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Threatening faces and social anxiety: A literature review

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ABSTRACT

A threatening facial expression is a potent social sign of hostility or dominance. During the past 20 years, photographs of threatening faces have been increasingly included as stimuli in studies with socially anxious participants, based on the hypothesis that a threatening face is especially salient to people with fears of social interaction or negative evaluation. The purpose of this literature review is to systematically evaluate the accumulated research and suggest possible avenues for further research. The main conclusion is that photographs of threatening faces engage a broad range of perceptual processes in socially anxious participants, particularly when exposure times are very short.

Contents

1. Introduction

The threatening facial expression is considered an ancient sign of threat in human evolutionary history (Darwin, 1872; Darwin, 1872/1965; Öhman, 1986). However, experimental psychology has only fairly recently begun investigating its clinical significance. A mental

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disorder that seems especially relevant in relation to threatening faces is social phobia. Socially anxious individuals are particularly concerned with humiliating or embarrassing themselves when under the scrutiny of others (American Psychiatric Association, 1994). A threatening facial expression can be a sign of disapproval and rejection, and might therefore function as an anxiety-provoking cue in people for whom approval is especially important. It has been suggested that angry faces are challenges to dominance contests (e.g. Öhman, 1986), which is also relevant for socially anxious individuals, who view themselves as less dominant than others (Alden & Taylor, 2004), and will often interact with others in a submissive way (Hofmann & Barlow, 2002).

A threatening expression is one that directs some form of hostility at the beholder. Anger is the most prominent example and also one that is very easily recognizable in other people across a variety of cultures (Ekman, 1973). Contempt, criticism, and disgust are other examples of expressions that will bear resemblance to anger in that they signal disapproval. In fact, anger is sometimes confused with disgust, when people have to judge different expressions (Mazurski & Bond, 1993; Montagne et al., 2006). Although other negative emotions, such as sadness and fear may serve to warn against an impending threat, they do not express direct hostility towards the beholder. On the contrary, both expressions may be interpreted as signs of submission or attaining the help of others (Gilboa-Schechtman, Erhard-Weiss & Jeczemien, 2002; Marsh, Kozak & Ambady, 2007). Hence, in the present context, they are not considered threatening.

The overall purpose of this review is to examine the effects of threatening expressions on the perception of photographs of human faces in clinical and non-clinical social anxiety. Perception in this context is to be understood in a broad sense, incorporating multiple somatic and cognitive processes, such as autonomic reactions, attention, memory, behavior, and interpretation. Although a large number of reviews to date have examined these processes in socially anxious individuals across a variety of methods and stimuli, no review has yet focused exclusively and systematically on the perception of threatening faces in social anxiety. Several reviews have examined cognitive processes in social anxiety in relation to a broad range of stimuli, such as faces, words, sentences, and video clips. Some have reviewed specific methodologies (Etkin & Wager, 2007; Frewen, Dozois, Joanisse & Neufeld, 2008; Frischen et al., 2008) or specific theoretical models (Clark & McManus, 2002; Schultz & Heimberg, 2008), while others have focused on discrete processes such as attention (Bögels & Mansell, 2004; Weierich, Treat & Hollingworth, 2008). Three reviews have included multiple processes and multiple methodologies (Heinrichs & Hofman, 2001; Hirsch & Clark, 2004; Ledley & Heimberg, 2006; Musa & Lépine, 2000), but their focus has not been exclusively on threatening faces and their inclusion of studies with such stimuli is limited. Heinrichs and Hofman (2001) included three studies with threatening faces, Hirsch and Clark (2004) included four, Musa and Lépine (2000) included four, and Ledley and Heimberg (2006) included seven. Since these reviews did not include all the studies on threatening faces available at the time of their publication, none of them provided an exhaustive view of this part of the literature.

The hypothesis that a threatening face is especially salient to socially anxious individuals, and consequently engages specific perceptual processes in people with clinical or subclinical social anxiety, is more or less explicit behind most research conducted in this field (e.g. Rapee & Heimberg, 1997; Öhman, 1986). One argument for such a saliency is Öhman's (1986) theory of biological preparedness, where threatening faces are considered particularly potent signs of threat alongside images of snakes, since these classes of stimuli have a long evolutionary history. In social phobia, this preparedness manifests itself as facilitated fear conditioning to angry human faces, which again should lead to increased autonomic and emotional responses. A different account emphasizes the cognitive aspects of an increased sensitivity to threatening faces in social anxiety (Rapee & Heimberg, 1997). In this theory, people with social phobia form negative assumptions about how other people see them, and these assumptions cause a particular attentiveness to threatening environmental cues. The theory predicts that cognitive biases should be apparent not only at the level of visual attention, but also in the memory of social encounters, the interpretation of ambiguous social events, and in judgment of social cues.

Because of this hypothesized specificity of threatening expressions, photographs of human faces have quickly become one of the most frequently used stimuli in research on social anxiety. However, based on the reviews mentioned above, it is not possible to determine exactly what the effects of threatening faces are, since studies with a variety of stimuli were included. The primary aim of this review is therefore to evaluate the effects of threatening faces in individuals with clinical and subclinical social anxiety across a broad range of methods. Recommendations and suggestions for future research will also be presented.

1.1. Search strategy

Studies were collected through searching PubMed and PsychINFO databases using the search words *social phob** (phobia) or *social anxiety* intersected with *face perception* and the following emotions followed by *fac** (face): *angry*, *threat** (threatening), *critic** (criticising), *harsh*, *disgust*, *hostile*, *contempt** (contemptuous) and *negative*. The searches were conducted no later than June 10th, 2009. References of the collected articles were scanned for additional studies meeting inclusion criteria (see below). Several authors were contacted for information on unpublished results. Additionally, the National Research Register was searched and selected key journals were prospectively scanned until submission. In gathering studies for the present review, the following inclusion criteria were observed:

1. The article was published in the English language before June 10th 2009. Dissertations and foreign language articles were excluded.
2. The article included an original study with adult participants (age ≥ 18 years) with social anxiety. Participants should either be diagnosed according to DSM criteria or selected for high social anxiety using a standardized measure of social anxiety.
3. The stimuli used were photographs of human faces displaying a threatening emotion (e.g. angry, critical, disgust, contemptuous).
4. The study included a measurement of the effect of the threatening face(s).

Using these strategies, 74 studies that met all inclusion criteria were found. The studies were divided into seven sections according to the main perceptual process being examined: autonomic reactivity; visual attention; emotional–behavioral reactivity; memory and recognition; subjective ratings; expectancy and interpretation; and brain activation. The motivation for this outline was to enable readers to quickly locate specific areas of interest. For the same reason, each section is relatively self-contained. The review will begin by looking at autonomic reactivity to threatening faces, which also represents the earliest research in the field. Throughout the review, the term *socially anxious* will refer to subclinical participants, while *social phobia* refers to clinical samples.

2. Autonomic reactivity

Increases or decreases in heart rate (HR), increases in the skin conductance response (SCR), and activation of the hypothalamus–pituitary–adrenal (HPA) axis are indicators of autonomic activation to emotional stimuli. Building on the hypothesis that humans are biologically predisposed to respond to threatening faces (e.g. Öhman, 1986), several independent research groups have not found any differences between participants with either clinical or subclinical social anxiety and controls using a variety of physiological measures,

including SCR (Clark, Siddle & Bond, 1992; Dimberg & Thunberg, 2007; Merckelbach, Van Hout, Van den Hout & Mersch, 1989; Vrana & Gross, 2004), HR (Dimberg & Thunberg, 2007; Kolassa & Miltner, 2006; Vrana & Gross, 2004) and frequency of eye-blinks (Merckelbach et al., 1989). Although angry faces reliably produce autonomic reactions in people in general in the studies reviewed, the literature does not suggest that social anxiety has any incremental or decremental effects on those reactions. This holds true for different stimulus exposure durations ranging from 1 to 8 s for both SCR and HR, and under different experimental conditions. Clark et al. (1992) included a condition, where participants were threatened with electric shock; Vrana and Gross (2004) asked participants to rate the faces on different dimensions such as dominance and arousal; and Kolassa and Miltner (2006) used a gender- and emotion discrimination task in their study (Table 1).

Two studies investigated the effects of increased HPA-axis activity on the avoidance response to angry faces in social phobia (Roelofs et al., 2009; van Peer, Spinhoven, van Dijk & Roelofs, 2009). The cortisol response is an indicator of activation of the HPA-axis, which is a primary stress response system in primates (Herman, Ostrander, Mueller & Figueiredo, 2005). In the first study, patients with social phobia, post-traumatic stress disorder and controls completed an approach–avoidance task in which they had to move their arm towards or away from briefly presented faces with different emotional expressions (Roelofs et al., 2009). The task was performed before and after a stressful public speaking task. Results showed that, in comparison with the two other groups, individuals with social phobia were quicker in avoiding, compared to approaching, angry faces following the stressful task. Importantly in relation to autonomic reactivity, avoidance behavior correlated with increases in salivary cortisol level. In the other study, individuals with social phobia completed a very similar approach–avoidance task, but instead of a public speaking task, cortisol was administered directly to half the participants, while the other half received a placebo (van Peer et al., 2009). Cortisol administration did not influence avoidance behavior contrary to the authors' expectations; rather, higher levels of social anxiety were associated with increased avoidance of angry faces.

