When a bad bias can be good: Anxiety-linked attentional bias to threat in contexts where dangers can be avoided.

Running head: attentional bias and danger mitigation.

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Abstract

Anxiety vulnerability is associated with an attentional bias to threat. When threat cues signal dangers that can be mitigated through behavioural action, vigilance for these threat cues can have an adaptive function. It is unknown however, whether the anxiety-linked attentional bias is maintained or eliminated in contexts where threat cues signal dangers that can be mitigated. The current study used a probe task to assess anxiety-linked attentional bias to threat cues signalling a danger (noise burst) that in one condition could, and in another condition could not be mitigated. Results showed that, high trait anxious participants exhibited a larger attentional bias to threat than low trait anxious participants, and importantly, this anxiety-linked attentional bias did not differ as a function of danger mitigability. These findings suggest that anxiety-linked attentional bias is a rather pervasive processing style that may be insensitive to contextual variation in the adaptiveness of attending to threat.

Key words: attentional bias; threat; anxiety; control; mitigation

Introduction

It is now well established that higher levels of anxiety vulnerability are reliably associated with an increased attentional bias to threat cues (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007). *Attentional bias to threat* refers to the tendency to selectively attend to threatening, rather than neutral information. This attentional bias is observed not only in people with high levels of trait anxiety, but also those suffering from anxiety disorders (Bar-Haim et al., 2007; Mogg et al., 2000; Williams, Mathews, & MacLeod, 1996). Research has shown that this attentional bias to threat is not just a symptom of anxiety, but in fact causally contributes to heightened anxiety vulnerability (Clarke, Notebaert, & MacLeod, 2014; MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). As a result, a wealth of research has focused on examining the precise nature of this effect and its therapeutic implications, in order to increase our understanding about the mechanisms underlying dysfunctional anxiety, as well as our ability to remediate dysfunctional anxiety (Cisler & Koster, 2010; Clarke et al., 2014; MacLeod & Clarke, 2015; Notebaert, Crombez, Van Damme, De Houwer, & Theeuwes, 2010).

Attentional bias to threat is now generally considered to be a pervasive cognitive processing style at the heart of anxiety vulnerability (Van Bockstaele et al., 2014). However, clearly, an attentional bias to threat is not universally maladaptive. In some situations, attending to threat can provide real-life benefits in term of mitigating potential dangers signaled by threat cues. For example, as a pilot, being vigilant for threat cues during the flight (such as volatile weather) allows taking corrective action to mitigate a potential danger (such as a crash). A passenger on this plane however, cannot avoid this danger from happening. Therefore for the passenger, being vigilant for threat cues will be of little functional value. The critical distinction between these two situations is whether an individual can mitigate an impending danger. The crash as a result of a storm is a danger that can be mitigated by the pilot, while it cannot be mitigated the passenger. This differentiation between dangers that can and cannot be mitigated has been highlighted for some time as a potentially crucial distinction by those that seek to understand and treat anxiety dysfunction. For example, it is recognized that worry (a hallmark feature of generalized anxiety disorder) can be an adaptive process that can contribute to problem solving when the worry concerns a controllable situation, however it will detrimental in response to uncontrollable situations (Barlow, 2002; Davey, 1994). Despite the importance of this distinction however, no research examining the cognitive processes underpinning individual differences in anxiety vulnerability has sought to investigate how the mitigability of danger influences the expression of information processing biases. This is important because biased attention may be highly context-dependent and nevertheless, existing research has exclusively examined only attentional bias to threat cues that either do not signal genuine dangers, or when they do, signal a danger that cannot be mitigated.

Indeed, in most studies examining anxiety-linked attentional bias, this attentional bias is assessed under conditions where threat cues do not signal genuine danger. In these assessment paradigms, whether it is the dot-probe paradigm, spatial cuing, stroop, or visual search, the stimuli that are presented are pictures or words that are either neutral or negative in valence, and the degree of vigilance for the negative relative to the neutral stimuli is assessed. Although the negative stimuli employed in these paradigms are operationalized as ‘threatening’ because of the affective tone that they communicate, they are not predictive of a genuine ‘danger’. That is, these stimuli do not predict the occurrence of an actual aversive event. In an exception to this, in a few studies researchers have presented stimuli that do predict an actual aversive event, such as an aversive noise burst or mild electrocutaneous stimulation (Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2004, 2005; Notebaert, Crombez, Van Damme, De Houwer, & Theeuwes, 2011). While these studies show that participants develop an attentional bias towards the cues that predict these dangers, it is still the case in these studies that participants were not able to mitigate (i.e. avoid) the danger. Thus, it remains unknown whether the attentional bias to threat associated with heightened anxiety vulnerability can be generalized across contexts where the danger signaled by threat cues can and cannot be mitigated. While contextual variation in the expression of attentional bias to threat is seldom investigated, it is possible that variation in the mitigability of danger may have a differential impact on the attentional bias expressed by high and low anxious individuals.

Given that attentional bias is often described as an adaptive neurocognitive function which serves to quickly identify and respond to imminent threats, one possible hypothesis is that in contexts where dangers can be mitigated, low anxious individuals will now also demonstrate an increased attentional bias to threat, and both high and low anxious individuals will display an equivalent attentional bias. This would corroborate with research showing that when cues are highly threatening, all individuals show increased vigilance for these threat cues (Notebaert, Crombez, Van Damme, et al., 2011; Wilson & MacLeod, 2003). It is possible that in these contexts, the cognitive mechanisms responsible for evaluating incoming stimuli and distributing processing resources are maximally responsive, eliminating the moderating impact of individual difference in anxiety vulnerability (Mathews & Mackintosh, 1998; Mogg & Bradley, 1998). Given that this hypothesis predicts that trait anxiety and danger mitigability will influence attentional bias in an interactive manner, this hypothesis will be called the Interactive Hypothesis. If this hypothesis is true, then the inflated anxiety levels experienced by high trait anxious individuals plausibly may result mainly from their maladaptive attentional vigilance for threats they can do nothing about.

However, an alternative hypothesis is that the increased attentional bias observed in anxiety will be consistent across contexts in which dangers can and cannot be mitigated. This hypothesis predicts that while all individuals may display an increased attentional bias to threats that can be mitigated relative to threats that cannot be mitigated, high anxious individuals will show a larger bias than low anxious individuals independent of danger mitigability. Given that this hypothesis predicts that trait anxiety and danger mitigability will influence attentional bias in an additive manner, this hypothesis will be called the Additive Hypothesis. If this hypothesis is true, this would suggest that anxiety-linked attentional bias is a more pervasive processing style that may be insensitive to contextual variation in the adaptiveness of attending to threat.

