Orienting and maintenance of attention to threatening facial expressions in anxiety – An eye movement study

Pawel Holas [a,b,*], Izabela Krejtz [c], Marzena Cypryanska [d], John B. Nezlek [e,f]

[a] II Department of Psychiatry, Medical University of Warsaw, Poland
[b] Psychology Department, University of Warsaw, Poland
[c] Interdisciplinary Center for Applied Cognitive Studies, Warsaw School of Social Sciences and Humanities, Poland
[d] Department of Psychology, Warsaw School of Social Sciences and Humanities, Poland
[e] Department of Psychology, College of William and Mary, Williamsburg, VA, USA
[f] University of Social Sciences and Humanities, Poznan, Poland

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ABSTRACT

Cognitive models posit that anxiety disorders stem in part from underlying attentional biases to threat. Consistent with this, studies have found that the attentional bias to threat-related stimuli is greater in high vs. low anxious individuals. Nevertheless, it is not clear if similar biases exist for different threatening emotions or for any facial emotional stimulus. In the present study, we used eye-tracking to measure orienting and maintenance of attention to faces displaying anger, fear and disgust as threats, and faces displaying happiness and sadness. Using a free viewing task, we examined differences between low and high trait anxious (HTA) individuals in the attention they paid to each of these emotional faces (paired with a neutral face). We found that initial orienting was faster for angry and happy faces, and high trait anxious participants were more vigilant to fearful and disgust faces. Our results for attentional maintenance were not consistent. The results of the present study suggest that attentional processes may be more emotion-specific than previously believed. Our results suggest that attentional processes for different threatening emotions may not be the same and that attentional processes for some negative and some positive emotions may be similar.

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1. Introduction

A basic function of attention is to select relevant stimuli in the environment for further scrutiny (Lavie et al., 2004). It has been suggested that threat-processing attentional biases play an important role in the etiology and maintenance of anxiety disorders (e.g., Beck et al., 1985; Williams et al., 1997). More specifically, numerous cognitive models suggest that individuals with high trait anxiety (HTA), compared to those with low trait anxiety (LTA), have a lower threshold for threat detection and exhibit an attentional bias, or increased vigilance toward threatening information (e.g., Mathews and Mackintosh, 1998; Williams et al., 1997).

Understanding the role of anxiety in attentional bias has theoretical importance (Bar-Haim et al., 2007), and it is important for advancing therapy for anxiety disorders, particularly attention modification training (Cisler and Koster, 2010). The present study was intended to advance our understanding of roles attentional

bias to emotional stimuli may play in the etiology and maintenance of anxiety, and more generally, to further our understanding of attentional biases to threatening facial expressions. Participants, who were classified as high or low in trait anxiety based upon their scores on the STAI (Spielberger et al., 1983), viewed faces that expressed different emotions. We measured their attention to these stimuli using eye-tracking and compared their responses to different emotional expressions. We describe the questions of interest and hypotheses that guided the study below.

A growing body of research suggests that anxious individuals, compared to the non-anxious, have an initial orienting biases toward threat (Armstrong and Olatunji, 2012; Bar-Haim et al., 2007; Cisler and Koster, 2010). Nevertheless, important questions about the roles anxiety plays in attentional biases remain unanswered. For example, it is unclear if attentional biases related to anxiety reflect faster orienting, what is sometimes referred to as the vigilance hypothesis, difficulty disengaging attention from threat, what is sometimes referred to as the maintenance hypothesis, or both (Weierich et al., 2008). A recent meta-analysis of 25 studies that used eye-tracking to study affective disorders (Armstrong and Olatunji, 2012) found broad support for the vigilance hypothesis in anxious individuals, and far less support for the maintenance

hypothesis. Furthermore, and more importantly for the present study, the specific type of emotional stimuli required to elicit attentional biases (e.g., Becker et al., 2001) and possible differences among attentional biases toward different emotional stimuli are not well understood.

Although researchers have used different facial expressions in studies of attention to threatening stimuli, they frequently provide no clear explanation of why they choose the expressions they used. Consequently, the exact source and nature of the biases are not clear. For example facial expressions of anger, disgust, contempt, and fear have been pooled together under the term "threatening" (Staugaard, 2010). This confusion and lack of clarity are exemplified by differences between two meta-analyses of threat-related biases in anxiety. Bar-Haim et al. (2007) classified fearful and angry expressions as threat-related, whereas Staugaard (2010) classified studies using anger and disgust, but not fear, as threat-related.

Similarly, although Armstrong and Olatunji (2012) found broad support for the proposition that anxious individuals detect threat more readily than the non-anxious, they did not distinguish different emotions. The majority of studies about attentional phenomena and anxiety have used anger as a threatening emotion, a few studies have used fear, and even fewer have used disgust (Buckner et al., 2010; Cislers et al., 2009). It remains to be seen if different facial expressions that have been treated as threatening faces elicit similar attentional biases.

