row is averaging wave.

* **Extract ERP Amplitude**

Press button ‘ERP amplitude’, the interface will popup (Fig. 4).

**Select Event/Type**: Select interested event/type. Here, select ECG event (label ‘2’).

**Select ICs**: Select ICs (e.g. IC-5).

**Method**: Use default ‘Maximal Absolute Value’.

**EEG Sampling rate**: EEG sampling rate.

**Baseline Correction**？: Baseline correction (for each trial, subtracting mean value of period before onset/stimuli). Checked.

**Normalize**？: Normalize amplitude values to [0, 1]. Checked.

**Match to fMRI timepoints?**: Match amplitude values to fMRI time scale. Checked.

**fMRI Onset (sec)**: Onset time of fMRI scanning (unit is sec). Here, set is as 38.177.

**fMRI Duration (sec)**: Duration of fMRI scanning (unit is sec). Set it as 420.

**TR**: fMRI repeating time (sec). Set it as 2.

Then press button ‘Run’. The results can be seen in the MATLAB work space (array ‘ampli\_results’): Press button ‘Save’ to save the results as .xlsx file.

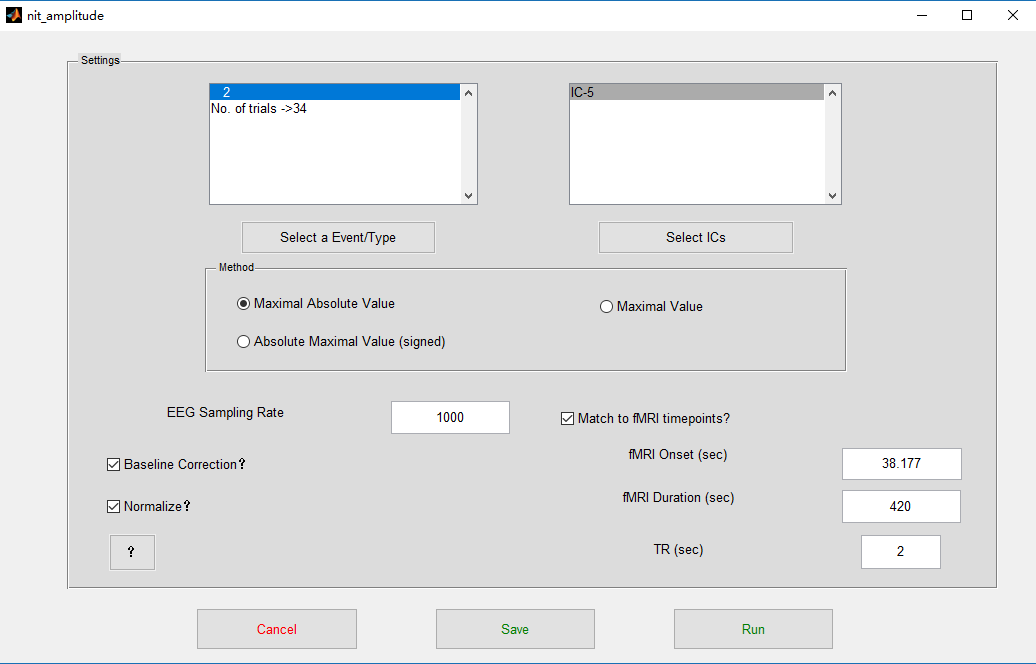


Fig. 4: The interface of ERP amplitude.

* **GLM analysis**

Click ‘GLM’ button, and the GLM GUI will popup (Fig. 5).

**fMRI Input Directory**: Directory of input data. The data are images files such as \*.img and \*.nii (NIFTI format). The example directory is ‘\*\ P300\_EEG\_informed\_fMRI\fMRI\_data\’.

**Nuisance Signals**: Covariables in the linear regression model. For example, 6 head motion parameters gained from realignment (E.g. ‘\*\ P300\_EEG\_informed\_fMRI\headmotion’).

**EEG Feature Series (Xs)**: The EEG feature series (P300 amplitudes) in the regression model (\*.txt; or Office \*.xls and \*.xlsx file). Row is time points, and column is number of EEG features. Here, select ‘\*\ P300\_EEG\_informed\_fMRI\Xs’).