Examining whether or not an anxiety-linked increased attentional bias for threat is equivalent in contexts where dangers can and cannot be mitigated has important theoretical implications. Many cognitive models of anxiety (such as Eysenck, Derakshan, Santos, & Calvo, 2007; Mathews & Mackintosh, 1998; Mogg & Bradley, 1998; Ohman & Mineka, 2001) are silent with respect to whether the opportunity for danger mitigation may affect anxiety-linked differences in attentional bias to threat. In addition, several authors have made the claim that elevated trait anxiety and some types of clinical anxiety disorders such as generalized anxiety disorder, are associated with a *general* attentional bias to threat, suggesting that this is likely to occur across different contexts (Flykt, 2006; MacLeod & Mathews, 2004). Such claims about the generality of attentional bias may require qualification if contextual variations in the opportunity for danger mitigation affects the relationship between anxiety and attentional bias to threat cues. This question also has important applied implications. Both in conventional cognitive behavioral therapy and in attentional bias modification procedures, therapeutic emphasis is placed on changing maladaptive patterns of cognition in anxiety patients, including attentional vigilance to threat (Flykt, Lindeberg, & Derakshan, 2012; MacLeod & Clarke, 2013; Tobon, Ouimet, & Dozois, 2011). To increase the effectiveness of these treatments, it is important to know whether this anxiety-linked attentional bias to threat is expressed across contexts where dangers can or cannot be mitigated, or whether this anxiety-linked bias is confined to contexts where danger cannot be mitigated.

Therefore, the aim of the current study was to discriminate the validity of these important alternative hypotheses regarding the expression of anxiety-linked attentional bias to threats signaling dangers that can and cannot be mitigated. To do this, we compared attentional vigilance to threat cues in high and low trait anxious participants under experimental conditions that either did or did not enable participants to mitigate the danger signaled by these cues. Danger mitigation consisted of preventing the occurrence of the danger. High and low trait anxious participants were presented with a task involving two-part trials. The first part of each trial delivered a probe task designed to assess attention to threat cues. The threat cue signaled the possibility that an aversive noise burst (the danger) would be delivered at the end of the trial. Participants had to identify a probe that was presented either in the locus of this threat cue (threat congruent trials) or in a spatially distal location (threat incongruent trials). As an attentional bias towards the threat cue would be reflected by faster probe discrimination responses on threat congruent trials as compared to threat incongruent trials, the degree of speeding on the former relative to the latter trials constituted a measure of attentional bias to threat cues. The second part of each trial was a simple digit identification task. In this task, the capacity to mitigate the danger signaled by the threat cue was manipulated. Specifically, half the participants were able to avoid delivery of the noise burst at the end of the trial by fast and accurate responding on the digit identification task, whereas this was not the case for the other half of the participants. Analysis of the probe discrimination latencies will reveal whether an increased attentional bias in high trait anxious as compared to low trait anxious participants is observed in both danger mitigation conditions (as predicted by the Additive Hypothesis), or whether it is confined to the condition in which no danger mitigation was possible (as predicted by the Interactive Hypothesis).

Method

Participants

For the current study we sought to recruit one group of high trait anxious and one group of low trait anxious individuals. To achieve this, participant recruitment was guided by initial screening of 841 first year undergraduates on the Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Those scoring in the top and bottom third of the distribution were considered eligible participate. One hundred and eleven high and low anxious participants were randomly allocated to either the mitigation or no mitigation condition. Three participants failed to provide age and gender information. After data trimming (see below), the final sample consisted of 52 low anxious participants, of which 26 were in the mitigation condition

(8 male, mean age 20.1, *SD* = 7.7) and 26 were in the no mitigation condition (6 male, mean age 20.1, *SD* = 4.9), and 52 high anxious participants, of which 25 were in the mitigation condition (3 male, mean age 20.3, *SD* = 7.3) and 27 were in the no mitigation condition (7 male, mean age 18.8, *SD* = 1.8). Participants in these four groups did not differ significantly in terms of age or gender (all $p > .1$). All had normal or corrected-to-normal vision, and reported not to be color-blind. Participants gave their informed consent, and were informed that they could terminate the experiment at any time. The study was approved by the ethical committee of the University of Western Australia.

Attentional Bias Assessment Task

The experiment was programmed using the E-Prime software package (Psychology Software Tools Inc., Sharpsburg, PA, USA). The task contained 420 trials, each of which consisted of two components. The first part of each trial involved a probe discrimination decision to measure attentional selectivity for a threat cue. This threat cue was a circle of one particular color that signaled the possibility of an upcoming danger, which was a 500ms 100 decibel white noise burst delivered through headphones. In the second component of each trial participants were given a simple digit identification decision, which in one condition was designed to give participants the opportunity to mitigate the danger.

The probe discrimination trial component. In this first part of each trial, a set of seven colored circles were presented, and the distribution of attention across the display was measured by requiring participant to identify a probe presented in one of these circles. A schematic representation of the display in this trial component can be found in Figure 1. The display consisted of seven circles (2.9° diameter) with a colored band (0.5° and black outlined) presented against a silver background. These colored circles were spaced equally distant from the midpoint of the screen (radius of 6° visual angle) and equidistant from their neighbors. All circles in the display had different colors. There were eight possible colors: blue, turquoise, yellow, green, orange, purple, red and grey. These colors were matched for intensity and luminance. The color of the stimulus predicting the noise burst was counterbalanced across participants. To measure the distribution of attention across the display, a target probe consisting of a line (extending 1°) was superimposed on one of the circles. This target probe was either perfectly horizontal or perfectly vertical in orientation, with equal frequency. Across trials, the target was presented equally often in each of the 7 circle positions. “Foil” lines were presented on the other circles, which were tilted line segments (22.5° to either side of the horizontal or vertical plane).

There were two types of trials (see Figure 1). On threat congruent trials, the color signalling the possibility of a noise burst at the end of the trial (the threat cue) was present, and the target probe was presented in the locus of this circle. On threat incongruent trials, the threat cue was present, and the target probe was presented in the locus of one of the other 6 circles. In addition, filler trials were included in which the color that signalled the possibility of a noise burse at the end of the trial was not presented. Consistent with other previous studies that have included noise bursts as aversive stimuli, these filler trials were included to increase the unpredictability of the threat cue (Notebaert, Crombez, Van Damme, et al., 2011).

This trial component started with a fixation cross at the centre of the screen (which participants were instructed to focus on) for a duration of 1000ms after which the stimulus display was presented until response. The speed of probe identification

– whether the probe line segment was horizontal or vertical- was measured using two keys on a standard keyboard (the left and down arrow respectively). In the event of an incorrect response, error feedback was displayed for 500ms. The inter trial interval was 500ms after which the digit identification component began.

The digit identification trial component. In the second part of each trial, participants were required to perform a simple digit identification task. Three black single digit numbers were displayed adjacent and simultaneously on the screen. Participants had to state whether the majority of these digits were even or odd by clicking one of the mouse buttons with their dominant hand. Half of the trials required an “odd” response, and half an “even” response. The digits were presented until response, and error feedback was given. Following the response a blank screen was presented for a random duration between 200-500ms after which the noise burst could be administered. This variable duration was included to make the onset of the noise burst less predictable.