Although faces displaying various emotions have been used as threatening stimuli in cognitive and neuro-scientific studies (Klumpp et al., 2010), it is not clear that these threatening emotions are interchangeable. For example, the nature of threat signaled by angry and fearful expressions seems to be qualitatively different (e.g., Whalen, 1998). Angry facial expressions convey hostility – a direct and immediate threat. Although a fearful face signals the presence of threat, the source of the fear is undetermined, and fearful faces are sometimes interpreted similarly to sad faces as a submissive behavior or as expecting help from others (Marsh et al., 2007). Disgust resembles anger because it signals disapproval – a threat to the self-esteem of the receiver, and some studies have found that when judging different facial expressions, people confuse anger with disgust (e.g., Montagne et al., 2006).

Moreover, the few studies that have compared reactions to different threat related stimuli have produced inconsistent results. In a study using a visual probe, Williams et al. (2005) found that angry, but not fearful, faces attracted more attention among the anxious. In contrast, Mogg et al. (2007) found that fearful and angry faces elicited similar attentional orienting biases, and Schofield et al. (2013) found similar gaze behavior for fear and anger. To our knowledge, no study has directly compared anger, fear, and disgust with one another in terms of attentional biases related to anxiety, and comparing attentional biases to these three stimuli was an important rationale for the present study.

It is also unclear if attentional biases exist only for threat information because some research suggests anxiety underlies a more general sensitivity to negative stimuli or to stimulus emotionality (e.g., Fox et al., 2002, exp. 1; Keil and Ihssen, 2004; Wieser et al., 2009). For example, two recent studies that have examined attentional processes in anxiety (social phobia) highlight the importance of considering attentional biases to positive stimuli. Chen et al., 2012 found that socially anxious participants disengaged from positive stimuli more readily than they did from negative stimuli. Schofield et al. (2013) found that social phobics attended similarly to emotional and neutral expressions across trials, in contrast to healthy controls who preferentially attended to happy expressions and were more likely to withdraw attention from threat expressions.

To examine the possibility that attentional processes to threatening faces may reflect a sensitivity to negative emotions or to emotionality per se, in the present study, we also included faces that displayed non-threatening emotions. As described below, participants viewed sad faces (to control for emotional valence) and happy faces (to control for emotional arousal).

In addition to considerations of the nature of the stimuli used to examine attentional processes in anxiety, there is also the issue of how to measure attention. The vast majority of research on attentional biases for emotional stimuli in anxiety has measured attention using reaction time (RT) (e.g., Bar-Haim et al., 2007; Weierich et al., 2008). Although this research has been informative, as discussed by Armstrong and Olatunji, (2012), RT based measures of attention are limited in some potentially important ways. One limitation is that when measuring attention using RT, there is a possible confound between the effects of a stimulus (particularly an emotional stimulus) and the time it takes to press a key to record a response. Another is that RT is based on measures of individual points in time ("a snapshot"), which makes it difficult to capture the dynamics of attention.

Eye tracking is an alternative method that measures perception dynamically and provides a good basis for evaluating the time course of visual attention. There is no delay between attending to a stimulus and the measurement of that attention, and the technique provides accurate measures across time. Moreover, eye-tracking has been shown to be an informative method of examining relationships between attentional processes and anxiety (e.g., Armstrong and Olatunji, 2012). Given these advantages, in the present study, we measured attentional processes using eye-tracking.

To disentangle the various factors that may be responsible for attentional biases in trait anxiety, we studied biases in initial orienting and maintenance of gaze toward faces displaying different emotions. Our study was designed to address the following questions within the context of understanding the roles of attentional processes in the formation and maintenance of anxiety.

1. Do the three threat inducing faces (fear, anger, and disgust) elicit the same attentional biases?
2. Do similar orienting and maintenance biases exist for all emotional faces (regardless of valence), or are they elicited by any type of negative cue, or are they elicited exclusively by threat-related cues?
3. To what extent do the processes described in #1 and #2 vary as a function of individual differences in trait anxiety?

Participants viewed faces displaying the three most commonly used threatening emotions (fear, anger, and disgust), and they viewed happy and sad faces as exemplars of positive active emotions and negative deactive emotions respectively (Feldman Barrett and Russell, 1998). We used the happy and sad faces because the valence (positive vs. negative) and activation level (active vs. deactive) of emotions have not been examined systematically in studies of attentional bias and anxiety, reducing the strength of inference of these studies. For example, a study that examines differences between processing threatening and neutral stimuli represents a confounding of valence and activation. Threat elicits a negative active emotional response and neutral is non-negative and non-active. Differences in reactions to neutral and threatening stimuli in such studies might represent participant's sensitivity to negative valence or to stimulus emotionality rather than anxiety relevance per se (Keil and Ihssen, 2004).

Regarding components of attentional bias, based on previous research (e.g., Mogg et al., 2007), we hypothesized that angry and fearful facial expressions would elicit similar biases in visuospatial orienting. That is, participants would direct their gaze initially