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Attention avoidance of the threat conditioned stimulus during extinction increases physiological arousal generalisation and retention

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ABSTRACT

Exposure therapy is a key component of efficacious treatment for anxiety. Biases in the allocation of attention towards versus away from threat assessed prior to exposure-based treatments such as cognitive-behavioural therapy differentially predict treatment outcomes. However, it is unclear whether monitoring versus avoiding threat stimuli influences learning *during* exposure. Extinction paradigms are the experimental analogue of exposure therapy. Therefore, manipulating attention towards versus away from threat during extinction trials may shed light on the role of attention during exposure therapy. This study utilised a Pavlovian fear conditioning and extinction paradigm to examine whether directing attention towards versus away from the threat conditioned stimulus (CS+) related to differences in extinction, as indexed by skin conductance responses (SCR), CS evaluations and subjective measures of anxiety. Following a fear conditioning phase in which a dog image (CS+) was paired with an aversive tone unconditioned stimulus (US) and another dog image (CS-) was presented alone, 57 participants were randomly assigned to one of three conditions during extinction in which both CSs were presented alone: monitor the CS+ (N = 19), avoid the CS+ and attend to another stimulus (N = 18), no attention manipulation control (N = 20). Eye movements were monitored for visual adherence to assigned location using horizontal electro-oculogram. In the context of the acquisition of differential conditioning and visual adherence during extinction, both active groups exhibited larger SCRs to the CS + relative to the CS- during the first extinction block compared to the control group, and the avoid group exhibited significantly larger SCRs on CS+ and CS- trials throughout the extinction phase compared to the other groups. The avoid group also exhibited less decline in SCRs to the CS+ during the extinction retest phase relative to the control group. No significant group differences were observed in between-phase CS evaluations and subjective anxiety ratings. Avoidance of threat conditioned stimuli may impair extinction learning and increase physiological arousal generalisation to safe stimuli.

1. Introduction

Anxiety disorders are common and debilitating mental health conditions affecting as many as 25% of individuals at some point in their lifetime (e.g. Costello, Egger, & Angold, 2005; Pynoos, Steinberg, & Piacentini, 1999). Exposure-based cognitive-behavioural therapy (CBT) is effective in reducing anxiety diagnoses and symptoms in 50–60% of anxious children and adults (see Loerinc et al., 2015 and Rapee, Schniering, & Hudson, 2009 for reviews). However, up to 40–50% of anxious individuals do not respond in the short- or long-term following exposure-based CBT, highlighting the need for further research into mechanisms that influence treatment response.

Learning models have provided a dominant theoretical framework for studying the acquisition and extinction of fear and anxiety disorders in the laboratory (see Waters & Craske, 2016; and Waters, Le Beau, & Craske, 2017 for reviews). Fear acquisition is based on the demonstration that when a neutral conditioned stimulus (CS+) is paired with an aversive unconditioned stimulus (US) and another stimulus is presented alone (CS-), the CS + becomes capable of eliciting a conditioned response (CR), as measured by increased defensive behaviour, stress hormone release and activation of the sympathetic nervous system (LeDoux, 1992, 1996; Lissek et al., 2005). Meanwhile, the CS- becomes a conditioned cue of safety. Extinction involves the repeated presentation of the CS- and CS + without the US so that the CS + no longer predicts the US and the CR gradually declines (see Boschen, Neumann, & Waters, 2009 for a review). It is generally accepted that extinction alters the CS-US association through inhibitory learning processes rather than erasing the learning of the CS-US association (Bouton, 1993; Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014; LeDoux, 1992, 1996).

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To date, mixed evidence has accrued regarding elevated CRs to the CS+ during acquisition in anxious relative to non-anxious individuals. However, evidence of generalisation of CRs from the CS + to the CS- (i.e., safety stimuli) and delayed extinction of CRs to the CS + have been reliably documented in anxious relative to non-anxious individuals (e.g. Duits et al., 2015; Lissek et al., 2005). Therefore, a greater understanding of mechanisms that contribute to threat generalisation and extinction impairments could have practical implications for exposure-based treatments in order to improve treatment outcomes (Waters & Pine, 2016).

Cognitive models have also provided an influential theoretical perspective of anxiety disorders over the past four decades (see Mogg & Bradley, 2016 for a review). Specifically, attention bias towards threat stimuli has been identified in earlier meta-analyses as being a cognitive correlate of anxiety disorders (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg & van IJzendoorn, 2007). However, accumulating studies over the last decade suggest heterogeneity in the direction of attention bias displayed by anxious individuals (see Cisler, Bacon, & Williams, 2009; Mogg & Bradley, 2016). This includes the finding that some anxious individuals display a theory-consistent attention bias towards threat stimuli whereas others exhibit an attention bias away from threat stimuli or no threat bias relative to non-anxious individuals who also typically do not exhibit a threat attention bias (e.g. Bar-Haim, Kerem, Lamy, & Zakay, 2010; Britton, Lissek; Grillon; Norcross & Pine, 2011; Brown et al., 2012; Eldar et al., 2012; Hankin, Gibb, Abela, & Flory, 2010; Heim-Dreger, Kohlmann, Eschenbeck, & Burkhardt, 2006; Monk et al., 2006; Pine et al., 2005; Salum et al., 2013; Stirling, Eley, & Clark, 2006; Waters, Bradley, & Mogg, 2014; Waters, Mogg, Bradley, & Pine, 2011; Zvielli, Bernstein, & Koster, 2014). Furthermore, it has been found that the direction of attention towards versus away from threat stimuli differentially predicts treatment outcomes following exposure-based treatments such as CBT (e.g., Legerstee et al., 2009; Niles, Mesri, Burklund, Lieberman, & Craske, 2013; Price, Tone, & Anderson, 2011; Waters, Mogg, & Bradley, 2012; Waters, Potter, Jamesion, Mogg, Bradley, & Pine, 2015). These studies found that anxious adults and children who avoided attending to threat stimuli had a poorer response to exposure-based CBT compared to anxious individuals who directed attention towards threat stimuli.

