Task relevance of emotional information affects anxiety-linked attention bias in visual search

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ABSTRACT

Task relevance affects emotional attention in healthy individuals. Here, we investigate whether the association between anxiety and attention bias is affected by the task relevance of emotion during an attention task. Participants completed two visual search tasks. In the emotion-irrelevant task, participants were asked to indicate whether a discrepant face in a crowd of neutral, middle-aged faces was old or young. Irrelevant to the task, target faces displayed angry, happy, or neutral expressions. In the emotion-relevant task, participants were asked to indicate whether a discrepant face in a crowd of middle-aged neutral faces was happy or angry (target faces also varied in age). Trait anxiety was not associated with attention in the emotion-relevant task. However, in the emotion-irrelevant task, trait anxiety was associated with a bias for angry over happy faces. These findings demonstrate that the task relevance of emotional information affects conclusions about the presence of an anxiety-linked attention bias.

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1. Introduction

Cognitive models of anxiety propose that dysfunctional cognitions lie at the core of anxiety pathology (e.g. Beck & Clark, 1997). A number of models focus specifically on anxiety-linked abnormalities in attention (e.g. Mathews & MacLeod, 1994; Mogg & Bradley, 1998; Wells & Matthews, 1994; Williams, Watts, MacLeod, & Mathews, 1988). Whilst there are some important differences between the precise mechanisms hypothesised in these models, all predict that individuals with high levels of anxiety have a chronic bias to preferentially orient attention to stimuli that are threatening. For example, Mogg and Bradley (1998) propose that individuals high in trait anxiety are more likely to appraise a stimulus as threatening than individuals low in trait anxiety and this in turn affects a goal engagement system, which orients attention toward the threat stimulus. From an evolutionary perspective, this mechanism is attributed to the adaptive function of fear (or anxiety), such that threat should be detected quickly in order to activate immediate defensive responses, which in turn will favour threat-related stimuli over neutral ones (Bradley, 2009; Öhman, 1996).

Extensive research has examined the association between anxiety and attention bias for threat. The vast majority of this work has employed behavioural tasks including the dot probe, Stroop, spatial cueing, visual search and attentional blink task (e.g. Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Fox, Russo, & Georgio, 2007; Koster, Leyman, De Raedt, & Crombez, 2006; Notebaert, Crombez, Van Damme, De Houwer, & Theeuwes, 2011). Neuroscientific techniques including fMRI, EEG, and tDCS have been used to provide insight into anxiety-related differences in attention (e.g. Bar-Haim, Lamy, & Glickman, 2005; Bishop, Duncan, & Lawrence, 2004; Bishop, Jenkins, & Lawrence, 2007; Clarke, Browning, Hammond, Notebaert, & Macleod, 2014; Etkin et al., 2004; Monk et al., 2006) and there has recently been a surge of work using eye tracking to capture attention over time in anxious populations (Armstrong and Olatunji, 2012; Chen, Thomas, Clarke, Hickie, & Guastella, 2015; Dodd et al., 2014).

Across this range of techniques, there has been some inconsistency in findings but on balance the evidence suggests that anxious adults display an attention bias for threat-related stimuli. A meta-analysis of research using the dot probe, Stroop, and spatial cueing task found that the attention bias is reliably found at a moderate effect size across these tasks (Bar-Haim et al., 2007). More recently, a meta-analysis of eye tracking studies reported an anxiety-related attention bias of similar magnitude (Armstrong & Olatunji, 2012).

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In the present paper, we aim to extend this work by investigating how top–down factors such as task goals that determine the relevance of emotional information in an attention task affect anxiety-linked attention bias. A number of theories of attention predict that goals guide visual attention such that individuals will preferentially attend to stimuli that have relevance for their current goal and disregard stimuli that are irrelevant to these goals, even when goal-relevant stimuli have no long-term emotional or motivational value (Corbetta & Shulman, 2002; Desimone & Duncan, 1995; Moskowitz, Li, & Kirk, 2004; Vogt, De Houwer, Moors, Van Damme, & Crombez, 2010; Vogt, De Houwer, & Moors, 2011). A series of studies examining basic emotional attention have recently tested this prediction in healthy samples. These studies have indicated that task instructions and goals can profoundly impact participants' performance during tasks measuring attention to emotion. Importantly, the findings suggest that attention bias to emotional information may be absent when emotion is task irrelevant (e.g. Hahn & Gronlund, 2007; Vogt, De Houwer, Crombez, & Van Damme, 2013; Vromen, Lipp, & Remington, 2015).