In summary, there is only subtle evidence limited to the HPA-axis that social anxiety involves abnormal autonomic activation to threatening faces. This is in line with evidence from other studies showing that when individuals with social phobia anticipate or perform a public speaking task, they either do not differ from controls in autonomic activation (Edelmann & Baker, 2002; Mauss, Wilhelm & Gross, 2004) or display continuous increased autonomic activity independent of task condition (Davidson, Marshall, Tomarken & Henriques, 2000). A more consistent finding is that socially anxious participants perceive their somatic symptoms as stronger than controls, which supports cognitive theories of anxiety that emphasize catastrophic interpretation of bodily sensations as part of the anxiety response (Edelmann & Baker, 2002; Mauss et al., 2004). Interestingly, increased cortisol level as a result of a stressful task may be a predictor of avoidance of threatening faces in social phobia, but there are no studies yet to indicate that angry faces themselves elevate cortisol levels in individuals with social phobia. Also, when administered directly, cortisol does not appear to influence behavioral avoidance.

3. Visual attention

Research on visual attention in relation to threatening faces has focused primarily on *attentional bias*—the propensity to be more or less aware of threatening environmental cues. The classic issue with socially anxious individuals originates from cognitive models of social anxiety and relates to the direction of attentional bias. The model put forth by Clark and Wells (1995) suggests that individuals with social phobia should show avoidance of threatening cues such as negative facial expressions in favor of self-directed attention. This in turn might promote or maintain social anxiety, since negative expectations about other peoples' reactions are not challenged. A social phobic person

Table 1
Autonomic reactivity.

Study (year)	*N* female/male (f, m), measure of SA, age (A)	Expressions (stimulus set), non-face stimuli	Exposure duration	Method (M), design (D), task (T)	Significant effects
Merckelbach et al. (1989)	9 SP (2f, 7m) 9 HC (2f, 7m) FQ A: 22, 18–31	Angry, happy (Ekman and Friesen, 1976) Objects	8 s	M: SCR, eye blink rate	No differences between groups
Clark et al. (1992)	40 HSA (33f, 7m) 45 LSA (26f, 19m) WQ A: 17–32	Angry, happy (Ekman and Friesen, 1976)	2 s	M: SCR D: includes threat of electric shock	No effects of group or anxiety
Vrana and Gross (2004)	10 HSA 9 LSA PRCS A: 20.7	Happy, angry, neutral (Ekman and Friesen, 1976)	8 s	M: electromyography, SCR, HR T: rate each face for valence, dominance, arousal and threat	SCR or HR did not differ between groups for angry faces
Kolassa and Miltner (2006)	19 SP (10f, 9m) 19 HC (10f, 9m) SCID A: 23.2	Angry, happy, neutral (Lundqvist, Flykt and Öhman, 1998)	1 s	M: electroencephalography, HR T: indicate gender or expression	There were no differences between groups on HR
Dimberg and Thunberg (2007)	28 HSA (all f) 28 LSA (all f) PRCS A: 23.3	Angry, happy (Ekman and Friesen, 1976).	1 s	M: electromyography, SCR, HR	Groups did not differ in SCR or HR
Roelofs et al. (2009)	18 SP (9f, 9m) 17 PTSD (11f, 6m) 22 HC (13f, 9m) SCID A: 36	Happy, angry (various sources)	100 ms	M: approach–avoidance D: the face-task is followed by a speech and arithmetic task; salivary cortisol and blood pressure is measured ten times	Cortisol level correlated with behavioral avoidance in SP only
van Peer et al. (2009)	20 SP (11f, 9m) SCID A: 32.8	Happy, angry (various sources)	100 ms	M: approach–avoidance, electroencephalography D: cortisol is administered prior to testing	In SP, cortisol administration correlated with increase in P150 when participants showed avoidance compared with approach

FQ = Fear Questionnaire (Marks and Mathews, 1979); HC = healthy controls; HSA = high social anxiety; LSA = low social anxiety; PRCS = Public Report of Confidence as a Speaker (Paul, 1966); PTSD = post-traumatic stress disorder; SCID = Structured Clinical Interview for DSM-IV (First, Spitzer, Gibbon, & Williams, 1995); SP = social phobia; WQ = Willoughby questionnaire (Willoughby, 1932).

Table 2
Visual attention.

Study (year)	*N* female/male (f, m), measure of SA, age (A)	Expressions (stimulus set), non-face stimuli	Exposure duration	Method (M), design (D), task (T)	Significant effects
Bradley et al. (1997) Experiment 1	21 HSA (21f) 19 HSA (19f) FNE A: 18–21	Threat, happy, neutral (Bradley et al., 1997)	500 ms	M: dot-probe	No effect of social anxiety on attentional bias to threatening faces
Gilboa-Schechtman et al. (1999)	16 SP (6f, 10m) 17 HC (10f, 7m) SCID A: 32.9	Angry, disgust, happy, neutral (Ekman and Friesen, 1976)	Until response	M: face in the crowd	SP were slower at detecting happy relative to angry faces compared to controls; SP were more distracted by angry and happy crowds compared to controls; SP showed a differential responding to angry vs. disgust faces whereas controls did not
Mansell et al. (1999)	35 HSA (23f, 12m) 36 LSA (19f, 17m) FNE A: 22.5	Angry, disgust, fear, sad, neutral, happy (Matsumoto and Ekman, 1988) Household objects	500 ms	M: dot-probe, memory D: includes threat of speech or no threat T: recognition	HSA, but not LSA, showed avoidance of negative and positive faces relative to neutral faces in the threat condition only
Chen et al. (2002)	20 SP (14f, 6m) 20 HC (14f, 6m) ADIS-IV A: 35.7	Neutral, happy, angry, sad, fear, disgust (Matsumoto and Ekman, 1988) Household objects	500 ms	M: dot-probe, memory T: indicate “old” or “new” faces	SP showed avoidance of faces regardless of expression, whereas controls showed no difference
Mogg and Bradley (2002)	16 LSA 11 HSA SADS, FNE A: 20	Threat, happy, neutral (Mogg and Bradley, 1999)	17 ms	M: dot-probe D: faces are masked after 17ms	HSA showed vigilance for threat faces, whereas LSA showed avoidance; bias scores correlated with SADS across the whole sample
Mansell et al. (2003)	32 HSA 32 LSA FNE A: 22.6	Angry, happy, neutral (Matsumoto and Ekman, 1988) Objects	25 s	M: probe detection D: probes can be either external (the letter E) or internal (a slight vibration to one finger); includes a threat condition	HSA showed a near-significant trend towards attentional bias for internal probes, while LSA showed a near-significant trend towards attentional bias for external probes, in response to emotional faces
Gotlib et al. (2004)	35 SP (23f, 12m) 88 MDD (62f, 26m) 55 HC (41f, 14m) SCID A: 33.8	Angry, happy, sad, neutral (various sources)	1 s	M: dot-probe	SP did not differ from the other groups on attentional bias to angry faces
Horley et al. (2004)	22 SP (9f, 13m) 22 HC (9f, 13m) SCID A: 40.2	Happy, angry, sad, neutral (Mazurski and Bond, 1993)	10 s	M: eye tracking	SP had increased raw scanpath length for angry, but not happy, faces compared to HC; compared to HC, SP had fewer fixations on the eye region of angry versus neutral faces
Mogg et al. (2004)	15 SP (7f, 8m) 15 HC (7f, 8m) MINI A: 31.5	Angry, happy, neutral (Bradley, Mogg, Falla and Hamilton, 1998)	500 ms; 1.25 s	M: dot-probe	In the 500ms condition, SP showed vigilance for angry versus happy faces, whereas HC had no bias; there were no differences between groups in the 1.25 s condition
Pishyar et al. (2004) Study 1	18 HSA 15 LSA FNE A: 19.45	Happy, disgust, judgemental, neutral (selfmade)	500 ms	M: dot-probe	LSA showed vigilance for happy faces and avoidance of threat faces, whereas HSA showed vigilance for threat faces and avoidance of happy faces
Pishyar et al. (2004) Study 2	15 HSA (all f) 14 LSA (all f) FNE A: 20	Happy, disgust, judgemental, neutral (selfmade)	500 ms	M: dot-probe D: faces are shown in profile turned towards each other and on one half of trials, the participant's own face is one of the pair	LSA showed vigilance for happy faces and avoidance of threat faces, whereas HSA showed vigilance for threat faces and avoidance of happy faces; seeing one's own face had no effect on attentional bias

