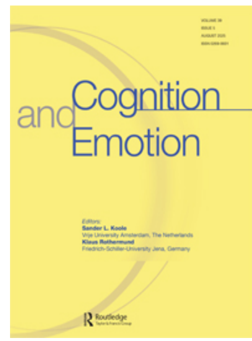

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The role of motivation in delayed disengagement from threat in anxiety

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ABSTRACT

The idea that highly anxious individuals have difficulty disengaging attention from threat is widely accepted, yet empirical support is limited. The term "difficulty" implies an involuntary delay in disengagement, but this has not been rigorously tested. Across three pre-registered experiments, we examined disengagement using different stimuli and protocols. Emotional and neutral images appeared at fixation, and healthy participants varying in self-reported anxiety were required to respond to a target elsewhere on the screen. Disengagement time was measured using eye-tracking (Experiment 1) and manual response times (Experiments 2 and 3). Motivation to disengage was manipulated by punishing slow responses (Exp. 1) or rewarding fast responses (Exp. 2 and 3). In Experiment 1, participants were slower to move their eyes away from a stimulus predicting punishment, regardless of anxiety level, even when delay resulted in an aversive noise. In Experiments 2 and 3, spider and snake images (but not emotional faces) slowed disengagement, but this effect was unrelated to anxiety or motivation. Disengagement bias scores showed poor reliability across all studies. These findings cast doubt on the idea that anxiety is reliably associated with impaired attentional disengagement from threat.

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Anxiety; delayed disengagement; attentional bias; threat; motivation

Anxiety disorders are highly prevalent, with large population-based surveys reporting that up to a third of the population are affected during their lifetime (Bandelow & Michaelis, 2015). A tendency to prioritise threat related information in the environment is argued to be an important factor maintaining anxiety. Anxious individuals are more likely to focus their attention on stimuli that signal potential threat which can promote the perception that threat is ubiquitous. This in turn can lead to increased monitoring for threat signals, creating a vicious cycle of fear (Mathews & MacLeod, 1994; Mogg & Bradley, 1998; Rapee & Heimberg, 1997).

Over the years, many experimental studies have demonstrated that the appearance of threatening stimuli (such as threatening words, angry faces and cues signalling aversive noises or electric shocks) can interfere with ongoing goal-directed behaviour. This is typically examined using tasks where participants are required to monitor the display and report on features of a target. Performance in this primary task is disrupted when a task-irrelevant yet threatening distractor image is presented, relative to when a neutral distractor is presented. Demonstrating the significance of biased attentional processes in anxiety, many studies have demonstrated that individuals reporting higher anxiety (whether clinical or sub-clinical) have increased interference from threatening relative to neutral stimuli (see for reviews: Bar-Haim et al., 2007; Cisler & Koster, 2010; Goodwin et al., 2017; Mogg & Bradley, 2005). In recent years, these attentional biases have become the target of "cognitive bias modification" interventions for anxiety (of which attentional bias modification is a subset).

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Using a simple computerised training protocol, participants are repeatedly trained to shift their attention away from threat stimuli towards neutral stimuli (Chelliah & Robinson, 2020; Lee et al., 2015; Liang & Hsu, 2016; Basanovic et al., 2021; see for reviews: Jones & Sharpe, 2017; MacLeod & Mathews, 2012; Mogg & Bradley, 2016).

Orienting attention to signals of threat is an adaptive behaviour exhibited by most individuals regardless of anxiety status. This has led to attempts to better characterise the specific stage of attentional processing that might be pathological in anxiety. Is it that individuals higher in anxiety attend more frequently and faster to threatening stimuli relative to low-anxious individuals? Or is it that once attention is located on a threatening stimulus, low-anxious individuals are faster at disengaging their attention and returning to the task at hand, whereas high-anxious individuals are delayed in reasserting goal-directed control? Beyond understanding whether attentional orienting and/or disengagement are specifically impacted, it is also important to understand the degree to which attentional prioritisation of threat signals is involuntary and exacerbated by anxiety rather than being entirely voluntary and driven by an increased (potentially maladaptive) desire to attend to threat stimuli. Understanding these questions has significant implications for how novel treatments are developed because voluntarily dwelling on threat can be best targeted by interventions that target goal-directed cognitions (i.e. cognitive behavioural therapy). By contrast, this approach is unlikely to be effective if behaviour is truly involuntary and outside an individual's control.

It is commonly reported in the literature that anxiety is characterised by "difficulty disengaging from signals of threat" (Amir et al., 2003; Cisler & Koster, 2010; Fox et al., 2002; Koster et al., 2006; Richards et al., 2014). Proponents of this idea argue that individuals higher in anxiety struggle to move their attention away from threat signals, once located there. However, experimental evidence does not yet concord with this statement for two reasons. The first reason is that most studies that claim to measure disengagement of attention from threat versus neutral stimuli do not use paradigms that can reliably isolate and measure the speed of attentional disengagement. This issue was first raised in 2013 by Clarke and colleagues who noted that most measures of biased attentional disengagement were compromised by biased attentional engagement towards threat stimuli. Take for example the "exogenous cueing paradigm" where only one stimulus (threatening or neutral) appears to the left or the right of the screen at any time, with an empty box appearing at the opposite location. The target probe can then appear at the same location of the image (valid trials), or on the opposite side (invalid trials). Slower responding to the target on threat-invalid relative to neutral-invalid trials is argued to index delayed disengagement, because attention must have been so focused on the threatening image location that the participant was delayed in shifting attention to the target on the opposite side of the screen. The issue identified by Clarke et al. (2013) was that if attention is indeed so biased towards threat stimuli at the initial engagement stage, then it will likely contaminate the subsequent disengagement measurement. Using this type of task, where participants must first orient to an image, it is impossible to know exactly where attention is located at the time that the target appears, if we accept that the initial orienting to threat vs. neutral images is likely to be different. Slower responding to the target on "invalid-threat" trials relative to "invalid-neutral trials" could be driven entirely by biased orienting towards the threat image relative to the neutral image. That is, overall RT on invalid-threat vs. invalid-neutral trials could be different even if the time spent dwelling at each image were equivalent. A recent analysis demonstrated that more than 50 studies had been conducted in the last 10 years claiming to measure attentional disengagement in anxiety but most of them used paradigms that were inappropriate for the isolation of the disengagement process (Watson et al., 2025).

To overcome this issue, we used a paradigm in the current set of experiments that can isolate the disengagement process without any contamination from biased orientation processes. By presenting the emotional stimuli in the centre of the screen, at the fixation point, no initial orienting is required. This means that disengagement from this stimulus to respond to a target presented elsewhere on screen is the only attentional process that is being measured. Some previous studies have used this type of paradigm to compare attentional disengagement speed between high and low anxious groups (Azarian et al., 2016; Yiend et al., 2015). With young healthy adults, Azarian et al. (2016) used eye tracking and compared the speed at which eyes began moving away from a centrally presented image depicting either a

threatening posture or a neutral posture. Results demonstrated that the within-subjects comparison of disengagement speed from threatening versus neutral images was significant only in the group of high-anxious individuals (with no significant difference between conditions for low-anxious individuals). However, this effect was difficult to interpret given that no significant differences between high- and low-anxiety groups were observed for either image category. Using a clinical sample, Yiend et al (Experiment 2) compared individuals with generalised anxiety disorder to healthy controls and measured the time taken for participants to respond to a peripherally presented cue after 300 ms presentation of a fearful or neutral face at the fixation point. No significant differences between groups were reported in this study.

The second reason that it is premature to conclude that anxiety is characterised by "difficulty disengaging from signals of threat" is that the involuntary nature of delayed disengagement has simply been assumed without being demonstrated experimentally. "Difficulty" implies that the participant *wanted* to disengage their attention quickly but couldn't. However, if there is no cost to participants for dwelling on threatening images, then they may not want to disengage attention quickly. Slower disengagement in anxiety could therefore be driven by a desire to focus on and process the task-irrelevant yet threatening image in its entirety rather than being due to impaired ability to disengage attention from that stimulus. Because there is never any consequence to participants for responding more slowly on the threat trials relative to the neutral trials, the in(voluntary) nature of this behaviour is currently unclear. In summary, no previous attempt has been made to manipulate participants' motivation to disengage attention quickly and thus the voluntary nature of delayed disengagement in anxiety is unknown.

One study did attempt to assess whether delayed disengagement required executive function, which could be taken as evidence that behaviour was likely under voluntary control (Delchau et al., 2020). A concurrent working memory load was used to assess whether slowing on threat trials required executive control function. However, it seems unlikely that going *slower* would require much executive control so it is perhaps not surprising that this study did not find any effect of working memory load on disengagement speed (nor was there any relationship between social anxiety and disengagement bias under any of the memory load conditions).

The overarching aim in the current set of studies was to determine whether attentional disengagement from threat is involuntary in individuals with high anxiety, or whether it may instead reflect a voluntary prioritisation of threat-related information. In the (pre-registered) experiments reported here, we presented a threatening or neutral stimulus at fixation and measured the time taken to begin moving eyes away from that stimulus (Experiment 1) or the time taken to respond to a target presented at a different spatial location (Experiments 2 and 3). This paradigm has been used in our lab to demonstrate delayed disengagement from cues that have been associated with high relative to low monetary rewards (Watson et al., 2020). The aim of Experiment 1 was to test whether delayed disengagement from a threat-related stimulus persists in individuals with high anxiety when they are externally motivated to disengage. We hypothesised that under conditions where participants were motivated to disengage attention quickly from a central stimulus signalling punishment, that there would be no significant effect of anxiety on disengagement speed. That is, we did not expect participants with high anxiety to have more "difficulty" than those with low anxiety at disengaging attention from a signal of threat. To this end, we used eye tracking to measure the speed of attentional disengagement from a coloured stimulus that participants had learned signalled either threat (an aversive white noise burst: CS+) or no-threat (no association with the noise: CS–). Following commonly used protocols in the literature, undergraduate students were pre-screened for anxiety score on the Depression Anxiety Stress Scales (DASS-21) and invited to participate if they scored in the range for either a high-anxiety or low-anxiety group.

Participants were explicitly instructed that on trials featuring the CS+ at fixation that they would receive a punishment (aversive noise burst) for moving their eyes too slowly. Under these instrumental task conditions, we expected to replicate previous findings (Watson et al., 2020; Yan et al., 2022) whereby participants are counterproductively slower to disengage attention from a motivationally salient stimulus (i.e. the CS+) relative to a neutral stimulus (CS–). Delayed disengagement under these conditions is largely involuntary (i.e. occurring despite awareness of the negative consequences). Critically however, we did not expect this effect to be exaggerated in those with high relative to low anxiety. That is, we expected that under conditions where participants were

motivated to disengage quickly, that high-anxious participants would not show delayed disengagement relative to low-anxious participants. Although follow up experiments would be required, such a finding could be indicative that previous reports of delayed disengagement as a function of anxiety (e.g. Curby & Collins, 2024; Grafton & MacLeod, 2014; Sagliano et al., 2014, 2018) were due to a voluntary tendency, rather than being an impairment in ability. On the other hand, exaggerated slowing of disengagement in high-anxious relative to low-anxious individuals, occurring despite negative consequences, would be indicative of increased difficulty in disengaging attention from signals of threat in high-anxious individuals, as is commonly asserted.

