Attentional biases toward internal and external threat in anxiety: Insights from the

stimulus-preceding negativity

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Abstract

Generalized Anxiety Disorder (GAD) is characterized by excessive and uncontrollable worry. Individuals who experience high levels of worry have unconscious attentional biases toward threatening stimuli and display a higher amount of anticipatory processing immediately prior to the onset of threat cues. The current study examined event-related brain potentials, particularly the stimulus-preceding negativity, to evaluate if attention to an internal source of threat, such as elevated heart rate, can act as a distraction from a subsequent external source of threat. Participants were placed into high and low worry groups and engaged in an S1/S2 task, in which 25% of S1 stimuli were designed to draw attention toward an internal threat (elevated heart rate), before exposure to either an emotional or neutral S2. Results found that those who viewed the S1 distractor heart rate cue showed less anticipatory processing for the following S2, as indexed by a less negative amplitude of the stimulus-preceding negativity. A moderately significant relationship was also found between group and cue, indicating that these results may be applicable to other populations, such as individuals with social anxiety. These findings are in line with the existing literature regarding attentional biases and anticipatory processing in anxiety disorders. Implications and limitations of the present results, as well as suggestions for future studies are discussed.

Introduction

Individuals with anxiety often experience chronic worry, which can have lasting effects on overall health and well-being. This uncontrollable worry could arise from an interaction between processes such as unconscious attentional biases and conscious attentional control (Hirsch & Mathews, 2012). Attentional control theory (Eysenck et al., 2007; Derakshan & Eysenck, 2009; Eysenck & Derakshan, 2011) distinguishes between the unconscious, or stimulus driven, attentional biases and the consciously controlled selective attention displayed by an individual, and states that anxiety interferes with these two systems. Initially increased attention toward emotional stimuli can lead to sustained selective attention toward a perceived threat (Grant & White, 2016), and result in chronic worry and the maintenance of anxiety (Hirsch & Mathews, 2012). Although attentional biases and sustained attention toward threatening stimuli are just some of the many cognitive symptoms that can be caused by clinical and subclinical anxiety (Eysenck et al., 2007; Grant & White, 2016), the study of selective attention as a marker of anxiety disorders could have far reaching implications, both in diagnosing and developing treatments for individuals with anxiety.

One method that can be used to research the effects of anxiety is the study of event-related potentials (ERPs) in the brain. ERPs are measured using electroencephalography (EEG) and can provide information about the neural processes that take place in response to a stimulus. This method is particularly well suited to examine attentional biases, as ERPs can detect covert attention which may not be perceptible in behavioral studies (Amodio, Bartholow, & Ito, 2014). Additionally, ERPs have high temporal accuracy and measure brain activity with no delay, making them especially helpful in understanding the allocation of attentional resources before, during, and after cognitive tasks (Wieser, Hamback, & Weymar, 2018; Luck, 2012).

One ERP of particular interest to this study is the stimulus-preceding negativity (SPN), a slow negative wave which effectively measures neural activity that is maximal at frontal sites on the scalp, and provides information regarding the amount of anticipation that occurs immediately before the onset of a stimulus (Poli et al., 2007; Brunia et al., 2012). High amplitude SPN is most often observed during the anticipation of emotionally salient information (Böcker et al., 2001), and individuals high in anxiety often display a high amplitude SPN during emotional anticipation, particularly before exposure to threatening stimuli (Poli et al., 2007). Multiple paradigms exist to elicit and examine an SPN response, however, a picture viewing paradigm seems to be the most effective (Poli et al., 2007).

Additionally, individuals with high levels of anxiety may have attentional biases toward internal threats, such as elevated heart rate. Whereas there is extensive research regarding the effects of worry on attention toward externally threatening stimuli (Eysenck et al., 2007; Grant & White, 2016; MacNamara & Hajcak, 2010), significantly less research has addressed the relationship between worry and attention toward internal threat cues. It is known that individuals high in anxiety show attentional biases toward internal threat (Pineles & Mineka, 2005) and increased levels of anticipation for external threatening stimuli (Grupe & Nitschke, 2013), however, the relationship between these two has not been well documented.

Previous research has found that drawing attention to an internal source of threat results in a reduced amplitude for the SPN (Judah et al., 2013). Additionally, several studies have documented the relationship between attention toward internal and external threat cues in samples with social anxiety. Judah et al. (2016) found that attentional biases toward internal threat cues are correlated with social anxiety, in that they increase self-consciousness and reduce performance on cognitive tasks. Pineles and Mineka (2005) also found that individuals high in

social anxiety display biased attention toward possible internal sources of threat, such as elevated heart rate, leaving fewer attentional resources available for subsequent external events. Well known cognitive models of social phobia have posited that self-focus can lower the amount of attentional resources available for external stimuli (Clark & Wells, 1995), however, as self-consciousness is not a large construct of of GAD, it is unknown if these results and models are also applicable to individuals with other anxiety disorders.

