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Cognitive reappraisal of snake and spider pictures: An event-related potentials study

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ABSTRACT

Fear of snakes and spiders are common animal phobias. Emotion regulation can change the response to emotional stimuli, including snakes and spiders. It is well known that emotion regulation modulates the late positive potential (LPP), which reflects sustained motivated attention. However, research concerning the effect of emotion regulation on the early posterior negativity (EPN), which reflects early selective attention, is scarce. The present research question was whether the EPN and LPP amplitudes are modulated by regulation of emotional responses to snake and spider stimuli. Emotion up- and down-regulation were expected to enhance and reduce the LPP amplitude, respectively, but emotion regulation was not expected to modulate the EPN amplitude. Female participants passively viewed snake, spider, and bird pictures, and up- and down-regulated their emotional responses to the snake and spider pictures using self-focused reappraisal, while their electroencephalogram was recorded. There were EPNs for snakes and spiders vs. birds, as well as for snakes vs. spiders. The LPP amplitude tended to be enhanced for snakes and spiders compared to birds. Most importantly, the LPP amplitude was larger in the up-regulate than in the down-regulate condition for both snakes and spiders, but there was no evidence that the EPN amplitude was modulated by emotion regulation. This suggests that emotion regulation modulated sustained motivated attention, but not early selective attention, to snakes and spiders. The findings are in line with the notion that the emotional modulation of the EPN is more automatic than the emotional modulation of the LPP.

1. Introduction

Fear of snakes and fear of spiders are common animal phobias (Frederikson et al., 1996), but processing of snakes and spiders is prioritized even in non-phobic individuals. For example, snake and spider pictures typically yield superior Pavlovian conditioning and visual search compared to other pictures (Atlas and Phelps, 2018; LoBue et al., 2014; Öhman et al., 2001; Öhman and Soares, 1993). To our ancestors, the fast and automatic detection of these threatening animate stimuli had great survival value. The superior aversive conditioning to snakes and spiders has therefore been explained in terms of evolutionary preparedness (McNally, 2016; Mineka and Öhman, 2002; Seligman, 1971). Nevertheless, fear and phobias can be reduced using emotion regulation (Cisler and Olatunji, 2012; Gallo et al., 2009; Hartley and Phelps, 2010).

Emotion regulation is the use of behavioral or cognitive strategies to decrease or increase the intensity of emotions (Ochsner and Gross, 2005). One class of emotion regulation strategies is cognitive reappraisal, which entails changing the meaning of a situation by reinterpreting it (Gross, 2002; Ochsner and Gross, 2005). Reinterpreting the situation can, for example, be done by imagining worse or better outcomes, which is called situation-focused reappraisal. Another way to reinterpret a situation is to decrease or increase its personal relevance, which is called self-focused reappraisal (Ochsner et al., 2004). Telling yourself that a scary movie is 'just a movie' would be an example of decreasing personal relevance to down-regulate fear. This is sometimes also called distancing (Ochsner et al., 2012). Conversely, imagining that the events in the scary movie are happening to you would be an example of increasing personal relevance to up-regulate fear. Previous research has shown that increasing and decreasing the personal relevance of spider pictures increased and decreased the negative emotions elicited by these stimuli (Hermann et al., 2009).

Emotions and emotion regulation have often been studied using event-related potentials (ERPs) (Hajcak et al., 2010; Hajcak et al., 2011) because they have excellent temporal resolution and can reveal which processing stage and/or cognitive processes are influenced by

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experimental manipulations of emotion and emotion regulation (Linden, 2007; Luck, 2005). Two ERP components that are sensitive to the emotional salience of information are the early posterior negativity (EPN) and the late positive potential (LPP) (Schupp et al., 2006a). The EPN is a relative negativity over the occipital scalp that is maximal between 200 and 300 ms after stimulus onset, while the LPP reflects multiple and overlapping positivities over the parietal scalp beginning in the time window of the P3, i.e., around 300 ms after stimulus onset (Hajcak et al., 2010; Hajcak et al., 2011; Schupp et al., 2006a). It is important to note that the EPN emerges as the *difference* between electrophysiological responses to experimental and control stimuli (Hajcak et al., 2011; Schupp et al., 2006a), rather than in response to a single stimulus or condition, like the LPP. The EPN occurs for emotionally arousing compared to neutral stimuli and the LPP is enhanced for emotionally arousing compared to neutral stimuli, such as for mutilation and erotic pictures compared to neutral pictures (Schupp et al., 2004; Schupp et al., 2006b; Schupp et al., 2007), and for pictures of scary animals such as snakes and spiders compared to bird pictures (Van Strien et al., 2016; Van Strien et al., 2014a; Van Strien et al., 2014b). The EPN is thought to reflect early selective attention, while the LPP is thought to reflect sustained motivated attention (Hajcak et al., 2010; Hajcak et al., 2011; Schupp et al., 2006a).