In the first (conditioning) phase, participants learned that a coloured circle signalled whether an aversive noise would be played over the headphones. For example, an orange circle (CS+) was associated with a burst of white noise, whereas a blue circle (CS–) was never associated with any noise (colour-noise associations were counterbalanced across participants). Participants then performed an eye-tracking task where they had to search a display of shapes to find the unique diamond target. Each trial began with fixation on the central stimulus which was usually the CS+ or CS– coloured circle. Participants were instructed that on some trials they would hear a loud noise in the headphones if they moved their eyes too slowly to the diamond but that this would only occur on trials featuring the CS+. The CS+ thus functioned as a threat stimulus (signalling potential punishment) but this punishment could mostly be avoided if participants disengaged their attention quickly and moved their eyes to the target. We preregistered our hypotheses. Firstly, that participants would be slower to disengage attention from the CS+ relative to a CS– despite this being counterproductive and increasing the likelihood of a punishment (loud noise in the headphones). Secondly, that the disengagement bias metric – the time taken to begin moving eyes (saccade latency) on CS+ minus CS–trials – would not differ significantly between high- and low-anxiety groups.

1. Experiment 1

1.1. Method

1.1.1. Transparency and openness

All hypotheses and analysis plans were pre-registered at https://osf.io/wg4cz. All task code and data reported in this manuscript can be accessed at https://osf.io/7zbex/. All research reported in this article was approved by the UNSW Sydney Human Research Ethics Advisory Panel (Psychology).

1.1.2. Participants & apparatus

Previous studies assessing attentional interference from punishment related distractors in visual search have reported large effect sizes $f = 0.43–1.15$ (Mikhael et al., 2021; Mulckhuyse & Dalmaijer, 2016; Nissens et al., 2017). We therefore aimed to recruit 120 participants in total, with half being assigned to the low-anxiety group and half being assigned to the high-anxiety group. Sixty participants in each group gives >85% power at alpha of 0.05 to detect a significant difference in attentional bias score (i.e. latency on CS+ minus CS– trials) between the two groups (one-tailed between subject *t*-test, assuming a medium effect size of $d = 0.5$).

In total, 142 participants completed the experiment. Eye tracking data from 13 participants was deemed unusable, and they were excluded from all analyses (see data processing section for more detail). Based on DASS-21 anxiety scores (collected on the day of testing), 62 participants were deemed low anxiety (DASS-21 score < 4) and 39 participants assigned to the high anxiety group (DASS-21 score >6). As preregistered, the 28 participants with scores in the middle range (4–6) were not included in the main analysis (but were included in exploratory analyses). Participant demographics can be seen in Table 1. The high and low anxiety groups did not differ in age but did of course differ in anxiety score.

Table 1. Participant demographics.

	Low anxiety ($N = 62$)	High anxiety ($N = 39$)	Group comparison
Age (years)	19.32 (0.26)	19.64 (0.59)	$t(99) = 0.56, p = 0.577$
Gender male/ female ratio	27/35	9/30	$X^2(1) = 4.37, p = .036$
DASS-21 anxiety score	1.31 (0.13)	9.28 (0.35)	$t(99) = 24.51, p < .001$.

Notes: Other than gender, rows show mean (SEM) for low and high anxiety groups. Comparisons between groups were conducted with independent sample *t*-tests (or with Chi Squared test for gender distribution).

The distribution of males/females across the two groups also differed. As expected, there were more females relative to males in the high anxiety group (with more equal distribution of females to males in the low anxiety group).

Participants were individually tested with their head position stabilised using a chin rest positioned 60 cm from the screen. Participants wore headphones and a 50 ms burst of white noise played in stereo at 95 decibels (L_{AI}) was used as the aversive sound stimulus. Gaze was monitored using a Tobii Pro Spectrum eye-tracker, which was mounted on a 23-inch monitor with a resolution of 1920 × 1280 and a refresh rate of 120 Hz. For gaze-contingent stimulus presentation, the recorded gaze data was initially down-sampled to 100 Hz for real-time calculations. Calibration of the eye tracker was performed at the beginning of the search task.

1.1.3. Materials

1.1.3.1. Visual search task. To ensure that participants had some experience with the aversive white noise, the task began with a short *Pavlovian Conditioning Phase.* On each trial a blue circle (CIE x,y chromaticity coordinates .192/.216) or orange circle (CIE x,y .493/.445), with similar luminance (~24.5 cd/m^2) was presented in the middle of the screen for 4 s. For half the participant the blue circle was designated the CS+, for the other half of participants the orange circle was the CS+. On trials where the CS+ was presented, the white noise burst was sometimes presented through the headphones at 95 db for the final 50 ms of CS+ presentation time. The noise was never played during presentation of the CS–. Each coloured circle was presented 12 times (in random order) and the reinforcement rate was 0.75 meaning that each participant heard the white noise burst nine times across the conditioning phase. The ITI was 3–5 s, selected at random.

During the *Visual Search Task* participants initiated each trial by fixating on the central fixation display for 700 ms (see Figure 1). The fixation cross and surrounding circle then turned yellow for 300 ms, indicating the imminent start of the trial. The search display then appeared, consisting of seven shapes (each 2.3 × 2.3° visual angle). Six shapes were evenly distributed around the screen's centre, each at an eccentricity of 5.1° visual angle, while the seventh shape remained at the centre, always a circle. Among the outer shapes, five were circles and one was a diamond (the target). All shapes in the outer circle were grey (CIE x,y .327/.400, luminance ~8.3 cd/m^2). Six trials in each block featured a grey circle at fixation (control trials), 15 trials featured the orange circle at fixation (i.e. CS+ or CS– depending on counterbalancing) and 15 trials featured the blue circle at fixation. In total each block consisted of 36 trials.

Participants' task was to move their eyes as quickly as possible to the diamond target. A response was recorded upon accumulating 100 ms of gaze dwell time within a 3.5° visual angle around the target. Trials ended immediately upon a response or after 2000ms (timeout). The colour of the circle at fixation (CS+) indicated whether participants would be punished with an aversive sound over the headphone for moving their eyes too slowly to the diamond target. Whether participants received the potential white noise burst on CS+ trials depended on their response time (RT) to the target. Initially, for all participants the time limit was set at 1500 ms from the onset of the search display. Subsequent blocks adjusted this time limit to the 75th percentile of RTs-to-target from the previous block. If 100 ms of dwell time was recorded on the target, but not within the current time limit, and the trial was a CS+ trial, then the white noise burst was played through the headphones and the text "Too Slow" was presented on screen for 1300 ms. On CS– trials, CS+ trials or trials featuring a grey circle at fixation (control trials), where participants completed the trial within the time limit, a blank screen was presented during the 1300 ms feedback period and no sound was played. If no eye gaze was registered on the target within 2000ms of the search display appearing, the text "TOO SLOW. Please try to look at the diamond more quickly" was presented (but no noise burst was played).

1.1.3.2. Questionnaires. **Noise Awareness Test.** Participants were asked a series of questions about the noise that had occurred during the task. First, they were asked to indicate the coloured circle (blue or orange) that had been associated with the delivery of the noise. They were then asked to use a 100-point slider and indicate how aversive the white noise burst had been, with slider labels ranging from "pleasant" (far left), "mildly annoying" (middle) and "very unpleasant" (far right). Finally, they were asked to indicate how often they heard a noise in the headphones with response options "never", "occasionally", "frequently" or "very frequently".

DASS-21. Participants completed the 21-item version of the Depression Anxiety Stress Scales, the

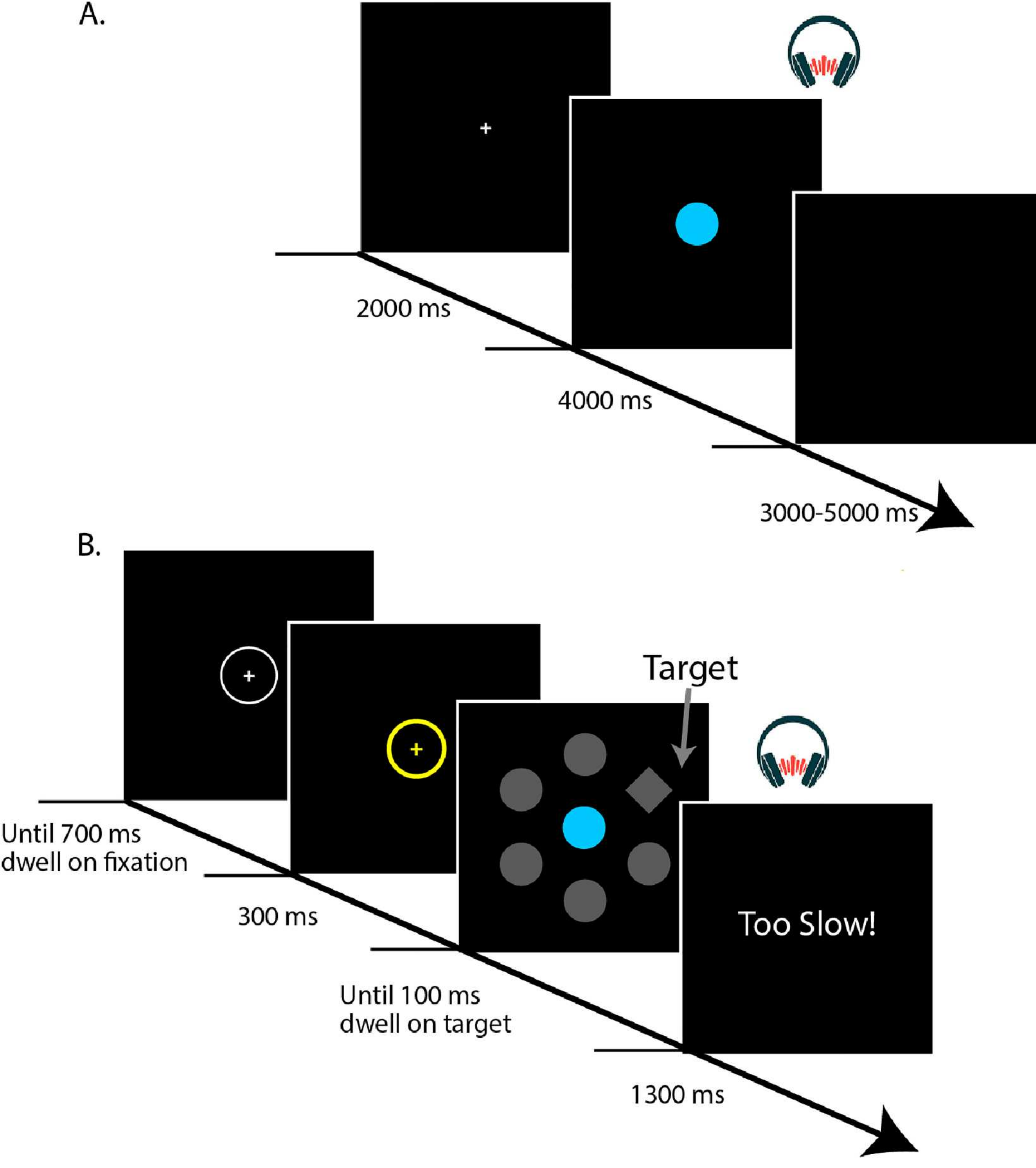


Figure 1. Trial structure of the eye tracking task used in Experiment 1.

