# You don't like me, do you? Enhanced ERP responses to averted eye gaze in social anxiety

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## ABSTRACT

Social anxiety is associated with an attentional bias toward angry and fearful faces, along with an enhanced processing of faces per se. However, little is known about the processing of gaze direction, a subtle but important social cue. Participants with high or low social anxiety (HSA/LSA) observed eye pairs with direct or averted gaze while subjective ratings and event-related potentials (ERPs) were measured. Behaviorally, all participants rated averted gaze as more unpleasant than direct gaze. Neurally, only HSA participants showed a trend for higher P100 amplitudes to averted gaze and significantly enhanced processing at late latencies (Late positive potential [LPP]), indicative of a specific processing bias for averted gaze. Furthermore, HSA individuals showed enhanced processing of both direct and averted gaze relative to the LSA group at intermediate latencies (Early posterior negativity [EPN]). Both general and specific attentional biases play a role in social anxiety. Averted gaze – a potential sign of disinterest – deserves more attention in the attentional bias literature.

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## 1. Introduction

Current theories of social anxiety (Clark and Wells, 1995; Rapee and Heimberg, 1997) suggest that socially anxious individuals have an attentional bias for negative social cues, such as facial displays of anger, that could indicate social rejection or threat. This bias is thought to fuel negative self-beliefs (e.g. "Others dislike me"), thereby playing a key role in the initiation and maintenance of social fears. If socially anxious individuals subsequently avoid these cues (e.g. by reducing direct eye-contact), they might be perceived as less warm and interested by others (Clark and Wells, 1995), creating a vicious cycle.

The bulk of experimental research suggests a specific role for facial anger and other emotions in social anxiety (reviewed below). Less clear, however, is whether these negative attentional biases extend to more subtle social cues, such as *gaze direction*, which are much more common in every day life than open displays of anger but might still signal either social attention (direct gaze, Moukheiber et al., 2010; Schneier et al., 2011; Wieser et al., 2009) or disinterest/rejection (averted, Itier and Batty, 2009). Thus, eye gaze is more ambiguous when compared to distinct facial emotion and may therefore leave more room for anxiety specific interpretation and processing biases (e.g. Clark and Wells, 1995). In the following sections, we review available evidence regarding the behavioral (dot-probe) and neural (event related potentials [ERPs]) processing of emotional faces and eye gaze in socially anxious individuals.

### 1.1. Behavioral responses to faces and gaze in social anxiety

The most frequently employed approach for the study of attentional biases in social anxiety is the dot-probe paradigm. In this task, participants respond to a probe which – after a certain cue presentation time – replaces one of two lateral stimuli (e.g. faces). Speeding or slowing of this response is taken as evidence for spatial attention. While most studies which used dot-probe methods found a hyper vigilance (enhanced attention) for fearful and angry faces in social anxiety (e.g. Klumpp and Amir, 2009; Sposari and Rapee, 2007; Stevens et al., 2009), there is also research reporting either an avoidance of these faces (e.g. Gotlib et al., 2004; Pineles and Mineka, 2005) or an absence of group differences between socially anxious participants and controls (e.g. Chen et al., 2002). Since cue presentations times varied between these studies, their discrepant findings could partially be explained by assuming a *biphasic* response pattern: After an early enhanced negative attention to social threat follows a consecutive later avoidance of the feared stimuli (hyper vigilance – avoidance hypothesis; see also Heinrichs and Hofmann, 2001).

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A very common yet subtle facial cue is gaze direction (Adams et al., 2010; Emery, 2000; Henderson et al., 2005; Itier et al., 2007a,b; Maurage et al., 2011). In the context of neutral facial expressions, direct gaze signals social attention, which can be perceived threatening to social anxiety (Clark and Wells, 1995; Rapee and Heimberg, 1997), whereas averted gaze might signal disinterest (Itier and Batty, 2009). Several studies have been conducted on gaze and social anxiety, showing elevated fear ratings of eye-contact and avoidance of the eye region in social anxiety (e.g. Baker and Edelmann, 2002; Horley et al., 2003; Schneier et al., 2011). For example, in an eye-tracking study Horley et al. (2003) examined the number of fixations on pictures of emotional and neutral faces in patients with social phobia and a healthy control group. As expected by the authors, social phobics showed fewer fixations on the eye-region of the presented faces, which was most pronounced for faces with an angry expression. However, a recent eye-tracking study by Wieser et al. (2009) on gaze processing in high socially anxious adults failed to confirm this. In their study, a sample of high (HSA) and low socially anxious (LSA) females watched animated neutral faces with either direct or indirect gaze. Surprisingly, the high anxious group did not avoid the eye-region of avatars with direct gaze more often than did low socially anxious females. Interestingly, both high and low socially anxious participants rated averted gaze as more unpleasant than direct gaze, pointing to the potential aversive quality of averted gaze when not paired with a negative facial emotion.

### 1.2. Brain responses to faces and gaze in social anxiety

To better understand the temporal dynamics of threat detection in social anxiety, researchers have used event-related potentials (ERPs), which due to their high temporal resolution allow detailed insights into early attentional and affective processing of facial information (e.g., Eimer and Holmes, 2007). Previous research has shown that ERPs to faces are modulated by gaze direction even at very early stages (e.g. 100 ms after stimulus onset), and may therefore serve as a highly sensitive indicator for the cortical processing of human gaze (Fichtenholtz et al., 2009; Itier et al., 2007a,b; Kloth and Schweinberger, 2010).

