1. INTRODUCTION

Although the neural mechanisms underlying the beneficial effect of emotion on cognitive functions (e.g., episodic memory) have been extensively investigated [e.g., 1,2], the neural correlates of the detrimental effect of emotion are largely unknown. Here, we investigate the effect of emotional and non-emotional distractors on the neural mechanisms associated with working memory operations.

We investigated 2 issues:

I. Role of the Prefrontal Cortex in Maintenance Operations during Working Memory Tasks with Distraction

Studies investigating the neural correlates of delayed-response working memory (WM) tasks suggest that WM maintenance operations are associated with sustained delay activity in dorsolateral PFC (dIPFC/middle frontal gyrus: MFG) regions [e.g., 3, 4], and thus link increased sustained delay dIPFC activity with increased WM performance. However, it is not clear how delay activity in these regions is modulated by the presence of distractors, which may interfere with the maintenance operations. A recent fMRI study from our group [5] showed that the presence of distractors was associated with increased delay activity in the dIPFC, but with decreased performance. One possibility is that this increased dIPFC delay activity reflects processing associated with encoding of salient stimuli into working memory. Another possibility is that increased dIPFC activity is particularly associated with processing of task-relevant (i.e., memoranda-specific) distracters. One goal of the present study was to investigate these issues.

II. Modulatory Effect of Emotion on the Neural Correlates of Working Memory Maintenance Operations

Based on evidence from clinical population [6], it has been proposed that cognitive-affective interactions are mediated by interplays between a dorsal neural system associated with executive processing (involving the dIPFC/MFG regions, the superior parietal cortex, etc.) and a ventral system associated with affective processing (involving the ventrolateral PFC/inferior frontal gyrus: IFG regions, the amygdala, etc.). However, direct functional neuroimaging evidence concerning such interactions from neurologically intact population and their behavioral consequences is missing. Although previous work from our group [7] provides evidence for such dorsal-ventral dissociations, it does not provide evidence that link cognitive-affective interactions to task performance. Thus, the main goal of the present study was to address this issue by investigating the neural correlates of the detrimental effect of emotional distractors on the neural correlates of WM maintenance operations.

2. METHODS

Subjects

- Participants were 15 healthy young female adults (19-30 yrs.). Four subjects were excluded from analysis due to performance below chance level.

Experimental task

- Subjects performed a delayed-response WM task with distractors presented during the delay interval (see diagram). Following the delay, subjects made Old/New responses to probes (50% old/50% new).
- Four types of distractors were presented in pairs: Faces, Scrambled Faces, Emotional Scenes, and Neutral Scenes.
- Some distractors were negative and neutral pictures selected from IAPS [8] based on their scores for arousal and valence, and divided into two categories: high arousing and negative and low arousing and neutral.
- Subjects were instructed to perform the main WM memory task, while attending to the novel stimuli presented during the delay, and to make fast and accurate responses to the probes.
- There were 40 trials per condition, randomly presented in 10 runs.

Data Acquisition and Preprocessing

Thirty axial slices (6 mm voxel) images sensitive to BOLD contrast (i.e., T2*-weighted) were acquired, using a 4 T scanner (spiral-in pulse sequence; TR = 2000ms; TE: 31ms). Preprocessing steps (SPM99) included motion correction, slice timing correction, normalization, and spatial smoothing (8mm) using SPM99.

Voxel-based analyses were conducted using custom MATLAB scripts. For each trial of interest, an epoch time-locked to stimulus onset (-2 sec to +30 sec) was selected and trials were averaged for each TR. Individual and group t-statistics were calculated on a time point-by-time point basis for the contrasts of interest.

5. CONCLUSIONS

I. The pattern of activity observed in the MFG suggests that increased dIPFC activity reflects processing of memoranda-specific distracters, rather than general processing associated with encoding of salient stimuli into working memory. If increased dIPFC reflected general encoding operations, one should expect increased activity for the most salient and richer in content distracters (i.e., the emotional scenes). This latter category, however, was associated with the highest increase in the MFG activity.

II. The dorsolateral dissociation observed in the present results is consistent with previous findings [7] identifying differential involvement of the dorsal vs. ventral brain regions in executive vs. affective aspects of information processing. Furthermore, the present results also provide evidence that the putative interaction between these separate systems is reflected in different patterns of WM memory performance in the presence of emotional vs. neutral distracters.

References


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