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Gaze direction differentially affects avoidance tendencies to happy and angry faces in socially anxious individuals

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ABSTRACT

Increasing evidence indicates that eye gaze direction affects the processing of emotional faces in anxious individuals. However, the effects of eye gaze direction on the behavioral responses elicited by emotional faces, such as avoidance behavior, remain largely unexplored. We administered an Approach-Avoidance Task (AAT) in high (HSA) and low socially anxious (LSA) individuals. All participants responded to photographs of angry, happy and neutral faces (presented with direct and averted gaze), by either pushing a joystick away from them (avoidance) or pulling it towards them (approach). Compared to LSA, HSA were faster in avoiding than approaching angry faces. Most crucially, this avoidance tendency was only present when the perceived anger was directed towards the subject (direct gaze) and not when the gaze of the face-stimulus was averted. In contrast, HSA individuals tended to avoid happy faces irrespectively of gaze direction. Neutral faces elicited no approach-avoidance tendencies. Thus avoidance of angry faces in social anxiety as measured by AA-tasks reflects avoidance of subject-directed anger and not of negative stimuli in general. In addition, although both anger and joy are considered to reflect approach-related emotions, gaze direction did not affect HSA's avoidance of happy faces, suggesting differential mechanisms affecting responses to happy and angry faces in social anxiety.

Introduction

Social anxiety is characterized by an extensive fear of being evaluated by others and leads socially anxious individuals to engage in so-called safety behaviors (e.g. Clark & Wells, 1995). Direct gaze is a clear signal of being attended to by someone else and hence a potential start of a social interaction. It may therefore constitute a critical threat stimulus for a socially anxious individual eliciting safety behaviors, such as social avoidance (Fox, Mathews, Calder, & Yiend, 2007; Heuer, Rinck, & Becker, 2007; Horley, Williams, Gonsalvez, & Gordon, 2003; Marks, 1987; Roelofs, van Peer, et al., 2009). The present study aimed to test the effects of eye gaze direction on social avoidance tendencies elicited by emotional faces in socially anxious individuals.

There is increasing evidence that social threat cues, such as emotional faces accompanied by direct gaze, elicit avoidance tendencies in high socially anxious individuals (Heuer et al., 2007; Horley et al., 2003; Horley, Williams, Gonsalvez, & Gordon, 2004; Lange, Keijsers, Becker, & Rinck, 2008; Roelofs, Elzinga, & Rotteveel, 2005; Roelofs, van Peer, et al., 2009; Van Peer et al., 2007; Van Peer, Spinhoven, Van Dijk, & Roelofs, 2009). For example, Heuer et al. (2007) applied a speeded Approach-Avoidance Task (AAT), where participants either pulled or pushed a joystick in response to visually presented emotional faces. The emotional faces gradually disappeared when participants pushed the joystick away from them and grew in size when participants pulled the joystick towards themselves. Comparison of high (HSA) versus low (LSA) socially anxious individuals demonstrated clear avoidance tendencies (faster pushing than pulling) in HSA, to both happy and angry facial expressions, but not to neutral faces or non-facial pictures. The fact that HSA not only avoided angry but also happy faces has been explained by the fact that both angry and happy facial expressions communicate emotions that are directed towards the subject (i.e. approach-related emotions, in contrast to sad and fearful faces communicating avoidance-related emotions; Adams & Kleck, 2003, 2005; Heuer et al., 2007). Although this hypothesis has not been tested directly yet, this may indicate that it is the subject-

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directedness of the emotional faces, and not the content of the emotion per se, that elicits avoidance tendencies in high socially anxious individuals.

