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HUMAN RECOGNITION MEMORY AND CONFLICT CONTROL: AN EVENT-RELATED POTENTIAL STUDY

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Abstract—The relationship between recognition memory and cognitive control is an important research topic. The current study investigated how conflict control influences an individual's emotional memory. During the encoding phase, participants were required to judge the affective valence of a Chinese Chengyu word (either positive or negative) in a modified Simon paradigm and to remember the word. Half of the words were presented in the congruent condition and the other half were displayed in the incongruent condition. During the retrieval phase, participants were instructed to make an 'old/new judgment' and decide whether the word had been presented previously. Electrophysiological responses were recorded using the event-related potential (ERP) technique. The behavioral results of retrieval processes showed that participants remembered more positive than negative words when they were encoded in the congruent condition. The electrophysiological results revealed that the retrieval of words encoded in the incongruent condition elicited less negative frontal negativity (FN) and early posterior negativity (EPN) amplitudes than those encoded in the congruent condition. The retrieval of words encoded in the incongruent condition induced greater late positive complex (LPC) amplitudes, relative to those encoded in the congruent condition on the left hemisphere. It was also observed that the recognition of positive words induced faster LPC responses than negative words when they were encoded in the incongruent condition. The present electrophysiological study illustrates that emotional memory processes may be affected by conflict control.

Key words: emotional recognition memory, conflict control, event-related potentials.

INTRODUCTION

Human recognition memory describes the ability to make judgments about whether presented items have been experienced or encoded before (Yonelinas, 2002; Rugg and Yonelinas, 2003; Rugg and Curran, 2007), and it consists of two processing phases: elaborative encoding processing during organized presentation of items (the encoding phase), and evaluation processing when retrieving both items and item-related information, such as context, and source information (the retrieval phase) (Blumenfeld and Ranganath, 2007; Mitchell and Johnson, 2009). Memory can be enhanced by emotionally arousing information compared to neutral information, which is thought to involve the recruitment of attention and elaborative encoding (Hamann, 2001; Kensinger and Corkin, 2003) and the modulation of amygdala on medial temporal lobe (MTL) during emotional memory consolidation (Ritchey et al., 2008). The brain network of several neuroanatomical regions, including the amygdala, hippocampus, prefrontal cortex (PFC) and anterior cingulated cortex (ACC), is responsible for processing emotional information and memories (Cahill et al., 1996; Phelps and Anderson, 1997; Adolphs, 1999; Hamann et al., 1999; Dolan et al., 2000; Balconi and Cobelli, 2014; Skipper and Olson, 2014). Behavioral and imaging studies have shown that participants show superior emotional memory for affective stimuli relative to neutral stimuli (Phelps and Anderson, 1997; Gabrieli, 1998; Hamann et al., 1999). Moreover, emotional memory for positive and negative information relies on different, valence-specific processes (Dolan, 2000; Canli et al., 2000). The neural function of emotional valence correlates with brain lateralization hypotheses (Canli et al., 1998; Davidson and Irwin, 1999), and an electrophysiological study reported that the left parietal old/new effect induced by negative words was smaller and shorter relative to that elicited by neutral words (Maratos et al., 2000). The dorsal lateral prefrontal cortex (DLPFC) contributes to the valence process during emotional memories (Ritchey et al., 2008; Balconi and Ferrari, 2012). In addition, prior studies have shown that emotional encoding of congruent rather than incongruent information or better rather than worse semantic integration leads to better elaboration/retrieval at the semantic level (Craik and Tulving, 1975; Greenberg et al., 2012).

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Abbreviations: ACC, anterior cingulated cortex; DLPFC, dorsal lateral prefrontal cortex; EEGs, Electroencephalograms; EPN, early posterior negativity; ERP, event-related potential; FN, frontal negativity; HEOG, horizontal electrooculography; LPC, late positive complex; MTL, medial temporal lobe; PFC, prefrontal cortex; RT, reaction time; VEOG, vertical electrooculography.

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Conflict control, a pivotal component of cognitive control, monitors conflicts in perceptual inputs or detects conflicts between an individual's preferred responses and required responses, and then executes attentional control on the conflicts (Fan et al., 2002; Botvinick et al., 2004; Kerns et al., 2004). The Simon paradigm is widely used to study conflict control processes, in which stimulus is presented on either the left or right side of the central view point and participant's left or right hand is instructed to respond to the stimulus according to non-spatial presentation dimension (Simon and Small, 1969). The Simon task consists of two conditions: the congruent condition (stimulus presentation location is ipsilateral to the response hand) and the incongruent condition (stimulus presentation location is contralateral to the response hand). The incongruent condition requires more conflict control processes (longer response time) to detect the conflicts and execute attentional control on the conflict situation, relative to the congruent condition (Simon, 1990; Lu and Proctor, 1995; Leuthold, 2011).