Gilboa-Schechtman et al. (2005)	18 SP (10f, 8m) 18 SP with comorbid MDD (12f, 6m) 18 HC (9f, 9m) SCID A: 28	Positive, negative, neutral	2.5 s	M: face-in-the-crowd T: indicate valence of crowd	SP with and without depression rated moderately negative crowds as more negative than HC, but only SP with major depression rated the extremely negative crowds as more negative than HC; SP with and without major depression had longer response times to balanced compared to negative crowds, whereas HC showed the opposite pattern
Juth et al. (2005) Study 1	16 HSA 16 LSA FNE A: 26	Happy, angry, neutral (Lundqvist, Flykt and Öhman, 1998)	Until response	M: face in the crowd D: half the faces are averted, the other half directed	SA did not have an effect on either accuracy or reaction time
Juth et al. (2005) Study 2	16 HSA 16 LSA FNE	Happy, angry, neutral (Lundqvist, Flykt and Öhman, 1998)	Until response	M: face in the crowd D: includes a threat condition; half the faces are averted, the other half directed	SA did not have an effect on either accuracy or reaction time to threat faces
Pineles and Mineka (2005)	49 HSA 42 LSA SDS	Threat, happy, neutral (various sources)	500 ms	M: dot-probe D: includes a threat condition; stimuli can be either wave patterns or faces	There were no differences between groups on response time to threatening faces
Garner et al. (2006a) Study 1	16 HSA (13f, 3m) 16 LSA (15f, 1m) FNE, SADS A: 20.6	Angry, happy, neutral (various sources) Household objects	1.5 s	M: dot-probe, eye tracking	The groups did not differ in attentional bias to angry faces
Garner et al. (2006a) Study 2	16 HSA (15f, 1m) 15 LSA (10f, 5m) FNE, SADS A: 22.1	Angry, happy, neutral (various sources) Household objects	1.5 s	M: dot-probe, eye tracking D: includes a threat condition	HSA showed quick vigilance followed by avoidance to all emotional faces, when compared to LSA, but the groups did not differ in bias to angry faces
Kolassa and Miltner (2006)	19 SP (10f, 9m) 19 HC (10f, 9m) 19 spider phobia (9m, 10f) SCID A: 23.2	Angry, happy, neutral (Lundqvist, Flykt and Öhman, 1998)	1 s	M: electroencephalography, heart rate, emotional Stroop task T: Indicate gender or emotion	No effect of social anxiety on reaction time
Alpers and Gerdes (2007)	30 (19f, 11m) SPAI, SPS, SIAS A: 24.5	Angry, fear, surprised, neutral, happy (Lundqvist, Flykt and Öhman, 1998)	15 s	M: binocular rivalry T: indicate if emotional or neutral expression is dominant	SA had no effect on emotional predominance
de Jong and Martens (2007)	17 HSA (all f) 17 LSA (all f) SPS	Angry, happy, neutral (Lundqvist, Flykt and Öhman, 1998; Martinez and Benavente, 1998)	120 ms	M: rapid serial visual presentation T: indicate number of target faces detected among distractors as well as their expression	There were no differences between groups
Sposari and Rapee (2007) Study 1	26 SP (8f, 18m) 20 HC (12f, 8m) ADIS-IV A: 39	Happy, neutral, sad, angry, disgust, fear (Matsumoto and Ekman, 1988) Household objects	500 ms	M: dot-probe D: includes a threat condition	SP showed vigilance for all faces regardless of emotion
Sposari and Rapee (2007) Study 2	31 SP (15f, 16m) 32 HC (18f, 14m) ADIS-IV A: 36.4	Happy, neutral, sad, angry, disgust, fear (Matsumoto and Ekman, 1988) Household objects	500 ms	M: dot-probe D: includes a threat condition	SP showed vigilance for all faces regardless of emotion

(continued on next page)

Table 2 (*continued*)

Study (year)	*N* female/male (f, m), measure of SA, age (A)	Expressions (stimulus set), non-face stimuli	Exposure duration	Method (M), design (D), task (T)	Significant effects
Helfinstein et al. (2008)	24 (all f) SAS, ATQ A: 20.3	Angry, neutral (MacBrain Face Stimulus Set)	500 ms	M: dot-probe; electroencephalography D: Each trial is preceded by either a neutral word or a threat word	HSA showed vigilance for angry faces after a neutral word, but not after a threatening word, whereas LSA showed the opposite pattern
Lange, Heuer, et al. (2008) Experiment 3	18 HSA (14f, 4m) 22 LSA (15f, 7m) LSAS A: 24.6	Angry, neutral, happy	100 ms	M: inhibition of return D: target location is correctly or incorrectly cued by a face T: identify location of target	No effect of face valence or social anxiety
Li et al. (2008)	HSA 12 (5f, 7m) HSA 12 (5f, 7m) SIAS A: 18–22	Happy, threatening (selfmade)	500 ms	M: dot-probe D: one group is trained to look at happy faces, the other is trained to maintain their initial bias; groups are trained 7 consecutive days	Both groups showed vigilance for threatening faces prior to training
Moser et al. (2008)	21 HSA (15f, 6m) 21 LSA (11f, 10m) SPIN	Threatening, reassuring (Pérez-López and Woody, 2001)	500 ms	M: modified Flanker test; electroencephalography D: three faces are shown side by side T: indicate emotion of central face	No differences between groups in reaction time
Pishyar et al. (2008)	32 (14f, 18m) DSM-IV A: 30.5	Happy, disgust, judgemental, neutral (selfmade)	500 ms	M: dot-probe D: 16 participants undergo cognitive–behavioral therapy while 16 are wait list controls; the dot-probe is administered before and after therapy	Both groups showed vigilance for threatening faces and avoidance of happy faces at time 1; at time 2, the therapy group only showed vigilance for happy faces and avoidance of threatening faces
Stevens et al. (2009)	40 SP (24f, 16m) 40 HC (24f, 16m) SCID A: 29	Happy, angry, neutral (Lundqvist, Flykt and Öhman, 1998)	175 ms; 600 ms	M: dot-probe D: one group is given alcohol; includes ambiguous versions of all emotions	SP showed vigilance for angry faces at 175 ms compared to controls, but not at 600 ms; participants given alcohol showed no attentional bias
de Jong et al. (2009)	33 HSA (all f) 34 LSA (all f) FQ	Angry, happy, neutral (Lundqvist, Flykt and Öhman, 1998)	118 ms	M: attentional blink D: letters and faces as targets T: identify letter and valence of face	Attentional blink did not differ between happy or angry faces and was not affected by social anxiety
Klumpp and Amir (2009)	39 HSA 37 LSA SPAI A: 19.7	Angry, happy, neutral (Matsumoto and Ekman, 1988)	500 ms	M: dot-probe D: baseline trials are included to investigate disengagement effects	HSA showed vigilance for angry faces compared to LSA; there were no effects consistent with disengagement difficulties

ADIS-IV = Anxiety Disorders Interview Schedule for DSM-IV (Brown, Di Nardo, & Barlow, 1994); ATQ = Adult Temperament Questionnaire (Rothbart, Ahadi and Evans, 2000); FNE = Fear of Negative Evaluation (Watson and Friend, 1969); FQ = Fear Questionnaire (Marks and Mathews, 1979); HC = healthy controls; HSA = high social anxiety; LSA = low social anxiety; LSAS = Liebowit'z Social Anxiety Scale (Liebowitz, 1987); MDD = major depressive disorder; MINI = Mini International Neuro-psychiatric Interview (Sheehan et al., 1998); SAS = Social Anxiety Scale for Adolescents (La Greca and Lopez, 1998); SADS = Social Avoidance and Distress Scale (Watson and Friend, 1969); SCID = Structured Clinical Interview for DSM-IV (First, Spitzer, Gibbon, & Williams, 1995); SIAS = Social Interaction Anxiety Scale (Stangier, Heidenreich, Berardi, Golbs and Hoyer, 1999); SP = social phobia; SPAI = Social Phobia Anxiety Inventory (Turner, Beidel, Dancu and Stanley, 1989); SPIN = Social Phobia Inventory (Connor et al., 2000); SPS = Social Phobia Scale (Mattick and Clarke, 1998); WSA = Willems Social Anxiety Scale (Willems, Tuender-de Haan and DeFares, 1973).

might expect a conversational partner to be rejecting or disapproving, and because of attentional avoidance may not discover that the partner is actually welcoming. Another influential cognitive model is that of Rapee and Heimberg (1997), which claims that individuals with social phobia—apart from being inwardly focused—will also direct their attention toward potential threats. This could also serve to maintain social anxiety symptoms since the phobic individual would find his fears confirmed through this elaboration of threat signals. The classical distinction therefore is one of avoidance vs. vigilance for threatening stimuli, and this distinction has been extensively studied in relation to facial expressions. A wide variety of tasks have been used in the study of attentional bias and these will be reviewed below (Table 2).

3.1. The dot-probe task

The dot-probe paradigm is the most frequently employed measure of attentional bias in social anxiety. In this paradigm, participants are presented with two faces on a PC-monitor, side by side or one above the other, for a brief period of time. One face has an emotional expression and the other has a neutral expression. When the faces disappear from view, a probe (typically in the form of one or more dots or a letter) appears in the location of one of them. This creates two conditions: a congruent one, where the probe appears in the same location as the emotional face, and an incongruent one, where it appears in the opposite location (the location of the neutral face). Participants must respond as quickly as possible to the probe by pressing a button and the difference in reaction time between a congruent and an incongruent trial is hypothesized to reflect where the participant has been focusing his attention while the faces were visible. This difference is known as a *bias index*.

Two recent meta-analyses have found moderate effect sizes across a large number of dot-probe studies investigating high and low trait anxious individuals (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg & van IJzendoorn, 2007; Frewen et al., 2008). Both of these meta-analyses found that high trait anxious individuals show vigilance for threatening stimuli whereas low trait anxious individuals show avoidance. These reviews did not limit their analysis to social anxiety and emotional faces, however, and results for these specific parameters may differ from the overall picture.

Using the dot-probe paradigm, several research groups have reported no differences between participants with clinical or subclinical social anxiety and controls (Bradley, Mogg, Millar & Bonham-Carter, 1997, Experiment 1; Garner, Mogg & Bradley, 2006b; Gotlib et al., 2004; Pineles & Mineka, 2005); avoidance of threat faces in participants with clinical and subclinical social anxiety compared to controls (that is, shorter response latencies on incongruent trials) (Chen, Ehlers, Clark & Mansell, 2002; Mansell, Clark, Ehlers & Chen, 1999); and vigilance toward threat faces in participants with clinical and subclinical social anxiety compared to controls (shorter response latencies on congruent trials) (Helfinstein et al., 2008; Klumpp & Amir, 2009; Li, Tan, Qian & Liu, 2008; Mogg & Bradley, 2002; Mogg, Philippot & Bradley, 2004; Pishyar, Harris & Menzies, 2004; Pishyar, Harris & Menzies, 2008; Sposari & Rapee, 2007; Stevens, Rist & Gerlach, 2009). One final study that used a modified dot-probe task, showed a near-significant trend towards internal focus in high socially anxious participants, when presented with emotional faces (Mansell, Clark & Ehlers, 2003). In this study, half the probes were replaced by a slight vibration to the finger, and participants were led to believe that the vibration reflected changes in their physiology. Attentional bias for the vibration was then hypothesized to reflect an internal focus. The trend towards increased internal focus in socially anxious participants could be seen as equivalent to attentional avoidance of the emotional faces, since low socially anxious participants had more externally directed focus when presented with emotional faces. However, as mentioned before, the result was only nearly significant. In summary, even though the bulk of the dot-probe studies reviewed are consistent with attentional vigilance for threatening faces, a substantial number of studies show conflicting results.

