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The costs of distraction: The effect of distraction during repeated picture processing on the LPP

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ABSTRACT

Confrontation with anxiety-provoking situations is an effective treatment for anxiety disorders. However, underlying processes of the effects of exposure and its prevention by avoidance are barely understood. We investigated consequences of repeatedly withdrawing attention from or maintaining it to unpleasant images using ERPs. Thirty-five healthy participants were presented with neutral and unpleasant images in two experimental phases. During habituation phase, participants should attend to or distract themselves from pictures. The same picture-instruction combinations were presented three times. In the re-exposure phase, all pictures were presented again with the attend instruction. In the habituation phase, repeated presentation reduced sustained attention as reflected in decreased late positive potential (LPP) amplitudes when participants attended to pictures. This habituation effect was absent during distraction. In the re-exposure phase, increased LPP amplitudes were found for pictures with a distraction history. This highlights the role of avoidance in the development and maintenance of exaggerated attention to threatening stimuli.

1. Introduction

Emotional stimuli are important for survival and therefore automatically attract attention and guide behavior (Lang, Bradley, & Cuthbert, 1997). However, sometimes emotions are misplaced or destructive and changing them according to emotional goals is critical for mental health (Gross & Muñoz, 1995).

Several event-related potential (ERP) components are sensitive to emotional stimuli. Earlier components, such as the P1 and early posterior negativity (e.g., Olofsson, Nordin, Sequeira, & Polich, 2008; Schupp et al., 2004), that can be observed within 300 ms after stimulus presentation have been related to the relatively automatic capture of attention. Later components have been suggested to reflect more elaborated emotion processing (Hajcak, Weinberg, MacNamara, & Foti, 2011; Olofsson et al., 2008). Several studies have reported a reliable and sustained emotion-sensitive positive deflection at centro-parietal electrodes, referred to as late positive potential (LPP, e.g., Schupp, Junghofer, Weike, & Hamm, 2003). Modulation of the LPP by emotional stimuli begins in the time range of the P300 and is sustained for the time of stimulus presentation (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000) and even beyond (Hajcak & Olvet, 2008). The initial part of the LPP is similar in timing and topography to the target-elicited P300 usually derived in oddball tasks (e.g., Olofsson et al., 2008; Polich, 2007) and it has been suggested that emotional stimuli represent 'natural targets' that capture attention (Foti, Hajcak, & Dien, 2009; Vuilleumier, 2005; Weinberg & Hajcak, 2011). Following this P300-like positivity, a sustained positivity can be observed. This sustained positivity seems to result from overlapping positive deflections (Foti et al., 2009; Matsuda & Nittono, 2015; Pourtois, Delplanque, Michel, & Vuilleumier, 2008; Weinberg & Hajcak, 2011) that are assumed to reflect different underlying processes related to continued attention allocation and stimulus elaboration. Source localization suggests that the LPP is generated in the occipital and posterior parietal cortex (Keil et al., 2002). These brain areas are critically involved in visual attention (Kanwisher & Wojciulik, 2000; Kastner & Ungerleider, 2000). Further, it has been shown that the magnitude of the LPP also covaries with neural activity in subcortical structures such as the amygdala (Liu, Huang, McGinnis-Deweese, Keil, & Ding, 2012; Sabatinelli, Keil, Frank, & Lang, 2013). Thus, the LPP is thought to reflect facilitated processing of motivationally meaningful stimuli (Hajcak et al., 2011; Schupp et al., 2004; Weinberg & Hajcak, 2010).

Attention to emotional stimuli is not only captured automatically by their motivational significance but can be influenced by top-down processes according to one's intentions and goals (Weinberg, Ferri, & Hajcak, 2013). Thus, attention can be deliberately directed towards or shifted away from emotional events and this can augment or reduce emotion effects (Schupp, Flaisch,

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Stockburger, & Junghofer, 2006). Manipulations of attention target early processing stages during emotion generation and are therefore very effective in altering immediate emotional responses (Gross, 1998). Accordingly, shifting attention away from emotional material either via internal cognitive (Paul, Simon, Kniesche, Kathmann, & Endrass, 2013; Thiruchselvam, Blechert, Sheppes, Rydstrom, & Gross, 2011; Thiruchselvam, Hajcak, & Gross, 2012) or visual processes (Dunning & Hajcak, 2009; Hajcak, Dunning, & Foti, 2009; MacNamara & Hajcak, 2009; Nordstrom & Wiens, 2012; Wangelin, Low, McTeague, Bradley, & Lang, 2011; Wiens, Sand, Norberg, & Andersson, 2011; Wiens & Syrjanen, 2013) resulted in reduced LPP amplitudes.