Notes: A. Participants first underwent a Pavlovian Conditioning Phase where they learned to associate one coloured circle (CS+) with the delivery of an aversive noise and a different coloured circle (CS−; not depicted) with the absence of any noise. B. During the Visual Search Task participants had to move their eyes as quickly as possible to the diamond target, before the RT limit was reached. If the CS+ was present at fixation, and participants did not beat the RT limit, they heard the aversive noise over the headphones. No feedback or punishment was given for trials not featuring the CS+. Images not to scale.

DASS-21 (Lovibond & Lovibond, 1995). The anxiety subscale of the DASS-21 comprises seven items measuring arousal, bodily sensations and subjective experience of anxious affect. It has good convergent and discriminant validity when compared with other measures of depression and anxiety and excellent reliability (Henry & Crawford, 2005). Cut-off scores for anxiety levels as measured with the DASS-21 are 0–7: normal, 8–9: mild, 10–14: moderate, 15–19: severe, 20–21: extremely severe.

1.1.3.3. Procedure. Following informed consent procedures, participants were instructed that they were going to complete a task where they would

occasionally hear a loud noise over the headphones. They were then played the white noise burst and if they were happy to proceed then the *Conditioning Phase* began. Participants were instructed that they were going to be introduced to some of the stimuli used in the eye tracking task and that they should watch the screen and pay attention to the association between the coloured circles and the loud noise. They were then instructed that they would need to move their eyes to the diamond during the *Visual Search Task.* Participants first practised moving their eyes to the diamond, on trials that had a yellow circle at fixation. After eight practice trials they were then instructed that during the real task they would occasionally hear a loud noise in the headphones if they moved their eyes to the diamond too slowly but that it would only ever happen on trials featuring the CS+ (the blue circle for half the participants, orange circle for the others). They were instructed that on trials featuring the *other* coloured circle (CS–) or a grey circle (control trials) that they would not hear any noise in the headphones but that they should still try to move their eyes as quickly as possible to the diamond. They were told that the speed at which they would need to move their eyes to the diamond would get faster as the task progressed. The experimenter then checked that participants could verbally explain what happened if they moved their eyes to the diamond too slowly on trials featuring a blue circle and an orange circle. Participants completed 10 blocks of 36 trials, with a self-paced block every 2 blocks. Afterwards, they removed their head from the headrest and completed the Noise Awareness Questionnaire and the DASS-21. Finally, participants were debriefed.

1.1.3.4. Data preprocessing. Our main variable of interest was the latency of the initial saccade made after the search display onset across CS+ and CS– trial types. We analysed the data following established saccade analysis protocols from prior studies (e.g. Watson et al., 2020, 2022). Trials were excluded if they involved anticipatory saccades (defined as latency below 80 ms; 11.1% of all trials), if the saccade's starting point was more than 100 pixels from the screen centre (11.0% all trials) or if there was insufficient eye-gaze data to accurately identify a saccade (4% of all trials). All other trials were included regardless of whether the saccade was in the direction of the target or another stimulus. We employed a velocity-threshold identification algorithm (Salvucci & Goldberg, 2000) to detect the speed of the initial saccade, using a velocity criterion of 40° visual angle per second based on raw eye tracker data sampled at 600 Hz (not the down-sampled data used for gaze-contingent stimulus presentation control). The Spearman-Brown corrected split-half reliability of initial saccade latency on CS+ trials was $r = .91$, for CS– trials it was $r = 0.94$. We also calculated a disengagement bias score by subtracting the latencies on CS– trials from CS+, where larger scores indicate delayed disengagement from threat. The Spearman-Brown corrected split-half reliability of the CS+ minus CS– latency difference score was $r = .341$.

In line with previous work, we had pre-registered that any participant with more than 20% trial exclusions would be excluded from all analyses. However, it became apparent that this criterion was too stringent and would have resulted in the exclusion of 63 participants. The reason for the increased trial exclusions was an increase in anticipatory trials relative to previous work, most likely because participants were trying to beat the RT time limit and avoid hearing the aversive noise and often started moving their eyes before the onset of the search display. We therefore decided to only exclude the 13 participants who had more than 50% of trials excluded. We note however that the pattern of results remains the same, if the pre-registered exclusion criteria is used, or if the entire sample is included (see Exploratory Analyses).

1.2. Results

Manipulation checks. A histogram displaying the distribution of DASS-21 anxiety scores can be seen in Figure 2. On average the proportion of excluded trials was .19 (*SEM*: .01) with no significant differences between low and high anxiety groups, $t(99) = .05$, $p = .959$, $d = 0\ .01$. The mean number of noise events that participants experienced was 36.21 (*SEM:* .48) with no significant differences between low and high anxiety groups, $t(99) = .84$, $p = .403$, $d = 0.17$. Contingency knowledge at the end of the experiment about the colour-noise relationships was 100% for all participants. High anxious participants rated the noise as being significantly more aversive (*M*: 82.4, *SEM:* 2.3) relative to the low anxious participants (*M*: 72.9, *SEM:* 2.3), $t(99) = .2.9$, $p = .005$, $d = 0.59$. Furthermore, the high-anxiety group rated the noise as more likely to appear "frequently" (54 counts) rather than "occasionally" (8 counts) but this distribution was different for the low-anxiety group ("occasionally": 21 counts, "frequently": 18 counts), $X^2(1) = 19.6$, $p < .001$.

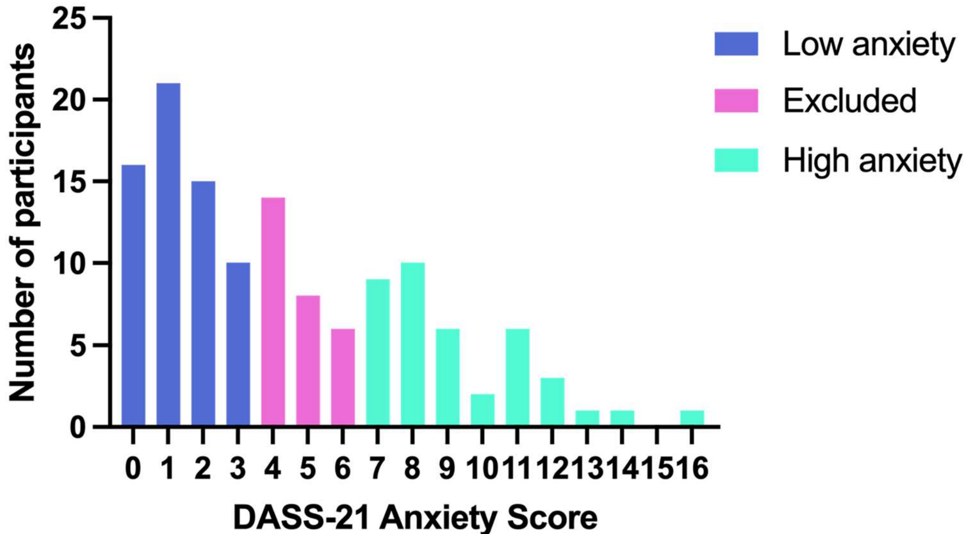


Figure 2. Experiment 1: distribution of DASS-21 anxiety scores.

Notes: Scores on the Depression Anxiety Stress Scales (DASS) 21 can range from 0–21. Participants with scores less than four were assigned to the low anxiety group, those with scores greater than six were assigned to the high anxiety group.

1.2.1. Preregistered analyses

We used repeated measures ANOVA with within-subjects factor of central stimulus type (CS+, CS–, absent) and between subject factor of high/low anxiety group. The analysis revealed a main effect of stimulus type, $F(2, 198) = 31.2, p < .001, \eta_p^2 = .24$, with participants significantly more likely to be delayed on the CS+ relative to the CS–, $t(128) = 6.62$, $p < .001$. $d_z = .58$, which in turn was significantly slower than when there was no coloured circle at fixation, $t(128) = 3.29$, $p < .001$. $d_z = .29$. Importantly however, as can be seen in Figure 3, there was no main effect of anxiety group, $F < 1$ $p < .983$, $\eta_p^2 < .001$, nor interaction between the two variables, $F(2,198) = 1.36$, $p = .259$, $\eta_p^2 = .01$.

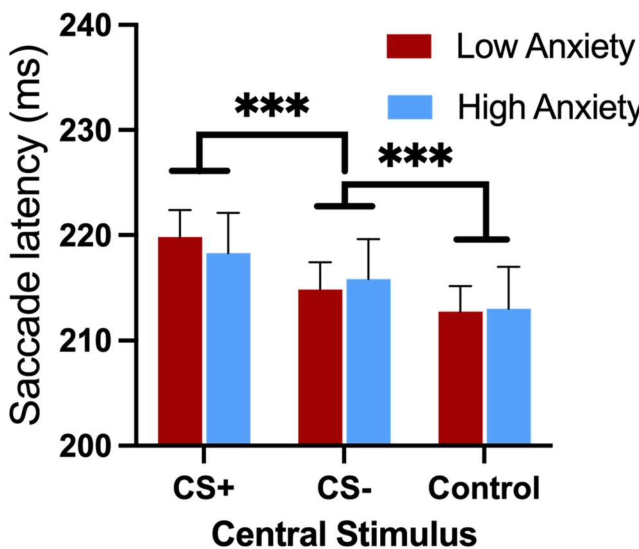


Figure 3. Experiment 1: first saccade latency as a function of stimulus type.

Notes: Mean latency of first saccade away from the central stimulus as a function of anxiety group (low or high) and central stimulus type: CS+, CS– or control (grey circle). *** = $p < .001$. Error bars show SEM.

We calculated the delayed disengagement score – the mean time taken to begin moving eyes on CS+ trials minus CS– trials with larger scores representing slower disengagement from threat. A Bayesian one-sided *t*-test of hypothesis that the delayed disengagement score was larger in the high-anxious relative to the low-anxious group found strong evidence in favour of the null hypothesis ($BF_{01} = 12.3$).