Different factors appear to influence attentional bias. First, several studies have used a public speaking task to induce higher state anxiety in their participants, but the effect of such a threat condition is not entirely clear. In three studies that included a threat condition, one of these found no differences between groups (Pineles & Mineka, 2005), one found avoidance of all faces regardless of expression (Mansell et al., 1999), while one found vigilance for all faces regardless of expression (Sposari & Rapee, 2007). State anxiety scores in the study by Pineles and Mineka (2005) suggest that the threat condition was ineffective, which could explain the negative result. Secondly, Sposari and Rapee (2007) included clinical participants whereas Mansell et al. (1999) had students with high and low social anxiety. It is possible that this difference in the clinical status of the participants can explain part of the discrepancy in results.

One study may shed some light on this inconsistency. Garner et al. (2006b, Experiment 2) used eye tracking to monitor gaze in high and low socially anxious participants, who completed the dot-probe design, while anticipating a public speech. High socially anxious participants showed initial vigilance for all emotional faces regardless of expression, but they also spent less time looking at the emotional faces compared to low socially anxious participants. This would indicate a pattern of initial vigilance followed by avoidance and may also explain the discrepancy in earlier studies: Relying on reaction time data alone to determine attentional bias may be unreliable.

Some dot-probe studies have found that the bias index changes or even disappears, when long compared to short exposure durations are used. Stevens et al. (2009) found vigilance for angry faces at 175 ms, but not at 500 ms, and Mogg et al. (2004) found vigilance for angry faces at 500 ms, but not at 1250 ms. This might indicate that attentional bias becomes more unreliable at exposure durations around 500 ms and longer, since participants will have had time to switch their attentional focus at least once (Weierich et al., 2008). In other words, participants may have looked at the angry face for the initial 250 ms and then switched to the neutral face just in time for the probe to appear or vice versa. In support of this, Garner et al. (2006b) found with eye tracking equipment that their participants on average initiated the first overt shift in attention (i.e. eye movement) 350 ms after stimulus onset.

It is also important to note that the only studies to find avoidance of emotional faces in social anxiety have all come from the same research group (Chen et al., 2002; Mansell et al., 2003; Mansell et al., 1999) and that all of these studies paired the facial stimuli with neutral objects rather than neutral faces. However, when Sposari and Rapee (2007) explicitly sought to replicate this design, they found the opposite result (that is, vigilance). This would suggest that more subtle differences in how the method is employed might influence the direction of attentional bias. One line of research that supports this assumption comes from psychometric evaluation of the dot-probe task. Two independent research groups have found very poor reliability estimates for different versions of the dot-probe task (Schmukle, 2005; Staugaard, 2009). This is not to say that the dot-probe task cannot be useful. Recent clinical trials found that participants with social phobia improved their symptoms compared to individuals with social phobia in a control condition, when they underwent attentional training with the dot-probe task (Amir et al., 2009; Schmidt, Richey, Buckner & Timpano, 2009). This would suggest that the dot-probe task can be used as a therapeutic tool and it might prove to be a promising avenue for research. In relation to attentional bias, however, the dot-probe task unfortunately appears to raise more questions than it answers (see also Schultz and Heimberg, 2008), and it might be fruitful to use alternative methods in capturing this phenomenon. It is to these the review will now turn.

3.2. Face-in-the-crowd

Another frequently used design to measure attentional bias is the face-in-the-crowd task. In this task, participants search arrays of emotional and neutral faces for the "odd one out." For example, in an array of predominantly positive faces, a negative face would be the odd one out. Socially anxious individuals can be expected to show faster detection of an angry face in a predominantly neutral or positive crowd consistent with vigilance for threat. Alternatively, they may be slower in detecting a positive face in an angry crowd, because of difficulties in disengaging attention from threat.

Using this task, Gilboa-Schechtman, Foa and Amir (1999) found that all participants detected angry faces faster than happy faces in neutral crowds, but individuals with social phobia showed a greater difference in response time between angry and happy target faces than controls. When detecting angry and neutral faces in happy crowds, the groups did not differ. Importantly, individuals with social phobia were not faster than controls in detecting angry faces, rather, they were slower in detecting happy faces. This would suggest that the difference between individuals with social phobia and controls was not the result of greater vigilance for angry faces in individuals with social phobia, but rather a difficulty in detecting happy faces. Individuals with social phobia did not appear to be slowed down by happy crowds though, so it is unlikely that the happy faces caused greater attentional interference than the angry faces. Juth, Lundqvist, Karlsson and Öhman (2005) found the opposite result, namely that all participants were faster in identifying happy relative to angry faces in neutral crowds, but groups did not differ in response time patterns. The studies differed in that Gilboa-Schechtman et al. (1999) used the same individual to represent all faces in the crowd, whereas Juth et al. (2005) used different individuals for each member of a crowd. Also, the participants had clinical levels of social anxiety in the study by Gilboa-Schechtman et al. (1999), but not in the Juth et al. (2005) study.

Also, using crowds of varying valence from extremely negative to extremely positive, Gilboa-Schechtman, Presburger, Marom and Hermesh (2005) found that individuals with social phobia with and without comorbid depression evaluated moderately negative crowds as more negative than controls, but for patients without major depression this effect disappeared, when crowds became extremely negative.

Taken together, the face-in-the-crowd task does not produce consistent evidence that social anxiety involves an attentional bias to threatening faces. Only one study out of three actually found a negativity effect (Gilboa-Schechtman et al., 2005), which disappeared when the negative valence of the crowd reached maximum intensity. These results question whether social anxiety involves a bias specifically to threatening faces, since socially anxious individuals more consistently show a bias for crowds regardless of their emotional valence. It may also be that the face-in-the-crowd paradigm measures effects that are simply "too late" in the perceptual process to be picked up using reaction time data. In other words, if threatening faces create early and automatic responses in socially anxious participants, these may no longer be in effect, once processes such as judgment and interpretation of stimuli set in; an argument that will be explored in detail in the appropriate sections below.

3.3. Other visual attention tasks

Aside from the dot-probe task and the face-in-the-crowd task, a multitude of paradigms have been used to investigate attentional bias. This section will review the main findings of these paradigms and discuss some of the inconsistencies in results.

Alpers and Gerdes (2007) used a binocular rivalry task, in which two different images were presented simultaneously to each eye. Although emotional expressions were found to dominate neutral expressions in all participants—emotional expressions were detected earlier and were perceived for longer durations compared with neutral expressions—social anxiety was not found to influence this bias. de Jong, Koster, van Wees and Martens (2009), and de Jong and Martens (2007), presented participants with an attentional blink task. In this task, a series of targets, of which some are faces, are presented in quick succession and participants have to identify the targets. Typically in this task, the first target will cause attentional interference and thereby impair the correct identification of the second target. However, if the second target is salient, this interference effect may be reduced. Although the studies did find an attenuated attentional blink effect, it was not specific to angry faces nor influenced by social anxiety. Kolassa and Miltner (2006) used an emotional Stroop task in their study, which required participants to identify either the gender or the expression of faces. If threatening faces cause interference, participants should take longer to identify the gender of angry faces compared to neutral and happy faces. This study did find interference, but it was not specific to angry faces, and social phobia did not influence the effect. In a study by Lange, Heuer, Reinecke, Becker and Rinck (2008), participants were tasked with identifying the location of a dot preceded by a face. The location of the face would cue either the correct or the incorrect location of the dot, thus facilitating or inhibiting the task respectively. Neither social anxiety nor the valence of the faces had an effect on reaction time in this study. Moser, Huppert, Duval and Simons (2008) presented participants with a flanker task, in which a central face was flanked by two photos of the same person. Participants were required to identify the emotion of the central face, while ignoring the flanking faces. If threatening faces cause interference, correct identification of the central face should be slowed. However, social anxiety did not influence reaction time in this study. Finally, Putman, Hermans and van Honk (2004) did find that social anxiety correlated with attentional bias as measured by the emotional Stroop task (that is, angry faces caused more interference in participants with higher social anxiety scores), but social anxiety in this study was not a better predictor of bias than state anxiety; a finding that seems to mirror results from dot-probe studies showing that bias only happens, when socially anxious participants are under threat (Mansell et al., 1999; Sposari & Rapee, 2007).

Turning from reaction time based tasks to eye tracking, Horley, Williams, Gonsalvez and Gordon (2004) presented individuals with social phobia and controls with single faces for 10 s each. Individuals with social phobia showed longer overall scanpaths—an indication of increased eye movements—and reduced duration of fixations on the eyes of faces compared to controls. This pattern was evident for all faces, but appeared most prominent in response to angry faces. This result would suggest that individuals with social phobia show both vigilance (increased scanning of faces) and avoidance (reduced fixation on the eyes) when presented with a threatening face over longer time spans. Importantly, this effect—although less pronounced—was also observed for happy faces.

Langner, Becker and Rinck (2009) used a paradigm in which high (HSF) and low spatial frequencies (LSF) of the faces were separated. Through a masking procedure, only small parts ("bubbles") of the faces were shown to the participants, who were then asked to identify the emotions portrayed. This design allowed for an examination of the type of information utilized by participants in order to perform the task. The results were that high socially anxious participants used more LSF information, when identifying emotional valence compared to low socially anxious participants, who relied on high spatial frequency (HSF) information. Importantly, fearful LSF faces have been shown to activate the amygdala, while fearful HSF faces do not.