A nice example of this work comes from Stein and colleagues (Stein, Zwickel, Ritter, Kitzmantel, & Schneider, 2009) who conducted three versions of the attentional blink task. In this task, participants are presented with a stream of visual stimuli in rapid succession. An 'attentional blink' occurs when participants fail to detect a second target (T2) that occurs within quick succession of a first target (T1), typically less than 500 ms (Shapiro, Arnold, & Raymond, 1997). This task can be used to estimate the attentional resources allocated to the T1 stimulus; with longer blinks associated with increased allocation of attention to T1 (Shapiro et al., 1997). In the three versions of the attentional blink task used by Stein et al. the stimuli were identical, with T1 being an emotional face and T2 being a scene. Participants' task at T2 was always to identify whether the scene was an outdoor or indoor scene but their task at T1 was manipulated across the three versions. In the first experiment, participants were asked to categorise the emotion shown on the face. In the second, they were asked to categorise the gender of the face. In the third, they were given no task for T1. The results indicated that fearful faces induced a stronger attentional blink than neutral faces only in the first experiment, when participants had been instructed to respond to the emotion shown on the face. No difference was found in the attentional blink caused by the fearful relative to neutral faces in the second and third experiment, when facial emotion was not task relevant. The authors interpret their findings as indicating that the effect of emotional faces on temporal attention is sensitive to participants' attentional set, which depends on the task goal.

In a similar study using visual search to examine spatial attention, Hodsoll, Viding, and Lavie (2011) examined whether emotional faces would capture attention when they were not relevant to the task. Across a series of five experiments, participants were asked to locate a target face, defined as the discrepant gender in the array, and to report the orientation of the face. Thus emotion was not relevant to the task. On one-third of trials one of the faces displayed an emotional expression; half of the time this was the target face and half of the time it was one of the distractor faces. Evidence for difficulty disengaging attention from emotional distractors was found across fearful, angry and happy stimuli; participants were slower to respond to the target face when the distractor faces included an emotional face. In contrast, there was no indication that negative emotional faces engaged attention; when the array displayed a negative target stimulus with neutral distractors, participants were no faster to respond to the target than when the array displayed a neutral target amongst neutral distractors. A facilitation effect, indicating attentional engagement was found when target faces were happy. Taken together, these results indicate that, in healthy individuals, when emotion is not task relevant, negative emotion does not engage attention. This is consistent with the results of Stein et al. (2009), although emotion may affect disengagement effects of attention from distractors. The former findings may appear to contradict the vast literature using visual search tasks, which demonstrates that emotion engages attention and facilitates target detection (e.g. Pinkham, Griffin, Baron, Sasson, & Gur, 2010; Williams, Moss, Bradshaw, & Mattingley, 2005). However, these findings are in fact consistent with those of Stein et al. (2009) and Hodsoll et al. (2011) because, in classic visual search studies, emotion is relevant to the task; thus an attention bias for emotional stimuli would be expected also from a top–down perspective.

The research outlined above indicates that the task relevance of emotion can have an important impact on whether a bias in attention is observed in healthy individuals or not. What is currently unclear is how this effect of task instructions and task goals interacts with long-term goals or biases in attention such as those observed in anxious individuals. For instance, attention bias to negative information might be more readily erased or overwritten in healthy participants because they appraise negative emotional events as less dangerous or have not acquired biases towards them. Relatedly, some theories of attention bias in anxiety have suggested that chronically activated long-term goals might underlie attention to threat in anxiety. For example, Wells and Matthews (1994) (see also Vogt et al., 2013) propose that the goal to search for threat is habitually active in anxious individuals and that it drives an attention bias for threat even when the task goal of the implemented attention task does not turn threat task relevant. If this is the case then it follows that anxious participants will attend to threat even when it is not their explicit task goal. However, when non-anxious individuals are given a goal of searching for emotion, their attention should resemble that of anxious participants such that anxiety-related differences in attention are minimised. This prediction is based on previous research suggesting that non-anxious participants display an attention bias to threatening information that is equivalent to the bias shown by high anxious individuals when threatening information is worth monitoring such as cues that predict the delivery of an electrocutaneous shock (Notebaert, Crombez, Van Damme et al., 2011). Thus, an anxiety-linked attention bias may be most apparent when the emotional content of stimuli is not relevant to the attention task. This prediction is examined in the present research.

In this study we draw upon the research outlined above, regarding the importance of task instructions and goals, to examine how the relevance of emotion to task goal affects conclusions regarding anxiety-linked attention bias. This is a vital area of study because a wide range of tasks are used to measure attention bias, and the task goals given to participants vary across these tasks. In some paradigms participants are instructed (given the goal) to search for emotion (e.g. Öhman, Flykt, & Esteves, 2001; Rinck, Becker, Kellerman, & Roth, 2003), other tasks do not give this as an explicit instruction but the task is designed in such a way that participants would quickly establish the goal of looking for emotion (e.g. Notebaert, Crombez, Van Damme, De Houwer, & Theeuwes, 2010; Notebaert, Crombez, Vogt et al., 2011), and in others, like the dot probe task, emotion is entirely irrelevant to the task (MacLeod, Mathews, & Tata, 1986). Despite these differences between tasks, to our knowledge, no research has examined how the emotional relevance of task goals affects attention bias associated with anxiety. This research will therefore have implications for the design and interpretation of studies focused on attention bias in anxiety.

We examine the association between anxiety and attention bias to threat using two consecutive visual search tasks, which differ on task goal. In one task, participants are given the goal of searching for an emotional face (emotion-relevant task). In the other task, emotion is present but is not the search goal (emotion-irrelevant