Behavioural Brain Research 291 (2015) 89–102

Contents lists available at ScienceDirect

Behavioural Brain Research

journal homepage: www.elsevier.com/locate/bbr

Research report

Positive and negative emotional contexts unevenly predict episodic memory

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HIGHLIGHTS

- Positive emotional contexts were better predictors of episodic memory.
- Arousal (measured through autonomic responses) was equivalent between valences.
- The SME observed in the frontal slow wave was sensitive to valence.

ARTICLE INFO

Article history:
Received 12 December 2014
Received in revised form 10 May 2015
Accepted 12 May 2015
Available online 21 May 2015

Keywords:
Episodic memory
Emotional valence
Event-related potentials
Subsequent memory effects
Face recognition

ABSTRACT

The aim of this study was to investigate whether the recognition of faces with neutral expressions differs when they are encoded under different emotional contexts (positive, negative or non-emotional). The effects of the emotional valence context on the subsequent memory effect (SME) and the autonomic responses were also examined. Twenty-eight participants performed a betting-game task in which the faces of their virtual opponents were presented in each trial. The probability of winning or losing was manipulated to generate positive or negative contexts, respectively. Additionally, the participants performed the same task without betting as a non-emotional condition. After the encoding phase, an old/new paradigm was performed for the faces of the virtual opponents. The recognition was superior for the faces encoded in the positive contexts than for the faces encoded in the non-emotional contexts. The skin conductance response amplitude was equivalent for both of the emotional contexts. The N170 and P300 components at occipital sites and the frontal slow wave manifested SMEs that were modulated by positive contexts; neither negative nor non-emotional contexts influenced these effects. The behavioral and neurophysiological data demonstrated that positive contexts are stronger predictors of episodic memory than negative or non-emotional contexts.

1. Introduction

Personal experiences are preserved as episodic memories, which are constituted by the events and the contexts in which they took place [45]. These experiences are better remembered when they are emotional, compared to non-emotional events (for a review see [7]). However, it still remains a controversy whether the emotional valence, positive or negative, might differently influence the subsequent retrieval of memory. Valence is referred as to the degree of pleasantness ranging from negative to positive and corresponds to one of the two dimensions of emotion outlined by [20]. The other dimension, termed arousal, is defined as the intensity level of emotion and varies from calmness to excitement; arousal is manifested through the activation of the autonomic nervous system.

Numerous studies of event-related potentials (ERPs) have attempted to establish whether events with positive or negative valence are more memorable; however, the results have been inconsistent. Some of them reported that negative events were remembered better than positive events (e.g., [40,47]), whereas others reported opposite results (e.g., [4]) or even no differences between positive and negative events [8,46]. The mixed results might be explained by the difficulty in maintaining an equivalent arousal intensity between events with different emotional valences.

However, few neurophysiological studies have investigated whether neutral events are better remembered when they are

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http://dx.doi.org/10.1016/j.bbr.2015.05.018
0166-4328/

encoded within emotional contexts. Some studies [25,26] have examined only the effects of negative sentences used as contexts for the recognition of neutral words and found no benefit compared to words encoded in neutral sentences. The studies that have directly compared positive and negative contexts [11,42,43] have found higher recognition for neutral events encoded under positive contexts compared with negative and neutral contexts, except for one study [12] that observed no differences for words presented over positive and negative scenes from the International Affective Picture System (IAPS) that were used as contexts [21].

The neural activity that takes place during the encoding of neutral events presented in emotional contexts has been rarely examined. One fMRI study [11] has addressed this question. The results revealed that the amygdala showed greater activation for events encoded in a negative context, whereas the prefrontal cortex was more active for events encoded in a positive context. However, neural activity during encoding of neutral events in emotional contexts has not been addressed using the ERP technique. Kiefer, et al. [18] examined subsequent memory effects (SMEs) for words that referred to positive and negative traits. The words were encoded under two constant emotional states (good and bad moods) evoked by watching films. Thus, SMEs in this study were not analyzed using the traditional procedure of varying the emotional valence for each stimulus. SMEs between 500 and 650 ms after stimulus onset were more positive in centro-parietal derivations and negative in fronto-temporal electrode sites for individuals in a good mood compared with those in a bad mood. Thus, this study demonstrated that an emotional state influenced the neurophysiological responses that predicted ulterior memory.

