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Direction of attention bias to threat relates to differences in fear acquisition and extinction in anxious children

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ABSTRACT

Anxious children show attention biases towards and away from threat stimuli. Moreover, threat avoidance compared to vigilance predicts a poorer outcome from exposure-based treatments, such as cognitive-behavioural therapy (CBT), yet the mechanisms underlying this differential response are unclear. Pavlovian fear conditioning is a widely accepted theory to explain the acquisition and extinction of fear, including exposure-based treatments, such as CBT. In typical fear conditioning experiments, anxious children have shown larger physiological responses to an aversive unconditional stimulus (i.e., US on CS+ trials) and to non-reinforced stimuli (CS−) during fear acquisition and to both CSs during fear extinction compared to non-anxious peers. This study examined whether threat avoidance compared to threat vigilance was related to differences in fear acquisition and extinction in anxious children. Thirty-four clinically-anxious children completed a visual probe task including angry-neutral face pairs to determine the direction of threat attention bias as well as a discriminant conditioning and extinction task in which a geometric shape CS+ was paired with an aversive tone US, while the CS− geometric shape was always presented alone during acquisition trials. Both CSs were presented alone during extinction trials. Fear acquisition and extinction were indexed by skin conductance responses (SCR) and subjective measures. Children were classified as threat vigilant ($N = 18$) and threat avoidant ($n = 16$) based on the direction of threat attention bias on the visual probe task. During acquisition, threat avoidant relative to threat vigilant anxious children displayed larger orienting SCRs to both CSs during the first block of trials and larger third interval SCRs to the US on CS+ trials as well as on CS− trials. During extinction, threat avoidant anxious children showed delayed extinction of SCRs to both the CS+ and CS− and reported higher subjective anxiety ratings after extinction compared to threat vigilant anxious children. Threat avoidant anxious children may be more reactive physiologically to novel cues and to stimuli that become associated with threat and this may interfere with extinction learning. These findings could help explain previous evidence that threat avoidant anxious children do not respond as well as threat vigilant anxious children to exposure-based CBT.

Introduction

Anxiety disorders are among the most common and debilitating disorders affecting children, with prevalence rates between 10% and 20% (Cartwright-Hatton, McNicol, & Doubleday, 2006). These disorders are associated with impaired social, academic and personal functioning (Messer & Beidel, 1994; Pine, Cohen, & Brook, 2001) and constitute a risk factor for later psychopathology in adolescence and adulthood (Bittner et al., 2007).

A first-line psychological treatment for anxiety disorders in children is cognitive behavioural therapy (CBT), which includes psycho-education, somatic management, cognitive restructuring and exposure therapy (e.g., Saavedra, Silverman, Morgan-Lopez, & Kurtines, 2010). Indeed, exposure therapy is considered to be the cornerstone of CBT (e.g., Kendall et al., 2005) and involves systematic, repeated exposure to either the anxiety-provoking stimulus/situation (in vivo exposure) or the memory of it (imaginal exposure) until anxiety levels decline.

Treatment outcome studies have shown that exposure-based CBT, in both individual and group format, is effective in eliminating anxiety disorders in approximately 50–85% of anxious children (Barrett, Dadds, & Rapee, 1996; Cobham, Dadds, & Spence,

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1998; In-Albon & Schneider, 2007; Kendall, 1994; Lyneham & Rapee, 2005; Saavedra et al., 2010; Silverman, Pina, & Viswesvaran, 2008; Waters, Ford, Wharton, & Cobham, 2009) with large scale reviews concluding that about 60% of anxious children will experience significant reductions in anxiety symptoms (James, Soler, & Weatherall, 2007). These rates highlight the need for further research into the underlying mechanisms of anxiety disorders in children and how such mechanisms influence treatment outcomes following exposure-based CBT.

Cognitive models of anxiety propose that biased attention to threat stimuli plays a critical role in the aetiology and/or maintenance of anxiety disorders (see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van-Ijzendoorn, 2007; Mogg & Bradley, 1998; Williams, Watts, MacLeod, & Mathews, 1997). One widely used method of assessing attention bias is the visual-probe task with emotional words or pictures. Paired stimuli (e.g., angry face-neutral face) are briefly presented simultaneously on a computer screen followed by a visual-probe in the spatial location of one of the stimuli, to which participants respond. Faster response-times (RTs) to probes replacing threat compared with neutral stimuli reflect an attention bias towards threat.

Adult studies provide relatively consistent evidence that anxious adults display an attention bias towards threat stimuli (see Bar-Haim et al., 2007 for a review), whereas findings from anxious children and adolescents are mixed. Several studies have found an attention bias towards threat in children with high anxiety symptoms and clinical anxiety disorders (Roy et al., 2008; Taghavi, Dalgleish, Moradi, Neshat-Doost, & Yule, 2003; Waters, Henry, Mogg, Bradley, & Pine, 2010; Waters, Kokkoris, Mogg, Bradley, & Pine, 2010; Waters, Mogg, Bradley, & Pine, 2008; Watts & Weems, 2006), other studies have found a bias away from threat (Brown et al., 2012; Hankin, Gibb, Abela, & Flory, 2010; Monk et al., 2006; Pine et al., 2005; Stirling, Eley, & Clark, 2006), while several other studies have noted the heterogeneity of the direction of the bias in anxious youth generally (Bar-Haim, Kerem, Lamy, & Zakay, 2010; Eldar et al., 2012; Heim-Dreger, Kohlmann, Eschenbeck, & Burkhardt, 2006; Salum et al., 2013; Waters, Bradley, & Mogg, 2014; Waters, Mogg, Bradley, & Pine, 2011).

