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Happy and angry faces: Subclinical levels of anxiety are differentially related to attentional biases in men and women ☆

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ABSTRACT

Sensitivity towards threat is a robust finding in anxious individuals. The dot probe task is one of the most commonly used experimental paradigms to study attentional biases in anxiety. However, previous research relied mostly on extreme group comparisons, suffered from small sample size and sex imbalance, and did not investigate sex differences or attentional biases toward facial emotional expressions other than anger and happiness. We present data of a large community sample showing that high-anxious women exhibit an expected attentional bias towards angry faces, whereas high-anxious men exhibit a bias towards happy faces. We discuss our findings with regard to the generalizability of previous research and the need for further studies.

1. Introduction

In normal as well as in clinical populations extensive research postulated increased attentional orienting and preoccupation with biologically relevant and mood-congruent environmental stimuli (Frewen, Dozois, Joanisse, & Nefeld, 2008; Yiend, 2010). Especially in anxiety or among high-anxious individuals, but also in depressive disorders, the visual-attentional system is overly sensitive towards threat cues (e.g., angry faces representing potential predators) and avoidant of cues of reward (e.g., happy faces representing potential mates; Frewen et al., 2008). Therefore, attentional biases seem to play a prominent role in the development and maintenance of symptoms of anxiety and depression (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007; Frewen et al., 2008; Staugaard, 2010).

Main experimental paradigms of the investigation of attentional biases are the emotional stroop, the emotional spatial cueing paradigm, the visual search paradigm, and the dot probe task. Of these, one of the most frequently used is the dot probe task (Bar-Haim et al., 2007). In its original version (MacLeod, Mathews, & Tata, 1986), subjects were presented with two words on a computer screen for 500 ms, one on the left, one on the right side of the screen, one emotionally valenced (threat-related) and the other one neutral, matched both for length and frequency. Immediately after display termination, a dot (the 'probe') appeared in the location of one of the words, either in the position of the emotional stimulus (=congruent trial) or in the position of the neutral stimulus (=incongruent trial). Subjects had to indicate visual detection of the probe by pressing a corresponding button as fast as possible. If attention is captured by the emotional stimuli, response times are shorter for congruent trials. If attention is guided away from the emotional stimuli (=avoidance), response times are shorter for incongruent trials. Subtracting mean response times in congruent from incongruent trials results in a commonly used bias index that is positive when attention is drawn to the emotional stimuli, considered an attentional bias, and negative when emotional stimuli are avoided.

When measuring attentional biases on a behavioral level, the dot probe task is assumed to be methodologically superior to the other paradigms. In contrast to the emotional spatial cueing task, two stimuli instead of one (one emotional and one neutral) are presented simultaneously in the dot probe task, thereby allowing the investigation of selective attentional processing with regard to the preference of one of the two stimuli over the other (Yiend, 2010). In the stroop task, participants have to respond to one aspect of the stimulus (e.g., color) while ignoring another aspect (e.g., emotional content of a picture). Whereas the emotional stroop task thus measures interference effects rather than simple attentional processes, the dot probe task assesses lower-order cognitive processes, as participants respond only to a neutral target stimulus (the dot probe). Therefore, reaction times of the dot probe task

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are not susceptible to a general arousal or response bias elicited by the emotional content of the target stimulus which may affect both the emotional stroop task and the emotional spatial cueing task (Bar-Haim et al., 2007; Yiend, 2010).

Research with the dot probe task showed that an attentional bias towards threat-related stimuli is a robust phenomenon that distinguishes anxious from non-anxious subjects – non-anxious subjects do not show such a bias (Bar-Haim et al., 2007). Moreover, presence and magnitude of this bias do not depend on a clinical diagnosis or on the type of anxiety disorder, because nonclinical high-anxious subjects (i.e., subjects scoring high in self-reported anxiety) show a similar bias (Bar-Haim et al., 2007; Mogg & Bradley, 1999; Salemink, van den Hout, & Kindt, 2007).

In contrast to the original version of the dot probe task (MacLeod et al., 1986), facial stimuli (e.g., angry or threatening faces) and presentation durations of less than 500 ms were later found to induce larger effects, especially when combined (Bar-Haim et al., 2007; Frewen et al., 2008; Staugaard, 2010). Recognition of facial expressions is a highly automatic process and takes place very quickly – even without awareness (Morris, Ohman, & Dolan, 1998). Because of their ecological and interpersonal relevance, we therefore focus on facial emotional stimuli for the remainder of this work. Moreover, while attentional bias effects in the emotional stroop likely reflect relatively late and controlled processes and therefore tend to be larger with longer presentation durations, the attentional bias effect in the dot probe task reflects earlier processes that do not depend on cognitive control (Bar-Haim et al., 2007). Short presentation durations may thus reveal attentional biases in the dot probe task more efficiently as they minimize effects of cognitive control that could otherwise interfere with primary behavioral responses (MacLeod et al., 1986).