A growing body of evidence from neurophysiological and imaging studies on face processing suggests that direct eye gaze, as compared to averted eye gaze, induces enhanced visual processing of facial information (e.g. Conty, N'Diaye, Tijus, & George, 2007; George, Driver, & Dolan, 2001; Pelphrey, Viola, & McCarthy, 2004). Direct gaze elicits enhanced activation not only in visual brain areas (e.g., Wicker, Michel, Henaff, & Decety, 1998; Wicker, Perrett, Baron-Cohen, & Decety, 2003), but also in the amygdala (George, Driver, & Dolan, 2001; Kawashima et al., 1999). Although the evidence for angry face stimuli is less conclusive (Adams, Gordon, Baird, Ambady, & Kleck, 2003; Sato, Yoshikawa, Kochiyama, & Matsumura, 2004), such enhanced processing associated with direct gaze may particularly occur when the faces communicate approach-driven emotions, such as anger and joy (Adams & Kleck, 2003, 2005). In a speeded emotion detection study, Adams and Kleck (2003) found that emotion detection of faces expressing approach oriented emotions (e.g. anger and joy) was faster when the faces presented with direct gaze. In contrast, faces expressing avoidance oriented emotions (e.g. fear and sadness) were labeled faster in combination with averted gaze. These findings suggest that gaze direction influences both the processing speed and the perceptual interpretation of facial cues. In 2005, Adams Jr. and Kleck replicated these findings and in addition showed that gaze direction influenced subjective intensity ratings of facial expressions. In addition, Hietanen et al. (2008) explored whether eye gaze direction may activate lateralized neural approach-avoidance systems and tested whether seeing another person's direct versus averted gaze influenced the hemispheric asymmetry in the frontal electroencephalographic (EEG) activity. Direct gaze indeed elicited a relative left-sided frontal EEG activation (taken as indicative of a tendency to approach), whereas averted gaze activated right-sided asymmetry (taken as indicative of avoidance). Moreover, direct gaze was associated with more intense autonomic activation and higher subjective ratings of emotional arousal and valence, supporting previous findings that direct gaze induces higher cardiac acceleration in healthy (for review see Kleinke, 1986) as well as in socially anxious individuals (Wieser et al., 2009).

In sum, studies in healthy participants suggest that eye gaze direction affects the processing of faces, both by itself and in interaction with the emotional expression of the faces (see also Fox et al., 2007; Holmes, Richards, & Green, 2006). However, to our knowledge, no studies have directly tested the effects of eye gaze direction on social approach-avoidance tendencies. Given the significance of gaze direction in emotion detection studies, one might predict that the previously found avoidance tendencies elicited by angry faces on manual Approach-Avoidance Tasks (Heuer et al., 2007; Lange et al., 2008; Rotteveel & Phaf, 2004; Roelofs et al., 2005; Roelofs, Minelli, Mars, van Peer, & Toni, 2009; Roelofs, van Peer, et al., 2009; van Peer et al., 2007, 2009) largely depend on the use of direct gaze.

The major aim of the present study was to test this hypothesis by manipulating gaze direction of emotional (happy, angry and neutral) faces on the AAT. Second, in addition to angry faces, happy facial expressions are also considered to communicate an approach-driven emotion. Although avoidance reactions to happy faces are less frequently observed, Heuer et al. (2007) and Lange et al. (2008) found HSA to avoid happy faces in addition to angry faces and suggested that direct gaze, even when accompanied by a positive expression may be threatening to a socially anxious individual as it may reflect an invitation to the feared social contact. Based on this hypothesis we predicted that happy faces would also elicit avoidance tendencies in HSA, but only when presented with direct gaze.

Methods

Participants

Twenty high (HSA) and twenty low (LSA) socially anxious individuals were selected from a sample of 480 students from Leiden University, based on their anxiety score on the Liebowitz Social Anxiety Scale (LSAS: Liebowitz, 1987), with LSAS-anxiety scores >27 for HSA and <13 for LSA (see Heuer et al., 2007). All HSA participants met the LSAS-total cutoff score of 30 for social anxiety disorder and 8 HSA participants met the LSAS-total cutoff of 60 for generalized social anxiety disorder – Rytwinski et al., 2009). Exclusion criteria for participation were: age > 40 or < 18, use of medication, color blindness, any chronic disease and currently being treated for a mental disorder other than social anxiety disorder. See Table 1 for an overview of gender, age and mean LSAS scores per group. Participants gave written informed consent and received either credits or money for participation. All participants were right handed and had normal or corrected to normal vision.

Zooming Approach-Avoidance Task (AAT)

Stimuli were oval cut-out photographs each showing a facial expression of one out of eight actors (four men and four women) selected from Ekman and Friesen (1976) and from Karolinska Directed Emotional Faces (Lundqvist, Flykt, & Öhman, 1998). For each model the angry, happy and neutral facial expressions were selected. For each picture, the eye-pupils were cut-out, the eyes were whitened and the pupils were subsequently pasted either in the centre (direct gaze) or at the right or left side (averted gaze) of the eye (see Fig. 1, for examples of direct and averted gaze face stimuli). All faces were presented in bright red and in bright green, leaving a total set of stimuli of 8 (Actors) × 3 (Emotional expression: neutral–happy–angry) × 3 (Gaze: straight–left–right) × 2 (Color: red–green) = 144 stimuli. The factor 'Gaze' was dichotomized into 'direct versus averted' gaze, leaving 96 stimuli-types that were presented 4 times (in such a way that left and right gaze were equally divided). Each participant was presented a total of 404 trials: 20 practice trials and 384 experimental trials. Stimuli were randomly presented, but no more than three of the same stimulus–response combinations (stimulus defined by emotion and gaze) were presented successively.

