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Sustained visual attention for competing emotional stimuli in social anxiety: An eye tracking study



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ABSTRACT

Background and objectives: Numerous studies have supported attentional biases toward social threats in socially anxious individuals. The aim of the present study was to investigate the time-course of sustained attention for multiple emotional stimuli using a free-viewing paradigm in social anxiety.

Methods: Thirty-two socially anxious (SA) and 30 non-anxious (NA) participants completed the free-viewing task. Participants were presented with a face array composed of angry, sad, happy and neutral faces for 10 s in each trial. Eye movements were recorded throughout the trial to assess the time-course of attentional processing.

Results: Although SA participants did not exhibit initial orienting bias, they had higher fixation probability for angry faces during the 250–1000 ms time intervals, relative to NA participants. SA participants also maintained their attention longer than NA participants did when angry faces were initially fixated upon. Moreover, NA participants showed higher fixation probability for happy faces during the 6–8 s after stimulus onset. We failed to observe attentional avoidance of threat in SA participants.

Limitations: First, this study used a non-clinical sample. Second, the stimuli used in this study were static.

Conclusions: The present findings suggest that, relative to non-anxious individuals, socially anxious individuals are characterized by enhanced engagement with social threat at an early stage of processing and difficulty in disengaging from social threat once their initial attention is located on it. Conversely, non-anxious individuals are characterized by enhanced engagement with positive stimuli at a later stage of processing.

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1. Introduction

Cognitive theories have assumed that anxious individuals are hypersensitive to information that signifies a threat or danger (Beck & Emery, 1985; Mogg & Bradley, 1998; Williams, Watts, MacLeod, & Mathews, 1997). In the context of social anxiety, numerous studies have supported the hypothesis that socially anxious individuals show attentional biases toward socially threatening stimuli (e.g., threatening faces) (Bantini, Stevens, Gerlach, & Hermann, 2016; Staugaard, 2010). However, attentional biases might comprise different components (Cisler & Koster, 2010). A vigilance-avoidance hypothesis states that socially anxious individuals automatically

orient their initial attention toward threats but subsequently direct their attention away from threats (Mogg, Bradley, De Bono, & Painter, 1997; Williams et al., 1997). The delayed disengagement hypothesis claims that socially anxious individuals are characterized by difficulty in disengaging attention from social threats (Amir, Elias, Klumpp, & Przeworski, 2003).

As suggested by Weierich, Treat, and Hollingworth (2008), the two hypotheses might not be incompatible when the duration of stimulus presentation extends over multiple seconds. Attentional vigilance toward threat might occur at an early stage of presentation and be followed by delayed disengagement from threat (Cisler & Koster, 2010; Moriya & Tanno, 2011; Weierich et al., 2008). The phenomenon of attentional avoidance, which is assumed to be a controlled strategy for emotion regulation, might be observed at a comparatively late stage of information processing (i.e., after a presentation time of 1250 ms or longer) (Cisler & Koster, 2010;

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Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006; Weierich et al., 2008).

In recent years, considerable concern has arisen over the time-course of attentional bias to socially threatening information in social anxiety (Staugaard, 2010). The most commonly used paradigm to investigate selective attention for social information in social anxiety is the dot-probe task using facial expressions as stimuli (Bantin et al., 2016). However, the dot-probe task has been criticized because it relies on a key-press reaction time to index allocation of attention. Reaction time might be confounded by other cognitive processes (Staugaard, 2010) and variable motor speed (Mogg, Millar, & Bradley, 2000). Moreover, the dot-probe task does not indicate the time-course of attentional processing over the stimulus duration. Several authors have suggested that an eye tracking paradigm appears to be a more promising tool for investigating the time-course of attentional processing for emotional stimuli because it provides a relatively continuous measurement of attentional processing under a more natural condition (Eizenman et al., 2003; Kellough, Beevers, Ellis, & Wells, 2008).

Eye tracking has been widely used in research on attentional biases of patients with social anxiety disorder or individuals with high social anxiety (Gamble & Rapee, 2010; Garner, Mogg, & Bradley, 2006a; Schofield, Inhoff, & Coles, 2013; Seefeldt, Kramer, Tuschen-Caffier, & Heinrichs, 2014; Stevens, Rist, & Gerlach, 2011). Researchers have commonly used a free-viewing paradigm to examine participants' sustained attention toward emotional stimuli. In such studies, participants are asked to freely view two or four pictures displayed for several seconds (i.e., 5 s, 10 s or longer) in each trial. Eye movements during each trial were continuously recorded to investigate the time-course of attentional processing. In free-viewing studies, attentional vigilance toward social threats can be measured with the probability of initial fixation on threatening faces and the probability of fixation on threatening faces at an early stage (e.g., the first 500 ms). The former indexes participants' initial orienting toward threats and the latter indexes facilitated engagement toward threats at an early stage (Armstrong & Olatunji, 2012; Nummenmaa, Hyona, & Calvo, 2006; Richards, Benson, Donnelly, & Hadwin, 2014). Furthermore, the duration of initial fixation on threatening stimuli is commonly used to assess attentional maintenance and to examine whether an anxious individual has difficulty in disengaging from threats (Garner et al., 2006a). Attentional avoidance refers to a tendency to avoid allocating attention to threatening stimuli and is indicated by a lower probability of fixating on threatening stimuli at a later stage of attentional processing.

