Temporal Dynamics of neural representations of affective pictures revealed by combining MVPA and EEG

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Introduction

- Our previous work has examined the neural representations of affective pictures by applying multivariate pattern analysis (MVPA) to fMRI evoked by pleasant, unpleasant, and neutral IAPS pictures. In this study we addressed three issues pertaining to the temporal dynamics of neural representations of affective pictures.
- Issue 1: It has been suggested that negative stimuli evoke faster and stronger neural responses compared to positive stimuli. ERP studies of this issue have been inconclusive. We applied MVPA to EEG data to test the hypothesis that speed and strength of processing is a function of picture category rather than valence alone.
- Issue 2: Are neural representations of affective pictures rapidly changing (dynamic coding) or stable over extended period of time (sustained coding)? We computed MVPA temporal generalization function to test the hypothesis that neural representations of affective pictures follow sustained coding.
- Issue 3: In what way are EEG and fMRI representations of affective pictures related? We utilized simultaneous EEG-fMRI data to test the hypothesis that the stability of EEG representations of affective pictures predicted the quality of fMRI representations of affective pictures.

Methods

Paradigm and data acquisition

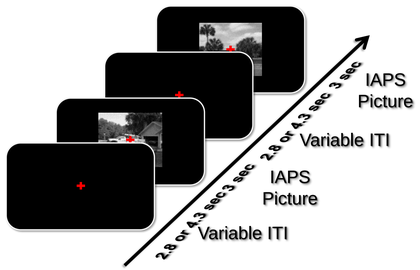

Figure 1. Timeline of affective picture viewing paradigm. 60 IAPS pictures (20 Pleasant, 20 Neutral, 20 Unpleasant) were used. 300 trials total divided into 5 sessions.

According to the emotional content, the 60 IAPS pictures are subcategorized as unpleasant (disgust and attack scenes), pleasant (happy scenes and erotic couples) and neutral (neutral people and neutral scenes) pictures. EEG and fMRI data were recorded simultaneously from 20 healthy subjects while they viewed the pictures passively.

Multivariate pattern analysis (MVPA)

MVPA was performed using a linear support vector machine (SVM) algorithm implemented in the LibSVM package. For EEG decoding, single-trial EEG data was minimally smoothed using a moving average filter (five time points). Ten-fold cross-validation was carried out for each time point. For temporal generalization analysis the classifier trained at each time point was used to decode data from all time points.

For fMRI decoding, single-trial fMRI was estimated using the beta-series method in each voxel of visual cortex. Linear SVM was applied to the BOLD response. Ten-fold cross-validation was carried out.

Results

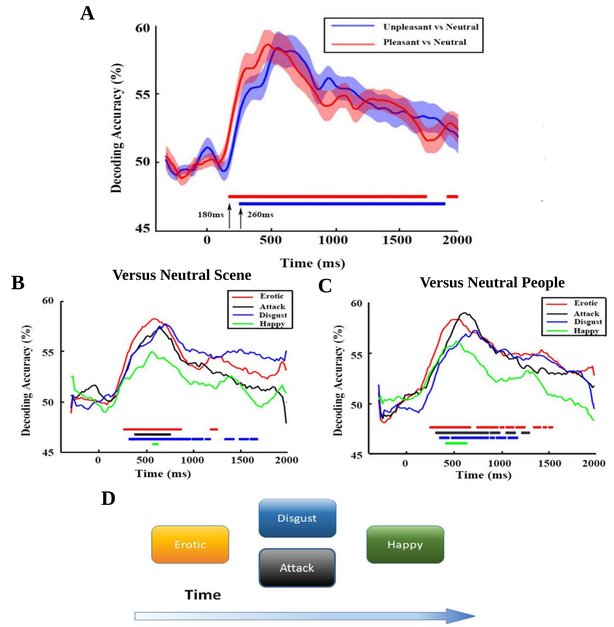

Figure 2. EEG decoding. **A**) Decoding accuracy time series for Unpleasant vs Neutral and Pleasant vs Neutral. **B**) Emotion subcategories vs natural scene. Onset latency: Erotic=260ms; disgust=320ms; attack=380ms; happy =560ms. **C**) Emotion subcategories vs neutral people. Onset latency: Erotic=260ms; attack=320ms; disgust=360ms; happy scene=420ms. **D**) Schematic showing the sequence of onset latency.