Pictures were presented on a computer screen with a resolution of 1024 x 768 pixels. A joystick of the type Logitech Attack 3 was positioned between the participant and the computer screen, in such a way that the participant could easily pull and push the joystick towards (approach) and away from (avoidance) their body, respectively. Each trial was self-paced: participants had to press the fire button while the joystick was in the resting (upward) position and the screen was blank. After pressing the fire button a face-stimulus appeared in the centre of the screen. Participants were

Table 1
Group characteristics of low (LSA) and high socially anxious (HSA) participants.

	LSA ($N = 19$)	HSA ($N = 20$)	Statistic	p-Value
Gender: male/female	11/8	9/11	X^2 (1) = 0.65	0.42
Age	21.8 (2.2)	21.5 (2.0)	$t = 0.51$	0.62
LSAS total	15.1 (7.5)	56.1 (11.5)	$t = 13.10$	<0.001
LSAS anxiety	6.5 (3.8)	31.2 (4.8)	$t = 17.75$	<0.001
LSAS avoidance	8.6 (4.9)	24.9 (8.1)	$t = 7.58$	<0.001
STAI-trait	32.3 (7.8)	40.2 (6.4)	$t = 3.78$	<0.001

Numbers for age and questionnaires represent: mean (SD).

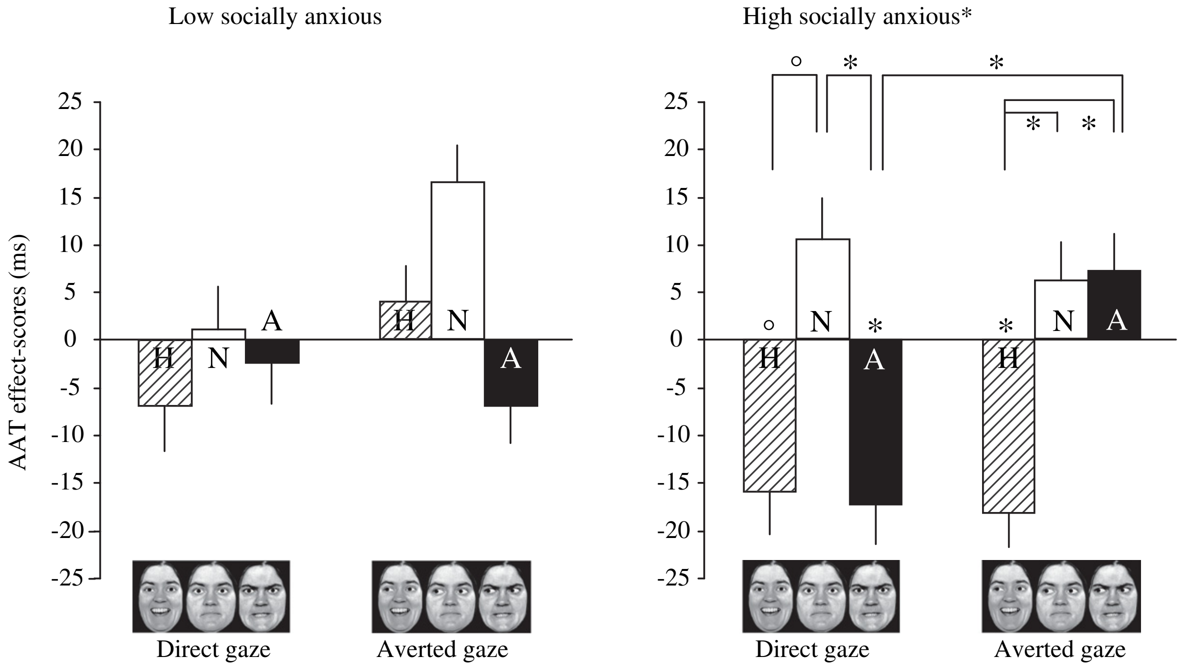

Fig. 1. Mean AAT effect-scores (in ms) for each emotion and gaze direction in each group. The AAT effect-scores are calculated by subtracting the individual reaction times for pull movements from the individual reaction times for push movements. Negative AAT effect-scores indicate stronger avoidance and positive effect-scores reflect stronger approach. The left panel presents the (non-significant) AAT effect-scores for low socially anxious participants and the right panel presents AAT effect-scores for high socially anxious participants, indicating avoidance tendencies to both happy and angry faces. The avoidance of angry faces disappears when the gaze of the face-stimulus is averted. H = happy facial expression, N = neutral facial expression, A = angry facial expression, * = $p < 0.05$; ° = $p < 0.07$.