More recently, researchers have begun to consider the clinical relevance of threat attention biases by examining whether the direction of the bias differentially influences outcomes following exposure-based CBT. Two studies have shown that although all anxious participants improved from pre-to post-treatment, a pre-treatment bias away from threat compared to a bias towards threat was associated with a poorer response following exposure-based CBT in adults with social phobia (Price, Tone, & Anderson, 2011) and anxious children (Waters, Mogg, & Bradley, 2012). Another study has shown that adults with social phobia who were slower to disengage from threat stimuli (i.e. more threat vigilant) prior to treatment had the strongest clinician-rated symptom reduction following exposure-based behaviour therapy (Niles, Mesri, Burkland, Lieberman, & Craske, 2013). Nevertheless, the mechanisms that underlie differences in treatment outcome from exposure-based CBT as a function of attention bias direction remain unclear.

Extinction learning is the theoretical basis underlying exposure-based CBT. Learning models emphasise that anxiety develops through the association of a conditioned stimulus (CS+) and an aversive unconditional stimulus (US) (see Boschen, Neumann, & Waters, 2009; Vervliet, Craske, & Hermans, 2012 for reviews). During extinction, the CS+ is repeatedly presented in absence of the US and after repeated presentations (akin to exposure therapy), elevated reactivity to the CS begins to weaken and the learnt fear is gradually "extinguished" (Boschen et al., 2009). However, extinction does not produce a "destruction" of the CS-US association. Rather, extinction reflects that the CS+ develops two meanings—one that is associated with the US and one that is not (Bouton, 2002).

Similar to findings in anxious adults (e.g., Blechert, Michael, Vriends, Margraf, & Wilhelm, 2007; Michael, Blechert, Vriends, Margraf, & Wilhelm, 2007; Orr et al., 2000; Peri, Ben-Shakhar, Orr, & Shalev, 2000), experimental studies using both physiological (i.e., skin conductance, startle eye blink) and subjective reports (i.e., valence and arousal ratings) have found that clinically anxious children and adolescents show greater delay in extinguishing fear responses to the CS+, in addition to overall elevated responding to the US on CS+ trials as well as CS− trials during acquisition and extinction compared to non-anxious children (e.g., Craske, Kircanski, et al., 2008; Craske, Waters, et al., 2008; Lau et al., 2008; Liberman, Lipp, Spence, & March, 2006; Waters, Henry, & Neumann, 2009). Conceptualised within an associative framework, these findings suggest that anxious children show elevated fear responding to excitatory cues of threat (i.e., CS+) as well as greater impairment in inhibiting fear responses to safety cues, such as the CS−, and when new information (i.e., US absence) should herald that the situation is now safe and fear responses are no longer warranted (Davis, Falls, & Gewirtz, 2000; see Lissek et al., 2005 for review).

Therefore, one way of advancing knowledge about factors that underlie differential outcomes from exposure-based CBT is to examine fear acquisition and extinction in anxious children as a function of the direction of threat attention bias. Previous research has combined fear conditioning with attention bias tasks to quantify the degree to which conditioning alters attention capture and disengagement (e.g., Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2005; Notebaert, Crombez, Van Damme, De Houwer, & Theeuwes, 2011; Pischek-Simpson, Boschen, Neumann, & Waters, 2009; Shechner, Pelc, Pine, Fox, & Bar-Haim, 2012; Van Damme, Crombez, & Notebaert, 2008). However, these studies have assessed conditioning effects on the development of attention biases rather than the reverse association. The present study also extends upon this research by examining differences in attention biases as a function of bias direction and by focussing on clinically-anxious children rather than non-selected adults.

According to contemporary learning theories (e.g., Craske, Kircanski, et al., 2008; Craske, Liao, Brown, & Vervliet, 2012; Craske, Waters, et al., 2008; Pearce & Hall, 1980; Mackintosh, 1975), establishing and maintaining the salience of the CS+ is critical for successful associative learning and fear extinction. This implies that the extent to which attention is directed towards or away from cues that do (CS+) and do not (CS−) predict threat (US), particularly when there is a change in the contingency between these stimuli (no US), could be an important predictor of the strength of fear acquisition and extinction. By virtue of avoiding threat stimuli or cues thereof, threat avoidant anxious children may be more reactive to explicit threat stimuli (the US) and less likely to attend to stimuli (the CS+) that predict threat (the US). Moreover, given that other stimuli (the CS−) share many stimulus properties with the CS+ (e.g., size; colour, shape, duration) (Lissek et al., 2014), avoidance of threat stimuli and related cues might mean that fear responses can be elicited by other stimuli. The timing of the US to coincide with CS+ offset conceivably makes the later stage of CS+ trials highly salient (cf. Grillon, Ameli, Merikangas, Woods, & Davis, 1993; Craske et al., 2009). By virtue of avoiding threat and cues thereof that distinguish them from other stimuli, elevated fear responding (to the US) in threat avoidant anxious children may not be time-locked to the end of CS+ trials specifically, but occur at the end of other stimulus presentations as well, such as the CS−, resulting in the expression of fear responses to safety cues as well (Davis et al., 2000; Lissek et al., 2005). Furthermore, when new