Several studies have investigated ERPs in socially anxious individuals to full faces (with direct gaze) and various emotional facial expressions. For example, Moser et al. (2008) presented HSA and LSA individuals with reassuring and threatening faces during a modified flanker task. While groups did not differ on behavioral measures, the HSA group showed larger parietal late positive potentials (LPPs) to threatening faces when compared to LSA individuals. Moser and colleagues interpret their findings as evidence for an enhanced processing of threatening faces in high social anxiety. This interpretation is supported by the results of other ERP studies on face processing in socially anxious samples (Kolassa and Miltner, 2006; Rossignol et al., 2007). However, there is also evidence for a priorized processing of faces in HSA individuals irrespective of expression. For example, Mühlberger et al. (2009) recently assessed ERPs elicited by both natural and artificial faces with fearful, angry, happy as well as neutral expressions in a sample of HSA and LSA participants. Over the right hemisphere, HSA individuals showed an enhanced P100 to all faces, possibly indicating very early attentional processing (cf. Luck et al., 2000; Mangun, 1995). Further, the LPP amplitudes discriminated between neutral and emotional faces in LSA individuals, while this was not the case in high socially anxious individuals, possibly due to their generally increased responding. Similar results are reported by Kolassa et al. (2007) who found enlarged P100 amplitudes in social phobics to emotional faces regardless of expression. Thus, there is evidence for specific biases (enhanced responses to certain expressions) as well as for generalized biases (enhanced responses to faces per se) in social anxiety.

### 1.3. The present study

The goal of the current study was to examine early attentional/emotional processing of direct and averted gaze in the absence of disambiguating facial expression in relation to social anxiety. HSA and LSA participants were exposed to images of isolated eye pairs with either direct or averted gaze while subjective ratings and ERPs were obtained. In line with previous findings from behavioral and eye-tracking studies on gaze processing and ERP studies on faces in social anxiety (Horley et al., 2003; Kolassa et al., 2007; Kolassa and Miltner, 2006; Moser et al., 2008; Moukheiber et al., 2010; Schneier et al., 2011) our hypotheses were the following. (1) Behaviorally, HSA participants will rate direct gaze as more unpleasant than LSA participants. (2) Neurally, on ERPs (P100; N170; EPN; LPP), HSA individuals will show an enhanced processing of direct eye-gaze and/or a generally enhanced processing of all gaze stimuli when compared to the LSA Group. We also assessed gaze effects on early posterior negativity (EPN), which may be particularly sensitive for an enhanced face processing in social anxiety (e.g. Blechert et al., 2012; Mühlberger et al., 2009). Since there have been reports of sex differences in responding (e.g. Bradley et al., 2001), we also assessed effects of participant and target sex.

## 2. Method

### 2.1. Participants

Participants were 55 (28 female) undergraduates from two West Coast universities in the United States who had normal or corrected to normal vision and who participated for course credit. Participants were recruited through a screening procedure to obtain a sample with a wide range of levels of social anxiety along an overrepresentation of extreme groups (high vs. low). None of the participants reported a history of a psychiatric or neurological disorders. Participants were split into two groups using their scores on the Brief Fear of Negative Evaluation Questionnaire (BFNE; Median: 33) and were assigned either to the low social anxiety (LSA; $n = 25$) or the high social anxiety group (HSA; $n = 26$). Two participants were excluded because their BFNE scores fell on the median. Details on the demographic and psychometric characteristics of the sample can be found in Table 1.

### 2.2. Measures

The *Brief Fear of Negative Evaluation* questionnaire (BFNE; Carleton et al., 2006) is a self-report measure assessing fear and worry of negative evaluation by others (e.g. "I am usually worried about what kind of impression I make"), the main diagnostic criterion for social phobia, and is composed of 12 items which are rated on a Likert Scale ranging from 1 ("Not at all") to 5 ("Extremely"). The BFNE Scale successfully discriminates social anxious from non-anxious participants, has an excellent reliability, and shows high correlations with other measures of social anxiety (Carleton et al., 2007; Wieser et al., 2009). We used the BFNE to split participants into HSA and LSA groups.

To more completely characterize participants, we also administered two other measures. The *Beck Depression Inventory* (BDI-II; Beck et al., 1996) is a 21-item self-report measure of depressive symptoms over the preceding two weeks (e.g. "I am sad all the time"). Items are rated on a 4-point Likert-type scale ranging from 0 to 3, based on severity of each item. It has a good internal consistency and concurrent

**Table 1**
Participant characteristics.

| | HSA $n = 26$ | LSA $n = 25$ | $p$-value |
|---|---|---|---|
| Age | 20.5 (2.87) | 21.5 (2.67) | .266 |
| Gender (m/f) | 13/13 | 14/11 | .668 |
| Ethnicity (% Caucasian) | 68% | 60% | .213 |
| BFNE | 41.7 (5.45) | 24.2 (6.79) | <.001* |
| BDI-II | 9.53 (6.77) | 5.56 (5.85) | .034* |
| STAI – Trait | 44.3 (10.8) | 33.0 (7.89) | .001* |
| STAI – State | 36.0 (7.21) | 31.7 (5.84) | .027* |

*Note.* BFNE, Brief Fear of Negative Evaluation Questionnaire (Carleton et al., 2006); BDI-II, Beck Depression Inventory (Beck et al., 1996); STAI, State-Trait Anxiety Inventory (Spielberger et al., 1970).