3.4. Summary of visual attention

Attentional bias to threatening faces in social anxiety is a controversial area of research in so far as it is difficult to draw any

Table 3
Emotional–behavioral reactivity.

Study (year)	*N* female/male (f, m), measure of SA, age (A)	Expressions (stimulus set), non-face stimuli	Exposure duration	Method (M), design (D), task (T)	Significant effects
Dimberg and Christmanson (1991)	15 HSA 15 LSA PRCS	Angry, happy (Ekman and Friesen, 1976) Geometric figures	8 s	M: electromyography	LSA showed more Corrugator activity to angry faces and more Zygomaticus activity to happy faces, whereas HSA did not differ in activity to faces
Dimberg (1997)	8 HSA (all f) 8 LSA (all f) PRCS	Angry, happy (Ekman and Friesen, 1976)	8 s	M: electromyography D: HSA and LSA groups were formed after the experiment	HSA had more Corrugator activity to angry faces and less Zygomaticus activity to happy faces compared to LSA
Vrana and Gross (2004)	10 HSA 9 LSA PRCS A: 20.7	Happy, angry, neutral (Ekman and Friesen, 1976)	8 s	M: electromyography, skin conductance, heart rate T: rate each face for valence, dominance, arousal and threat	HSA had greater Corrugator activity to angry faces compared to LSA;
Dimberg and Thunberg (2007)	28 HSA (all f) 28 LSA (all f) PRCS A: 23.3	Angry, happy (Ekman and Friesen, 1976)	1 s	M: electromyography, skin conductance, heart rate	Compared to LSA, HSA showed a greater difference in Corrugator activity to angry and happy faces as well as a greater difference in Zygomaticus activity to angry and happy faces
Heuer et al. (2007)	43 HSA (36f, 7m) 43 LSA (30f, 13m) LSAS A: 22.5	Angry, happy, neutral (selfmade) Puzzles	Until response	M: approach–avoidance D: faces grow or shrink according to the participant's response T: move a joystick towards or away from the stimuli	HSA were faster to push rather than pull the joystick in response to angry and happy faces, whereas LSA did not show this difference
Lange, Keijsers, et al., 2008	25 HSA (all f) 30 LSA (all f) LSAS A: 19.3	Angry, neutral, happy (Lundqvist, Flykt and Öhman, 1998)	Until response	M: face in the crowd, approach–avoidance T: push or pull a joystick to indicate colour of display	HSA were faster to push crowds away than to pull them closer regardless of valence, whereas LSA did not show this pattern
Roelofs et al. (2009)	18 SP (9f, 9m) 17 PTSD (11f, 6m) 22 HC (13f, 9m) SCID A: 36	Happy, angry (various sources)	100 ms	M: approach–avoidance D: the face-task is followed by a speech and arithmetic task; salivary cortisol and blood pressure is measured	SP showed faster avoidance relative to approach to angry faces when under social stress only; the other groups did not show avoidance
van Peer et al. (2009)	20 SP (11f, 9m) SCID A: 32.8	Happy, angry (various sources)	100 ms	M: approach–avoidance, electroencephalography D: cortisol is administered prior to testing	Cortisol administration did not influence avoidance, but a high level of SA within the sample correlated with avoidance of angry faces

HC = healthy controls; HSA = high social anxiety; LSA = low social anxiety; LSAS = Liebowit'z Social Anxiety Scale (Liebowitz, 1987); PRCS = Public Report of Confidence as a Speaker (Paul, 1966); PTSD = post-traumatic stress disorder; SCID = Structured Clinical Interview for DSM-IV (First, Spitzer, Gibbon, & Williams, 1995); SP = social phobia.

definitive conclusions. Taken together, the evidence suggests a complex pattern of both vigilance and avoidance that is not limited to threatening expressions, but also includes positive faces. Most consistently, findings from the dot-probe task indicate that social anxiety entails an initial vigilance for threatening faces that happens within the first 100–500 ms of stimulus presentation. When longer exposure durations are employed, attentional bias becomes increasingly unreliable and thus difficult to interpret. At these exposures, attentional bias either "expands" to include positive emotional expressions; changes from vigilance to avoidance; or simply disappears (becomes statistically non-significant). It is possible that at longer exposure durations, cognitive processes such as interpretation and judgment begin to influence participant responses in reaction time tasks such as those reviewed above.

Several studies investigating other visual attention tasks have generally not been able to identify any differences between high- and low socially anxious participants (notable exceptions are Horley et al., 2004; Langner et al., 2009). Although the studies do find that the tasks produce the hypothesized effects in all the participants, social anxiety does not appear to influence the effects. This questions whether social anxiety really does entail attentional biases as the dot-probe task shows. Notably, apart from two (Horley et al., 2004; Kolassa & Miltner, 2006) all of the studies using other visual attention tasks have relied on subclinically anxious participants. It is possible that attentional bias is simply not apparent in subclinical social anxiety or alternatively that the tasks are not sensitive enough to capture bias. Since the dot-probe does find attentional bias even in subclinically anxious participants (e.g., Li et al., 2008; Klumpp & Amir, 2009), the latter explanation appears most probable at this time. One tentative explanation for a lack of sensitivity might be related to task demands: The emotional Stroop task, flanker task, attentional blink task, and binocular rivalry task to some extent all require participants to identify the emotional expression of the target face. As reviewed in the sections on Subjective Ratings, and Expectancy and Interpretation, participants with social anxiety generally do not show biases in these areas. Therefore, emotion identification may actually negate attentional bias. Since the dot-probe task relies solely on reaction time to a neutral probe, this paradigm is not influenced by this potential confounder.

4. Emotional–behavioral reactivity

Two lines of evidence have investigated emotional–behavioral responses to photographs of threatening faces: studies using facial electromyography (EMG) and studies using the approach–avoidance task (Table 3).

Several researchers have investigated the hypothesis that a biological predisposition to react to emotional faces will manifest itself in a type of facial mimicry that can be measured with EMG. More specifically, the large facial muscles, Zygomaticus major that controls smiling, and Corrugator supercilii that controls frowning, should show increased activation in response to happy and angry faces respectively. Some studies have found increased Corrugator activity (frowning) to angry faces in high, compared to low, socially anxious participants (Dimberg, 1997; Vrana & Gross, 2004), whereas others found no group differences in response to angry faces (Dimberg & Christmanson, 1991; Dimberg & Thunberg, 2007). Dimberg and Thunberg (2007) argue that research should focus on whether Corrugator activity differs between angry and happy faces within each group and then compare this difference, rather than compare Corrugator activity to angry faces between groups. They found that participants scoring high in self-reported public speaking fear had a significantly larger difference in Corrugator activity to angry versus happy faces, than participants scoring low in public speaking fear. However, Dimberg and Christmanson (1991) found that whereas participants with low speaking fear indeed showed differential EMG responding to emotional faces (i.e. smiling when viewing happy faces and frowning when viewing angry faces), the high speaking fear participants did not show differential EMG activity. One explanation for this discrepancy might be exposure duration, since Dimberg and Thunberg (2007) used an exposure duration of 1 s, while Dimberg and Christmanson (1991) exposed their sample for 8 s. Dimberg and Thunberg (2007) suggest that the longer duration may have allowed for strategic processes such as avoidance to be engaged, which would explain the lower EMG activity in the socially anxious participants. This explanation does not seem entirely plausible however, since participants in Dimberg's (1997) study—selected on the basis of the same criteria as participants in the other two studies from Dimberg's research group—did show increased Corrugator activity to angry faces even at the 8 s exposure duration. Eight seconds may simply be too long to achieve reliable results using EMG, since both vigilance and avoidance processes could be active within this time window.

In the approach–avoidance task, participants are required to either pull a joystick away from or towards themselves in response to specific facial expressions (e.g., Heuer, Rinck & Becker, 2007). The latency to push threatening faces away compared to pulling them closer is hypothesized to reflect a behavioral defensive reaction that is considered automatic (Heuer et al., 2007) and intuitive (van Peer et al., 2009). Using the approach–avoidance task, Heuer et al. (2007) found faster avoidance responses in socially anxious participants to emotional faces regardless of their valence, while a similar study by Roelofs et al. (2009) found that socially anxious participants were faster to avoid (push the joystick) rather than approach (pull the joystick) angry faces, when under threat of performing in front of an audience. Finally, van Peer et al. (2009) found that higher levels of social anxiety within their clinical population correlated with more pronounced avoidance of angry faces, compared to patients with lower levels of social anxiety.

In a variation of the approach–avoidance task, using crowds of faces with varying ratios of threatening expressions, Lange, Keijsers, et al. (2008) presented high and low socially anxious students with crowds of faces that varied in valence from extremely negative to extremely positive. When participants moved the joystick away from or toward the screen, the crowds were reduced or enlarged in size, respectively. Lange, Keijsers, et al. (2008) found that high socially anxious participants were faster in pushing crowds away than pulling them nearer, whereas low socially anxious participants did not show this effect. The effect was independent of the emotional valence of the crowds, although the high socially anxious participants did show a non-significant trend towards a correlation between avoidance and the number of angry faces in the crowd.

Taken together, these studies would suggest that the approach–avoidance task is a promising tool for investigating attentional bias under different conditions. Importantly, the two studies to find an effect specific to the angry faces, both used 100 ms exposure durations (Roelofs et al., 2009; van Peer et al., 2009), while Heuer et al. (2007) presented their stimuli until participant response. This difference in exposure duration may explain why the effect in the latter study was not specific to angry faces, but included all faces: As reviewed in the section on visual attention above, findings from the dot-probe paradigm indicate that shorter exposure durations generally produce more reliable attentional bias to threatening faces in socially anxious participants.