Many studies have shown that the amplitude of the LPP is modulated by emotion regulation instructions (Hajcak et al., 2010). Up-regulation of emotions typically enhances the LPP amplitude (Langeslag and Van Strien, 2010, 2013; Moser et al., 2009), while down-regulation of emotions typically reduces the LPP amplitude (Hajcak and Nieuwenhuis, 2006; Krompinger et al., 2008; Moser et al., 2006; Moser et al., 2009). To our knowledge, no previous studies have examined whether regulation of emotional responses to snake and spider stimuli modulates the LPP amplitude.

It has been suggested that the emotional modulation of the EPN is more automatic than the emotional modulation of the LPP (Olofsson et al., 2008), but empirical evidence for this idea is scarce. For example, only two previous studies have examined the effect of emotion regulation on the EPN amplitude. In one study, a facial expression identification task was preceded by a word matching task with three different types of words: word related to down-regulation (e.g., “adjust”, “inhibit”), words related to up-regulation (e.g., “release”, “express”), or control words (e.g., “cancel”, “run”). Word type did not modulate the EPN or LPP amplitude in response to the faces (Wang and Li, 2017). Because participants just performed a matching task with the regulation words and were not explicitly instructed to regulate their emotional responses to the faces, the absence of regulation effects in this study could have been the result of the implicit nature of regulation. In the other study, fearful and happy faces were preceded by negation cues (e.g., “no fear” and “no fun”) or control cues (i.e., “xxxxx”) and participants were explicitly instructed to down-regulate their emotional responses to the faces by using the cues to verbally negate their emotions. Verbal negation reduced both the EPN and the LPP amplitude in response to the fearful, but not the happy, faces (Herbert et al., 2013). Faces with emotional expressions are typically less arousing than other types of emotional stimuli (Britton et al., 2006) and do not necessarily elicit the emotion they display (Borod, 1993; Marsh et al., 2005). Unfortunately, in the Herbert et al. (2013) study no data suggesting that participants exhibited emotional responses to the faces were reported. In addition, from the self-reported strategy use, it seems like participants mostly reappraised the cues rather than the emotional faces. Therefore, it remains unclear whether reappraisal of emotional stimuli, in particular stimuli that are potentially phobia-inducing such as snakes and spiders, modulates the EPN amplitude to those stimuli.

The research question of the present study is whether the EPN and LPP amplitudes are modulated by regulation of emotional responses to snake and spider stimuli. Based on the abundant previous work (Hajcak et al., 2010), it is expected that up-regulation will enhance the LPP amplitude and that down-regulation will reduce the LPP amplitude. In contrast, assuming that the EPN reflects a more automatic process than the LPP (Olofsson et al., 2008), it is expected that regulation instructions will not modulate the EPN amplitude. Because fear of snakes and spiders, as well as the prevalence of snake and spider phobias, are much higher in women than men (Frederikson et al., 1996) we tested female participants only.

2. Methods

2.1. Participants

Participants were 20 female students (mean age = 20.1 years, *SD* = 2.1) from the Erasmus University Rotterdam. Eighteen participants were right-handed and two were left-handed, by self-report. The study was approved by the departmental ethics committee. Participants provided written informed consent and were rewarded with course credit.

2.2. Stimuli

The stimuli were 60 emotionally arousing pictures of snakes (30 pictures) and spiders (30 pictures), and 30 low arousing pictures of birds, see Fig. 1 for examples. Pictures were obtained from the internet and showed a complete specimen against a natural background. Pictures were 600 × 450 pixels, and were presented on a on a medium grey background on a 20-in. PC monitor with a resolution of 1024 × 768 pixels, at a distance of approximately 135 cm in front of the participants, resulting in a visual angle of about 10.0° × 7.5°.

2.3. Procedure

First, participants completed the Spider Phobia Questionnaire (Klorman et al., 1974) (Chronbach's alpha = 0.92) to assess fear of spiders, as well as the Snake Phobia Questionnaire (Chronbach's alpha = 0.88), which was an adapted version of the Spider Phobia Questionnaire, to assess fear of snakes. Both questionnaires consisted of 31 statements that participants rated as true or false, so the scores on both questionnaires could range from 0 (no fear) to 31 (very high fear).

Next, participants were seated in a dimly lit and sound-attenuated room, and the EEG cap was attached. The regulation task consisted of three blocks. The first block was a view block in which participants passively viewed the 30 snake, 30 spider, and 30 bird pictures in

Fig. 1. Examples of the a) snake stimuli, b) spider stimuli, and c) bird stimuli.