Preregistered hierarchical regression analysis suggested that neither age, gender, DASS anxiety score, number of noise events or aversive noise rating predicted latency difference between CS+ and CS–. The overall model was not significant, $F < 1$, $p = .460$, nor were any of the individual predictors, all $ps > .123$.

1.2.2. Exploratory analysis

Given the number of participants and limited test-retest reliability of the bias score, the experiment may have been underpowered to detect smaller (but meaningful) effects. Therefore we ran a Linear Mixed Model in Jamovi (*Jamovi Project*, 2021) to analyse trial level saccade latency data, for all 142 participants regardless of the number of trial exclusions. The mean number of discarded trials was 82.12 (*SEM:* 5.5) out of a total of 360 trials. Residuals were first plotted and inspected for normality. Distractor type (three levels) was entered as fixed factor with DASS-anxiety as covariate (means centred). The two-way interaction was included in the model with data clustered at the subject level (random intercept). The pattern of results did not change with only a significant main effect of distractor type, F (2, 39314) = 57.2, $p < .001$. The main effect of anxiety was not significant, $F < 1$, $p = .771$ nor was the interaction F(2, 39314) = 2.4, $p = .094$.

1.3. Discussion Experiment 1

The aim of Experiment 1 was to test whether delayed disengagement from a threat-related stimulus persists in individuals with high anxiety when they are externally motivated to disengage. To this end we used eye tracking to investigate the speed at which participants could disengage their attention from a signal of threat, when they were motivated to do so. A coloured circle was presented at fixation with the target presented elsewhere in the display. Participants were instructed that an aversive noise would be played over the headphones as punishment for moving eyes too slowly to the target, but that this would only happen when one coloured circle (CS+) was presented at fixation. As expected, participants were slower to begin moving their eyes on CS+ relative to CS– trials, despite this being completely counterproductive and increasing the likelihood that a punishment would be delivered. These results are thus conceptually in line with literature showing that stimuli signalling punishment, not only capture attention involuntarily (Mikhael et al., 2021; Nissens et al., 2017), but also act as motivational magnets, from which it is harder to move attention away from.

In this experiment, where participants had a valid reason to quickly disengage attention from the threatening CS+, we were primarily interested to see whether there would be any differences in disengagement speed as a function of anxiety. Following protocols commonly used in the literature we pre-screened participants based on their anxiety scores and invited those with low (<4) or high anxiety (>6) scores on the DASS-21 to participate in the experiment. We then used this as a between-groups factor in the analyses. As hypothesised, we found strong evidence for the null hypothesis, that there was no significant difference between high and low anxiety groups in the time taken to begin moving eyes away from a signal of threat, when there was sufficient motivation to do so. While this between-subjects design may have been underpowered to detect smaller (but still meaningful) effects, we still did not observe any significant effects of anxiety when we included all 142 participants in a Linear Mixed Model and used the DASS-21 anxiety score as covariate (as is more appropriate: McClelland et al., 2015).

The high-anxious group in our experiment had sufficiently high levels of anxiety with scores ranging from 7–16 on the DASS-21 anxiety subscale which are reportedly in the 94th – 99th percentile of anxiety scores for a non-clinical sample (Henry & Crawford, 2005). Furthermore, we did observe important differences between the low and high anxiety groups in their perceptions of the experiment. Participants in the high-anxious group found the sound significantly more aversive and reported it occurring more frequently than the low-anxious individuals, despite there being no significant difference between groups in the average number of sound events that were experienced. This provides some evidence that there were meaningful differences between high and low anxiety groups, but this did not translate to any differences in disengagement speed from the threat-signalling stimulus. We also

note however that while split-half reliability for saccade latencies was excellent, reliability for the disengagement score (the difference in latency on CS+ minus CS− trials) was poor ($r = .341$). Poor split-half reliability of difference scores is a common issue in attentional bias research (Edwards et al., 2024; Green et al., 2016; Pronk et al., 2022) and would have likely reduced power for the analysis examining the interaction between trial type and anxiety. This would have been somewhat mitigated by the large sample size and powerful linear mixed model but is an important caveat when interpreting the results.

At face value, these results are in line with our hypothesis that high-anxious individuals do not have difficulties disengaging attention from signals of threat, any more than low-anxious individuals do, when there is sufficient motivation to do so. This could suggest that previous demonstrations of delayed disengagement in high-anxious participants (see meta-analysis: Watson et al., 2025) captures voluntary rather than involuntary slowing. However, there may be alternative explanations for the pattern of results in Experiment 1. The overall slowing on CS + relative to CS− trials could be attributed to other, non-attentional processes. Specifically, participants might freeze (a common fear response) in the presence of the CS+ but not the CS− which could artificially inflate disengagement speed (Clarke et al., 2013). Alternatively, participants may have been monitoring for the aversive sound stimulus on CS+ (but not CS− trials) which could effectively operate as a concurrent second task and delay the initiation of eye movements. Given that these are behavioural responses to threat, we might expect that these would cause exaggerated slowing in responding for high-anxious relative to low-anxious individuals, but this was not observed. Nonetheless, we cannot rule out these alternative explanations with the current data.

Even if we accept that the delayed saccade latencies were due to a delay in attentional processing induced by the threat rather than having some other non-attentional cause, it is perhaps not surprising that we did not see any differences between low and high anxiety participants. The threat stimulus was signalling a general threat – an aversive white noise burst over the headphones. This general threat may be anxiety-provoking for all participants and not therefore appropriate for detecting between-group differences as a function of DASS anxiety. Most previous studies that have reported differences in attentional bias between high and low-anxious individuals have used emotional face stimuli and compared the time taken to respond to the target when angry or fearful faces are presented relative to the neutral face. These emotional faces could be more motivationally relevant for high anxiety participants, thus causing delayed disengagement from these stimuli, only in this subset of participants (Curby & Collins, 2024; Fernandes et al., 2018; Lazarov et al., 2016; Liang et al., 2017). We decided therefore to measure disengagement speed in a second experiment, using emotional faces as the centrally presented stimulus that participants needed to disengage attention from. In contrast to Experiment 1, these threatening stimuli (emotional faces) were entirely task irrelevant. To further examine the role of motivation, we manipulated this variable between groups. Half of the participants earned points for fast responses (with points later translated into a monetary bonus), while the other half only received correct or incorrect feedback on each trial. We expected the monetary bonus to motivate participants to try and disengage their attention quickly. We could then examine whether delayed disengagement from emotional stimuli as a function of anxiety occurred when participants had no reason to disengage their attention quickly (i.e. the unmotivated group) and whether this effect would disappear (or at least be reduced) when participants were motivated by monetary reward to disengage attention quickly and find the target.

2. Experiment 2

The aim of Experiment 2 was to examine whether individuals with higher anxiety show delayed disengagement from emotionally negative stimuli (fearful or angry faces) under conditions of low motivation and whether these effects would be reduced or absent when participants were externally motivated to disengage attention quickly. We used a fully crossed experimental design to test the (pre-registered) hypothesis that individuals scoring high in anxiety would show delayed disengagement from negative emotional faces (relative to those scoring low in anxiety), but only under conditions where there is no cost to participants for disengaging attention slowly. Such a finding would suggest that previous reports of delayed disengagement in anxiety (meta-analysis: Watson et al., 2025) reflect a voluntary behaviour, rather than an impairment in the ability to perform this function. To this end, we used emotional faces (angry, fearful and neutral) as centrally presented stimuli in a task designed to measure speed of attentional

disengagement, without contamination from biased attentional orientation processes. As in Experiment 1, this was achieved by presenting the face stimulus at the fixation point and measuring the time participants took to find the unique diamond target displayed in another location on the screen. To reduce the experimental burden on experimenters and participants we chose to use the RT version of the task which could be delivered over the internet and completed at any time convenient to the participant. The RT version of the task uses manual response time to the target as a proxy for disengagement speed, with slower responding putatively due to extended dwell time at the central stimulus location (see e.g. Watson et al., 2020). All hypotheses and analysis plans for this experiment were pre-registered at https://osf.io/p7skj. To increase statistical power, we decided to include anxiety as a covariate in the analysis rather than pre-screen participants and assign them to dichotomous low and high anxiety groups. We expected that we would observe delayed disengagement from fearful and angry emotional faces in those scoring higher in anxiety, with no effect of anxiety on disengagement from neutral faces (thus an interaction between face stimulus type and anxiety score). However, we only expected to see this in the not-motivated group, where there was no external motivation to disengage from emotionally fearful or angry faces. We did not expect a significant interaction between face stimulus type and anxiety score in the motivated group where participants had external motivation (monetary reward) for disengaging attention quickly from the central stimulus and responding to the diamond target.

2.1. Method

2.1.1. Participants & apparatus

Participants were recruited from the UNSW undergraduate pool, participating for course credit. In total we aimed to test 200 participants, assuming that up to 20% of the sample would need to be excluded for poor performance. G*Power analysis indicated that for the critical *t*-test comparison of RT difference scores between high and low anxiety groups (analysed separately for the motivated/not-motivated conditions) 44 participants in each group (166 participants total) would provide 80% power to detect a medium size effect ($d = 0.55$; one-tailed). In total 237 participants completed the study with 36 participants excluded for requiring excessive trial exclusions in the visual-search task (see data-preprocessing section for details). Of the remaining 201 participants, 102 were in the motivated group and 99 were in the not-motivated group. Demographics for these participants can be seen in Table 2.

Table 2. Participant demographics for Experiment 2.

	Not-motivated group ($N = 99$)	Motivated group ($N = 102$)	Group comparison
Age (years)	19.8 (0.3)	19.8 (0.4)	$t(199) = 0.15$, $p = .880$
female/ male/ other gender ratio	65/31/3	73/28/1	$X^2(2) = 1.57$, $p = .456$
DASS-21 anxiety score	3.7 (0.3)	4.0 (0.3)	$t(199) = 0.72$, $p = .470$
BFNE score	36.6 (1.0)	38.3(0.9)	$t(199) = 1.31$, $p = .191$

Notes: Other than gender, rows show mean (SEM) for motivated and not-motivated groups. Comparisons between groups were conducted with independent sample *t*-tests (or with Chi Squared test for gender distribution). DASS-21 = Depression Anxiety Stress Scale (Anxiety Subscale), BFNE = Brief Fear of Negative Evaluation.

The experiment was programmed in Inquisit (*Inquisit 5*, 2016) and participants completed it online in their own time.

