International Journal of Psychophysiology 79 (2011) 249–258

Contents lists available at ScienceDirect

International Journal of Psychophysiology

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

Deficient distracter inhibition and enhanced facilitation for emotional stimuli in depression: An ERP study

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ARTICLE INFO

Article history:
Received 17 May 2010
Received in revised form 17 October 2010
Accepted 27 October 2010
Available online 4 November 2010

Keywords:
Depression
Attentional bias
Distracter inhibition
Negative priming task

ABSTRACT

The aim of the present study was to investigate distracter inhibition ability for emotional faces in depression using a negative affective priming (NAP) task combined with event-related potentials (ERP). The reaction times and the ERP amplitudes were recorded during the task. In a first behavioral experiment, control participants (NC), participants who were currently remitted (RMD), and participants diagnosed with a current major depressive disorder (MDD), performed a modified NAP task. The main finding was that compared with the NC group, MDD participants had enhanced positive priming and less inhibition of sad faces. RMD individuals were characterized by general inhibitory impairments for all emotional faces and a facilitation for sad faces compared with NC individuals. In a second experiment combing the modified NAP task with ERP, the MDD participants had a larger P1 and P3 amplitude for sad faces in the positive priming condition compared with the other groups, and smaller P3 amplitude for sad faces in negative priming condition compared with other faces. Interestingly, RMD participants showed a distinct pattern of results compared with NC and MDD participants. Across the experiments, it can be concluded that MDD participants have deficient distracter inhibition and excessive facilitation for negative stimuli. The RMD participants show a mixed pattern of deficient distracter inhibition and excessive facilitation for both positive and negative stimuli. The results are in line with the idea that impaired distracter inhibition of emotional material is a cognitive risk factor of depression.

1. Introduction

Major depressive disorder (MDD) is a highly debilitating psychiatric disorder and is known for a high prevalence rate and marked risk of recurrence after remission (Goodwin et al., 2006; Taylor et al., 2010). The identification of vulnerability factors for the development, maintenance, and recurrence of MDD is an important challenge, crucial to the prevention and treatment of (recurrent) depression. From a cognitive perspective there is marked interest in delineating biases at the level of emotion processing. Traditionally, many of those information-processing studies have primarily focused on memory and attention. Recent findings indicated that depressed individuals displayed an attentional bias for negative material at more elaborative stages of information processing (Koster et al., 2005; De Raedt and Koster, 2010). Moreover, it was found that depressed individuals had a better memory for negative information (Matt et al., 1992; Walter et al., 2007; Taylor and John, 2004). At present, there is little explanation for the mechanisms underlying these information-processing characteristics in MDD.

In recent years there has been increasing research into the construct of inhibition in depression, which could provide an important link between memory, attention, and depression (Joormann et al., 2007). That is, the inability to inhibit processing of negative material may underlie attention and memory bias which can cause increased levels of negative affect. Two relevant aspects of inhibition can be of particular relevance to depression. First, inhibitory processes play an important role in reducing interference from (emotional) distracters. In this case emotional material is present at the *input level* of information processing. Second, inhibition is important in directing attention away from emotional material that has been processed but then needs to be removed from working memory in function of other goals. In the latter case inhibition of emotional material is a mental operation at the end-stage of processing. Empirical studies have showed that depression is associated with impaired inhibition at both stages (Goeleven et al., 2006; Joormann, 2004; Joormann and Gotlib, 2008). In the present study we aimed to further investigate impaired inhibition of emotional material at the input level.

Research on inhibition of emotional material at the input level has typically used the Negative Affective Priming task (NAP). This task is an affective modification of the negative priming paradigm (Joormann, 2004). A complete trial in this task includes two separate trials: a prime trial and a probe trial. Note that the participants are not aware of this

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doi:10.1016/j.ijpsycho.2010.10.016

separation into prime and probe trials. These two types of trials involve a stimulus pair consisting of an affective distracter and a target (pictures of emotional faces) that are assigned, in this study, through the color of the faces (i.e., colored vs. black and white). The participant is instructed to evaluate the valence of the target (e.g. color picture), while ignoring (inhibiting) the distracter (e.g. picture in black and white). To investigate attentional inhibition, the correspondence between the valence of the distracter in the prime trial and the target in the probe trial is crucial. In the control condition, there is no similarity between prime distracter and probe target. However, in the negative priming condition both share the same valence. In this task, successful inhibition of the stimulus valence of the distracter in the prime trial slows down the response to the target in the probe trial when this target has the same valence as the distracter. In other words, responding to a negative face as probe target would be slower if the previous prime distracter is a negative face (experimental condition) compared to if the previous prime distracter is a positive face (control condition). This slowdown is referred to as the NAP effect and can be considered as a valid index of inhibitory function towards affective material (Wentura, 1999).

In a first study using the NAP task, Joormann (2004) found that dysphoric individuals and remitted depressed patients (RMD) were characterized by impaired inhibition of negative words. Further study of this phenomenon in clinically depressed patients indicated that compared with never depressed (NC) and RMD, MDD patients were characterized by impaired inhibition of negative material (Goeleven et al., 2006). Interestingly, there are mixed findings on the presence of impaired inhibition in RMD individuals with one study showing impaired inhibition of negative words (Joormann, 2004) but another study showing no impaired inhibition for sad facial expressions (Goeleven et al., 2006). Recently, it was found that induced negative mood did not impair inhibition of sad faces (Goeleven et al., 2007).