This study sought to understand if attentional biases toward internal threatening stimuli acts as a distraction from external threatening stimuli in individuals with high levels of worry. This was done by measuring the SPN during an S1/S2 task in which the first stimulus was either a "+" or an "x", and the second stimulus was either an emotional or neutral image. In order to draw attention toward an internal threat, participants were told that the "x" S1 would be presented when their heart rate was elevated, though in reality it was randomly displayed in 25% of trials. It was expected that the SPN would be lower in amplitude, or less negative, following the heart rate cues for the high worry group.

Methods

<u>Participants</u>

Thirty individuals recruited from a large midwestern university and the surrounding community participated in this study. Participants were classified into either the Worry group or the Non-worry group based on a conducted ADIS-5 diagnostic interview and self-reported ratings of worry. Individuals who displayed clinically significant worry in the diagnostic interview and self-reported levels of worry higher than one standard deviation above the mean were selected for the high worry group. Individuals with low or no level of worry and no other DSM-5 (APA, 2013) mental disorders were selected for the low worry group. The Penn State

Worry Questionnaire (PSWQ; Meyer et al. 1990) was then used to confirm and quantify the level

of worry for the individuals in both groups. Participants were compensated $20 after attending

each session in the lab.

Measures

The Penn State Worry Questionnaire (PSWQ; Meyer et al. 1990) is a 16-item self-report

test which measures the level of uncontrollable, excessive worry experienced by an individual.

The response to each presented scenario is recorded on a 5-point Likert-type scale, ranging from

1 (not at all characteristic of me) to 5 (very characteristic of me). Scores can total from 16-80,

with 16-39 indicating little to no experiences of chronic worry, 40-59 indicating moderate levels

of worry, and 60-80 indicating severe and frequent experiences of worry.

Electrophysiological Measures

EEG and heart rate data from the in-lab session were collected using BIOPAC Systems

MP150 Hardware and recorded using AcqKnowledge software. Data with impedances below 10

kΩ were collected from nine channels (FZ, F3/4, CZ, C3/4, PZ, P3/4). The EEG data were then

sampled at 256 Hz and filtered with a .1-35 Hz bandpass filter. The recorded EEG data were

event-locked to Stimulus 1 (S1) and epoched from -200 – 3500ms, using the 200ms preceding

the event as a baseline. The SPN was evaluated as the mean amplitude at the FZ channel from

2900-3500ms after the display of S1. Lateral eye movements were additionally taken into

account by placing an electrode at the outer corner of the left and right eyes, and blinks were

detected by an electrode placed under the right eye.

Procedure

After being classified into either the Worry or Non-worry group in session one,

participants were invited back to the lab for a second session. In this session, participants

engaged in an S1/S2 task, where stimulus 1 (S1) was a warning stimulus, indicating that a

subsequent stimulus (S2) would soon be displayed. In 75% of trials, S1 was a fixation cross (+),

and in 25% of trials, S1 was an "x." Participants were told that the "x" S1 would occur when

their heart rate was elevated; this was done in order to assess if the presence of an internal source

of threat decreases subsequent attentional resources. Both emotional and neutral images were

used for S2 in all trials, with the "x" S1 equally distributed between emotional and neutral S2
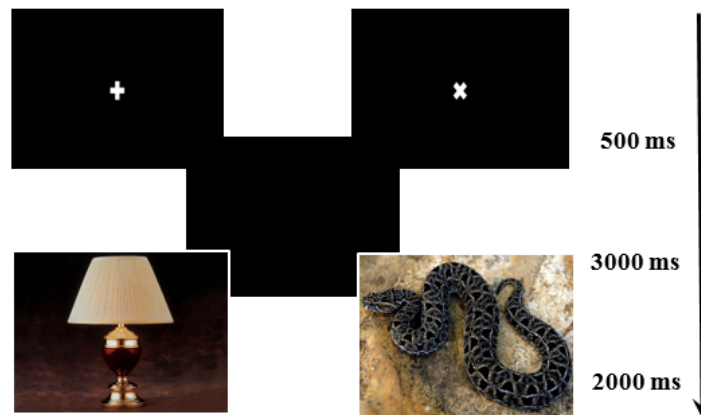
images.

Figure 1.