2.1.2. Materials

2.1.2.1. Visual search task.

Face stimuli was downloaded from the FACES database (Ebner et al., 2010). We chose two female and two male faces, each depicting two neutral, angry and fearful faces (totalling 24 unique face stimuli, eight unique stimuli for each emotion condition). On each trial of the visual search task, participants saw the white fixation cross appear for 400–600 ms (selected at random). After 150 ms blank screen the search display appeared, featuring a face stimulus presented at the central fixation point (cropped to a circle, diameter 18% of the screen height) and six shapes (each 9% of screen height x 9% of screen height) spaced evenly around an invisible outer circle centred on the fixation point with radius 20% of the screen height (see Figure 4). One of the outer shapes was a diamond (the target) and the other outer shapes were circles. Each circle had a white line in the centre, angled at 45 degrees to the left or right. The white line in the diamond target was oriented 90 degrees horizontal or vertical (orientation selected randomly on each trial). Participants' task was to respond to the orientation of the line within the diamond, pressing "C" for horizontal or "Z" for vertical. After a response, or 2000ms timeout, the feedback screen was presented for

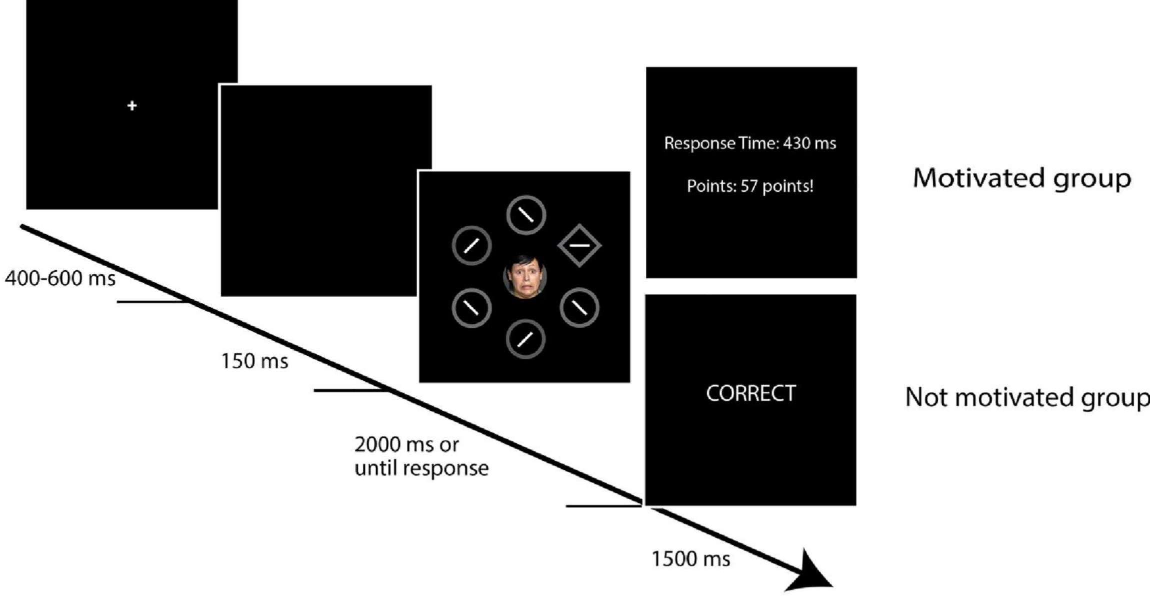


Figure 4. Trial structure of the RT task used in Experiment 2.

Notes: During the Visual Search Task participants had to respond to the orientation of the line inside the diamond as quickly as possible. Emotional faces (angry or fearful) or neutral faces were presented at fixation. Participants in the motivated group received feedback on their response time, earning points that could be later translated into a financial bonus. Participants in the not-motivated group received correct/incorrect feedback on each trial.

1500 ms. Participants in the motivated group earned points for correct responses at the rate of 1 point for every 10 ms that their response was faster than 1000 ms. They were presented with this feedback following each correct response e.g. "RESPONSE TIME: 430 ms. POINTS EARNED: + 57 points!". Participants in the not-motivated group simply saw "CORRECT" following a correct response. For all participants, feedback following an incorrect response read "ERROR" and feedback following a timeout trial was "TOO SLOW. Please try to respond faster".

2.1.2.2. Questionnaires. **DASS-21.** As in Experiment 1, participants completed the DASS-21 with the anxiety subscale used in the analyses.

BFNE. Participants also completed the 12-item Brief Fear of Negative Evaluation (BFNE) Scale (Leary, 1983) which evaluates concerns about saying or doing the wrong things and facing other's judgement and disapproval. The scale has good psychometric properties in both non-clinical populations (Duke et al., 2006) and those with social anxiety disorder (Weeks et al., 2005).

2.1.2.3. Procedure. Participants first provided informed consent and were then randomly assigned to the motivated or not-motivated group. They were instructed that they were going to complete a task where they had to locate and respond to the orientation of a diamond as quickly as possible. Participants completed eight practice trials that contained a yellow circle at fixation. They were then instructed that during the real task they would see faces presented at fixation but that they could ignore these and search for the diamond on each trial. Participants in the motivated group then received the additional instructions that they were earning points for fast responses and that the 20% of participants with the most points would earn a $15 voucher from the store of their choice. Participants completed 2 blocks of 48 trials, with each image repeated twice in each block. This resulted in 16 trials per block of each face type (angry, fearful and neutral). A self-paced break was included between the blocks, with extra information provided to participants in the motivated group about their mean RT for correct responses in that block, the points earned in that block and the total points earned in the experiment so far. After the visual search task participants provided demographic information and completed the DASS-21 and BFNE before being debriefed.

2.1.3. Data preprocessing

As pre-registered we analysed the data following established protocols from our prior studies using RT versions of visual search tasks (e.g. Watson et al.,

2020). Trials where participants made anticipatory responses (<150 ms) or responded too slowly (>1000 ms) were excluded (10.2% of all trials). Thirty-seven participants who had more than 20% of trial data excluded or less than 60% accuracy were then excluded from all analyses.

Mean RT on correct trials only was calculated for all participants, for each condition. Spearman-Brown corrected split-half reliability estimates were $r = .824$ for angry RT, $r = .811$ for fearful RT and $r = .819$ for neutral RT. We also created an angry bias score (RT on angry minus neutral face trials) and a fearful bias score (RT on fearful minus neutral face trials). However, inverse correlations were observed between the angry bias score in the first versus second half ($r = -.09$) and the threatening bias in the first versus second half ($r = -.10$; uncorrected)

2.2. Results

Figure 5 As pre-registered we used Repeated Measures ANCOVA with face stimulus as within-subjects factor, group (motivated vs. not motivated) as between-groups factor and DASS-21 anxiety score as covariate (means centred). The RT analysis revealed a non-significant main effect of face type, $F(2, 396) = 1.39$, $p = .250$, $\eta_p^2 = .007$. There was no significant effect of DASS-21 score, $F < 1$, $p = .792$, $\eta_p^2 < .01$. There was a main effect of motivation group, with participants in the motivated group responding significantly faster than those in the not-motivated group $F(1, 198) = 8.92$ $p < .003$, $\eta_p^2 = .043$. These results can be seen in Figure 6 (with median split of anxiety score used for visualisation purposes).

Similarly, analysis of error rates analysis revealed a non-significant main effect of face type, $F < 1$, $p = .515$, $\eta_p^2 = .003$. There was no significant effect of DASS-21 anxiety score, $F < 1$, $p = .483$, $\eta_p^2 = .002$. There was a main effect of motivation group, with participants in the motivated group significantly less accurate (mean error rate: 13%, *SEM*: 0.7%) than those in the not-motivated group (mean: 11%, SEM: 0.7%), $F(1, 198) = 6.85$ $p < .010$, $\eta_p^2 = .033$.

As preregistered, despite not finding any significant effects of the anxiety covariate in the analysis (and despite the poor reliability of the disengagement bias scores), we excluded participants with DASS scores of 4 or 5 and created high and low anxiety groups. We then used (Bayesian) *t*-tests to compare the angry and fearful disengagement bias scores for the high and low anxiety groups, separately for the motivated and not-motivated groups. However as can be seen in Figure 7, there were no significant differences between high and low anxiety groups (all *p*s > .129; one-sided). One-sided Bayesian *t*-tests of the angry disengagement bias score (disengagement slower in the high anxiety group) provided moderate evidence for the null hypothesis ($BF_{01} > 6$) for both the motivated and not-motivated groups. For the fearful disengagement bias comparison, moderate support for the null hypothesis was seen for the motivated group ($BF_{01} = 6.94$) and anecdotal for the motivated group ($BF_{01} = 1.95$). Given the poor reliability estimates for the disengagement bias scores, these null effects are to be expected.

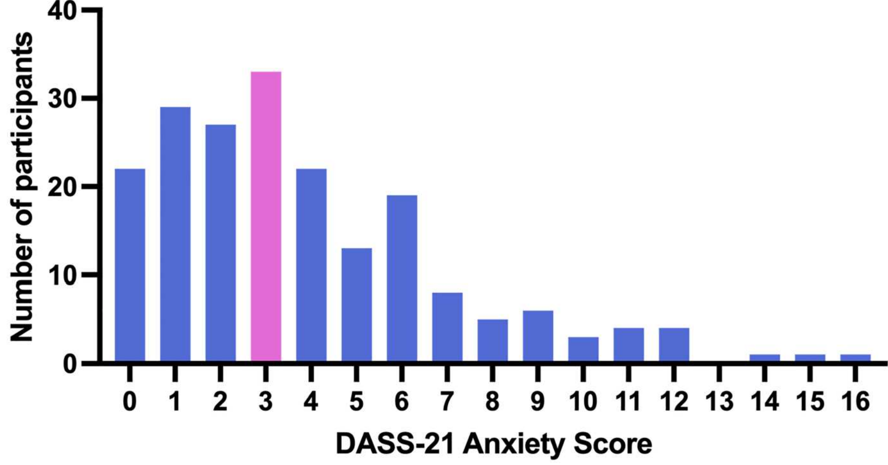


Figure 5. Experiment 2: distribution of DASS-21 anxiety scores.

Notes: Scores can range from 0–21. The median was 3 (depicted in pink).

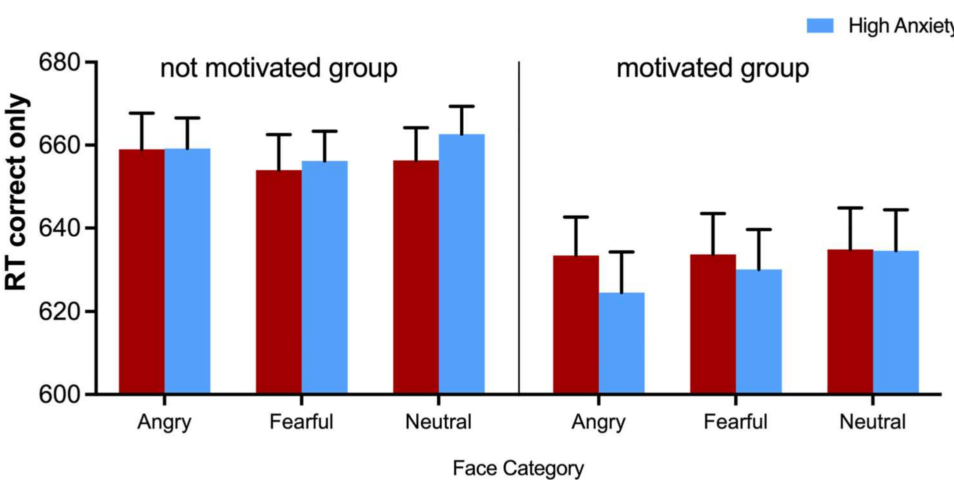


Figure 6. Experiment 2: RT on correct trials as a function of stimulus type, motivation group and anxiety level (median split for visualisation purposes).