Given the central role of extinction principles in exposure-based CBT, researchers have begun to consider whether attention bias direction influences extinction learning in the laboratory, the experimental analogue of exposure therapy. Waters and Kershaw (2015) investigated the impact of attention bias towards versus away from threat assessed using the visual-probe task in clinically anxious children during differential Pavlovian fear conditioning and extinction. Threat avoidant anxious children relative to threat vigilant anxious children displayed significantly larger orienting SCRs to both CSs (CS+ and CS-) during the first block of acquisition trials and significantly larger SCRs to the US on CS + trials as well as during the same temporal interval on CS- trials during acquisition (i.e., physiological arousal generalisation to safe stimuli). Moreover, during extinction, threat avoidant anxious children exhibited delayed reduction of SCRs to both CSs and reported higher subjective anxiety after extinction compared to threat vigilant anxious children. Findings suggested that threat avoidance might contribute to physiological arousal to threat conditioned and safe stimuli presented in the same context as threat conditioned stimuli, impaired extinction of physiological arousal to the discrete threat conditioned stimulus and interference in anxiety reduction.

A shortcoming of these studies is that they have assessed attention bias direction *prior to* differential conditioning and extinction tasks or *prior to* exposure-based CBT (Waters & Pine, 2016). Therefore, it remains unclear the extent to which attention avoidance of threat conditioned stimuli *during* extinction is associated with impaired extinction of physiological arousal responses to the CS+ and elevated physiological arousal responses to safe stimuli (i.e., the CS-). Moreover, threat avoidance has been indexed in prior studies by preferential attention allocation to a neutral stimulus simultaneously presented with a threat stimulus during the visual-probe task. In that task, when attention is directed away from a threat stimulus, it is directed towards a neutral stimulus (as indexed by reaction-time) present within the same visual context as the threat stimulus. Yet, in an extinction experiment, the CSs are typically presented alone during each trial which limits the examination of whether the threat avoidance process indexed using the visual-probe task occurs during CS + trials and thus is associated with enhanced physiological arousal to the CS+ (i.e., the threat stimulus) and persists when attention shifts to, and is sustained upon, the newly attended to neutral stimulus (cf. Waters & Craske, 2016). Thus, the present study aimed to extend upon prior studies (e.g., Waters & Kershaw, 2015) by comparing physiological arousal during, and subjective responses after, instructed attention avoidance of the CS+ (by shifting attention to a neutral stimulus) relative to attention monitoring of the CS+ (by maintaining attention upon the CS+) and no attention manipulation control condition during extinction trials.

Thus, this study involved a Pavlovian differential conditioning and extinction experiment in which during extinction, one group was instructed to attend to the CS+, another group was instructed to shift visual attention from the CS + to a neutral stimulus (a black and white circular shape), and the control group received no attention instruction. We hypothesised based on prior studies (Waters & Kershaw, 2015) that in the context of acquiring differential conditioning to the CS + versus the CS-, participants instructed to avoid the CS + by shifting visual attention from the CS+ and attending to a neutral stimulus (the avoid condition) would display significantly larger SCRs on CS + trials (when attention was focused upon the newly attended to neutral stimulus) and on CS- trials during extinction and extinction retest due to threat generalization compared to participants instructed to monitor the CS+ (the monitor condition) and those who did not receive attention instructions (the control group). Moreover, if attending to the CS + enhances extinction learning, then participants in the monitor condition were expected to exhibit smaller SCRs to the CS+ and CS- relative to the control group during extinction and extinction retest. In terms of between-phase subjective ratings, the avoid group was expected to rate the CS + as significantly more negative and more arousing than the monitor and control groups whereas the monitor group was expected to provide more positive and less arousing ratings of the CS + relative to the control group after extinction and extinction retest. In terms of between phase subjective anxiety ratings, the avoid group was hypothesised to report significantly more anxiety and the monitor group significantly less anxiety after extinction and extinction retest compared to the control group.

2. Method

2.1. Participants

Participants were 63 first-year university psychology students (58.7% female; 41.3% male) between 17 and 52 years of age (M = 25.62, SD = 9.07). Participants were recruited from the research participation pool after the project had been approved by the Griffith University Human Research Ethics Committee. All participants gave written informed consent. Each participant was randomly assigned to one of three conditions (monitor, avoid, control). Six participants were excluded from analyses (physiological and subjective); one due to non-adherence to experimental instructions as indicated by closed circuit camera observations and electro-oculogram (EOG) recording, two due to physiological (skin conductance recording and EOG) equipment error, and three due to SCR non-response. This resulted in a total of 57 participants with usable data.

2.2. Measures and materials

Anxiety symptom measures. The State-Trait Anxiety Inventory for