The implications of performance on this digit identification task component differed for participants in the mitigation condition and no mitigation condition who respectively did and did not have the opportunity to avoid the noise burst. All participants were told that if the threat cue was present on the probe discrimination trial component, there was a chance that the noise burst would be delivered at the end of the trial. Participants in the mitigation condition were further informed that on trials where the threat cue was present, if they gave a correct response on the digit identification trial component within 2 seconds[1], they would avoid the noise burst delivered at the end of the trial, but that if they reacted incorrectly or too slowly then

[1] The actual cut-off was 2268ms, which was the average reaction time of a pilot test (n=11) of the digit identification task. Using this value, it would be feasible with some effort to avoid the noise burst.

the noise burst would be delivered. Participants in the no mitigation condition instead were instead told that the delivery of the noise burst is independent of their speed or accuracy on the probe discrimination and digit identification task. In this way, participants in the mitigation condition were provided with the opportunity to mitigate the danger signalled by the threat cues, whereas participants in the no mitigation condition were not. To ensure that participants in the no mitigation condition were presented with an equal number of noise bursts as participants in the mitigation condition, a yoked design was used. Each participant in the no mitigation condition was matched to a participant in the mitigation condition with the same gender and from the same anxiety group, and was given the same number of noise bursts as that participant had received, similarly distributed across threat congruent and threat incongruent trials.

Procedure

Upon arrival, participants completed the state and trait version of the Spielberger State Trait Anxiety Inventory (Spielberger et al., 1983). Participants were seated approximately 60 cm from the screen. A two stage practice task was given. Across the first stage of practice, 24 trials were given to familiarize participants with the task, but noise bursts were not applied. The second part of the practice phase was designed to enable participants to learn which color of stimulus predicted the subsequent noise burst. This began with trials that presented only circles, without probes, and participants were instructed to find out which color predicted the noise burst. There were sixteen trials on which one colored circle was presented centrally, followed by eight trials where seven circles were presented as in the probe discrimination task. On two of the trials with one stimulus, and two of the trials with seven stimuli, the threat cue was presented, and a noise burst was delivered. Trials consisted of a 1000ms fixation cross, 1000ms stimulus presentation, a blank screen (random duration between 200 and 500ms), the noise burst if delivered, and a 500ms inter trial interval. At the end of the practice phase, participants had to report which color was linked to the noise burst.

The experiment phase was comprised of two blocks of 210 trials, each block consisting of 15 threat congruent, 90 threat incongruent probe discrimination trials, and 105 filler trials. The ratio of threat congruent versus threat incongruent trials was 1 in 7 to ensure that the threat cue was not predictive of the target. At this point participants in the mitigation condition were instructed that they could avoid the noise burst if they reacted quickly and accurately enough on the digit identification component, whereas participants in the no mitigation condition were not given these instructions.

After the practice phase and at the end of the experiment, participants were asked to indicate on a 9 point scale how much they felt they had control over the delivery of the noise burst (No control to Complete control) to assess whether the mitigation manipulation was successful.

Results

Data preparation

Of the 111 participants who completed the study, six had an accuracy rate of less than 50% on either the probe discrimination task component or the digit identification task component. As this suggests they failed to comply with task instructions, these participants were removed from further analyses. One participant’s average reaction time on the probe discrimination trial component was more than 5 SD's above the sample's mean. This participant was considered and outlier and removed from further analyses. These exclusions led to a final sample of 104 participants.

Visual inspection of the probe discrimination data revealed one data point which was an extreme outlier, with a reaction time of more than 2 minutes; this data point was deleted prior to further analyses. To analyze probe discrimination reaction times, outliers were defined as reaction times deviating more than 2.5 standard deviations from an individual's mean reaction time calculated for every trial type separately. These outliers (2.11% of data) and trials with incorrect responses (10.4% of data) were deleted. A similar outlier analysis was performed on digit identification data, removing incorrect responses (9.8% of data) and responses deviating more than 2.5 standard deviations from an individual's mean response time (2.42% of data). For the probe discrimination data, test of within-subject effects are reported and where sphericity assumptions were violated Greenhouse-Geisser adjusted *p* values are reported.

Participant characteristics and manipulation check

Participants in the high anxious (HA) and low anxious (LA) group differed significantly in their trait anxiety scores, $t(100) = 13.06$, $p < .001$) as well as state anxiety scores, $t(100) = 7.62$, $p < .001$, with HA participants displaying higher scores ($M_{\text{trait}} = 51.4$, $SD = 8.5$; $M_{\text{state}} = 41.2$, $SD = 10.8$) than LA participants ($M_{\text{trait}} = 32.8$, $SD = 5.7$; $M_{\text{state}} = 27.7$, $SD = 6.7$).

All participants responded correctly when asked at the end of the practise phase to identify which color predicted the noise burst. During the test phase, participants received on average 21.1 (range 6 – 109) noise bursts. There was no significant difference in the average number of noise bursts received by high anxious participants (*M* = 22.8, *SD* = 19.8) and low anxious participants (*M* = 19.4, *SD* = 13.6), $t < 1$, $d = 0.20$.

Next we sought to confirm that the danger mitigation manipulation effectively led to the impression of either having control (in the mitigation condition) or not having control (in the no mitigation condition) over the delivery of the noise burst. To achieve this a mixed-design ANOVA was conducted on the self-report measures taken after the practice phase and at the end of the experiment, indexing the degree to which participants felt able to control the delivery of the noise bursts (see Table 1). This ANOVA considered Assessment Point (post practice versus end experiment) as within-subjects variable, and Danger Mitigation Condition (mitigation versus no mitigation) and Trait Anxiety (high trait anxiety versus low trait anxiety) as between-subjects variables, see Table 1.

Results showed a marginally significant main effect of Trait Anxiety $F(1,100) = 3.66$, $p = .058$, $\eta_p^2 = .35$, indicating a trend for HA participants to feel less in control of the noise bursts (*M* = 3.03, *SD* = 1.69) than LA participants (*M* = 3.63, *SD* = 1.92) across both Assessment Points. There was also a significant main effect of Assessment point, $F(1,100) = 18.56$, $p < .001$, $\eta_p^2 = .16$, and Danger Mitigation Condition, $F(1,100) = 32.36$, p < .001, $\eta_p^2 = .24$, which was qualified by an interaction between Assessment point and Danger Mitigation Condition, $F(1,100) = 46.34$, $p < .001$, $\eta_p^2 = .32$. Consistent with the aim of the mitigation manipulation, there was no significant difference in self-reported control over the delivery of the noise burst between danger mitigation conditions after the practice phase in which neither group was able to mitigate the delivery of the noise burst ($t < 1$, $d = 0.12$). However, at the end of the experiment participants in the mitigation condition reported feeling significantly more in control over the delivery of the noise bursts (*M* = 5.9, *SD* = 2.4) than participants in the no mitigation condition (*M* = 2.5, *SD* = 2.6); $t(102) = 9.75$, $p < .001$, $d = 1.93$). All other effects were non-significant (all $p > .07$). Data from this analysis are displayed in Table 1.