Notes: Mean RT to locate the target when an emotional or neutral face was presented at fixation. Data show separately for participants in the motivated group (could earn a monetary bonus for fast responses) and the not-motivated group (no motivation to respond quickly). Anxiety score was entered as a covariate in the analysis, but median split data shown here for convenience. Error bars show SEM.

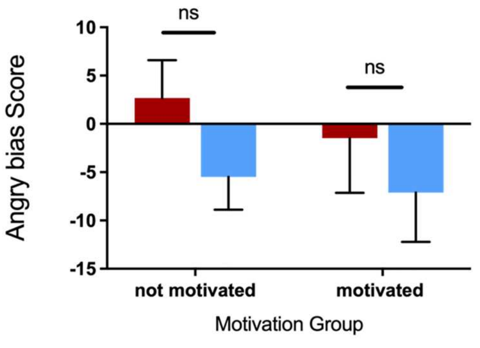
2.2.1. Exploratory analyses

We repeated the analysis using the BFNE rather than the DASS-anxiety score as covariate in the RT and error rate repeated measures ANCOVA models. However, this did not change the pattern of results.

We also used a Linear Mixed Model to analyse trial level RT data (correct trials only). After inspecting residuals, trial type and group (motivated vs. not motivated) were entered as fixed factors with DASS-anxiety as covariate (means centred). The two-way interactions between trial type and motivation group and trial type and anxiety score were included as was the three-way interaction between trial type, motivation group and anxiety score. Data was clustered at the subject level (random intercept). The pattern of results did not change with only a significant main effect of motivation group, $F(1, 417) = 15.5$, $p < .001$. There were no further significant effects, all $Fs < 2.13$, $ps > 0.146$.

2.3. Experiment 2 discussion

The aim of Experiment 2 was to examine whether individuals with higher anxiety show delayed



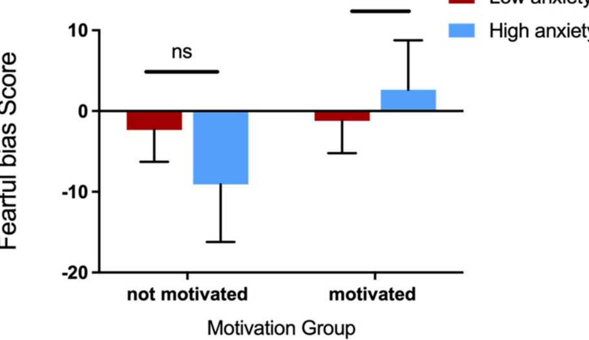


Figure 7. Experiment 2: disengagement bias scores.

Notes: The left panel shows the angry disengagement bias score (RT on trials featuring an angry face – neutral face), the right panel shows the fearful disengagement bias score (RT on trials featuring a fearful face – neutral face). Positive values indicate slowed disengagement from emotional faces relative to neutral. Bias scores were compared between low anxiety and high anxiety participants (median split), separately for the motivated and not motivated groups. Error bars show SEM.

disengagement from emotionally negative stimuli (fearful or angry faces) under conditions of low motivation and whether these effects would be reduced or absent when participants were externally motivated to disengage attention quickly. We expected to replicate previous reports of delayed disengagement from emotional faces (angry and fearful) relative to neutral, in individuals scoring high in anxiety (meta-analysis: Watson et al., 2025), but only in the unmotivated group. By contrast, we expected that delayed disengagement as a function of anxiety would be reduced (or eliminated) when participants were motivated by monetary reward to disengage their attention as quickly as possible from the emotional faces. Such a pattern of results would confirm that previous demonstrations of delayed disengagement from emotional faces in anxiety represent a voluntary behaviour rather than an impairment and difficulty in disengagement attention. The motivation manipulation was clearly successful, with participants responding faster when reward was at stake (albeit less accurately). However, the effect of motivation on disengagement speed in high-anxious individuals became a moot point because the delayed disengagement effect could not be reliably measured in the baseline (not-motivated) condition.

The lack of an effect of emotional faces on disengagement speed contrasts with the aversive noise punishment used in Experiment 1, where an effect across the entire sample was observed. However, there are many differences between the two protocols. In Experiment 1 the CS+ was motivationally relevant for all participants, because it signalled that they could expect to receive a punishment if they responded too slowly. We saw in Experiment 1 that overall, participants were slower to disengage from this motivationally relevant stimulus, even though this was entirely counterproductive and increased their likelihood of punishment. This pattern of results mirrors previous findings in both the reward and punishment domains (Watson et al., 2020; Yan et al., 2022). By contrast the emotional faces used in Experiment 2 were completely task-irrelevant and may only be motivationally relevant for some participants, particularly those with high anxiety.

Previous studies reporting delayed disengagement in high-anxious individuals have used a variety of task designs, many of which were not optimal for assessing disengagement speed as distinct from biased orientation towards threat (Watson et al., 2025). In the current experiments, we used a task that can isolate the process of attentional disengagement, but we were not able to replicate reports of delayed disengagement from emotional versus neutral faces (e.g. Curby & Collins, 2024; Liang et al., 2017; Sagliano et al., 2016). Instead, our data suggest that the emotional faces (whether fearful or angry) did not cause delayed attentional disengagement (relative to the neutral faces) regardless of DASS anxiety score. We note that split-half reliability of the RT difference score on emotional vs. neutral face trials was extremely poor, which would have precluded interpretation of the interaction with anxiety score in any case. It is not clear why we did not observe slowing in the presence of emotional versus neutral faces, in Experiment 2. The FACES database face stimuli have been frequently used in studies investigating attentional biases in anxiety (e.g. Boal et al., 2018; Tran et al., 2013). One interpretation therefore is that emotional faces can capture attention but that subsequent disengagement from those faces occurs at the same speed, regardless of the emotional content. This would align with some previous studies that have used a centrally presented emotional stimulus at fixation to measure disengagement speed (Azarian et al., 2016; Yiend et al., 2015, Exp. 2), and could mean therefore that delayed disengagement from signals of threat is simply not a feature of anxiety.

An alternative explanation for the finding that disengagement speed was not significantly different across emotional face conditions is that the stimuli used in Experiment 2 were not appropriate and/or that the current RT paradigm is not sensitive enough to measure delayed disengagement from threatening stimuli. To address these potential issues, in Experiment 3 we used a different face stimulus database and included an additional category of threatening images depicting snakes and spiders. These images typically evoke strong fear responses (McNally, 2016) and thus the chance of inducing delayed RT should be optimised. Another (related) issue is that participants may have been able to complete the visual-search task without processing the emotional content of the face images. By presenting the search display at the same time as the central face stimulus, there may not have been any engagement with the emotional content. This seems unlikely seeing as the faces in Experiment 2 were presented at fixation and processing of emotional faces is argued to be rapid and automatic (Batty & Taylor, 2003). However, we note that Yiend et al (Experiment 2)

presented the emotional face stimuli at fixation for 300 ms before the search display appeared. It is possible therefore that providing participants with some extra time to engage with the face stimulus before any other stimuli appears would ensure that participants engage sufficiently (increasing the likelihood of delayed disengagement).

3. Experiment 3

The aim of Experiment 3 was to evaluate whether delayed disengagement from biologically salient threat cues (e.g. snakes, spiders) was modulated by anxiety status and motivational context, and whether such stimuli produce more consistent effects than facial expressions of emotion. We made significant adjustments in Experiment 3, given the surprising finding in Experiment 2 that regardless of anxiety status, emotional faces did not delay disengagement relative to neutral faces. Firstly, we presented the stimulus of interest at the central fixation point for 500ms[1] before the search display appeared, thus providing participants with some extra time to engage with this central stimulus, in the absence of any other stimuli. We also used a different stimulus database – The Karolinska Directed Emotional Faces (KDEF; Lundqvist et al., 1998) – for the emotional face stimuli. To increase the emotional contrast between conditions we replaced the fearful face stimuli with happy face stimuli. We also included images of spiders and snakes as another reference category. These images typically evoke strong fear responses and were presented less frequently than face stimuli – thus potentially amplifying the emotional content (Domínguez-Borràs et al., 2008; Ferrari et al., 2022; Weierich et al., 2010). Finally, we note that the STAI-T is more commonly used than the DASS as a measure of anxiety in the attentional bias literature (Azarian et al., 2016; Grafton & MacLeod, 2014; Yiend et al., 2015). We therefore used this questionnaire as the measure of anxiety in Experiment 3 (alongside the BFNE for exploratory analyses).

All hypotheses and analysis plans for Experiment 3 were pre-registered at https://osf.io/93pfj. We expected that participants would show delayed disengagement from spider and snake images, relative to all other conditions. With the extra processing time available to participants (500 ms SOA between the central stimulus and the search display) we expected that we would observe delayed disengagement from angry faces in those scoring higher in anxiety, with no effect of anxiety on disengagement from neutral faces (thus an interaction between face stimulus type and anxiety score), but only for those in the not-motivated group. In this experiment we used linear mixed models to better assess the expected three-way interaction between motivation group, stimulus category (neutral face, angry face, happy face, threatening animals) and anxiety (as measured with the STAI-T).

3.1. Methods

3.1.1. Participants & apparatus

In total we aimed to test 166 participants, assuming that up to 20% of the sample would need to be excluded for poor performance. G* power analysis for multiple linear regression for five predictors suggested that if the effect size was medium ($f^2 = 0.15$) for the critical comparison of response time to each different image presented, that 138 participants would give 95% power to observe an effect. In total 198 participants completed the study with only 3 participants excluded for having more than 40% of trials excluded from the visual-search task (see data-preprocessing section for details). Of the remaining 195 participants, 106 were in the motivated group and 89 were in the not-motivated group. Demographics can be seen in Table 3.

3.1.2. Materials & procedure

The visual search task and procedure was as outlined in Experiment 2 with the following changes. Face stimuli was downloaded from The Karolinska Directed Emotional Faces (KDEF; Lundqvist et al., 1998). Images of 24 men and 24 women were included with each

Table 3. Participant demographics for Experiment 3.