One meta-analysis of eye movement studies in affective disorders has supported the hypothesis that anxious individuals demonstrate increased vigilance toward threats and have difficulty in disengaging attention from threats (Armstrong & Olatunji, 2012). However, this analysis did not specially focus on social anxiety but included studies of a variety of different types of anxiety. With regard to social anxiety, most studies have used a free-viewing task with face pairs (e.g., angry-neutral pair) as stimuli. In addition to conducting an event-related analysis of the critical first eye movement event (i.e., the first fixation), some studies have also conducted epoch-related analysis by dividing the stimulus duration into several temporal segments (i.e., time bins) to examine the time-course of attentional processing. Some studies have shown attentional vigilance toward threatening faces in social phobia (Gamble & Rapee, 2010; Seefeldt et al., 2014; Stevens et al., 2011), while other studies have failed to support these findings. Other studies have found that socially anxious individuals showed attentional avoidance of both positive and negative faces (Byrow, Chen, & Peters, 2016; Chen, Clarke, MacLeod, & Guastella, 2012).

Schofield et al. (2013) reported that over time, participants with social phobia paid less attention to emotional faces, especially to happy faces. Another study found that socially anxious individuals demonstrated difficulty in disengaging from threatening faces (Buckner, Maner, & Schmidt, 2010b).

Although facial expressions are important signs of evaluation by others within social situations (Mansell, Clark, Ehlers, & Chen, 1999), face pairs may be too simple to resemble a real social situation and to induce anxious individuals' feelings of being threatened. Some researchers have suggested that research on threat-related attentional biases should use more complex stimuli arrays with various competing emotional stimuli (e.g., threatening, non-threatening and positive) presented simultaneously (Richards et al., 2014). Lazarov, Abend, and Bar-Haim (2016) utilized a free-viewing paradigm that presented a 4×4 matrix comprising eight disgusted and eight neutral facial expressions for 6 s. They found that socially anxious participants spent more time fixating on threatening faces. Although Lazarov et al. used a matrix of 16 faces in their study, they included only two categories of facial expressions (i.e., disgusted and neutral) in a matrix. Buckner, Dewall, Schmidt, and Maner (2010a) used a 2×2 matrix including angry, sad, happy and neutral facial expressions for 30 s. They found that the highly socially anxious participants allocated more attention to negative faces in the absence of social-exclusion threat. Unfortunately, neither of these studies addressed the time-course of attentional processing during stimuli presentation.

The present study aims to investigate the time-course of sustained attention for multiple emotional stimuli in individuals with social anxiety. We used a free-viewing task that presented a matrix of four faces including angry, sad, happy and neutral faces for a relatively long stimulus duration (i.e., 10 s). This task was designed to simulate an ambiguous social situation containing positive, negative, and neutral information. Angry faces have been frequently used to evaluate threat-related attentional bias in previous studies of social anxiety (Staugaard, 2010). Although some research suggests that disgusted faces may be more relevant for social anxiety-related fears, we chose angry faces to represent threatening stimuli because the angry expression has been assumed to be the most salient sign of criticism and hostility in social situations (Ekman, 1973; Staugaard, 2010). The location of initial fixation and initial gaze duration were used to index the initial orienting and maintenance of attention, respectively. To evaluate changes in attentional processing in detail in the early phase, the first 2 s of the stimulus duration were divided into eight time bins of 250 ms, because studies have suggested that we generate 3–4 fixations per second (Hoffman, 1998; Rayner, 1998). To explore sustained attention for emotional faces in social anxiety, we also divided the 10-s stimuli duration into five 2-s time bins. Socially anxious participants were predicted to be more likely to fixate on angry faces initially and to fixate on angry faces at an early stage (i.e., vigilance). They were also expected to exhibit a longer initial gaze duration when angry faces were initially fixated upon (i.e., difficulty in disengagement). Moreover, we hypothesized that socially anxious participants would have a lower probability of fixating on angry faces at a relative late stage (>1250 ms) and that they would continuously inhibit to fixate on angry faces during sustained exposure to emotional faces (i.e., avoidance).

2. Method

2.1. Participants

The participants in this study were recruited from a large pool of potential participants at a university in Taiwan. Socially anxious (SA) and non-anxious (NA) groups of participants were selected

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