instructed to ignore the emotional facial expression and to respond to the color. Half of the participants in each group were instructed to push the joystick in response to green stimuli and to pull the joystick in response to red stimuli, the other half was instructed to pull green and to push red.

By pushing or pulling the joystick the picture shrank, respectively grew, in size and disappeared from the screen when the minimum, respectively the maximum size was reached (initial size and minimal and maximal size of the stimuli in degrees were: 9.5*13°; 3.5*4.5°; and 15.5*20° respectively). A practice phase, in which the pictures remained visible after an erroneous response (allowing participants to practice until the response was correct) preceded the experimental phase. Participants were instructed to respond as fast and as accurately as possible. The time between the stimulus onset and the reach of the maximum joystick displacement was recorded (RT).

Anxiety questionnaires

The Liebowitz Social Anxiety Scale (LSAS: Liebowitz, 1987) is a twenty-four item self-report questionnaire that measures fear and avoidance of social situations. Each item describes a social situation and participants rate how anxious/fearful they would feel (using a 4-point scale with 0 = 'not at all' and 3 = 'very much') and how often they would try to avoid the described situation (using a 4-point scale with 0 = 'never' and 3 = 'almost always'). The LSAS was found to be a valid and reliable measure of social anxiety (Heimberg et al., 1999).

The Spielberger Trait Anxiety Inventory (STAI-trait: Spielberger, Gorsuch, & Lushene, 1970) is a 20 item self-report questionnaire by which participants rate how anxious they feel in certain situations (using 4-point frequency scales with 1 = 'almost never' and 4 = 'almost always'). The STAI-trait was found to be a reliable and valid instrument to measure anxiety (Barnes, Harp, & Jung, 2002). Whereas the LSAS was used for preselecting high and low socially anxious participants, the STAI-trait was administered at the start of the test day in order to obtain information on levels of general anxiety in addition to social anxiety (see Table 1).

Data reduction and statistical analyses

Reaction time (RT) outliers were filtered using a <150 and >1000 ms cutoff. For each participant, the median of the remaining RTs (97%) for the correct responses were calculated per cell [defined by: Group, Emotion, Movement and Gaze]. Subsequently, AAT effect-scores were calculated per cell [defined by Group, Emotion and Gaze] by subtracting the individual median RTs for pull movements form the individual median RTs for push movements. Negative AAT effect-scores indicate stronger avoidance and positive effect-scores reflect stronger approach tendencies (e.g. Heuer et al., 2007). To test differential effects of Group and Gaze on the AAT, we conducted a 3-way repeated measures Analysis of Variance (ANOVA rm) for the AAT effect-scores with between-subject factor Group (HSA and LSA) and within-subject factors Emotion (neutral, happy, angry) and Gaze (direct, averted). For these analyses, alpha was set at 0.05 and effect sizes are reported in partial eta squared (η_p^2). Finally, we tested whether AAT effect-scores for angry and happy faces reflected significant avoidance tendencies (i.e. were significantly different from zero) by conducting separate one-sample t-tests (one-tailed) for the AAT effect-scores in these conditions.

Results

One LSA participant was excluded from analysis because of RTs deviating > 3 SD from the group mean. See Table 2 for mean RTs per cell. Error rates were low. HSA: 2.6% and LSA: 3.2%.

The 3-way (Group × Emotion × Gaze) ANOVA rm for the AAT effect-scores revealed a significant main effect for Emotion

Table 2
Reaction times in ms [RT(SEM)] for push and pull movements in response to emotional faces with direct and averted eye gaze direction.

	Direct gaze			Averted gaze		
	Happy	Neutral	Angry	Happy	Neutral	Angry
LSA						
Push	540 (15)	535 (15)	535 (14)	531 (14)	543 (17)	525 (15)
Pull	547 (15)	534 (14)	538 (15)	527 (15)	525 (17)	532 (15)
HSA						
Push	604 (16)	620 (15)	602 (14)	590 (14)	609 (17)	610 (14)
Pull	620 (15)	609 (13)	620 (15)	609 (15)	603 (16)	603 (15)

LSA = low socially anxious.
HSA = high socially anxious.