	Not-motivated group ($N = 89$)	Motivated group ($N = 106$)	Group comparison
Age (years)	18.8 (0.2)	18.7 (0.2)	$t(193) = 0.14$, $p = .888$
female/ male/ other gender ratio	69/17/3	76/27/3	$X^2(2) = 1.14$, $p = .566$
STAI-T score	48.4 (1.0)	49.1 (0.8)	$t(193) = 0.49$, $p = .628$
BFNE score	41.3 (1.0)	39.7 (0.8)	$t(193) = 1.20$, $p = .233$

Notes: Other than gender, rows show mean (SEM) for motivated and not-motivated groups. Comparisons between groups were conducted with independent sample *t*-tests (or with Chi Squared test for gender distribution). STAI-T = State Trait Anxiety Inventory (Trait Subscale), BFNE = Brief Fear of Negative Evaluation.

individual demonstrating a neutral, happy and angry face (48 unique images for each emotional face stimulus pool). We also included eight images of spiders and eight images of snakes (downloaded from google images and presented on a black background; 16 unique images in the spider/snake stimulus pool). On each block, participants saw neutral faces, happy faces, angry faces and spider/snake images taken at random from these four stimulus pools at a ratio of 3:3:3:1. Due to a programming error, each block contained 36 rather than 40 trials, meaning that the exact number of stimuli taken from each pool differed slightly block to block (on average across all blocks participants saw 10.9 occurrences of each face category and 3.6 occurrences of spiders/snake stimuli). Participants completed 4 blocks, with each block containing 36 trials. They then completed the STAI-T and the BFNE questionnaires.

Data processing followed a similar protocol as Experiment 2. As pre-registered, trials where participants responded too slowly (>1200 ms[2]) or made anticipatory responses (<150 ms) were excluded (3.5% of trials). Error trials were then excluded (7.9% of all remaining trials). The three participants who had more than 40% of total trials excluded were then excluded from all analyses. Mean RT on correct trials only was calculated for each participant, for each condition. Spearman-Brown corrected split-half reliability estimates were $r = .902$ for angry RT, $r = .791$ for fearful RT and $r = .905$ for neutral RT. The disengagement bias scores were calculated by subtracting neutral RT from both the angry RT and the spider/stimuli RT. Larger (positive) scores indicate delayed disengagement from angry faces or threatening animals. There was an inverse correlation between the angry bias score in the first and second half ($r = -.07$, uncorrected). The Spearman-Brown corrected split-half reliability of the snake/spider difference score was $r = .03$.

STAI-T: The State Trait Anxiety Inventory (Spielberger et al., 1983) consists of two subscales measuring trait anxiety (STAI-T) and state anxiety (STAI-S). Items on the STAI-T ask about the general tendency to experience anxiety symptoms (e.g. excessive worry, rumination, feelings of inadequacy) with items scored from 1 (almost never) to 4 (almost always). Total STAI-T scores can therefore range from 20 to 80 with the distribution across the current sample shown in Figure 8. The scale is argued to have good reliability (Barnes et al., 2002; Spielberger et al., 1983) but may not differentiate between anxiety-related disorders and depression due to its focus on general negative affect/neuroticism (Knowles & Olatunji, 2020).

3.2. Results

As pre-registered we used Linear Mixed Models in Jamovi (*Jamovi Project*, 2021) to analyse trial level RT data. Residuals were first plotted and inspected for normality. Trial type (four levels: neutral face, happy face, angry face, snakes/spiders) and group (motivated vs. not motivated) were entered as fixed factors with STAI-T as covariate (means centred). The two-way interaction between trial type and motivation group and the three-way interaction between trial

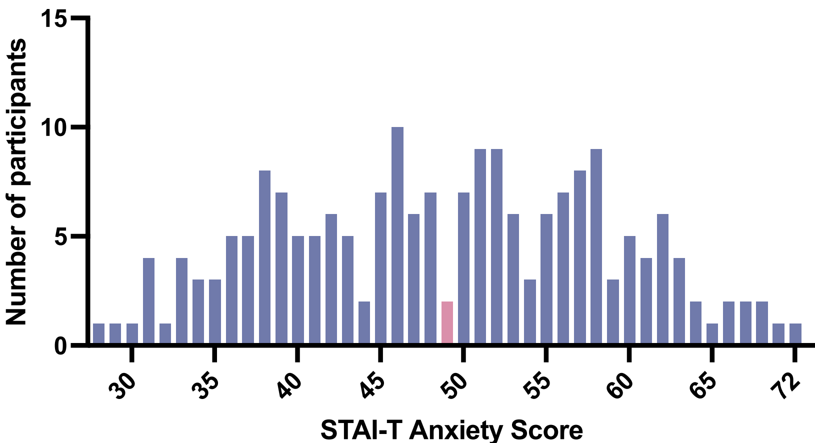


Figure 8. Experiment 3: distribution of STAI-T scores.

Notes: STAI-T = State Trait Anxiety Inventory – Trait subscale. Scores can range from 20–80. The median was 49, depicted in pink.

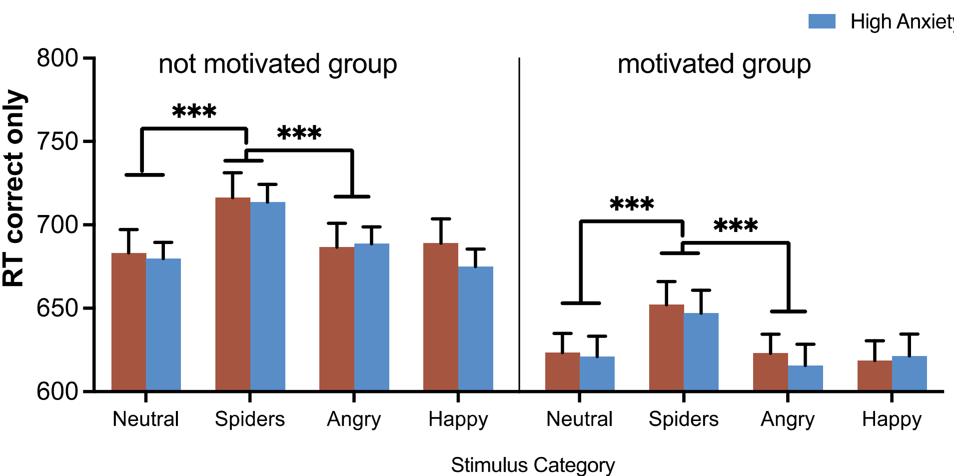


Figure 9. Experiment 3: RT on correct trials as a function of stimulus type, motivation group and anxiety level (median split for visualisation purposes).

Notes: Mean RT to locate the target when an emotional face, neutral face or spider/snake image was presented at fixation. Data show separately for participants in the motivated group (could earn a monetary bonus for fast responses) and the not-motivated group (no motivation to respond quickly). Anxiety score was entered as a covariate in the analysis, but median split data shown here for convenience. Error bars show SEM.

type, motivation group and anxiety score were also included. Data was clustered at the subject level (random intercept).

The results of this analysis can be visualised in Figure 9 (with median split of anxiety score used for visualisation purposes). The main effect of stimulus type was significant in the model, F (3, 25028) = 35.5, $p < .001$. Overall, participants were significantly slower to respond on spider/ snake trials relative to all other trial types (all $ts > 8.9$, all $ps < .001$). There were no significant differences between any of the emotional face conditions (all $ts < 0.95$, all $ps > .344$). As was observed in Experiment 2, the financial motivation led to reduced RT in the motivated group vs. not-motivated group, $F(1,191) = 26.2$, $p < .001$. Importantly however there was no main effect of STAI-T score, $F(1,192) = 1.18$, $p = .278$, nor significant interaction between anxiety score and trial type, $F(3,25028) = 1.21$, $p = .304$, nor was the three-way interaction significant $F(4,748) = 1.23$, $p = .295$.

As preregistered, we followed common protocols in the literature, using a median-split approach to create high and low anxiety groups. We then used *t*-tests to compare the disengagement bias scores for the high and low anxiety groups, separately for the motivated and not-motivated groups. However as can be seen in Figure 10, there were no significant differences between high and low anxiety groups for any comparison (all $ps > .191$; one-sided). One-sided Bayesian *t*-tests of the angry disengagement bias score (bias greater in the high anxiety group) provided moderate evidence for the null hypothesis ($BF_{01} = 8.42$) for the motivated group and $BF_{01} = 2.13$ (anecdotal) for the not-motivated group. There was moderate evidence in favour of the null hypothesis for the spider/snake disengagement bias score comparison, for both the not-motivated group ($BF_{01} = 4.20$) and motivated group ($BF_{01} = 6.00$). Given the extremely poor reliability of the disengagement bias difference scores, these null findings are not unexpected.

3.3. Discussion Experiment 3

The aim of Experiment 3 was to evaluate whether delayed disengagement from biologically salient threat cues (e.g. snakes, spiders) was modulated by anxiety status and motivational context, and whether such stimuli would produce more consistent effects than facial expressions of emotion. To increase the likelihood of replicating previous reports of delayed disengagement from emotional-face relative to neutral-face stimuli (Boal et al., 2018; Curby & Collins, 2024; Liang et al., 2017; Sagliano et al., 2016; Tran et al., 2013), we made a significant number of changes in Experiment 3. Relative to Experiment 2 we used a different emotional face database and

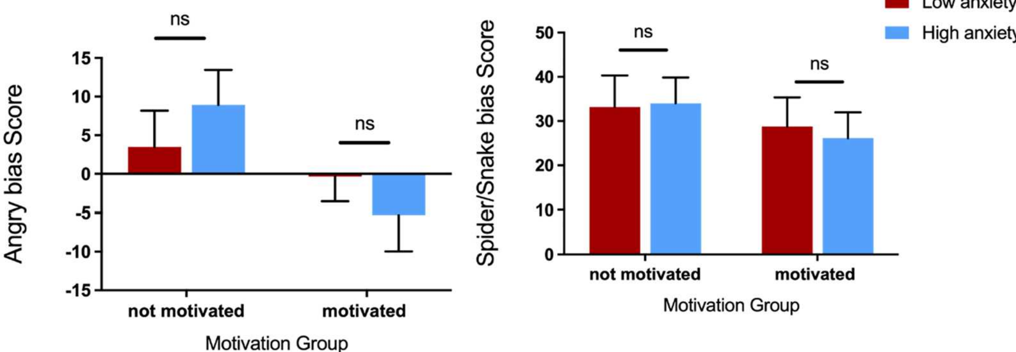


Figure 10. Experiment 3: bias scores.