A further indicator of the efficacy of the danger mitigation manipulation is provided by performance on the digit identification task. Accuracy rates were generally high on this task (*M* = 90.1%, *SD* = 8.6), and were unaffected by Trait Anxiety Group or Danger Mitigation condition (all $p > .1$). However, the speed with which this task was performed was influenced by danger mitigation condition. Specifically, a between group ANOVA carried out on these latency data, that considered the variables Danger Mitigation Condition (mitigation versus no mitigation) and Trait Anxiety (high trait anxiety vs low trait anxiety), revealed a significant main effect of Danger Mitigation Condition, $F(1,100) = 11.58$, $p = .001$, $\eta_p^2 = .10$, which was the only significant effect obtained (all other $p > .3$). As would reasonably be expected, this reflected the fact that participants in the mitigation condition performed this task significantly faster (*M* = 1133ms, *SD* = 259) than did participants in the no mitigation condition (*M* = 1348, *SD* = 367). Furthermore, a distinction can be made between digit identification responses on trials where the threat cue had been present in the attentional task, versus trials where the threat cue had been absent. Using this Trial Type distinction (threat present, threat absent) as a factor in a mixed method ANOVA that also included the factors Danger Mitigation Condition and Trait Anxiety, revealed a significant interaction between Trial Type and Danger Mitigation Condition, $F(1,102) = 11.62$, $p = .001$, $\eta_p^2 = .104$. Decomposing this interaction shows that in the danger mitigation condition, participants responded faster to the digit task when a threat cue had been present in the attentional task (*M*

= 1157ms, *SD* = 281) as compared to when no threat cue had been present (*M* = 1226ms, *SD* = 338), $p = .003$, $d = 0.22$; whereas participants in the no-mitigation did not respond faster to the digit task when a threat cue had been present in the attentional task (*M* = 1435ms, *SD* = 418) as compared to when no threat cue had been present (*M* = 1408ms, *SD* = 406), p >.1, $d = 0.06$. This interaction was not further qualified by Trait Anxiety, $F < 1$, $\eta_p^2 < 0.00$. Combined, these findings suggest that participants were motivated to avoid the noise burst when they could, and that they were using the presence of the threat cue in the attentional task to maximize their danger mitigation performance.

Testing the veracity of the Additive and Interactive Hypothesis

To assess the manifestation of anxiety-linked attentional bias to threat cues under conditions where the danger signalled by these threat cues can and cannot be mitigated, an attentional bias index was first computed. This bias index was calculated by subtracting average response latencies on threat congruent trials from average response latencies on threat incongruent trials. A larger bias index score thus corresponds to a bigger attentional bias to the threat cue. The Interactive Hypothesis predicts that these biases index scores will be higher in high anxious participants than in low anxious participants, only when treat cues signal dangers that cannot be mitigated, and that when dangers can be mitigated, high anxious and low anxious individuals will have comparable bias index scores. In contrast, the Additive Hypothesis predicts that independent of whether threat cues signal dangers that can or cannot be mitigated, high anxious participants will have higher bias index scores than low anxious participants.

To test these alternative hypotheses, bias index scores were subjected to a univariate ANOVA including Danger Mitigation Condition (mitigation versus no mitigation) and Trait Anxiety (high trait anxiety versus low trait anxiety) as factors. Results showed a significant effect of Trait Anxiety, $F(1,100) = 4.17$, $p = .044$, $\eta_p^2 = .04$, indicating that – consistent with previous literature, overall, high trait anxious participants exhibited a larger attentional bias to threat as compared to low anxious participants across both the mitigation and no mitigation conditions.Specifically, while high anxious participants showed a 263ms (*SD* = 311) advantage for processing probes in the location of threat cues over neutral cues, low anxious participants only had a 153 ms (*SD* = 246) advantage for processing threat cues.

There was also a significant main effect of Danger Mitigation Condition, $F(1,100) = 5.40$, $p = .022$, $\eta_p^2 = .05$, indicating that, participants in the mitigation condition showed a larger attentional bias to threat (*M* = 270 ms, *SD* = 314) as compared to participants in the no-mitigation condition (*M* = 145 ms, *SD* = 240). Crucially, the interaction between Trait Anxiety and Danger Mitigation Condition was not significant, $F < 1$, $\eta_p^2 = .01$, suggesting there was no significant difference in the observed anxiety-linked attentional bias in the two danger mitigation conditions. In contrast, the two significant main effects and the lack of a significant interaction suggest that trait anxiety and danger mitigability both independently contribute to attentional bias. These results are in line with the predictions generated by the Additive Hypothesis, and contradict the predictions generated by the Interactive Hypothesis. An overview of these results is presented in Figure 2.

Discussion

The aim of this study was to examine whether or not anxiety-linked attentional bias to threat cues is expressed consistently across contexts where the danger signaled by such threat cues can or cannot be mitigated. Because the opportunity for danger mitigation has not been systematically manipulated in previous studies investigating anxiety-linked attentional bias, it has been unclear whether this attentional selectivity is a pervasive processing style associated with anxiety (as per the Additive Hypothesis), or whether it is confined to contexts where danger cannot be mitigated (as per the Interactive Hypothesis). The results of the present study provide support for the former hypothesis. Specifically, participants who were able to mitigate the danger showed a larger attentional bias to threat than participants who were not able to mitigate the danger. This is in line with previous research examining attentional capture by cues predicting controllable and uncontrollable pain (Notebaert, Crombez, Vogt, et al., 2011), as well as research showing that attentional bias is supressed when individuals are exposed unpredictable and uncontrollable dangers (Shechner, Pelc, Pine, Fox, & Bar-Haim, 2012). Furthermore, high trait anxious participants showed a larger attentional bias to threat than low trait anxious participants, and importantly, this anxiety-linked attentional bias was observed across task conditions in which the danger was and was not mitigable. In other words, there was no evidence that in contexts where dangers can be mitigated, high and low anxious individuals have an equivalent attentional bias to threat cues signalling these dangers.

These findings suggest that an enhanced attentional bias in anxious individuals is present both in contexts where danger can be mitigated and in contexts where danger cannot be mitigated. The latter observation is consistent with previous literature. In almost all paradigms used to assess attentional bias to threat, participants are presented with threat-related stimuli (words, pictures, aversive auditory or tactile stimuli), that cannot be mitigated. It is under these conditions that an anxiety-linked attentional bias is typically observed (Bar-Haim et al., 2007). The novel observation arising from the current study is that while attentional bias in both high and low anxious individuals was increased in the mitigation condition as compared to the condition where danger could not be mitigated, it was not the case that the increased attentional bias in high anxious individual disappeared when the danger could be mitigated. Although it would not have been unreasonable to expect that there would no longer be evidence for an anxiety-linked effect in contexts were dangers can be mitigated, the current findings show that there was an equivalent anxiety-linked attentional bias in both mitigation conditions.