Even though the dot probe task is a frequently used paradigm, some authors suggest that the commonly used framework of the dot probe task and the bias index is inherently deficient. Positive scores in the bias index may either be due to fast reactions in congruent trials (reflecting increased attention towards target stimuli) and/or due to slow reactions in incongruent trials (reflecting delayed disengagement from target stimuli; Cisler & Koster, 2010; Salemink et al., 2007). Thus, including trials with two neutral stimuli in the task may differentiate fast orienting more clearly from a difficulty to disengage as reaction times in the neutral–neutral trials may serve as a baseline. Consequently, two alternative bias indices can be computed: one reflecting difficulties in disengagement and the other one reflecting increased orienting (see Section 2.4 for details). Applying these methods, anxiety-related attentional biases seem to reflect specifically effects of delayed disengagement but not of increased attention (Cisler & Koster, 2010).

Some further issues also remain unclear or have not been investigated thoroughly with regard to the dot probe task. We focus on three points in this work concerning issues with regard to sampling, sex differences, and emotional content of facial stimuli used in previous research.

First, most investigations with the dot probe task relied on the extreme groups approach (EGA; Preacher, Rucker, MacCallum, & Nicewander, 2005) and compared patients or nonclinical subjects with high self-reported anxiety with non-anxious (i.e., healthy) subjects scoring especially low in self-reported anxiety. While this may raise statistical power, it may also result in the overestimation of effects and model misspecification (Preacher et al., 2005). One tenet of research on attentional biases is that these biases play a specific role in the development and maintenance of anxiety (Bar-Haim et al., 2007; Frewen et al., 2008; Staugaard, 2010). This involves the assumption that the relationship between attentional biases and anxiety is either linear or – alternatively – that discernible attentional biases only set in with higher levels of anxiety. However, research with the EGA is barred from investigating this relationship directly as it relies on subjects from the tails of the distribution and excludes healthy subjects with intermediate levels of anxiety.

Existing studies with the dot probe task in the general population focused mainly on conceptual issues, like the intensity of stimuli and stimulus duration (Yiend, 2010). They were suggestive of the vigilance-avoidance hypothesis (Mogg & Bradley, 1998) that predicts adaptive avoidance of mild threat but increased orienting towards threat as intensity increases. Thus, an attentional bias towards threat may also depend on threat intensity and is not a pure anxiety-related phenomenon. While previous studies used only pictorial scenes as stimuli, meta-analytical evidence (Bar-Haim et al., 2007) suggests that non-anxious individuals may avoid all threat-related stimuli. However, the aggregated effect was only small and inconsistent. Currently, it is thus not well-known whether facial stimuli may also elicit attentional biases in healthy subjects and to what extent threat-related attentional biases towards facial stimuli are anxiety-specific, as investigations comparing individuals from the whole range of the anxiety distribution are currently mostly lacking.

Second, investigations of sex differences in attentional biases are to date underrepresented in the literature (Sass et al., 2010). Research typically relied on rather small sample sizes and did not focus on sex differences. Yet, prevalence rates of anxiety disorders differ markedly between men and women (Kessler et al., 2005). Women also score higher than men in self-reported anxiety in nonclinical samples (Costa, Terracciano, & McCrae, 2001; Feingold, 1994). Various biological, temperamental, cognitive, and environmental factors are known to contribute to women's higher vulnerability to anxiety (see McLean & Anderson, 2009, for a review). Thus, sex imbalance (i.e., women outnumbering men) has to be expected both in clinical and nonclinical samples if not actively controlled by the researchers.

Moreover, recent studies – applying, however, other paradigms and methods than the dot probe task – provided suggestive evidence that men and women differ in attentional processes towards emotional stimuli. For example, an event-related potential (ERP) study, using a stroop task and word stimuli, found that women with high levels of anxious arousal showed enhanced neural activity during early visual processing stages (i.e., P100) compared to men, regardless of the emotional content of the stimuli (Sass et al., 2010). Behavioral studies with facial stimuli found that women had a greater ability than men to perceive and respond at an automatic processing level to positive stimuli (Donges, Kersting, & Suslow, 2012) and that a threat-related attentional bias was specifically limited to women, whereas men showed avoidance of threat (Tan, Ma, Gao, Wu, & Fang, 2011). Overall, women recognize emotional facial expressions also consistently better than men (Du & Martinez, 2011). Even though all cited studies applied a variety of experimental paradigms, different stimuli (words versus faces), and differed with regard to some other important aspects of design (e.g., Donges et al., 2012, used an affective priming paradigm with sad, happy, and neutral faces, and a presentation duration of 33 ms for primes; Tan et al., 2011, used an attentional cueing task with fearful, happy, and neutral faces, and a presentation duration of 800 ms), they suggest that attentional processes may differ between men and women, and, specifically, that a threat-related attentional bias may apply only to women but not to men. Given its high methodological standards, it is thus of interest whether sex differences in attentional biases towards facial stimuli can also be observed with the dot probe task.

Third, with regard to facial stimuli themselves, previous research with the dot probe task examined mostly only one (threat-related; e.g., angry faces) or two different emotional expressions (e.g., one threat-related, like anger, and one reward-related, like happiness). Less is known of attentional biases towards