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Worry and Discrimination of Threat and Safety Cues: An Event-Related Potential Investigation

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Overgeneralization of fear to safety cues is increasingly being studied in order to further our understanding of the maintenance of anxiety disorders. The current study used event-related potentials (ERPs) to evaluate whether worry affects anticipation and processing of threat and neutral pictures during a conditioning task. Fifty-two high (n = 24) and low (n = 28) worriers completed a paradigm in which a neutral stimulus indicated the valence of a second stimulus, either a threat or neutral picture. Results found that worriers displayed reduced anticipatory responses to both stimulus types as indexed by the stimulus preceding negativity, although they displayed an increased stimulus preceding negativity to threatening images during the second half of the task. In addition, high and low worriers differed in processing of threat and neutral images as indexed by the late positive potential. These findings support the overgeneralization of fear literature, suggesting that worriers display difficulty discriminating safety cues from threat cues, and this affects the attentional resources devoted to subsequent stimuli. Implications of these results are discussed.

Keywords: worry; event-related potentials; overgeneralization of fear

RECENT ADVANCEMENTS HAVE SUGGESTED that overgeneralization of conditioned fears may be important to the development of anxiety disorders (e.g., Lissek et al., 2005; Vervliet, Kindt, Vansteenwegen, & Hermans, 2010). This literature has found that following acquisition of a fear response to a neutral stimulus, individuals with anxiety disorders display increased physiological responses to safety cues compared to nonanxious controls (Grillon & Ameli, 2001; Hermann, Ziegler, Birbaumer, & Flor, 2002). This suggests that anxious individuals may exhibit difficulties discriminating safety signals from threat signals, which is important for our understanding of neurobiological risk factors for anxiety disorders (e.g., Lissek, 2012; Mineka & Oehlberg, 2008). However, few studies have evaluated whether this affects later processing of threat and neutral stimuli. This gap in the literature is particularly important for generalized anxiety disorder (GAD), a condition characterized by excessive and uncontrollable worry that is theorized to maintain fear learning based on biases in information processing (Borkovec, Alcaine, & Behar, 2004). Therefore, the goal of the present report was to address this gap in the literature by evaluating neural indicators of anticipation and subsequent emotional processing of safety and threat stimuli among individuals high and low in worry.

Theories of GAD describe the function of worry in maintaining this condition (Borkovec et al., 2004; Newman & Llera, 2011; Wells, 2004). Borkovec et al. (2004) suggests that (a) worry is mistakenly considered by worriers to be an effective method to prepare for a future bad event and (b) worry reduces physiological responding to feared images, which in turn precludes adaptive emotional processing. Newman and Llera expand on this by suggesting that worry is used to elevate baseline physiology and negative emotions in order to avoid a large negative

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shift in these states that an unexpected negative event might bring. Therefore, worry is negatively reinforced by avoiding a negative emotional contrast (Newman & Llera). This leads to an overactive attentional system that scans for signs of danger, affecting one's ability to habituate to nonthreatening stimuli (e.g., Mathews & MacLeod, 2005). Wells (2004) further posits that the perception of a threatening stimulus leads to cognitive activity aimed at avoiding this threat. These models suggest that worry should be associated with difficulty distinguishing threat and safety cues, which may affect later attentional allocation and processing of stimuli.

Supporting these models, research has found that individuals with GAD display greater physiological arousal to neutral stimuli compared to healthy controls (Andor, Gerlach, & Rist, 2008; Lissek et al., 2014; Thayer, Friedman, Borkovec, Johnsen, & Molina, 2000). For example, Thayer et al. (2000) used an S1-S2 paradigm to evaluate phasic changes in heart rate among GAD patients. In this task, a cue stimulus (S1) is used to indicate the particular characteristics of a second stimulus (S2) that appears following a given interstimulus interval. Results indicated that GAD patients showed less habituation than controls to novel neutral stimuli, and less autonomic flexibility to stimuli compared to controls. In addition, several studies have supported that GAD and worry are associated with biased processing of stimuli (Mathews & MacLeod, 2005). Therefore, growing data support the importance of evaluating overgeneralization of fear among worriers and individuals with GAD.

However, these studies do not directly test the consequences of difficulty distinguishing between threat and safety cues on subsequent processing of emotionally salient stimuli. One methodology particularly well-suited to evaluate responses to threat stimuli is the event-related potential (ERP) technique. ERPs are derived from the electroencephalograph and represent markers for cognitive processes with temporal resolution at the level of milliseconds (Luck, 2005). In the current study we measured two ERP components to evaluate allocation of attentional resources in response to threat and safety cues, as well as preparation and processing for threat stimuli.

First, we used the stimulus-preceding negativity (SPN), a fronto-central slow wave negativity that emerges just prior to an emotionally or motivationally significant stimulus. The SPN has been shown to be an index of the expectancy or amount of attentional resources recruited to respond to the upcoming stimulus (van Boxtel & Böcker, 2004), and is more negative in anticipation of emotional pictures (e.g., Amrhein et al., 2005; Poli, Sarlo, Bortoletto, Buodo, & Palomba, 2007). More recent studies have found that during attention tasks or anxiety manipulations, anxiety symptoms are associated with a reduced contingent negative variation (Ansari & Derakshan, 2011; Judah, Grant, Mills, & Lechner, 2013), a slow-wave component that consists of the SPN and neural activity related to an upcoming motor response (e.g., Brunia, 1988). Second, we evaluated the late positive potential (LPP), a slow positive component that emerges approximately 300–400 ms after stimulus onset, is maximal at parietal sites, and is enhanced in response to emotionally significant images compared to neutral images (e.g., Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000; Hajcak, Dunning, & Foti, 2009). Individuals high in trait anxiety as well as GAD patients have been shown to display decreased LPP amplitudes to emotional pictures compared to controls (Holmes, Nielsen, & Green, 2008; Weinberg & Hajcak, 2011). These results indicate that the LPP may be a neural marker of sustained or motivated attention to threatening stimuli.

Therefore, the goal of the current study was to evaluate whether worriers display an attentional style characterized by difficulty discriminating threat and safety cues, as indicated by allocation of attentional resources to an upcoming emotional stimulus as indexed by the SPN. We also then evaluated whether expectation of S2 affected motivated attentional processes, as indexed by the LPP. The current study builds and extends the fear overgeneralization literature by evaluating neural indicators of the effects of difficulty with discrimination of safety cues on subsequent emotional processing. These results can evaluate fear overgeneralization while simultaneously evaluating attentional processes initiated by perceived signs of threat, therefore evaluating possible mechanisms of avoidance associated with worry. We utilized an S1-S2 conditioning paradigm to evaluate this question. Two types of S1 were used which indicated to participants whether S2 would be either a neutral image or a threat image, allowing us to evaluate discrimination of safety cues. Based on theories of GAD (Borkovec et al., 2004; Newman & Llera, 2011), we hypothesized that high worriers would display decreased SPN magnitude compared to low worriers, particularly for upcoming threatening stimuli. To evaluate learning effects, we also evaluated the change in SPN amplitude from the first half of the task to the second half of the task. Second, we hypothesized that LPP amplitude would be higher for threatening pictures compared to neutral pictures for low worriers only, as worriers would display reduced LPP amplitude to threatening pictures, suggestive of emotional avoidance.