**Output Directory**: Output directory. E.g. ‘\*\GLM\_results’.

**Brain Mask**: Use default brain mask.

**Adding Nuisance Signals**: Adding the covariables (such as head motion parameters) in regression model? Checked.

**Adding Linear Drift Signal**: Adding the linear drift signals in regression model? Checked.

**Multiple Runs?**: Multiple runs for each subject? Unchecked.

**TR**: Repeating time of fMRI (TR = 2).

**Method**: Select the method, GLM1.

**HRF settings**: Use default HRF (used in GLM1).

**Xs checking**: Checking whether Xs is matched to fMRI time courses. Checked.

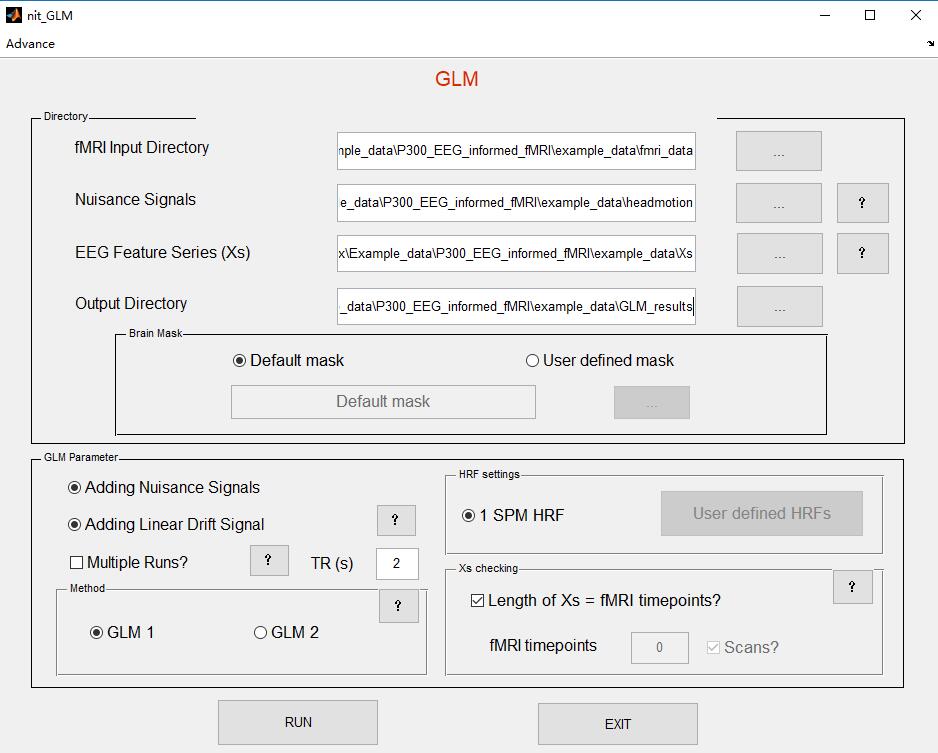


Fig. 5: Interface of GLM.

**Results**

Press ‘Run’ butten. When finished, you can click ‘DesignMatrix’ in Advance (Fig. 6), and select GLM\_results.mat file to show the design matrix and generate contrast/T map. The activation map related to P300 amplitude of sub\_01 is showed in Fig. 7.

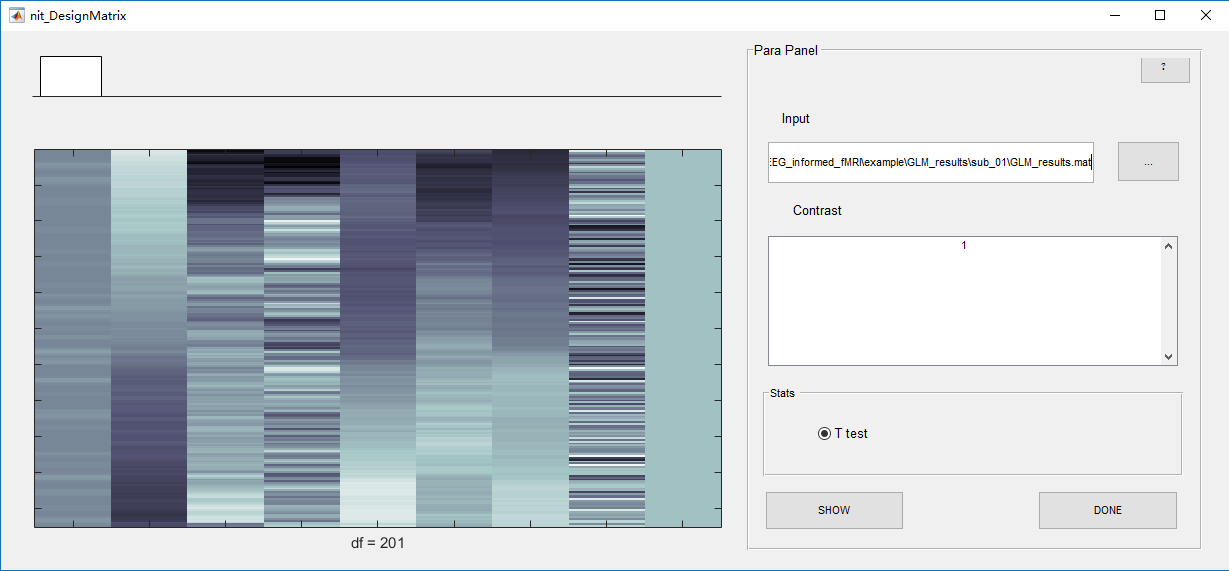


Fig. 6: Design matrix of GLM results.

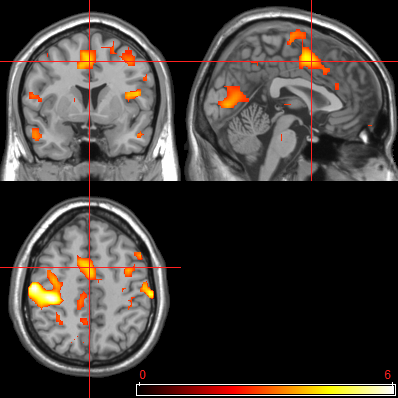


Fig. 7: The result of EEG-informed fMRI analysis (one subject). The threshold of T value is 2.5.

**Copyright**

The EEG and fMRI data are collected from a healthy subject from UESTC, and are used to be example data in NIT software only.

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