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What does the facial dot-probe task tell us about attentional processes in social anxiety? A systematic review

Trisha Bantin [a], Stephan Stevens [a, b, *], Alexander L. Gerlach [b], Christiane Hermann [a]

[a] Department of Clinical Psychology, Justus Liebig University Giessen, Otto-Behaghel-Str. 10F, 35394 Giessen, Germany
[b] Department of Clinical Psychology and Psychotherapy, University of Cologne, Pohligstraße 1, 50969 Cologne, Germany

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ABSTRACT

Background/objectives: Current models of SAD assume that attentional processes play a pivotal role in the etiology and maintenance of social anxiety disorder. Social anxiety is supposedly associated with an attentional bias towards disorder related stimuli such as threatening faces. Using the facial dot probe task in socially anxious individuals has, however, revealed inconsistent findings.
Methods: The current systematic review aims at disentangling the heterogeneous findings using effect sizes across results by systematically taking into account potential moderating variables (stimulus type, stimulus duration, situational anxiety, disorder severity).
Results: Results provide some evidence that socially anxious individuals preferentially allocate their attention towards threat faces compared to non-anxious controls. This bias seems to depend on the type of reference stimulus, stimulus duration and clinical level of social anxiety. Avoidance of threat was neither found at early, nor at later stages of attentional processing.
Limitations: Importantly, the results have to be considered in the light of the only few studies available. Given the heterogeneity of results and some methodological restrictions of the studies included, the picture of attentional bias seems to be much less clear than suggested in the recent social anxiety literature.
Conclusions: Methodologically, combined measures of dot-probe and eye movement measures might be beneficial to detect overt attentional biases. Importantly, our results show that preferential processing of threat cues might guide early attentional processes in social anxiety, depending however on several contextual and situational factors. Clinically, patients with greater severity of SAD may be more prone to such an attentional bias, thus therapists should take this into account when planning behavioral experiments and exposure therapy.

1. Introduction

According to cognitive models of social anxiety, attentional processes play a pivotal role in the etiology and maintenance of social anxiety disorder (SAD; Clark & Wells, 1995; Rapee & Heimberg, 1997). Specifically, individuals with SAD supposedly show biased processing of disorder related stimuli such as threatening faces compared to neutral stimuli (Bogels & Mansell, 2004; Heinrichs & Hofmann, 2001; Staugaard, 2010). According to the vigilance-avoidance hypothesis (e.g., Bradley et al., 1997), initial attention is automatically shifted towards threat stimuli (vigilance). Subsequently, an avoidance response follows as a strategic attempt to reduce anxiety (e.g., Mogg, Bradley, Miles, & Dixon, 2004). This hypothesis was tested with several experimental paradigms. Several studies with the *emotional Stroop test* showed that individuals with SAD take longer to color-name social threat words compared to neutral words (e.g., Amir, Freshman, & Foa, 2002; Becker, Rinck, Margraf, & Roth, 2001; Gerlach, Schiller, Wild, & Rist, 2006; Mattia, Heimberg, & Hope, 1993), suggesting a vigilance effect. However, this effect is likely based not only on attention, but also on subsequent information processing that is independent from attention (Waters, Sayette, & Wertz, 2003). A paradigm that overcomes several of the problems of the Stroop test is the *visual dot-probe task* (MacLeod, Mathews, & Tata, 1986). Participants in the visual dot-probe task are to respond to probes

* Corresponding author. Department of Psychology, Clinical Psychology and Psychotherapy, University of Cologne, Pohligstraße 1, 50969 Köln, Germany. Tel.: +49 221 470 4723; fax: +49 221 470 5034.
E-mail address: stephan.stevens@uni-koeln.de (S. Stevens).

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that follow a cue either at the same spatial location or in a different spatial location. The two simultaneously presented stimuli (e.g., words or faces) differ, for example, in emotional content (e.g., threat-related vs. neutral) and/or relatedness to the disorder (e.g., physical threat, social threat). Probes appearing at the same location as the previously presented target stimulus are considered "congruent", those presented at the location of the neutral reference stimulus as "incongruent". By pressing a button, participants indicate the position of the probe as quickly and accurately as possible. Alternatively, a forced choice discrimination task can be used, where individuals have to respond to specific probe features, e.g., direction of an arrow (e.g., Stevens, Rist, & Gerlach, 2009). Since the response to stimuli presented at an attended location is usually faster, it is presumed that the difference in reaction time (RT) between congruent and incongruent trials reflects the allocation of attention. Shorter RTs in congruent compared to incongruent trials indicate vigilance towards the emotional stimulus. In contrast, shorter RTs in incongruent compared to congruent trials indicate avoidance.

Dot-probe tasks have frequently been used to measure biased attentional processing in social anxiety. Earlier studies mainly used word stimuli. These studies often failed to find an effect of social anxiety on attention (e.g., Horenstein & Segui, 1997; Pishyar, Harris, & Menzies, 2004). The processing of facial stimuli, however, may allow a more sensitive measurement of biased processing (Bradley et al., 1997; Pishyar et al., 2004). Facial expressions may be especially important for socially anxious individuals since this information may inform about negative evaluation by others (Rapee & Heimberg, 1997). For example, an angry face is a potent social sign of hostility (Staugaard, 2010). Thus, dot-probe studies often include negative faces depicting anger or disgust. Some studies (e.g., Mansell, Clark, Ehlers, & Chen, 1999; Yuen, 1994) additionally use other negative facial expressions, such as sadness and fear as control stimuli for negative valence.