More recently, a number of studies have investigated the complex interactions between memory (emotional or non-emotional) and cognitive control (or attention) during encoding and/or retrieval processes (Cansino et al., 2002; Banich et al., 2009; Kuhl and Wagner, 2009; Vermeulen and Luminet, 2009; Richter and Yeung, 2012; Ferré et al., 2013, 2014; Hutchinson et al., 2014). There are two contrary opinions or research findings on the interaction between memory and conflict control: one regards that items that are encoded in the incongruent condition will show better recall performance in subsequent memory (Chun and Turk-Browne, 2007; Krebs et al., 2015), which bases on the conflict monitoring model (Botvinick et al., 2001, 2004) and considers that conflicts trigger enhanced attention onto task-relevant information and further facilitate subsequent memory for that information. However, the other contrary opinion regards that the additional conflict control might impair the encoding process on items and subsequent memory because of limited cognitive resources (Uncapher and Wagner, 2009). Electrophysiological methods, like event-related potentials (ERPs) with high temporal resolution, can afford more neural dynamic information about brain activities relative to behavioral and neuroimaging methods. Therefore, it is essential to investigate the neural dynamic interactions between memory (emotional and/or non-emotional) and conflict control.

Moreover, three ERP components have been used to map the neural responses of affective processes and memory. The early posterior negativity (EPN), a negative deflection at posterior electrode sites in the time window of 200–300 ms, is considered to be triggered by early attentional perception of affective stimuli (Bayer et al., 2012; Herbert et al., 2008a,b; Junghöfer et al., 2001; Schupp et al., 2003, 2004a,b; Kissler et al., 2007; Schacht and Sommer, 2009) and is also attributed to associate with lexical mechanisms (Kissler and Herbert, 2013) and early detection of recognition (Schacht et al., 2012; Zhang et al., 2012; Du et al., 2014). The frontal negativity (FN), peaking between 300 and 500 ms, relates to familiarity-based recognition processes (Curran, 2000; Friedman and Johnson, 2000; Curran and Cleary, 2003; Duarte et al., 2006; Rugg and Curran, 2007; Wolk et al., 2009; Dulas and Duarte, 2013). The late positive complex (LPC), distributed over the parietal cortex within the time range of 500–800 ms, reflects sustained processing and successful retrieval of emotional information (Donaldson and Rugg, 1999; Rugg and Wilding, 2000; Finnigan et al., 2002; Curran and Cleary, 2003; Iidaka et al., 2006), and correctly remembered words induce larger LPC amplitudes over left parietal brain areas (Donaldson and Rugg, 1999).

The current study aimed to explore whether conflict control on the items could lead to different neural dynamic processes (EPN, FN, and LPC responses) of subsequent emotional memory. In the present study, each Chinese affective word (positive or negative) was displayed on either the left or right side of a screen during the encoding phase, and participants were required to use their left or right hands to respond according to the affective valence of the word. With regard to the retrieval phase, the old/new paradigm was adopted with participants reporting whether the centrally presented word was old or new. We would compare both behavioral and ERP responses during emotional memory for words encoded in the incongruent and congruent conditions, and we would also analyze whether these interaction patterns were different between positive and negative words.

EXPERIMENTAL PROCEDURES

Participants

Twenty right-handed participants (10 women, 10 men) with a mean age of 23.3 years (SD = 1.1 years) were paid 100 RMB for participating in the current ERP experiment. All the participants reported normal or corrected-to-normal vision and were naïve to the purpose of the experiment. None of them reported any history of neurological or psychiatric diseases. All the participants provided written informed consent prior to their participation. This study was approved by the Ethics Committee of the Institute of Psychology, Chinese Academy of Sciences.

Stimuli and procedure

The current study adopted the encoding-retrieval paradigm to measure participants' recognition memory. The stimuli were Chinese Chengyu words, and each word consisted of four Chinese characters with an explicitly positive or negative meaning. Examples are presented in Fig. 1 and their meanings are given in the figure legend. In the current study we used 640 words (320 positive and 320 negative words), and the valence and familiarity of each word were judged by 10 linguistic experts using 5 point scales. Positive items were evaluated as significantly more positive than negative items ($t = 3.7$, $p < 0.01$), and the t test showed that there were no differences between positive and negative words with regard to familiarity ($t = 0.8$, $p > 0.05$). The stimuli and fixation point were displayed in white on a