It is important to note that these findings are observed in response to a relatively moderate danger (a loud noise burst). It is entirely possible that extreme (e.g. life-threatening) dangers that can be mitigated would elicit a different pattern of attentional vigilance, such that cues predicting these dangers would capture everyone's attention. However it is important to consider individual differences in attentional responding to stimuli that represent the more moderate dangers that are frequently encountered in everyday life. Interestingly, given the potentially adaptive function of attentional bias to threats signalling dangers that can be mitigated, the observed pattern of findings indicates that is it high anxious individuals who show the most "functional" attentional bias in the mitigation condition. Indeed, if individuals with heightened anxiety vulnerability are the most vigilant for threat cues signaling danger that can be mitigated, this could ultimately operate to reduce the degree to which high trait anxious people encounter such dangers. However, this heightened vigilance will only be adaptive if the resulting benefits in terms of risk mitigation outweigh the emotional cost (i.e. increase in anxiety) associated with this vigilance (Notebaert, Masschelein, Wright, & MacLeod, 2015). In line with this, it should be noted that in the present study participants' enhanced attention to threat cues signalling mitigable danger did not make high trait anxious participants more successful in avoiding the noise bursts than low anxious participants. There was no significant difference in the number of noise bursts successfully avoided by high and low anxious participants. This suggest that the higher 'costs' of attentional vigilance for threat, and the consequent higher levels of trait anxiety do not necessarily contribute to tangible benefits in terms of threat mitigation. Heightened vigilance for cues signalling dangers that can be mitigated can thus be maladaptive, if the benefits in term of risk mitigation are not exploited. Determining whether or not anxiety is indeed associated with a maladaptive trade-off between the costs of heightened vigilance on the one hand and the benefit of effective danger mitigation behaviour on the other hand, is therefore an important new avenue for future research, which could have a number of clinical applications. Indeed, if anxious individuals show the 'right' attentional bias in contexts where dangers can be mitigated but fail to engage in appropriate danger mitigation behaviour, this would suggest that the most effective treatment protocol will be the one that addresses behavioural inaction rather than cognitive processes in these contexts.

Further research could also inform and refine existing cognitive models of anxiety, which currently do not make specific predictions about how contextual factors such as danger mitigation opportunity impact on attentional bias to threat. For example, Mogg and Bradley (1998) proposed a cognitive-motivational analysis of anxiety, in which the Valence Evaluation System (VES) is responsible for assessing the threat value of a stimulus. A stimulus with a high threat value will cause the Goal

Engagement System (GES) to switch to the ‘danger mode’, which interrupts ongoing activities and allocates processing resources (such as attention) to the threat. It is proposed that the VES is more reactive in anxiety-prone individuals, such that a mildly aversive stimulus may be tagged with a high subjective threat value. Although danger mitigability is not accounted for in the model, it could in principle influence either of these systems. The output of the VES is influenced by the situational context, thus this system may be more reactive in contexts where dangers can be mitigated. On the other hand, it is also not unlikely that danger mitigability would affect the Goal Engagement System, as it would be likely to allocate more processing resources to threats signalling dangers that can be mitigated, as compared to threats signalling dangers that cannot be mitigated, as in the latter case, interrupting ongoing activities in favour of processing threat will not results in any benefits in terms of risk reduction. Similarly, although Bar-Haim et al. (2007)’s Integrative Model of anxiety does include a provision for the situational context to influence the mechanisms underlying anxiety-linked attentional bias to threat, this aspect of the model is not elaborated on much further. Further research on contextual influences on selective allocation of attention to threat (e.g. Pearson, McGeary, Maddox, & Beevers, 2015) therefore has the potential to significantly enhance our knowledge about the aetiology and maintenance of attentional bias.

It is important to emphasize both the strengths and limitations of the current study. We believe a particular strength of the study is the experimental design, which has in past research shown capable of illuminating several factors that moderate the manifestation of attentional bias to threat (e.g. Notebaert et al., 2010; Notebaert, Crombez, Van Damme, Durnez, & Theeuwes, 2012). Currently, an important methodological issue in the literature on attentional bias to threat concerns the reliability of attentional bias assessment tasks, which has often been examined through the split-half reliability of bias indices. Therefore, we calculated the split-half reliability of the attentional bias index of the current task[2]. The resulting score of .69, is considerably higher than the split-half-reliability scores typically reported for dot-probe type studies (Kappenman, Farrens, Luck, & Hajcak Proudfit, 2014; Price et al., 2014; Schmukle, 2005; Staugaard, 2009; S. Waechter & Stolz, 2015; Stephanie Waechter, Nelson, Wright, Hyatt, & Oakman, 2014). Further research is needed to determine the design features that contribute to this heightened reliability (e.g. task complexity, number of stimuli in the display, consistency of stimuli in the display, simplicity of the stimuli, ...), however this finding offers confidence in our interpretation of the current results, and indicates this is a promising task to further use to advance our understanding about the attentional underpinnings of psychopathology.

A first potential limitation is that participants were selected based on high and low trait anxiety scores. Because of this non-clinical sample, the current findings cannot be generalised to clinical populations. A meta-analysis of attentional bias in anxiety found no significant difference between the effect sizes of the threat-related bias in clinically diagnosed populations versus populations with high self-reported levels of anxiety. Moreover, the magnitude of the bias did not differ as a function of anxiety disorder (ranging from general anxiety disorder to specific disorders such as phobias) (Bar-Haim et al., 2007). However, even though an attentional bias to threat is apparent across these populations, it is possible that the opportunity for danger mitigation exerts very different effects in non-clinical versus clinical populations, and

[2] This reliability measure was calculated by computing an index of attentional bias for correct odd trials and even trials separately (using the same outlier criteria as reported in the results section). Next, these two indices were correlated, and the Spearman-Brown correction was applied.

depending on the type of disorder. For example, Obsessive Compulsive Disorder appears to be disproportionally characterised by excessive danger mitigation behaviour. As such, danger mitigability may contribute differently to patterns of attentional bias to threats signalling dangers that can or cannot be mitigated as compared to for example Generalised Anxiety Disorder. Future research could therefore examine whether the opportunity for danger mitigation differentially impacts on attentional bias in different clinically anxious populations, in order to enhance our understanding about the unique and common cognitive processes contributing to these disorders.