EMG also appears to be a sensitive method for measuring emotional–behavioral responses to threatening faces, especially at short exposure durations. According to Dimberg and Thunberg (2007), EMG can be seen as a form of automatic mimicry that helps to promote interpersonal communication. It can then be hypothesized that socially anxious individuals "overdo" this mimicry due to heightened interpersonal sensitivity. According to this explanation, socially anxious individuals should be expected to smile more at happy faces, which Dimberg and Thunberg (2007) also found using a 1 s exposure duration. Following this initial mimicry, socially anxious

Table 4
Memory and recognition.

Study (year)	*N* female/male (f, m), measure of SA, age (A)	Expressions (stimulus set), non-face stimuli	Exposure duration	Method (M), design (D), task (T)	Significant effects
Winton et al. (1995)	13 HSA (7f, 4m) 11 LSA (6f, 5m) FNE A: 21.7	Angry, sad, disgust, contempt, fear, neutral (Matsumoto and Ekman, 1988)	60 ms	M: recognition D: includes threat of speech T: identify emotion	HSA showed a negative response bias towards all faces, but did not show enhanced recognition of threatening faces
Mansell et al. (1999)	35 HSA (23f, 12m) 36 LSA (19f, 17m) FNE A: 22.5	Angry, disgust, fear, sad, neutral, happy (Matsumoto and Ekman, 1988) Household objects	500 ms	M: dot-probe, memory D: includes threat of speech or no threat T: identify emotions	No differences between groups in recognition
Foa et al. (2000) Experiment 1	13 SP 11 HC SCID A: 35.2	Angry, happy, surprise, disgust, fear, sad, neutral (Ekman and Friesen, 1976)	35 s (encoding); 5 s (recall)	M: memory D: includes four phases: name learning, emotional encoding, free recall, cued recall T: recall the names of the persons, label the emotions	SP had better recall than controls for all types of faces; during cued recall, SP recognized angry faces better
Foa et al. (2000) Experiment 2	15 SP (3f, 12m) 16 HC (10f, 6m) SCID A: 32.1	Angry, happy, disgust, neutral (Matsumoto and Ekman, 1988)	5 s (encoding); until response (recall)	M: memory T: label faces as “old” or “new”	SP recognized all types of faces better than controls; SP recognized negative faces better, and with longer latencies, than non-negative faces whereas controls did not show these differences
Pérez-López and Woody (2001)	24 SP (9f, 15m) 20 HC (8f, 12m) SCID, ADIS-IV A: 34.5	Angry, disgust, surprise, happy (selfmade)	3.75 s	M: memory D: includes preparing for a public speech T: indicate whether facial expression is “old” or “new”	SP had worse recognition of expressions than controls, but this effect disappeared when controlling for state anxiety; SP had slightly better recognition of positive than negative faces, whereas controls showed no difference
Chen et al. (2002)	20 SP (14f, 6m) 20 HC (14f, 6m) ADIS-IV A: 35.7	Sad, fear angry, happy, disgust (Matsumoto and Ekman, 1988) Household objects	500 ms	M: dot-probe, memory T: indicate “old” or “new” faces	The groups did not differ in recognition
D'Argembeau et al. (2003)	24 HSA (21f, 3m) 22 LSA (18f, 4m) SISST A: 19.7	Happy, angry, neutral (various sources)	5 s	M: memory D: emotional faces are shown during encoding, neutral are shown during recognition T: indicate valence of neutral face during encoding	Social anxiety showed no effect on accuracy
Coles and Heimberg (2005)	25 SP (14f, 11m) 25 HC (15f, 10m) ADIS-IV A: 30.8	Critical, accepting (Matsumoto and Ekman, 1988; selfmade)	5 s (encoding); 2 s (recall)	M: memory T: rate each face for valence during encoding, indicate “old” or “new” during recognition	SP recognized more critical faces than HC; SP did not differ in recognition of critical and accepting faces, whereas HC recognized more accepting than critical faces
Silvia et al. (2006) Study 2	13 HSA (10f, 3m) 14 LSA (11f, 3m) SIAS, SPS	Happy, angry (Ekman and Friesen, 1976)	200 ms	M: recognition T: indicate expression	Both groups recognized happy faces faster than angry faces, but the difference was greater for LSA than HSA
Hunter et al. (2009)	24 HSA 121 LSA SPS A: 18.7	Happy, angry, sad, fear (Nowicki and Carton, 1993)	2 s	M: recognition T: indicate expression	HSA had better recognition of facial emotion overall compared to HSA, but the groups did not differ with respect to angry expressions

ADIS-IV = Anxiety Disorders Interview Schedule for DSM-IV (Brown, Di Nardo, & Barlow, 1994); FNE = Fear of Negative Evaluation (Watson and Friend, 1969); HC = healthy controls; HSA = high social anxiety; LSA = low social anxiety; SCID = Structured Clinical Interview for DSM-IV (First, Spitzer, Gibbon, & Williams, 1995); SIAS = Social Interaction Anxiety Scale (Stangier, Heidenreich, Berardi, Golbs and Hoyer, 1999); SISST = Social Interaction Self-Statement Test (Glass, Merluzzi, Biever and Larsen, 1982); SP = social phobia; SPS = Social Phobia Scale (Mattick and Clarke, 1998).

Table 5
Subjective ratings.

Study (year)	*N* female/male (f, m), measure of SA, age (A)	Expressions (stimulus set)	Ratings	Significant effects
Merckelbach et al. (1989)	9 SP (2f, 7m) 9 HC (2f, 7m) FQ A: 22, 18–31	Angry, happy (Ekman and Friesen, 1976)	Pleasantness	No differences between groups
Dimberg and Christmanson (1991)	15 HSA 15 LSA PRCS	Angry, happy (Ekman and Friesen, 1976)	Valence, friendliness, hostility and directedness	HSA rated angry faces as more negative than LSA
Dimberg (1997)	8 HSA (all f) 8 LSA (all f) PRCS	Angry, happy (Ekman and Friesen, 1976)	Valence, friendliness, hostility and directedness	Groups did not differ for angry faces, but HSA rated happy faces as less positive and more hostile than LSA
de Jong et al. (1998)	32 HSA (all f) 28 LSA (all f) FQ A: not reported	Angry, happy, neutral (Ekman and Friesen, 1976, de Jong et al., 1998)	Fearfulness, valence	No difference between groups
Stein et al. (2002)	15 SP (5f, 10m) 15 HC (5f, 10m) SCID A: 39.2	Angry, fear, contempt, happy, neutral (Matsumoto and Ekman, 1988)	Harshness	No difference between groups
Straube et al. (2004)	10 SP (6f, 4m) 10 HC (6f, 4m) SCID A: 24.1	Angry, neutral (MacBrain Face Stimulus Set)	Pleasantness, arousal	No difference for valence; SP rated angry faces as more arousing than HC
Vrana and Gross (2004)	10 HSA 9 LSA PRCS A: 20.7	Happy, angry, neutral (Ekman and Friesen, 1976)	Valence, arousal, dominance, cost of speech if target was audience	No difference between groups; near-significant trend towards increased cost of speech in HSA compared to LSA
Amir et al. (2005)	11 SP (8f, 3m) 11 HC (8f, 3m) SCID A: 24	Disgust, neutral (various sources)	Pleasantness	No difference between groups for disgust expressions
Coles and Heimberg (2005)	25 SP (14f, 11m) 25 HC (15f, 10m) ADIS-IV A: 30.8	Critical, accepting (Matsumoto and Ekman, 1988; selfmade)	Acceptance/criticism	No difference between groups
Straube et al. (2005)	9 SP (5f, 4m) 9 HC (5f, 4m) SCID A: 24.2	Angry, happy, neutral (Lundqvist, Flykt and Öhman, 1998)	Valence, arousal	No difference between groups for threat faces; SP rated happy faces as more pleasant
Dimberg and Thunberg (2007)	28 HSA (all f) 28 LSA (all f) PRCS A: 23.3	Angry, happy (Ekman and Friesen, 1976).	Valence, pleasantness, directedness	HSA showed a larger difference in ratings of pleasantness and disgust between angry and happy faces than LSA

Heuer et al. (2007)	43 HSA (36f, 7m) 43 LSA (30f, 13m) LSAS A: 22.5	Angry, happy, neutral (selfmade)	Valence	No difference between groups
Schofield et al. (2007)	49 HSA (37f, 12m) 51 LSA (27f, 24m) BFNE A: 18.7	Happy, disgust, neutral (Matsumoto and Ekman, 1988)	Valence, cost of hypothesized social interaction	HSA rated a hypothetical social interaction with disgust faces as more costly than LSA
Yoon and Zinbarg (2007)	51 SPS	Angry, disgust, happy, neutral (Ekman and Friesen, 1976)	Tell a story that will link the faces	HSA did not make more negative stories than LSA to angry faces
Lange, Keijsers, et al., 2008	32 HSA (all f) 34 LSA (all f) LSAS A: 19.4	Angry, neutral, happy (Lundqvist, Flykt and Öhman, 1998)	Judge friendliness of crowds with varying numbers of angry faces	No difference between groups
Mühlberger et al. (2009)	18 HSA (10f, 8m) 18 LSA (8f, 10m) SPAI A: 23.4	Angry, neutral, fear, happy (Lundqvist, Flykt and Öhman, 1998)	Arousal, pleasantness	No difference between groups
Stevens et al. (2008)	40 SP (24f, 16m) 40 HC (24f, 16m) SCID A: 29	Happy, angry, neutral (Lundqvist, Flykt and Öhman, 1998)	Friendliness, rejection	There were no differences between groups in ratings of angry faces
Campbell et al. (2009)	12 SP (7f, 5m) 28 HC (10f, 18m) MINI A: 31.2	Happy, disgust, angry (Matsumoto and Ekman, 1988)	Valence, likelihood of approaching target in a social interaction	SP did not differ from controls in ratings of valence or approachability of the negative faces
Furmark et al. (2009)	34 SP (20f, 14m) 18 HC (9f, 9m) SCID A: 36.0	Angry, neutral (Ekman and Friesen, 1976)	Anxiety following each face	SP reported higher anxiety than HC, but this was unrelated to the valence of the faces
Goldin et al. (2009)	15 SP (9f, 6m) 17 HC (9f, 8m) ADIS-IV A: 31.9	Harsh (selfmade)	Negative emotion following each face	SP reported more negative emotion than HC, but this was unrelated to the valence of the faces