Although the influence of the emotional context on SMEs is not well known, emotional events have been shown to modulate these effects. Some of these studies mixed faces with different emotional expressions [23] or words with diverse emotional meanings [33] to test the influence of emotion, independently of its valence, on SMEs; however, few studies have compared negative and positive emotions [8,39]. Dolcos and Cabeza [8] examined the influence of valence using IAPS images and found that the emotional images, independent of their valence, heightened the amplitude of a set of components identified as N200, N300, P300 and Slow Wave (SW). SMEs were observed at central-parietal sites between 400 and 600 ms after stimulus onset, which correspond to the P300. This component was insensitive to valence, as both positive and negative images elicited equivalent SMEs that were greater than those elicited by neutral images.

The effect of valence on SMEs was also examined with faces [39]. In this study, the N100, N170 and late positive potential (LPP) were recorded at encoding; however, only the LPP component observed at parietal sites (350–600 ms after stimulus onset), showed SME. In contrast to [8], the effect recorded by [39] was sensitive to emotional valence; fearful faces elicited greater positive SMEs than neutral faces, whereas those for happy faces did not differ from those of the other two facial expressions. Although SMEs were not assessed by Marini, et al. [27], ERPs were recorded in this study during encoding while neutral faces were randomly associated with a monetary reward. Several components such as the P100 and LPP showed greater amplitudes under rewarding conditions; in particular, the N170 was characterized as being of greater amplitude under non rewarding conditions.

The aim of the present study was to determine whether positive or negative emotional contexts have greater impact on the recognition of neutral faces and to what extent each of these emotional contexts enhances memory performance compared with a non-emotional context. Moreover, a second aim was to use ERPs to examine whether SMEs are modulated by the valence of the emotional context in which the neutral events are encoded.

To achieve this goal, we introduced an original paradigm to generate emotion that consisted of a gambling task against virtual opponents (neutral faces) in which participants bet money. The positive and negative emotional contexts consisted of winning or losing, respectively. In addition, the faces were encoded in a non-emotional context with no bets. An old/new recognition task for the faces followed the gambling task.

This procedure has the advantage of integrating the stimuli to be remembered (faces) with the emotional contexts. Previous studies have typically used scenes (e.g., images from the IAPS) as emotional contexts for neutral words [11,12] or objects [42,43], which are completely unrelated to the images. Another advantage of our approach over the use of scenes is that we guarantee that the emotional experience produced by winning and losing is homogenous across trials. The use of scenes might not produce emotion with the same intensity across trials and individuals because they are strongly affected by culture and gender factors (e.g., [3,38]). Moreover, we used neutral faces to avoid the possible confusion that might cause the use of items and contexts; both with emotional valence, which has been observed in previous studies [18]. We selected faces as stimuli because they are socially relevant and difficult to remember when there is no interaction, and emotion is usually experienced in social situations. Thus, the paradigm used in this study to evaluate the effects of emotions was similar to a real life situation.

The probability of winning or losing was equivalent and highly likely ($p = .70$) to evoke emotional excitement with the same intensity when both situations occurred. Moreover, to establish which emotional context, positive or negative, enhances greater recognition, it is crucial to ensure that both events provoke equivalent arousal. Given that the two dimensions of emotion, valence and arousal, may interact to influence memory, we measured both of them to exclude the possibility of confounding their effects on memory. Skin conductance responses (SCRs) and cardiac frequency (CF) were recorded during each trial to ensure that the arousal levels were equivalent for both the positive and negative contexts.

We expected that the recognition of neutral faces would be greater for faces encoded in positive contexts relative to those encoded in negative contexts, as has been observed in previous neurophysiological studies that have contrasted the effects of both valences on neutral words [11] and objects [42,43]; see [12] for a lack of valence effects.

The faces of the virtual opponents to be remembered were presented twice during each trial; therefore, we were able to examine the SME for the same face in a non-emotional context before the bet and in a positive or negative context after the bet. We predicted that the SMEs during the first presentation of the face would be present independent of the context (positive, negative or non-emotional) in which that same face would be encoded during its second presentation. In particular, we expected that faces subsequently recognized would elicit greater amplitude waveforms at parietal and frontal sites than faces subsequently forgotten, as has been observed in several memory studies (e.g., [1,34]). By contrast, during the second presentation of the face, we expected that the SMEs would be modulated by the valence in which the face was encoded. Specifically, faces subsequently recognized and encoded in positive contexts would elicit greater positive amplitudes of the SW recorded at frontal sites than faces encoded in negative contexts. This prediction is based on the fact that SMEs have been shown to be sensitive to valence in frontal derivations [18]. Moreover, we expected that the P300 would show SMEs modulated by the emotional context at parietal sites, independently of their valence, as has been previously observed for emotional events [8]. In addition, for the second presentation of the face, we expected that the N170 and N300 would be modulated by the emotional contexts but not by SMEs, as observed in previous studies [8,27].