A second limitation of the current study was that participants varied in terms of their success in mitigating the danger. Participants in the danger mitigation condition had the opportunity to avoid 210 noise bursts by providing a swift accurate response on the digit identification task, but across participants the number of noise bursts successfully averted ranged from 101 to 204. However, such variability in effective danger mitigation would also be expected in the naturalistic environment. Thus, for example, when drivers encounter the same threat on the road signalling a danger that can be mitigated by an adaptive action on the part of the driver, there will be variability across drivers in the degree to which such adaptive action is successfully taken and the danger averted. Importantly, in the present study, there were no significant differences in the number of noise bursts that was avoided by high and low anxious participants. Hence, anxiety-linked differences in the degree to which successful danger mitigation was accomplished are unlikely to have contributed to anxiety-linked patterns of attentional bias. Nevertheless, future research should heed the possibility that the participant differences in the effectiveness of danger mitigation could influence attentional bias. Indeed, it may be that subjective differences in perceived ability to mitigate the danger signalled by threat cues, relating to variability in self-efficacy (Bandura, 1977), could influence the degree to which attentional vigilance for such threat cues is demonstrated. Thus, future investigators could also consider the impact that perceived self-efficacy in danger mitigation may have on anxiety-linked attentional bias to threat cues, either by including self-reports of self-efficacy, or by manipulating self-efficacy directly.

There may also be other individual difference factors that may plausibly contribute to individuals' attentional bias to threat cues signalling mitigable danger. Depression for example shows a high comorbidity with anxiety, and is similarly characterised by low levels of perceived control and self-efficacy. However, depression is also uniquely characterised by a reduced engagement in the pursuit of positive outcomes, which can in part be achieved through the active mitigation of aversive experiences (Dickson & MacLeod, 2004a, 2004b). Therefore is it possible that high levels of depressive symptoms may contribute to a maladaptive reduced difference in attentional bias for threat cues signalling dangers that can, as compared to cannot be mitigated. Similarly, having a more external locus of control is associated with reduced goal commitment (Hollenbeck, Williams, & Klein, 1989) and a greater stress response, especially in situations where individuals believe they have control over danger (Bollini, Walker, Hamann, & Kestler, 2004). An external locus of control may therefore also contribute to a reduced attentional bias to threat cues signalling mitigable dangers. Given the potential contribution of such dispositional factors, in future studies, such state and/or trait measures of these factors that could plausibly contribute to context-inappropriate patterns of attentional bias could be assessed or manipulated to determine their degree of influence on maladaptive patterns of selective attentional processing.

Future research could usefully examine the boundary conditions of the observed findings. For example, in the current study mitigability of danger was binary (dangers either could, or could not be mitigated). While a situation in which dangers cannot be mitigated most clearly constitutes a context in which attentional vigilance is a maladaptive process, in many situations there may be some form of mitigation possible. For example, while a passenger in a plane may not be able to mitigate potential dangers facing the pilot, a passenger in a car may alert the driver to potential danger on the road. Therefore, researchers could examine to what extent the current findings generalise to situations in which mitigability of danger is low or high, as opposed to absent or present.

Secondly, researchers could examine to what extent these findings generalise to vigilance for threat cues that contain information relevant to dealing with the upcoming danger. In the current study, the danger mitigation response did not require the use of information contained in the threat cue. This is representative of many real life circumstances, where the means of mitigating dangers signalled by threat cues are independent of the detailed information contained within the threat cue. Thus, for example, a building fire does not contain any relevant information for the observer trying to locate the nearest fire extinguisher. However, there are some real world situations where threat cues signalling danger do contains detailed information vital to effective danger mitigation. For example, if someone is bitten by a potentially venomous spider, picking up information about the spider's color, size, and other characteristics will help to identify the species, which in turn will expedite the delivery of the appropriate anti-venom. It is possible that, when successful danger mitigation requires effective use of detailed information contained with threat cues signalling such danger, patterns of attentional responding to these threat cues could be different to those observed in the present study. However, there are a couple of potential difficulties we foresee in evaluating the type of design where the measure of attentional bias and successful danger mitigation are dependent on the same stimulus. Firstly, if the task requires a second response to the threat stimulus to mitigate the danger (in addition to the response through which attentional bias is measured), this may impact on the initial response times to the orientation of the probe, which means the measure of attentional bias could become compromised. A possible way to overcome this problem however is by not relying on manual response times for the assessment of attentional bias, but perhaps on eye tracking data, which would be more resistant to interference from an additional manual response time task. A second potential problem is that in a task where participants need to attend to the threat cue in order to execute a danger mitigation response, all participants may attend to the threat cue in order to be able to make this response. As such, allocation of attention to the threat cue could no longer reflect biased attention to threat, but it will simply be a product of a task requirement. Despite these difficulties however, we view this line of research as one that is well worth pursuing, as in many real-life situations, information about potential danger and the way to mitigate it can be contained within the same stimulus.

For the moment though, the current findings suggest that anxiety-linked increased vigilance for threat cues is a pervasive processing bias observed across contexts in which the danger signalled by these threat cues can and cannot be mitigated. The current study was the first to investigate the relationship between trait anxiety and danger mitigation opportunity, and paves the way for a further research examining the behavioural consequences of this anxiety-linked attentional bias to threat, and its contribution to maladaptive functioning.

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References

Bandura, Albert. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215. doi:10.1037/0033-295x.84.2.191

Bar-Haim, Yair, Lamy, Dominique, Pergamin, Lee, Bakermans-Kranenburg, Marian J., & van Ijzendoorn, Marinus H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin, 133*(1), 1-24. doi:10.1037/0033-2909.133.1.1

Barlow, D. H. (2002). *Anxiety and its disorders: The nature and treatment of anxiety and panic* (2nd ed.). New York: Guilford Press.

Bollini, Annie M., Walker, Elaine F., Hamann, Stephan, & Kestler, Lisa. (2004). The influence of perceived control and locus of control on the cortisol and subjective responses to stress. *Biological Psychology, 67*(3), 245-260. doi:http://dx.doi.org/10.1016/j.biopsycho.2003.11.002

Cisler, Josh M., & Koster, Ernst H. W. (2010). Mechanisms of attentional biases towards threat in anxiety disorders: An integrative review. *Clinical Psychology Review, 30*(2), 203-216. doi:10.1016/j.cpr.2009.11.003

Clarke, Patrick J. F., Notebaert, Lies, & MacLeod, Colin. (2014). Absence of evidence or evidence of absence: reflecting on therapeutic implementations of attentional bias modification. *BMC Psychiatry, 14*(8). doi:10.1186/1471-244X-14-8

Davey, Graham C. L. (1994). Pathological worrying as exacerbated problem-solving. In G. C. L. Davey F. Tallis (Ed.), *Worrying: Perspectives on theory, assessment and treatment* (pp. 35-59). Oxford, England: John Wiley & Sons.