Notes: The left panel shows the angry disengagement bias score (RT on trials featuring an angry face – RT on neutral face trials), the right panel shows the spider/snake disengagement bias score (RT on trials featuring a snake/spider – RT on neutral face trials). Positive values indicate slowed disengagement from emotional stimuli relative to neutral. Bias scores were compared between low anxiety and high anxiety participants (median split), separately for the motivated and not motivated groups. Error bars show SEM.

presented the stimuli at fixation for 500 ms before target onset to encourage meaningful processing of the stimulus. However, in a sample of 201 participants, there was no evidence of reaction times to identify the target (taken as a proxy of disengagement speed) to differ across any of the emotional face categories (happy, sad or neutral). One possible explanation is that the current task is simply not sensitive enough to capture differences in disengagement speed from signals of threat. To investigate this, we also included infrequent images of snakes and spiders as the centrally presented stimulus from which participants are required to disengage attention from in order to respond to the target. Images of snakes and spiders typically evoke strong fear responses (McNally, 2016) and in addition, infrequent stimuli tend to be more salient (Courchesne et al., 1975; Sokolov et al., 1963). This category of stimuli thus confirmed that the RT version of this task is sensitive enough to capture differences in RT as a function of stimulus salience (see also Watson et al., 2020; Yan et al., 2022). The results clearly showed that the infrequent images of spiders and snakes, relative to all other stimuli, caused significant delays in responding to the target. This occurred for both motivated and non-motivated groups, suggesting that even when participants were motivated by external rewards to disengage attention as quickly as possible from infrequent threat stimuli, delayed disengagement was inevitable.

Of course, we are unable to disentangle whether the delayed disengagement from the infrequent spider/snake stimuli is due primarily to the threatening nature of these stimuli or simply due to novelty effects (increased salience that may have resulted from the less frequent presentation rate). A matched neutral image category presented at the same frequency as the snake/spider category would have allowed us to quantify the effect of threat, as distinct from novelty. However, previous studies have shown that novelty amplifies the emotional content of stimuli (Domínguez-Borràs et al., 2008; Ferrari et al., 2022; Weierich et al., 2010), which should have maximised the likelihood that the threatening content interfered with disengagement processes in Experiment 3. In line with this, we observed significantly slower RT to identify the target on spider/snake trials, relative to all other conditions, regardless of whether participants were motivated or not to disengage quickly. Critically however we found no evidence to suggest that delayed responding to the target on trials featuring either infrequent threatening animals or emotional faces was exaggerated in individuals scoring high in anxiety. Specifically, there was no main effect of, nor interactions involving STAI-T anxiety score in the overall analysis. Follow-up Bayesian analyses investigating whether individuals scoring higher in anxiety showed increased interference from either faces or infrequent threatening animals presented at fixation, found consistent evidence for the null hypothesis. This was not surprising given the poor split-half reliability of the difference scores. Combined with the results of Experiment 2, these studies raise doubts about the narrative that disengagement from signals of threat is a common feature of anxiety, particularly when measured using

common RT paradigms where poor reliability of difference scores is an issue (Edwards et al., 2024; Xu et al., 2025).

4. General discussion

Over the years, the notion that individuals scoring high in anxiety have "difficulties disengaging attention from threat" has become commonly accepted as fact in the literature (e.g. Cisler & Koster, 2010; White et al., 2009; Williams et al., 2024). Across three pre-registered experiments, we investigated the validity of this claim by manipulating the degree to which participants incurred a cost for lingering too long at a threat stimulus presented at fixation. Our overarching hypothesis was that delayed disengagement from signals of threat in high- relative to low-anxious individuals would be eliminated (or at least reduced) when there was sufficient motivation to disengage attention quickly. In Experiment 1 we used eye-tracking to demonstrate that a CS+ signalling potential punishment held attention for longer than a CS–, even though participants were aware that moving their eyes away too slowly from the CS+ would result in delivery of that punishment (an aversive noise burst being presented over headphones). Under these task conditions, where there was a cost to delayed disengagement, there were no significant differences in initial saccade latency (time taken to being moving eyes) between participants scoring high and low on the DASS anxiety measure.

In addition to the poor test-retest reliability which may have reduced power to detect effects between anxiety groups in Experiment 1, the experimental protocol differed in many ways to previous studies studying disengagement processes in anxiety (see Watson et al., 2025 for review). The task was instrumental in that the participant's responses caused punishment, if they responded too slowly in the presence of the CS+ at fixation. Thus, for all participants the CS+ was motivationally salient as it signalled a potential punishment, which they had to try and prevent occurring. These findings could be interpreted to suggest that a stimulus signalling punishment is a motivational magnet from which it is difficult to move attention away from, similar to what has been observed previously in both the reward and punishment domains (Watson et al., 2020; Yan et al., 2022). However, we cannot rule out that non-attentional processes (such as behavioural freezing or increased monitoring for the aversive sound stimulus on CS+ trials) could be driving the observed difference between CS+ and CS– conditions. Theoretically we might expect that high-anxious individuals would show exaggerated behavioural responses to threat stimuli, with increased behavioural freezing, more intense sensory monitoring and slower disengagement. However, despite important group differences between low and high-anxiety groups in their perceptions of the punishment frequency and aversiveness, no additional slowing of disengagement (either voluntary or involuntary) was observed in those scoring high in anxiety.

In Experiments 2 and 3 we used a task design that more closely resembles previous studies in the literature. In these experiments, we used emotional faces (and infrequent spider/snake images) that were entirely task irrelevant. These should only interfere with disengagement processes to the degree that participants find them salient. We expected to replicate previous findings, from studies using various experimental paradigms, that emotional faces (angry and/or threatening) would be particularly salient for those scoring high in anxiety (Boal et al., 2018; Curby & Collins, 2024; Liang et al., 2017; Sagliano et al., 2016; Tran et al., 2013). The main aim of Experiments 2 and 3 was to examine, with a fully crossed experimental design, whether high anxiety participants have "difficulty" disengaging attention from emotional stimuli (i.e. indicating an involuntary behaviour) or whether high-anxiety participants dwell on these stimuli in a voluntary manner. To this end, we manipulated whether participants were motivated or not to disengage quickly from the stimuli presented at fixation. Half the participants in each experiment received a monetary bonus for responding quickly to a target presented in the periphery. We found that even when participants were motivated to respond quickly, infrequent spider and snake stimuli (but not emotional face stimuli) delayed disengagement relative to the neutral condition. This was therefore a replication of the pattern observed in Experiment 1, where attention was maintained on a salient (potentially threatening) stimulus even when it was counterproductive to do so. Again, this pattern was observed across the entire participant group and was not modulated by anxiety status. One potential reason for the observed null effects is that (infrequently presented) snakes and spider images are salient for all participants, not just those scoring high in anxiety. Alternatively, the extremely poor reliability of the RT difference score (disengagement bias score) reduced the sensitivity of the

analysis to detect an interaction involving RT on spiders/snakes vs. neutral trials.

It is not clear why, overall, we failed to find delayed disengagement from emotional relative to neutral faces, particularly in participants scoring high in anxiety. The participant sample was unlikely to be the issue with University students commonly used in most previous studies investigating attentional biases in anxiety. We observed considerable variability in anxiety scores, with many participants scoring in the 90th percentile according to normative data of the DASS-21 (Henry & Crawford, 2005). The mean STAI-T score across the whole participant group in Experiment 3 was higher than the mean score in the "high-anxiety" group of some other studies (e.g. Clarke et al., 2014; Curby & Collins, 2024). Our preferred interpretation of the results is that previous studies reporting increased attentional bias to threat in anxiety (Amir et al., 2003; Fox et al., 2002; Koster et al., 2006; Richards et al., 2014; review: Cisler & Koster, 2010) were primarily measuring differences in attentional orienting, rather than isolating the specific attentional process of disengagement (Clarke et al., 2013; Watson et al., 2025). We note that using a similar paradigm to that employed here, where attentional disengagement can be measured without contamination by differences in orientation, Yiend et al. (2015, Experiment 2) did not find any evidence for differences in disengagement speed between individuals with generalised anxiety disorder and healthy controls.

As is common in psychological research (Edwards et al., 2024; Green et al., 2016; Pronk et al., 2022), reliability for disengagement bias scores (difference scores) was incredibly poor, with inverse correlations between the first and second half observed in Experiments 2 and 3. This poor test-retest reliability is thought to stem from these measures having low variance between individuals, which makes them effective for detecting easily replicable experimental effects at the group level but less useful for analysing individual differences. Reliability of difference scores calculated for attentional bias tasks such as the dot-probe was similarly argued to be near-zero (Xu et al., 2025) and for the Attentional Response to Distal versus Proximal Emotional Information (ARDPEI) task was reported to be around 0.4 (Dondzilo et al., 2024). This is a serious issue for attentional bias research where reliability estimates are frequently not reported (Green et al., 2016) but interpretation of the interaction between RT on neutral vs. emotional trials and some individual differences variable (e.g. anxiety scores) is central to the conclusions of most studies. Regular reporting of reliability estimates will inform the field as to the experimental paradigms that are best suited for these research questions. The current task used in Experiment 2 and 3 (presenting emotional stimuli at fixation and measuring RT to find a target presented peripherally) is obviously not suitable. The reliability of the disengagement bias score in the eye tracking version (Experiment 1) was much better, but still fell far short of the recommended threshold of .7 (George & Mallery, 2003; Nunnally, 1978).

In summary, our data examining disengagement speed at the group level can be interpreted to suggest that delayed disengagement from signals of threat (here a stimulus signalling an aversive noise punishment for slow responding and infrequently presented snakes/spiders) is largely involuntary. This delayed responding occurred even when the behaviour was counterproductive (i.e. increased the likelihood of punishment and/or reduced the likelihood of reward). There are some important caveats about the degree to which non-attentional processes might be contributing to this pattern of results, but we note that our interpretation is in line with previous studies in both the reward and punishment domains that have used similar tasks to study involuntary delayed disengagement from motivationally relevant stimuli (Watson et al., 2020; Yan et al., 2022). We did not find emotional face stimuli (e.g. angry or fearful) to be sufficient to delay response time, at the group level. Regardless of motivation level, we did not find evidence to support the notion that individuals scoring higher in anxiety have delayed attentional disengagement from threat stimuli relative to low-anxious individuals. Poor reliability of the RT/saccade latency difference scores suggests that these analyses investigating the interaction with anxiety scores were in any case futile. Future research should continue to investigate this issue, using tasks that can assess disengagement speed without contamination from biased attentional engagement processes and that have excellent reliability of disengagement bias (difference) scores.

Notes

1. Although 500 ms may seem to be an overly extended duration for initial cue presentation we note that another experiment was conducted ($N = 142$), with the central stimulus (angry, happy or neutral face from the

KDSF database) presented for 200 ms before the search display appeared. No significant main effect nor interactions involving emotional face type on disengagement speed were observed. For brevity that experiment is not reported in this manuscript, but interested readers can access the data and analysis output at https://osf.io/7zbex/.

2. In previous experiments the RT limit was set at 1000 ms which seemed overly prohibitive to the student leading this project and 1200 ms was therefore the "too slow" limit pre-registered for Experiment 3.

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