($F(2,36) = 5.66$; $p = 0.007$; $\eta_p^2 = 0.24$) and, most importantly, a significant 3-way interaction of Group × Emotion × Gaze ($F(2,36) = 4.61$; $p = 0.017$; $\eta_p^2 = 0.21$). To explore the nature of this interaction, separate analyses for each emotion were conducted, yielding a significant Group × Gaze interaction for angry faces ($F(1,37) = 5.04$; $p = 0.031$; $\eta_p^2 = 0.12$) and not for neutral ($F(1,37) = 2.38$; $p = 0.13$) and happy faces ($F(1,37) = 0.80$; $p = 0.38$). As predicted, angry faces elicited significant avoidance effects in HSA, only in the direct gaze condition ($t(19) = 1.70$, $p = 0.049$) and not in the averted gaze condition ($t(19) = 0.90$, $p = 0.17$) – see Fig. 1. There were no such effects for LSA (all $p > 0.2$). These effects were also reflected by a significant Gaze-effect for angry facial expressions in HSA ($F(1,19) = 6.99$; $p = 0.016$; $\eta_p^2 = 0.27$) and not in LSA ($F(1,18) = 0.25$; $p = 0.62$). Together, these findings indicate that angry faces elicited significant avoidance tendencies in HSA, but only when the face was coupled with direct gaze and not when it was presented with averted gaze.

For a complete overview of results, we also tested the remaining interactions and main effects displayed in Fig. 1: For HSA, there was a significant Emotion × Gaze interaction ($F(2,18) = 3.50$; $p = 0.05$; $\eta^2{}_p = 0.28$) and not for LSA ($F(2,17) = 1.37$; $p = 0.28$). In addition, a separate 'angry–neutral' comparison in HSA yielded a significant Emotion-effect when stimuli were presented with direct gaze ($F(1,19) = 4.3$; $p = 0.05$; $\eta_p^2 = 0.18$) and not when stimuli were presented with averted gaze $F(1,19) = 0.024$; $p = 0.88$). These effects again indicate that HSA displayed a relative avoidance tendency in response to angry faces, but only when the anger was directed at the participant (see Fig. 1). A 'happy–neutral' comparison in HSA yielded a trend towards a significant Emotion-effect for direct gaze stimuli ($F(1,19) = 4.1$; $p = 0.055$; $\eta_p^2 = 0.18$), indicating relative avoidance of happy faces as well. Interestingly, this Emotion-effect remained present even when the gaze was averted ($F(1,19) = 5.31$; $p = 0.033$; $\eta_p^2 = 0.22$). The AAT effects for happy faces in HSA were significant for happy faces in the averted gaze condition ($t(19) = 2.32$, $p = 0.016$) and showed a trend towards significance in the direct gaze condition ($t(19) = 1.53$, $p = 0.069$). Finally, HSA showed larger avoidance tendencies to happy as compared to angry faces when eye gaze was averted ($F(1,19) = 6.29$; $p = 0.021$; $\eta_p^2 = 0.25$) but showed comparable avoidance tendencies to angry and happy faces when the eye gaze was direct ($F(1,19) = 0.01$; *ns*).

Taken together, these findings indicate that HSA only show a tendency to avoid angry faces when the eye gaze of the presented face is directed at the subject and not when it is averted. In contrast, a trend towards avoidance of happy faces occurs irrespectively of the eye gaze direction displayed by the face-stimulus (see Fig. 1).

Discussion

Previous research using the zooming AAT (Heuer et al., 2007) indicated that HSA individuals show increased avoidance tendencies in response to both angry and happy facial expressions. In the present study we largely replicated these results and moreover extended these findings by showing that avoidance of angry faces depends on the eye gaze direction displayed by the face, whereas avoidance of happy faces does not.