Dickson, Joanne M., & MacLeod, Andrew K. (2004a). Anxiety, depression and approach and avoidance goals. *Cognition and Emotion, 18*(3), 423-430. doi:10.1080/02699930341000013

Dickson, Joanne M., & MacLeod, Andrew K. (2004b). Approach and Avoidance Goals and Plans: Their Relationship to Anxiety and Depression. *Cognitive Therapy and Research, 28*(3), 415-432. doi:10.1023/B:COTR.0000031809.20488.ee

Eysenck, Michael W., Derakshan, Nazanin, Santos, Rita, & Calvo, Manuel G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion, 7*(2), 336-353. doi:http://dx.doi.org/10.1037/1528-3542.7.2.336

Flykt, Anders. (2006). Preparedness for Action: Responding to the Snake in the Grass. *The American Journal of Psychology, 119*(1), 29-43. doi:10.2307/20445317

Flykt, Anders, Lindeberg, S., & Derakshan, Nazanin. (2012). Fear makes you stronger: Responding to feared animal targets in visual search. *Attention Perception & Psychophysics, 74*(7), 1437-1445. doi:10.3758/s13414-012-0336-6

Hollenbeck, John R., Williams, Charles R., & Klein, Howard J. (1989). An empirical examination of the antecedents of commitment to difficult goals. *Journal of Applied Psychology, 74*(1), 18-23. doi:10.1037/0021-9010.74.1.18

Kappenman, Emily S., Farrens, Jaclyn L., Luck, Steven J., & Hajcak Proudfit, Greg. (2014). Behavioral and ERP measures of attentional bias to threat in the dot-probe task: Poor reliability and lack of correlation with anxiety. *Frontiers in Psychology, 5*. doi:10.3389/fpsyg.2014.01368

Koster, Ernst H. W., Crombez, Geert, Van Damme, Stefaan, Verschuere, Bruno, & De Houwer, Jan. (2004). Does Imminent Threat Capture and Hold Attention? *Emotion, 4*(3), 312-317. doi:10.1037/1528-3542.4.3.312

Koster, Ernst H. W., Crombez, Geert, Van Damme, Stefaan, Verschuere, Bruno, & De Houwer, Jan. (2005). Signals for threat modulate attentional capture and holding: Fear-conditioning and extinction during the exogenous cueing task. *Cognition & Emotion, 19*(5), 771-780. doi:10.1080/02699930441000418

MacLeod, Colin, & Clarke, Patrick J. F. (2013). Cognitive Bias Modification: A New Frontier in Cognition and Emotion Research. In M. D. Robinson, E. R. Watkins, & E. Harmon-Jones (Eds.), *Handbook of Cognition and Emotion* (pp. 540-562). New York: Guilford.

MacLeod, Colin, & Clarke, Patrick J. F. (2015). The Attentional Bias Modification Approach to Anxiety Intervention. *Clinical Psychological Science, 3*(1), 58-78. doi:10.1177/2167702614560749

MacLeod, Colin, & Mathews, Andrew. (2004). Selective Memory Effects in Anxiety Disorders: An Overview of Research Findings and Their Implications. In D. Reisberg & Paula Hertel (Eds.), *Memory and emotion* (pp. 155-185). London: Oxford University Press.

MacLeod, Colin, Rutherford, Elizabeth, Campbell, Lyn, Ebsworthy, Greg, & Holker, Lin. (2002). Selective attention and emotional vulnerability: Assessing the causal basis of their association through the experimental manipulation of attentional bias. *Journal of Abnormal Psychology, 111*(1), 107-123. doi:10.1037/0021-843X.111.1.107

Mathews, Andrew, & Mackintosh, Bundy. (1998). A cognitive model of selective processing in anxiety. *Cognitive Therapy and Research, 22*(6), 539-560. doi:10.1023/a:1018738019346

Mogg, Karin, & Bradley, Brendan P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour Research and Therapy, 36*(9), 809-848. doi:10.1016/s0005-7967(98)00063-1

Mogg, Karin, McNamara, J., Powys, M., Rawlinson, H., Seiffer, A., & Bradley, B. P. (2000). Selective attention to threat: A test of two cognitive models of anxiety. *Cognition & Emotion, 14*(3), 375-399. Retrieved from <Go to ISI>://WOS:000087316100007

Notebaert, Lies, Crombez, Geert, Van Damme, Stefaan, De Houwer, Jan, & Theeuwes, Jan. (2010). Looking out for danger: An attentional bias towards spatially predictable threatening stimuli. *Behaviour Research and Therapy, 48*(11), 1150-1154. doi:10.1016/j.brat.2010.07.013

Notebaert, Lies, Crombez, Geert, Van Damme, Stefaan, De Houwer, Jan, & Theeuwes, Jan. (2011). Signals of Threat Do Not Capture, but Prioritize, Attention: A Conditioning Approach. *Emotion, 11*(1), 81-89. doi:10.1037/a0021286

Notebaert, Lies, Crombez, Geert, Van Damme, Stefaan, Durnez, Wouter, & Theeuwes, Jan. (2012). Attentional prioritisation of threatening information: Examining the role of the size of the attentional window. *Cognition & Emotion*. doi:10.1080/02699931.2012.730036

Notebaert, Lies, Crombez, Geert, Vogt, Julia, De Houwer, Jan, Van Damme, Stefaan, & Theeuwes, Jan. (2011). Attempts to control pain prioritize attention towards signals of pain: An experimental study. *Pain, 152*(5), 1068-1073. doi:10.1016/j.pain.2011.01.020

Notebaert, Lies, Masschelein, Stijn, Wright, Bridget, & MacLeod, Colin. (2015). To Risk or Not to Risk: Anxiety and the Calibration Between Risk Perception and Danger Mitigation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. doi:10.1037/xlm0000210

Ohman, Arne, & Mineka, S. (2001). Fears, phobias, and preparedness: Toward an evolved module of fear and fear learning. *Psychological Review, 108*(3), 483-522. doi:10.1037//0033-295x.108.3.483

Pearson, Rahel, McGeary, John E., Maddox, W. Todd, & Beevers, Christopher G. (2015). Serotonin Promoter Polymorphism (5-HTTLPR) Predicts Biased Attention for Emotion Stimuli: Preliminary Evidence of Moderation by the Social Environment. *Clinical Psychological Science*. doi:10.1177/2167702614562470

Price, R. B., Kuckertz, J. M., Siegle, G. J., Ladouceur, C. D., Silk, J. S., Ryan, N. D., . . . Amir, N. (2014). Empirical Recommendations for Improving the Stability of the Dot-Probe Task in Clinical Research. *Psychol Assess*. doi:10.1037/pas0000036

Schmukle, S. C. (2005). Unreliability of the dot probe task. *European Journal of Personality, 19*(7), 595-605. doi:10.1002/per.554

Shechner, T., Pelc, T., Pine, D. S., Fox, N. A., & Bar-Haim, Y. (2012). Flexible attention deployment in threatening contexts: an instructed fear conditioning study. *Emotion, 12*(5), 1041-1049. doi:10.1037/a0027072

Spielberger, C, Gorsuch, R, Lushene, R, Vagg, P, & Jacobs, G. (1983). *Manual for the State-Trait Anxiety Inventory STAI (Form Y): Self-evaluation questionnaire.* Alto: Ca: Consulting Psychologist Press.

