Temporal Dynamics on Decoding Target Stimuli in Rapid Serial Visual Presentation using Magnetoencephalography

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Introduction

Background

Rapid serial visual presentation (RSVP) has been widely used in brain-computer interface (BCI) as a high efficient paradigm [1]. RSVP-BCI has been applied in many areas such as data categorization [2], face recognition [3] ,speller [4] and website evaluation [5].

Introduction

Motivation

- Little has been known about the temporal dynamics of the neural activity that triggered by target stimuli in RSVP.
- Besides the successful engineering applications of RSVP-BCI, the underlying neural activity is still unclear.

Introduction

This work

- The temporal dynamic of target event-related responses in a static RSVP paradigm was investigated using paired structural MRI and MEG signal with different frequency bands.
- The MVPA was applied on MEG epoch responses to estimate the decoding power dynamic.

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Task Design

Subjects Recruited 10 college students (7 males and 3 females, aged 23.79$\pm$3.6).

Design During a block, 100 pictures were shown to the subject in random ordered sequences at a rate of 10 Hz.

Ratio The chance of target pictures (odd ball) was set to 4%.

MEG and MRI acquisition

MEG MEG data were scanned with a whole-head CTF MEG system with 272 channels (MISL-CTF DSQ-3500, Vancouver, BC, Canada) at the MEG Center of Institute of Biophysics, Chinese Academy of Sciences.

MRI MRI data were scanned with a 3.0 T MRI scanner (Siemens, Germany) at the MRI Center of Institute of Biophysics, Chinese Academy of Sciences.

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MEG Preprocessing

Software The MEG data were preprocessed using *MNE* software.

De-noise Suppressing artificial noise using ICA method. The artificial sources were zeroed out from raw data.

Filter The bands used in this research were Delta, Theta , Alpha bands, and two custom bands: U07 and U30 band.

Table: Filter bands

Filter Name	**Freq band**
Delta	$1 - 4Hz$
Theta	$4 - 7Hz$
Alpha	$8 - 12Hz$
U07	$0.1 - 7Hz$
U30	$0.1 - 30Hz$

MVPA

Feature Feature extraction was applied to training data, using xDAWN algorithm. Number of components was set as 6.

Classifier Support Vector Machine (SVM) was applied as classifier.

Validation The MVPA was applied in a 10-folder cross-validation protocol. In each folder, we use one run as testing data and others as training data.

Cortical Neuronal Activation Estimation

Surfaces The subject-specific cortical surfaces were build based on the MRI data using *freesurfer* software.

Model A forward model was calculated to project the MEG data into cortical surfaces using the *'oct6'* space.

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MEG Signal Visualization

Joint plot of evoked
U07
U30

MVPA Scores

Accuracy
F1-score
Recall ratio

MVPA Scores

Scores in temporal resolution

Cortical Neuronal Activation

Evoked activations

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Conclusion

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Big thanks