The relative tendency to avoid angry faces in HSA subjects is in line with previous findings in high socially anxious individuals (Heuer et al., 2007) as well as in patients with social anxiety disorder (Roelofs, van Peer, et al., 2009). According to Heuer et al. (2007) these findings can be explained by the emotion communicated by the actor: anger is an approach-related emotion and evokes withdrawal in HSA. Our findings indicate significant AAT effects for angry faces in HSA, only when the faces are presented with direct gaze and not when the gaze is averted. These findings fit with early notions by Marks (1987) emphasizing that direct gaze is one of the most upsetting cues for socially anxious individuals and validate previous findings from eye tracking studies by Horley et al. (2003, 2004) indicating that patients with social anxiety disorder tend to avoid looking at the eye-regions of angry face stimuli accompanied by direct gaze. Our findings contribute to this discussion by showing that it is the interaction between the eye gaze and the emotion, i.e. combination of an angry expression and direct gaze that elicits such avoidance tendencies and that an angry face with averted gaze does not elicit avoidance. Averted gaze in angry facial expressions may be perceived as a safety signal, which indicates that the anger is not directed at the participant but at someone else, diminishing the acute need to withdraw. Such interpretation is supported by findings of Sato et al. (2004), indicating that angry facial expressions coupled with direct gaze result in a stronger amygdala response than angry facial expressions coupled with averted gaze.

Our findings for angry faces coupled with direct gaze are also in line with previous findings by Adams and Kleck (2003) indicating that faces expressing approach oriented emotions, like anger and joy, were more quickly labeled in combination with direct gaze as compared to avoidance oriented emotions, like fear and sadness, that were more quickly labeled when coupled with averted gaze. In 2005, Adams Jr. and Kleck replicated these findings and in addition showed that gaze direction also influences the perceived intensity of a facial expression.

In line with these results and previous results by Heuer et al. (2007), we found that not only angry but also happy faces coupled with direct gaze elicited avoidance tendencies. This finding may be interpreted as supporting results from fMRI studies demonstrating that happy and angry facial expression elicit comparable neural activity in patients with SAD (e.g. Straube et al., 2005). Such findings were previously explained by the fact that happy faces may communicate an invitation for contact. However, in our set-up avoidance of happy faces was not reduced when the smile was no longer directed at the participant. HSA were significantly avoidant of happy faces presented with averted gaze as well. These results indicate that contrarily to angry facial expressions, behavioral tendencies generated by happy facial expressions are less influenced by gaze direction. At least two explanations may account for this result. First, a happy face coupled with averted gaze may be perceived as rejection, as the actor finds something else that is positioned next to the subject more interesting. Alternatively, a happy face coupled with averted gaze may still be perceived as threatening because positive mood (generally associated with a broad attentional scope – e.g. Rowe, Hirsh, & Anderson, 2006) may involve the risk that the subject eventually becomes focus of attention. More research is needed to explore the mechanisms behind the differential findings for happy faces.

Previous findings by Hietanen et al. (2008) indicated direct gaze (of neutral faces) to activate basal approach systems, a conclusion based on findings of increased left lateralized hemispheric asymmetry in the EEG of non-anxious individuals. With the present set-up we found no significant approach or avoidance effects for neutral faces in anxious or non-anxious individuals associated with direct gaze. Our findings for emotional faces, however suggest that – at least in anxious individuals – direct gaze is more likely to elicit avoidance than approach tendencies. It would be interesting for future hemispheric lateralization studies to account for individual differences in anxiety and to test gaze-effects for emotional faces in addition to neutral faces.

The present study is the first demonstrating differential effects of eye gaze on social approach-avoidance tendencies. When evaluating the findings, some strengths and limitations should be considered. First, participants were preselected on the basis of their LSAS score, which is a self-report questionnaire and we did not re-examine the subjects using the same questionnaire at the test day. However, we did administer an additional anxiety questionnaire at the test day and confirmed higher scores for the HSA group than for the LSA group (see Table 1). Also, the presently applied Approach-Avoidance Task was an implicit emotion evaluation task in which not the emotion, but an emotion-irrelevant feature of the faces was responded to. This makes the findings less susceptible to task demands. In addition, the zooming function makes the meaning of the joystick movements in the AAT less susceptible to alternative interpretations that may arise in the participants during the task (such as pushing the joystick means approaching the picture instead of avoiding it – see Rinck & Becker, 2007). Future studies using eye-tracking techniques should investigate whether differential effects of gaze direction by the actor affects allocation of eye movements in a similar way as it affects avoidance tendencies measured by the AAT.

To conclude, the present study is the first to show effects of gaze direction on social approach-avoidance tendencies. HSA showed significant avoidance of angry faces but this occurred only when the angry face was coupled with direct gaze and not when it was averted. This finding supports social avoidance tendencies to play a role in social anxiety and provides further validation of the AAT as a measure of social avoidance tendencies in socially anxious subjects.

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