Moreover, there are at least two types of attention biases: attention disinhibition and attention facilitation. Research on healthy participants has often examined distraction inhibition effects (negative priming) as well as processing facilitation effects (positive priming) for stimuli simultaneously (Wright et al., 2006). However, the previous studies on depression using the NAP task only examined distracter inhibition (negative priming condition), showing reduced inhibition for negative information in MDD patients (e.g., Goeleven et al., 2006). Therefore, it is uncertain whether depressed individuals possess an enhanced facilitation as well as impaired inhibition for negative information. The absence of such positive priming trials could result in systematic deviations between specific valences in the prime and probe trial. Therefore, in the present study we also included a positive priming condition, in which the prime target had the same identity as the probe target (see Table 1 for an overview of all trial types). The effects of positive affective priming can be indexed by the degree to which responding to the probe target is faster by the previous prime target having the same valence. This allows examining the possibility of enhanced facilitation as well as impaired inhibition in a single design.

The behavioral findings in depression are complemented by recent neuroimaging data (Rogers et al., 2004). For instance, in event-related potentials (ERP) study, it was observed (Holmes and Pizzagalli, 2008) that MDD was associated with a pronounced error negativity effect (ACC signaling) but impaired connectivity between ACC and dorsolateral prefrontal cortex (DLPFC) and abnormal posterior ERP amplitude (Zhu et al., 2010), causing reduced attentional control. Despite of these encouraging findings, neuropsychological studies on inhibition have typically used the emotional Stroop task, which does not allow distinguishing between active selection of task relevant material and active inhibition of task-irrelevant (emotional) material (Hasher and Zacks, 1988). Moreover, it is noteworthy that no study has combined a negative and positive priming task to investigate neural alterations in depressed patients. Therefore, it would important to combine the NAP task with ERP measures in depression research. The recording and analysis of ERPs is the preferred technique here as ERP allows to track, with a millisecond time-resolution, specific neural events related to inhibitory processes (Olofsson et al., 2008). With regard to the neural mechanisms, several specific components related to affective priming were examined in previous study, with the P1 component used as a marker of early, rapid processing of spatial stimuli; the N1 component reflected the attentional focus on target and a discrimination process within the focus of attention; P3 component reflected additional resources needed when the probe targets were still inhibited or updating of object-representations when objects were repeated (Kathmann et al., 2006; Taylor, 2002; Gibbons, 2006). In negative priming experiments, a smaller N1 amplitude was found. Since a repetition control condition elicited a similar N1 reduction, this was interpreted as a general adaptation effect with repetition (DeSchepper and Treisman, 1996). Ceballos et al. (2003) adopted a visual identity negative priming task and found larger P3 amplitudes and delayed P3 latencies. Similar effects with regard to P3 amplitude were observed in a recent study (Kathmann et al., 2006). It can be concluded that larger P3 amplitude in NAP task reflects the recruitment of attentional resources which are required for successful inhibition of emotional stimuli, while smaller P3 amplitude reflects deficient inhibition. Therefore, the specific components under investigation here are the P1 (time window 60–140 ms), N1 (100–200 ms), and P3 (200–450 ms).

The main aim of the present study was to examine the neural correlates associated with depression-related impaired inhibition over emotional material. To this end we included MDD patients and healthy controls. In order to examine whether this cognitive characteristic of depression disappears in remission we also included a group of RMD patients (Atchley et al., 2007). In a first behavioral experiment we used the NAP task in an attempt to replicate and extent the findings of Goeleven et al. (2006) in order to depart from a reliable behavioral effect. In experiment 2 we combined the NAP task with ERP recordings. Our hypotheses were: ① in contrast to the NC participants, MDD individuals would show deficient distracter inhibition ability and enhanced facilitation for sad faces in the behavioral data in NAP task. ② In contrast to the NC participants, MDD individuals would show neurophysiological indices of deficient distracter inhibition ability and enhanced facilitation for sad faces on the N1, P1, and P3 components of the ERPs in NAP task. ③ There might be similarity and differentiation between MDD and RMD participants on the behavioral and ERP data in NAP task.

Table 1
Negative affective priming task design.

		Negative priming condition		Positive priming condition		Control condition	
		Happy faces	Sad faces	Happy faces	Sad faces	Happy faces	Sad faces
Prime trial	Target	−	+	+	−	−	+
	Distracter	+	−	−	+	−	+
Probe trial	Target	+	−	+	−	+	−
	Distracter	N	N	N	N	N	N

Note: − means Sad faces, + means Happy faces, N means Neutral faces.

2. Experiment 1

2.1. Method

2.1.1. Participants

Three groups of participants took part in this study (Chinese-speaking adults between the ages of 18 and 40 years of age): NC, RMD, and MDD.

First, participants were surveyed by Beck Depression Inventory—II (BDI—II) and Beck Anxiety Inventory (BAI) (Liu and Shu, 1999). The Hamilton Depression Rating Scale (HDRS) (Liu and Shu, 1999) was