Results

SPN Amplitude

A 2 Group (High Worry, Low Worry) x 2 Cue (Normal, Heart Rate) x 2 Stimulus

(Neutral, Threat) mixed model ANOVA was used to evaluate the mean SPN amplitude. These

data indicated a significant main effect for cue, $F(1, 29) = 5.221$, $p = 0.03$, such that the overall

SPN for the fixation cross S1 cue was more negative ($M = -0.2262$, $SD = 4.54$) than for the

elevated heart rate "x" S1 cue ($M = 1.6696$, $SD = 4.07$). No main effects were found for group or

stimulus, however, a marginally significant effect was found for the interaction of group and cue,
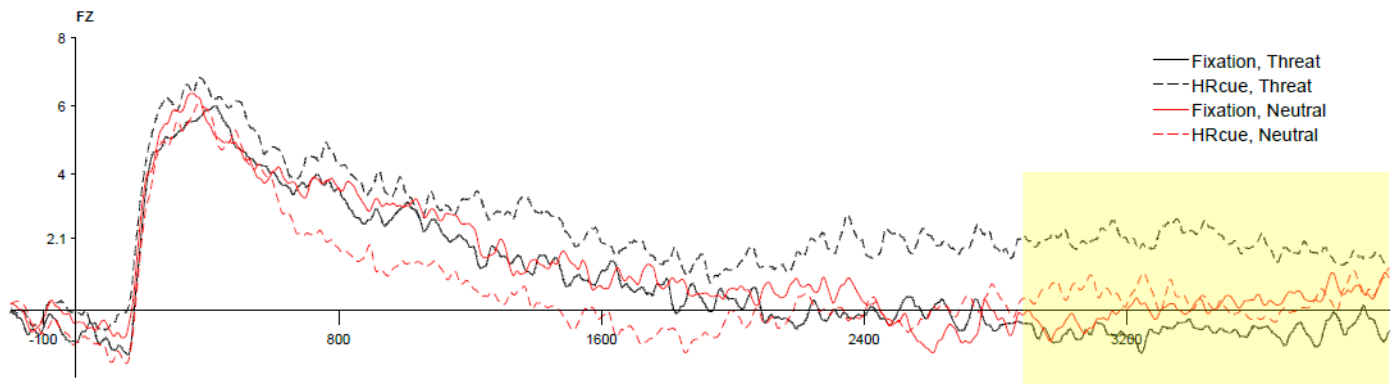
$F(1, 29) = 3.343, p = 0.078.$

Figure 2.

Discussion

The goal of the present report was to investigate the effects of attentional biases toward internal threat cues on the amount of anticipation for external threat cues in individuals with high levels of worry. Consistent with the hypothesis, the SPN amplitude was found to be smaller for those individuals who had been shown a cue which shifted attention to their heart rate, an internal source of threat. A less negative SPN amplitude indicates that these individuals expressed less anticipatory processing for external threatening stimuli as a result of their attention toward a perceived internal threat. This supports previous research which has shown similar results in individuals with social anxiety (Judah et al. 2013; Judah et al., 2016; Pineles & Mineka, 2005). This also supports cognitive models of anxiety, which state that anxiety impacts an individual's subconscious attentional biases toward threat (Eysenck et al., 2007; Derakshan & Eysenck, 2009; Eysenck & Derakshan, 2011), and expands that this bias encompasses internal sources of threat as well as external. Previous research has shown that by using depleting attentional resources, attention to internal threat may cause subsequent lack of bias toward

external threat (Judah et al. 2016); while the current study did not test for lack of bias toward the threatening S2, a follow-up study may find pertinent results regarding this matter.

The moderately significant relationship that was found between group and cue indicates that there is not as significant of a difference between high and low worry groups as was expected. This could be due to the fact that perceived internal threat may act as a distractor even for individuals who do not suffer from GAD. This would indicate that the present results may not be specific to individuals with high worry, but could perhaps be applicable to other populations as well, even outside of those with social anxiety or GAD. Further study should be done to examine the concept of internal threat as a distractor in other populations, both clinical and subclinical.

This study was subject to limitations. First, participants were recruited based on level of worry rather than selecting individuals from a clinical sample. Although worry has been found to be an important construct of anxiety (Ruscio, Borkovec, & Ruscio, 2001), this possible limitation could still indicate that results may not be generalizable to populations with clinically diagnosed GAD. Second, there is always the possibility of bias when using self-report questionnaires, which could lead to error in results. Future studies may benefit from the use of diagnostic criteria to determine group assignments.

In sum, this study used the SPN, an ERP associated with anticipatory processing, to examine the possible role of internal threat as a distraction from external threat in individuals with anxiety. The results indicate that internal threat cues did act to distract participants from the subsequent external threat cues, although future research should be done to determine if these results apply to populations outside of anxiety, as there was only a marginally significant effect between these results and anxiety grouping. The results presented here, as well as those of future

study in this area could have implications for our understanding of generalized anxiety disorder,

as well as other anxiety disorders, such as social phobia, where increased attention is already

placed on internal sources of threat.

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