Staugaard, S. R. (2009). Reliability of two versions of the dot-probe task using photographic faces. *Psychology Science, 53*(3), 339–350.

Tobon, Juliana I., Ouimet, Allison J., & Dozois, David J. (2011). Attentional bias in anxiety disorders following cognitive behavioral treatment. *Journal of Cognitive Psychotherapy, 25*(2), 114-129.

Van Bockstaele, Bram, Verschuere, Bruno, Tibboel, Helen, De Houwer, Jan, Crombez, Geert, & Koster, Ernst H. W. (2014). A review of current evidence for the causal impact of attentional bias on fear and anxiety. *Psychological Bulletin, 140*(3), 682-721. doi:10.1037/a0034834

Waechter, S., & Stolz, J. A. (2015). Trait Anxiety, State Anxiety, and Attentional Bias to Threat: Assessing the Psychometric Properties of Response Time Measures. *Cognitive Therapy and Research, 39*(4), 441-458. doi:10.1007/s10608-015-9670-z

Waechter, Stephanie, Nelson, Andrea L., Wright, Caitlin, Hyatt, Ashley, & Oakman, Jonathan. (2014). Measuring Attentional Bias to Threat: Reliability of Dot Probe and Eye Movement Indices. *Cognitive Therapy and Research, 38*(3), 313-333. doi:10.1007/s10608-013-9588-2

Williams, J., Mathews, Andrew, & MacLeod, Colin. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin, 120*(1), 3-24.

Wilson, Edward, & MacLeod, Colin. (2003). Contrasting two accounts of anxiety-linked attentional bias: Selective attention to varying levels of stimulus threat intensity. *Journal of Abnormal Psychology, 112*(2), 212-218. doi:http://dx.doi.org/10.1037/0021-843X.112.2.212

Table 1. Means and standard deviations of self-reported control over the delivery of the noise bursts.

	Mitigation Condition				No mitigation condition			
	Low Anxious		High Anxious		Low Anxious		High Anxious	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
After practice	2.38	2.52	2.64	2.64	3.50	2.73	2.15	1.75
End experiment	6.38	2.65	5.44	2.00	2.23	1.61	1.89	1.53

Table 2. Mean probe discrimination latencies (in milliseconds) and standard deviations on each trial type for high and low anxious participants in both danger mitigation conditions. Attentional bias is calculated by subtracting reactions times on threat congruent trials from those on threat incongruent trials.

	Mitigation Condition				No mitigation condition			
	Low Anxious		High Anxious		Low Anxious		High Anxious	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Threat congruent	1415	532	1343	153	1513	508	1319	262
Threat incongruent	1607	603	1692	523	1627	498	1495	259

Figures

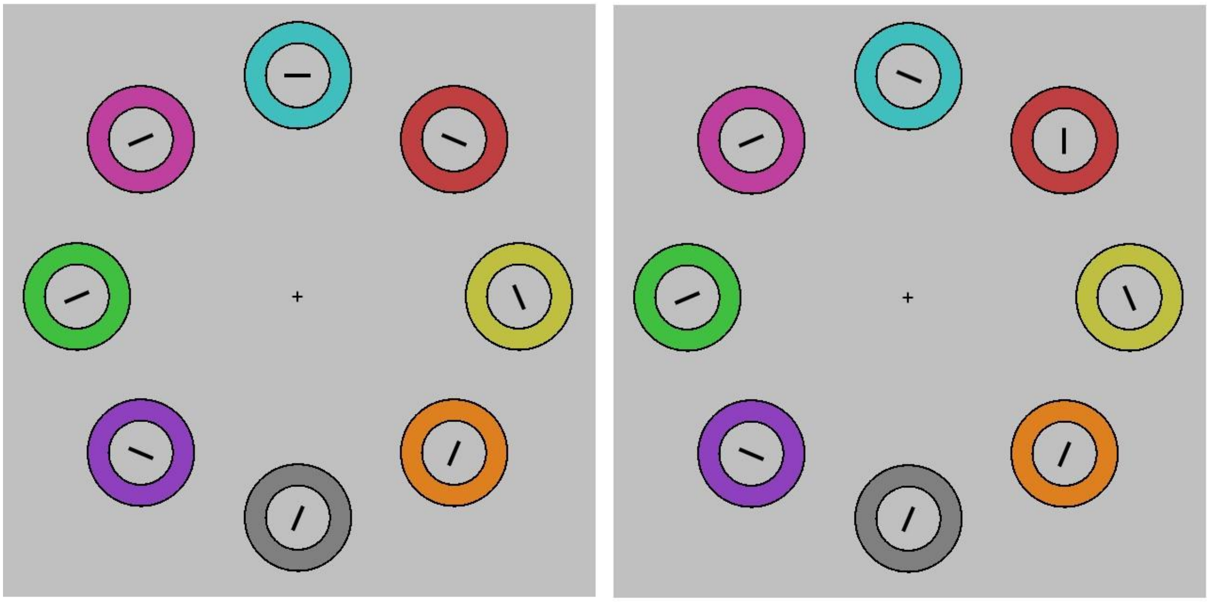

Figure 1. Example of the probe discrimination stimulus display. With red as the threat cue color, the left panel depicts a threat incongruent trial; the right panel depicts a threat congruent trial.

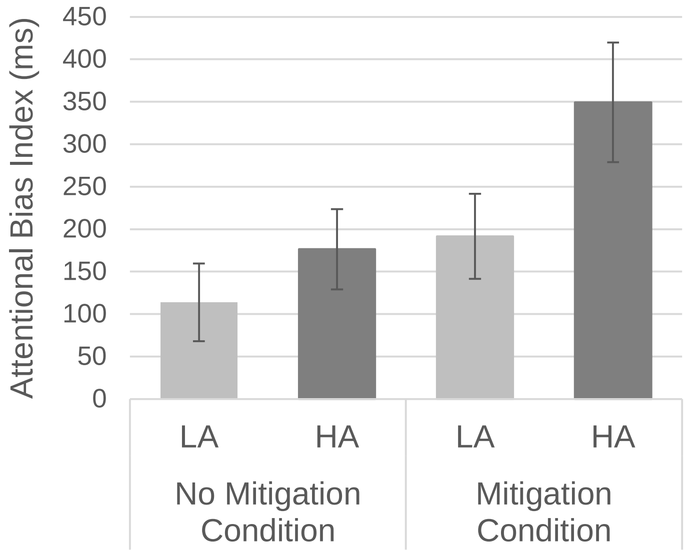

Figure 2. Mean attentional bias indices (in ms) for high anxious (HA) and low anxious (LA) participants in the mitigation and the no mitigation condition. Error bars represent standard errors of the mean.