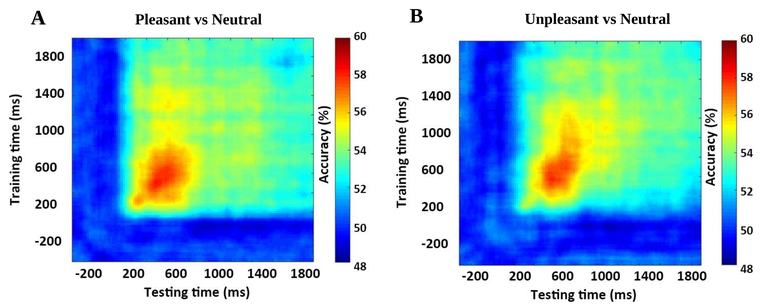

Figure 3. Temporal generalization map averaged across subjects. A) Pleasant versus Neutral. B) Unpleasant versus Neutral.

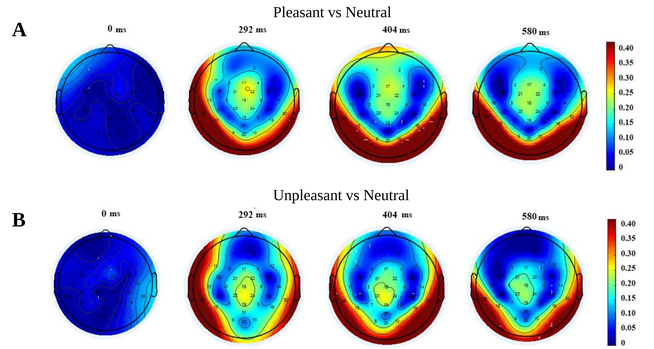

Figure 4. MVPA weight maps at different time points. **A**) Unpleasant versus neutral. **B**) Pleasant versus neutral.

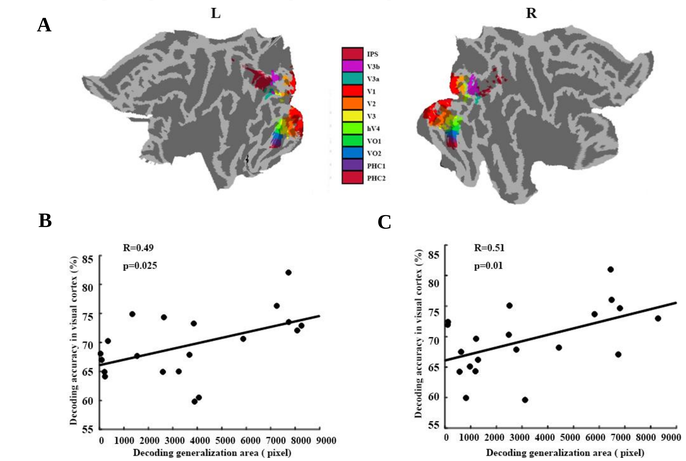

Figure 5. Relationship between EEG temporal generalization and fMRI decoding accuracy in visual cortex. **A**) Retinotopic ROIs of visual cortex. **B**) Unpleasant versus Neutral. **C**) Pleasant versus Neutral.

Summary and Discussion

- The formation of neural representations of pleasant pictures was found to be earlier than that of unpleasant pictures, and at the subcategory level, the following sequence of onset was observed: erotic → disgust/attack → happy. This finding is not in support of the idea that the processing of negative information is prioritized and supports the hypothesis that speed of information processing is picture category specific.
- Neural representations of affective pictures are temporally stable, suggesting sustained coding rather than dynamic coding.
- The stability of picture representations, measured by the area of above-chance level decoding in the temporal generalization map, predicted fMRI decoding accuracy in visual cortex. This suggests that stability of neural representations facilitates the formation of distinct BOLD activation patterns.

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