Recent reviews support a vigilance towards threat stimuli in high compared to low trait anxious individuals (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJendoorn, 2007; Frewen, Dozois, Joanisse, & Neufeld, 2008). Schulz, Mothes-Lasch, and Straube (2013) reviewed studies on automatic information processing in SAD. They found initial evidence for automatic activation shown in a higher activation of limbic regions, as the amygdala, insula, and sensory cortices to angry vs. neutral faces in SAD, as well as automatic early ERP components, especially under implicit conditions. Findings of studies using the visual dot probe task with facial stimuli in socially anxious individuals are less consistent (e.g. Helfinstein, White, Bar-Haim, & Fox, 2008; Klumpp & Amir, 2009; Mansell et al., 1999; Pishyar, Harris, & Menzies, 2008; Pishyar et al., 2004; Pineles & Mineka, 2005; Stevens et al., 2009). This heterogeneity of results may be accounted for by substantial methodological differences in these studies. First, the type of reference stimulus may influence whether or not an attentional bias is observed. Most studies used neutral faces as reference stimuli, others used neutral household objects (Chen, Ehlers, Clark, & Mansell, 2002; Mansell et al., 1999; Sposari & Rapee, 2007). Second, an attentional bias may be more likely to be detected if situational anxiety is induced. For example, biased information processing may occur primarily when the fear network is activated. Consequently, in some studies, the visual dot probe task was performed while participants anticipated a speech (e.g. Mansell et al., 1999; Pineles & Mineka, 2005). Third, stimulus duration varies considerably across studies. As suggested by the vigilance-avoidance hypothesis (Mogg, Bradley, DeBono, & Painter, 1997), the likelihood of measuring an anxiety-related attentional bias will depend on stimulus duration. For example, in high socially anxious individuals a vigilance effect has been observed rather consistently for shorter stimulus durations (e.g., Mogg & Bradley, 2002; Pishyar et al., 2008; Stevens et al., 2009). By contrast, studies using longer stimulus durations yielded no vigilance effect for social anxious individuals (e.g. Gotlib et al., 2004; Mogg, Philippot, & Bradley, 2004). Rossignol et al. (2012) used an emotional oddball task in which they investigated the cognitive processing of different emotional facial expressions appearing amongst neutral faces over time. The results show that social anxiety enhances early perceptual facial processing. There were no effects concerning late components. Furthermore, recent research suggests that initial attention might only be measured by dot-probe tasks using short presentation times of facial stimuli (e.g., <200 ms), while when using longer presentation times measures of eye movement should be preferred (Stevens, Rist, & Gerlach, 2011). Fourth, the attentional bias may depend on the severity of social anxiety. Assuming that social anxiety is distributed along a continuum from no or little social anxiety up to clinical levels of social anxiety, an attentional bias may be more readily observed in patients rather than in high socially anxious individuals.

Understanding whether and under what circumstances such an attentional bias can be found in social anxiety sufferers has become even more relevant since the dot probe methodology is used to train attention away from threatening facial stimuli. The first two studies found impressive effects of such a training in social phobia patients (Amir et al., 2009; Schmidt, Richey, Buckner, & Timpano, 2009). However, three newer studies failed to demonstrate such an effect (Boettcher, Berger, & Renneberg, 2011; Carlbring et al., 2012; Neubauer et al., 2013). Intriguingly, as pointed out by Clarke, Notebaert, and MacLeod (2014), in some of these studies, patients were not assessed for biased attention prior to the attentional training. Possibly, patients may benefit from attentional retraining whether or not they actually show biased attention. Thus, it is not clear whether biased attention is indeed a core mechanism in SAD which needs to be addressed by treatment.

Several factors might influence whether or not an attention bias is present in socially anxious individuals and thus can be retrained. The objective of this systematic review is to disentangle the heterogeneous findings by systematically taking into consideration the stimulus type, stimulus duration, situational anxiety, and severity of social anxiety as potential moderators of attention as measured with facial dot-probe tasks in social anxiety. In order to quantify their influence, within and between-group effect sizes were computed. This review helps to further clarify which attentional processes (vigilance vs. avoidance) contribute to the psychopathology of SAD considering different factors influencing the experimental assessment and retraining of attention.

2. Method

2.1. Literature search and selection criteria

We searched Medline, PsycInfo and PubMed databases for facial dot probe studies in socially anxious individuals. Search terms were "dot probe", "facial stimuli", "social anxiety", "social phobia", "attention", "attention AND social anxiety", "attention allocation", "attentional bias". In addition, the unpublished Yuen (1994) study was sent to us after personal communication with Professor Anke Ehlers, Mai, 2010. No other research group in the field which we had contacted provided unpublished data using dot-probe methodology. Information on study design, participant characteristics, dot probe paradigm, stimuli and outcome variables were extracted and are documented in Table 1.

Studies were included when they used a facial dot probe task comparing either emotional faces to neutral ones or emotional faces to household objects, and both types of stimuli were