ADIS-IV = Anxiety Disorders Interview Schedule for DSM-IV (Brown, Di Nardo, & Barlow, 1994); BFNE = Brief Fear of Negative Evaluation (Leary, 1983); FD = formerly depressed; FNE = Fear of Negative Evaluation (Watson and Friend, 1969); FQ = Fear Questionnaire (Marks and Mathews, 1979); HC = healthy controls; HSA = high social anxiety; LSA = low social anxiety; LSAS = Liebowit'z Social Anxiety Scale (Liebowitz, 1987); MINI = Mini International Neuropsychiatric Interview (Sheehan et al., 1998); PRCS = Public Report of Confidence as a Speaker (Paul, 1966); SCID = Structured Clinical Interview for DSM-IV (First, Spitzer, Gibbon, & Williams, 1995); SP = social phobia; SPAI = Social Phobia Anxiety Inventory (Turner, Beidel, Dancu and Stanley, 1989); SPS = Social Phobia Scale (Mattick and Clarke, 1998).

participants either show increased frowning to angry faces compared to controls (Dimberg, 1997), or reduced EMG activity (Dimberg & Christmanson, 1991; Vrana & Gross, 2004).

5. Memory and recognition

Some researchers hypothesize that socially anxious individuals should have superior memory for negative faces, due to interpersonal sensitivity (Foa, Gilboa-Schechtman, Amir & Freshman, 2000; Winton, Clark & Edelmann, 1995), while others hypothesize that they should do worse than controls, because they avoid looking at faces (Mansell et al., 1999). In their review, Heinrichs and Hofman (2001) did not find evidence that social anxiety was related to memory biases for threatening words. They suggest that such absence of a bias may be related to the semantic nature of words versus pictorial stimuli, where the latter may be more directly related to social evaluation. Consequently, they call for research that evaluates cognitive biases to faces. This section will investigate whether socially anxious individuals are biased towards recognizing and remembering threatening faces (Table 4).

Several research groups failed to find any differences between high socially anxious participants and low-anxious controls (D'Argembeau, Van der Linden, Etienne & Comblain, 2003; Hunter, Buckner & Schmidt, 2009; Mansell et al., 1999; Silvia, Allan, Beauchamp, Maschauer & Workman, 2006), or individuals with social phobia and controls (Chen et al., 2002), with regard to memory and recognition of threatening faces. It should be noted that in two of these studies (Chen et al., 2002; Mansell et al., 1999) all participants performed poorly, which might have obscured any effects of recognition. Winton et al. (1995) found that, when presented very briefly (60 ms) with photographs of faces, high socially anxious participants recognized more negative than neutral faces compared with low socially anxious participants. However, signal detection analysis revealed that this was likely due to a negative response bias—that is, the socially anxious participants were not actually better at detecting negative faces, they simply labelled more faces as negative, even if they had not seen them.

In two experiments, Foa et al. (2000) found that participants diagnosed with generalized social phobia had better memory for faces regardless of their emotional expression compared to controls. In the second experiment, individuals with social phobia also recognized more negative than positive faces—a difference not evident in the control group. Coles and Heimberg (2005) did not replicate this latter finding. In their study, individuals with social phobia did not show a difference in recognition of negative and positive faces, although they did show enhanced recognition of negative faces compared to controls.

In direct contrast with these findings, Pérez-López and Woody (2001) found that participants with social phobia had worse memory for faces than control participants while anticipating a public speech. In fact, the individuals with social phobia showed a small bias towards remembering positive faces better than negative faces. However, when the effect of state anxiety was controlled for, the statistically significant difference between individuals with social phobia and controls disappeared, suggesting that the memory impairment seen in individuals with social phobia may have been a result of state anxiety rather than social anxiety.

Does social anxiety facilitate memory for threatening faces? Based on the research, it would seem to depend on at least two factors: the clinical status of the participants and their level of state anxiety during the experiment. First, studies using non-clinically anxious participants have not found any differences between groups, which would indicate that only participants with clinical levels of social anxiety will show a memory bias. Second, clinical participants appear to show facilitation for remembering all types of faces regardless of their valence. Finally, when a threat condition is used, individuals with social phobia appear to actually perform worse than controls, likely due to their elevated state anxiety. Interestingly, whereas clinical participants in the Foa et al. (2000) study showed superior memory for threatening compared to reassuring faces, in the study by Pérez-López and Woody (2001) they showed the exact opposite pattern: remembering more reassuring than threatening faces. Notably, both of these studies hypothesized that social phobia would entail better memory for threatening faces. It is possible that increased state anxiety reduces performance in people with social phobia, and at the same time causes them to strategically avoid the threatening faces. This might lead to a slight memory bias for the safer, positive faces.

In summary, there is some evidence that people with clinical levels of social anxiety will show superior memory for emotional faces, but increased state anxiety appears to eliminate or even reverse this effect.

6. Subjective ratings

Several studies have included Likert-style self-report rating scales of the intensity or arousal of faces (Table 5). These studies allow for an examination of whether people with high social anxiety evaluate threatening faces as more negative, arousing, or unpleasant, than people with low social anxiety. Out of 21 studies that included self-report ratings, only five found that social anxiety led to increased ratings (Dimberg & Christmanson, 1991; Dimberg & Thunberg, 2007; Goldin, Manber, Hakimi, Canli & Gross, 2009; Schofield, Coles & Gibb, 2007; Straube, Kolassa, Glauer, Mentzel & Miltner, 2004). Typically, ratings were collected as part of a larger study, sometimes during neuroimaging, other times following the experimental procedures as a control condition. The fact that the ratings were not always the main focus of these studies may limit the validity of the results (e.g. participants might consider them a side note or habituation to the stimuli might occur if ratings were collected after the main experimental session).

However, when the main focus of the study was evaluation of threatening faces, results were still negative. Asking individuals with social phobia and controls to make up stories about pairs of faces with different expressions, Yoon and Zinbarg (2007) did not find any differences between the content of stories provided by the two groups when the pairs included an angry face. When the pairs included a disgust expression, socially anxious participants actually produced fewer stories scored as negative when compared to controls, and consequently produced more stories where an emotion could not be identified.

In a study by Campbell et al. (2009), individuals with social phobia and controls were asked to rate the approachability of different emotional faces ("rate how likely you are to approach and engage the presented person (face) in a social interaction", p. 421). Surprisingly, there were no differences between patients and controls in their ratings of the approachability of disgust and angry faces, even though the task appears to tap into one of the core features of social anxiety, namely fear of interaction with (unwelcoming) strangers. Instead, individuals with social phobia had a significantly lower approachability score for *happy* faces compared to controls.

In summary, there is substantial evidence that individuals with social anxiety do not differ from non-anxious controls, when it comes to self-reported judgments of threatening facial expressions. Even though the studies appear to sample one of the core features of social anxiety, namely the avoidance of social encounters, they do not find that individuals with social phobia or subclinical social anxiety differ from controls. However, one cannot be certain that the participants in these studies actually consider the prospect of a real interaction with the persons they rate. Under those circumstances, participants with social anxiety may not have any reason to judge the faces as more unfriendly, unpleasant or threatening than controls. It is possible that

Table 6
Expectancy and interpretation.