However, avoiding confrontation with an unpleasant stimulus in favor of immediate emotional well-being may come at the expense of long-term consequences. Avoidance of feared objects or situations is thought to play a central role in the development and maintenance of anxiety and anxiety disorders (Foa & Kozak, 1986; Salkovskis, 1991). Avoiding feared stimuli prevents an individual from making new experiences that disconfirm existing fears. Accordingly, exposure-based treatments have proven effective in the treatment of these disorders (Deacon & Abramowitz, 2004; Foa & Kozak, 1985; Hofmann & Smits, 2008; Norton & Price, 2007) and are recommended as first-line treatment by the American Psychological Association (e.g., Koran, Hanna, Hollander, Nestadt, & Simpson, 2007). During exposure therapy, patients are repeatedly confronted with feared objects or situations and refrain from using any avoidance or safety behaviors (e.g., distracting from the situation). During repeated exposure to the fearful event, feelings of anxiety or fear naturally fade away. The reduction in anxiety or fear has originally been linked to habituation (cf., Groves & Thompson, 1970; Harris, 1943; Thompson & Spencer, 1966). Thereby, the individual unlearns the association between the feared event and feelings of anxiety. Other approaches link the success of exposure therapy to the disconfirmation of threat-laden beliefs (Foa & Kozak, 1986; Foa & McNally, 1996; Salkovskis, Hackmann, Wells, Gelder, & Clark, 2007) or to inhibitory learning (Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014). The latter states that the originally learned association between a stimulus and an emotional response is not erased during extinction or repeated exposure, but rather a second inhibitory association is learned indicating that the stimulus no longer predicts an aversive outcome. Despite differences between these approaches regarding the assumed underlying mechanisms of exposure, they all require repeated confrontation with aversive events and aversive emotions to be permitted. Further, all suggest that distraction and avoidance counteract the anxiety-reducing effects of exposure. However, underlying neural mechanisms by which distraction impedes the effects of confrontation during repeated exposure, and how it may thus contribute to exaggerated attention to feared stimuli is less well understood.

Therefore, we tested the prediction that distraction, a strategy that has proven effective at regulating emotions in the short run (for a review see Webb, Miles, & Sheeran, 2012), has maladaptive consequences in the long run by preventing habituation or reduction in responsiveness more broadly and thereby increasing responsiveness to aversive stimuli during subsequent re-exposure. To test this, neutral and unpleasant pictures were presented in two phases while the LPP was recorded. In the first phase, called the habituation phase, stimuli were repeatedly presented across three blocks and participants either distracted themselves from the unpleasant pictures or attended to them. In the second phase, called the re-exposure phase, the same pictures were presented again and participants were now instructed to attend to all of them (i.e., to the formerly attended and avoided pictures). Based on clinical observations and studies showing LPP habituation during repeated picture processing (e.g., Codispoti, Ferrari, & Bradley, 2006, 2007), we hypothesized that attention to and perceived unpleasantness of unpleasant stimuli would decrease with repeated stimulus presentation when participants attended to the pictures. This should be reflected in a decline of LPP amplitudes and self-ratings of unpleasantness across blocks. This effect was expected to be absent when participants avoided confrontation by distracting themselves. During the re-exposure phase, when participants attended to all previously presented pictures, we expected increased LPP amplitudes and higher subjective unpleasantness in response to pictures that were presented in the *distract* compared to the *attend* condition during the habituation phase. Further, we analyzed the time course of the LPP to shed light on the underlying psychological processes by which avoidance behavior contributes to the development and maintenance of exaggerated attention to feared stimuli. These analyses are rather explorative but have the potential to increase our understanding of the mechanisms by which avoidance interferes with the effects of repeated exposure. While earlier portions of the LPP have been linked to automatic attention, later portions are assumed to reflect more controlled top-down and elaborate processes (Hajcak et al., 2009). According to models that link the effectiveness of exposure therapy to the disconfirmation of threat-laden beliefs (Foa & Kozak, 1986; Foa & McNally, 1996; Salkovskis et al., 2007), we hypothesized that repeated attention to unpleasant stimuli would facilitate elaborated processing and that effects of repeated exposure in the attend condition would be observable in later portions of the LPP. In contrast, effects in earlier portions of the LPP would suggest that repeated exposure reduces automatic attentional allocation to unpleasant stimuli. In addition, we examined whether individual differences in the use of emotion regulation strategies influenced the effects of distraction. Individual differences in emotion regulation have been shown to modulate the processing of emotional stimuli and have been linked to differences in cognitive, affective, and social consequences (Gross & John, 2003; McRae et al., 2010). Instructed expressive suppression as opposed to reappraisal impairs memory for emotional material and habitual expressive suppression is associated with general memory impairments (Gross & John, 2003; Richards & Gross, 2000). Thus, one could assume that individuals who more habitually suppress their emotions may show a stronger rebound of LPP amplitude once they stop distraction. This effect could be related to a stronger reallocation of attention due to disturbed memory formation during repeated exposure to unpleasant stimuli.

2. Method

2.1. Participants

Thirty-eight undergraduate students participated in the study for course credit. Three participants had to be excluded due to recording problems ($n = 1$) and presence of a psychiatric disorder ($n = 2$), leaving 35 participants for data analysis (23 females; mean age: 24.1 ± 5.1). These participants reported normal or corrected-to-normal vision and to be free of neurological illness, use of psychotropic medication, and present or past psychiatric disorders according to the Structured Clinical Interview for DSM-IV (First, Spitzer, Gibbon, & Williams, 1996). To examine whether the effects of distraction on attentional allocation during repeated picture processing are modulated by habitual emotion regulation strategies, we assessed the Emotion Regulation Questionnaire for all participants (ERQ, Gross & John, 2003; German version: Abler & Kessler, 2009). The ERQ measures individual differences in the habitual use of two regulation strategies (i.e., suppression and reappraisal). The questionnaire has good psychometric properties (Gross & John, 2003; German version: Abler & Kessler, 2009). All participants gave written informed consent, approved by the local ethics committee.