

# A High Resolution fMRI Study of Episodic Memory Retrieval at 7T

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**Introduction:** Human recollection has the ability to remember details of the context in which events were experienced as well as details of the events themselves [1]. It is well-established that the prefrontal cortex (PFC) is important for higher-order cognitive functions [2,3] and the anterior part is involved in the recollection of context details. However it is still a matter of debate whether anterior PFC is responsive to the collection process itself or to the cue indicating the retrieval mode. In this study, the brain regions associated with the memory retrieval process were investigated in an event-related fMRI study using a 7T MR scanner. We aimed to test these two different types of responses in the anterior PFC.

**Experimental Design and Procedure:** Seven normal volunteers participated in the study so far. Prior to entering the scanner, the participants were asked to make one of two semantic judgments (indoor/outdoor or pleasant/unpleasant) about 120 words. During fMRI scanning, two types of trial were presented to the subjects in a pseudo-random fashion: 1) Episodic recall trial (REC); 2) Semantic judgment trial (SEM) (Fig. 1). Each trial lasted for five TRs. In each trial, a blank screen with a fixation cross in the middle of a colored background was shown in the first two TRs, followed by a word in the third TR to which a response was made, a fourth TR with fixation, and fifth TR with a second word requiring a response. Throughout the REC trial, the background was pink, and it was blue throughout the SEM trial. For each of the two words In REC, subjects indicated which kind of judgment (indoor/outdoor judgment or pleasant/unpleasant judgment) they had been asked to make about the word during the study period. The SEM trial acted as a control in which new words were presented in the third and fifth TRs. The subjects were asked to make a semantic judgment (living or non-living) about the new words. Between the trials there was a randomly jittered gap with an average duration of one TR. Total of 8 sessions were performed with about 24 trials in each session.

**fMRI Data Acquisition and analysis:** All the MRI experiments were performed on a whole-body 7T (GE Signa) MR scanner. For signal reception, a 20-channel phase array coil (NOVA Medical) was used (16 out of 20 channels were used for the image reconstruction). The scanning protocol included  $T_2^*$ -weighted anatomical images at the spatial resolution of isotropic 1mm. The  $T_2^*$ -weighted BOLD images were acquired using an echo-planar imaging (EPI) technique with an acceleration factor of 3. The acquisition parameters were TE/TR=32/3000ms, spatial resolution=1.25x1.25x2.2mm<sup>3</sup> and 39 axial oblique slices to cover the entire brain. A total of 149 time frames were acquired in each session, the first 7 frames were discarded to allow tissue magnetization to achieve a steady state. All analyses were performed with the AFNI package. Preprocessing steps included motion correction, physiological noise correction, slice timing correction, spatial smoothing with FWHM=3mm, and the intensity was normalized voxel-wise with respect to the mean of each time series. Data from one subject were excluded from further analysis due to severe motion artifacts. For each trial, the ensuing BOLD response was modeled as a combination of triangular functions and deconvolution analysis was performed on the basis of the general linear model. The trend of the baseline was modeled with a polynomial up to the 4<sup>th</sup> order. The functional contrast between the episodic memory recall and semantic judgment trials were extracted by using a general linear test. Brain activation maps from individual subjects were obtained by using a voxel-wise t-score threshold of 3.0 and a minimum cluster size 30, which corresponding to a significance level of  $p < 0.001$ .

**Results and Discussion:** The preliminary activation results for the episodic recall versus semantic judgment trials exhibit fairly similar activation patterns in the medial and lateral anterior PFC among the individual subjects. For each subject, one slice of the brain activation maps at the similar anatomical locations is depicted in Fig. 2. To different extends, we observed medial and lateral PFC activations in all subjects. It is noted that there are also major differences in the activation patterns. Some subjects displayed activations only in one side of the lateral anterior PFC regions (Fig. 2A,C,D,E), while the others have both sides of the lateral anterior PFC regions activated (Fig. 2B,F). The average time-courses for the activated brain region (C1, see Fig. 2) located in the anterior PFC in one subject (subject A) was also shown in Fig. 3. Actually, this time course is quite representative for the PFC activation in all other subjects. The BOLD response during REC were significantly increased after the fourth TR, which is more consistent with the recall event presented at the third TR rather the cue presented at the first 2TRs indicating the recall mode. This preliminary analysis suggests that these regions are specifically activated by the memory retrieval episode.

**References:** [1] JS Simons et al, *Neuropsychologia* 43:1174-83, 2005; [2] N Ramnani and AM Owen, *Nat. Rev. Neurosci.* 5:184, 2004; [3] Johnson JD and Rugg MD, *Cereb Cortex.* 17:2507-15, 2007.

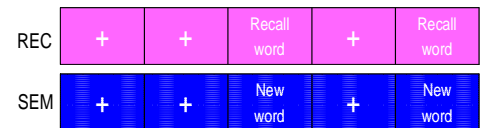


Fig. 1: Experiment paradigm

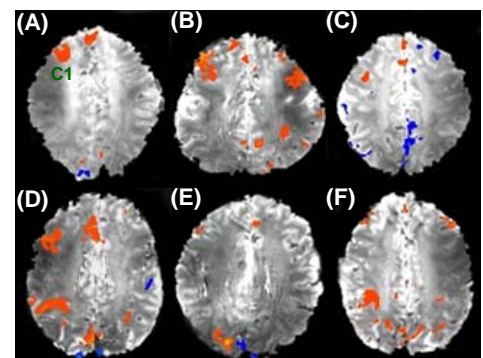


Fig. 2: Activation maps for all the six subjects.

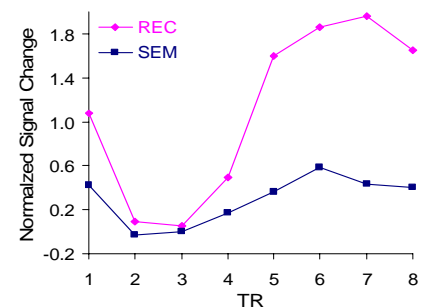


Fig. 3: Time course of Cluster 1(see Fig.2)