Study (year)	*N* female/male (f, m), measure of SA, age (A)	Expressions (stimulus set), non-face stimuli	Exposure duration	Method (M), design (D), task (T)	Significant effects
De Jong et al. (1998)	32 HSA (all f) 28 LSA (all f) FQ A: not reported	Angry, happy, neutral (Ekman and Friesen, 1976, de Jong et al., 1998)	8 s	M: illusory correlation D: equal chance of shock, siren or no aversive outcome following each face T: indicate likelihood of outcome	No differences between groups
Richards et al. (2002) Study 1	15 HSA 15 LSA SPAI A: 26.1	Happy, surprise, fear, disgust, sad, angry (Ekman and Friesen, 1976)	Until response	M: interpretation D: faces are morphed to create ambiguous expressions (90% original emotion) T: identify each emotion	HSA classify more faces as fearful, but there is no effect of social anxiety on responses to anger and disgust faces
Richards et al. (2002) Study 2	20 HSA 18 LSA SPAI A: 23.8	Happy, surprise, fear, disgust, sad, angry (Ekman and Friesen, 1976)	Until response	M: interpretation D: faces are morphed to create ambiguous expressions (90% original emotion). Includes a mood manipulation T: identify each emotion	No effect of social anxiety on responses to anger and disgust faces
Mullins and Duke (2004)	73 (all f) FNE, SADS A: 19.2	Angry, happy, sad, fear (Nowicki and Carton, 1993)	Until response	M: interpretation D: includes three different threat conditions T: indicate emotion shown	There was no effect of SA on errors made; SADS, but not FNE, was associated with slower responses in the no-threat and high-threat conditions, and faster responses in the medium-threat condition
Philippot and Douilliez (2005)	21 SP (7f, 14m) 39 HC (20f, 19m) MINI A: 31.5	Happy, angry, disgust, sad, neutral, fear (Matsumoto and Ekman, 1988)	Until response	M: interpretation D: faces are morphed to create ambiguous expressions of varying intensity T: rate faces for emotion	The groups did not differ on accuracy; in the SP group only, FNE scores correlated with self-reported difficulty of making judgments about angry and disgust faces
Garner et al. (2006b)	23 HSA (21f, 2m) 23 LSA (20f, 3m) FNE, SADS A: 20.2	Angry, happy, neutral (Ekman and Friesen, 1976)	5 s	M: illusory correlation D: equal chance of an unpleasant, pleasant or neutral picture, or nothing at all, following each face T: indicate outcome	After the experiment, HSA overestimated the percentage of trials where an angry face had been presented compared to LSA; no other differences between groups
Joormann and Gotlib (2006)	26 SP (16f, 10m) 25 HC (17f, 8m) SCID A: 31	Sad, happy, angry, fear (Ekman and Friesen, 1976)	Until response	M: interpretation D: faces are morphed T: indicate expression as quickly as possible	Groups did not differ in accuracy; SP identified angry expressions at lower intensities than HC
Montagne et al. (2006)	24 SP (14f, 10m) 26 HC (14f, 12m) MINI A: 37.2	Angry, disgust, surprise, fear, happy, sad, neutral (selfmade)	Until response	M: interpretation D: faces are morphed to create ambiguous expressions of varying intensity T: indicate type of expression	HC recognized negative faces at lower intensity than SP, especially angry and disgust faces
Schofield et al. (2007)	49 HSA (37f, 12m) 51 LSA (27f, 24m) BFNE A: 18.7	Happy, disgust, neutral (Matsumoto and Ekman, 1988)	Varies	M: interpretation D: faces are morphed T: indicate expression as quickly as possible	No differences between groups on response time to threat faces
Stevens et al. (2008b)	40 SP (24f, 16m) 40 HC (24f, 16m) SCID A: 29	Happy, angry, neutral (Lundqvist, Flykt and Öhman, 1998)	Until response	M: interpretation D: one group is given alcohol: includes ambiguous versions of all emotions T: rate the faces for valence	There were no differences between groups in ratings of angry faces

BFNE = Brief Fear of Negative Evaluation (Leary, 1983); FNE = Fear of Negative Evaluation (Watson and Friend, 1969); FQ = Fear Questionnaire (Marks and Mathews, 1979); HC = healthy controls; HSA = high social anxiety; LSA = low social anxiety; MINI = Mini International Neuro-psychiatric Interview (Sheehan et al., 1998); SADS = Social Avoidance and Distress Scale (Watson and Friend, 1969); SCID = Structured Clinical Interview for DSM-IV (First, Spitzer, Gibbon, & Williams, 1995); SP = social phobia; SPAI = Social Phobia Anxiety Inventory (Turner, Beidel, Dancu and Stanley, 1989).

negative thoughts and judgments concerning strangers are only engaged prior to, or during, an actual social interaction.

7. Expectancy and interpretation

This section reviews studies that hypothesize a relationship between social anxiety and the tendency to interpret ambiguous faces as negative, or to expect a negative outcome to follow the presentation of a threatening face. Earlier reviews have concluded that social anxiety entails both an interpretation bias and an expectancy bias (Clark & McManus, 2002; Heinrichs & Hofman, 2001; Hirsch & Clark, 2004), but these conclusions are based on studies that focus on social interaction or social events rather than threatening faces. Such studies typically involve interpreting ambiguous sentences or short descriptions of events, or rating the expectancy of a hypothetical social interaction. Importantly, it is not clear from the mentioned reviews if interpretation and expectancy biases are also activated by faces (Table 6).

Investigating whether social anxiety would influence how people relate negative cues and unpleasant outcomes, de Jong, Merckelbach, Bögels and Kindt (1998) and Garner, Mogg and Bradley (2006a) showed pictures of emotional faces to participants high and low in social anxiety and then asked them to rate expectancy of negative outcomes (e.g. an electric shock or an unpleasant image). All groups in both studies had a higher expectancy of a negative outcome following an angry face, but there was no effect of social anxiety on expectancy in either study.

If social cues generally evoke negative interpretations in socially anxious individuals, it can be hypothesized that such individuals should judge ambiguous faces (e.g. an angry expression mixed with a happy expression) to be predominantly negative. Richards et al. (2002) investigated this in two experiments, one of which included a mood manipulation. They found that the manipulation increased anger judgments when evaluating ambiguous faces, but there was no effect of social anxiety in any of the experiments. Yoon, Joormann and Gotlib (2009) morphed negative and neutral faces to create expressions of low intensity (40% emotion). They then paired these low-intensity negative faces with low-intensity happy faces, and asked individuals with social phobia, controls and patients with major depressive disorder to indicate which face was the most intense. Compared to controls, individuals with social phobia were more likely to select the negative face as more intense, indicating that they either perceived the happy faces as less intense, or the angry faces as more intense, than controls. An alternative explanation could be that the individuals with social phobia attended more to the negative faces due to attentional bias for threat (see section on visual attention above). Finally, depressed patients showed an even stronger bias towards selecting the negative faces as more intense, indicating that this effect was not specific to social anxiety.

Some research groups have mixed emotional and neutral expressions, thus creating varying intensities of emotion. However, none of these studies have found an effect of social anxiety on the interpretation of emotional valence (Mullins & Duke, 2004; Philippot & Douilliez, 2005; Schofield et al., 2007; Stevens, Gerlach & Rist, 2008).

Other groups have presented facial stimuli continuously in order to create the illusion of a neutral face slowly taking on an emotional expression of increasing intensity. Using this method, Montagne et al. (2006) found that controls identified ambiguous faces as negative at lower intensities compared to individuals with social phobia—an indication that socially anxious participants may actually need *more* affective information than controls before making judgments regarding valence. However, Joormann and Gotlib (2006) found the opposite pattern, namely that individuals with social phobia identified negative faces at a lower intensity than controls. This inconsistency may be explained in part by differences in methodology between these two studies. Joormann and Gotlib (2006) presented the faces slowly (a high number of expressions of increasing intensity was displayed for 500 ms each) until response. Montagne et al. (2006) on the other hand, showed series of clips where the faces would quickly (500 ms–2 s) morph into an expression of increasing intensity and then remain on screen until response. This means that while participants in the Joormann and Gotlib (2006) study would have to judge the expression while it was continuously changing, in the Montagne et al. (2006) study they could wait until the clip had stopped before making their judgment. An important difference might therefore be, whether the study required the participants to be as quick as possible, or as accurate as possible, when making judgments. A demand for speed might increase the efficiency of detecting negative emotion in individuals with social phobia whereas a demand for accuracy might decrease it (people with social phobia may wait longer before giving their response, in order to make sure that they get it right). It is therefore not entirely clear whether these findings reflect an interpretation bias, an attentional bias, or the demand characteristics of the studies themselves.

In summary, people with social phobia seem to show increased sensitivity to threat, when they need to make a quick assessment of a neutral face slowly changing into a negative expression. However, when the task calls for accuracy, this advantage is actually reversed into a slowed response. There is no evidence to suggest that socially anxious individuals expect negative outcomes following presentations of threatening faces to a higher degree than controls. At a glance, this conclusion seems to be in conflict with Clark and McManus' (2002) view that social phobia entails an expectancy of catastrophic outcomes following mildly negative social events. However, whether a negative social event and a threatening face can be equated is not entirely obvious. As also suggested in the section on subjective ratings above, a threatening face may not engage negative thoughts and expectations in individuals with social anxiety, since they do not necessarily entail an impending social interaction. Rather, the participants may perceive them as simply stimuli.

Finally, there is only one study to demonstrate an interpretation bias in relation to ambiguous faces in socially anxious individuals (Yoon et al., 2009), and the cause of this bias is not entirely clear as discussed above. The absence of an interpretation bias is consistent with research showing that socially anxious individuals generally do not differ in subjective ratings of unambiguously threatening faces as reviewed in the preceding section. Social anxiety therefore does not seem to influence in any systematic way how photographs of threatening faces are consciously evaluated or judged.

8. Brain activation

This final section reviews research focusing on the central neural systems involved in the processing of threatening faces in social anxiety. Until recently, no studies were published in this area, but interest has been steadily increasing. The first study to investigate brain activation to human faces in social anxiety was Birbaumer et al. (1998), but this study relied on neutral faces only and therefore does not directly add to the literature on threatening faces. Given the amount of evidence linking the amygdaloid complex to processing of threatening cues (Davis & Whalen, 2001; Zald, 2003), an increased metabolic response in these nuclei should be expected when people with social anxiety are confronted with threatening faces. Several controlled functional neuroimaging studies with socially anxious participants have indeed found increased activation of the amygdala in response to threatening faces (Phan, Fitzgerald, Nathan & Tancer, 2006; Stein, Goldin, Sareen, Zorrilla & Brown, 2002; Straube et al., 2004; Straube, Mentzel & Miltner, 2005). Three studies did not find this difference: Blair et al. (2008), Furmark et al. (2009), and Goldin et al. (2009) (Table 7).

First, Blair et al. (2008) was the only study to use morphed faces to create varying intensities of expressions. The use of these stimuli in

Table 7
Brain activation.

Study (year)	*N* female/male (f, m), measure of SA, age (A)	Expressions (stimulus set), non-face stimuli	Exposure duration	Method (M), design (D), task (T)	Significant effects
Stein et al. (2002)	15 SP (5f, 10m) 15 HC (5f, 10m) SCID A: 39.2	Angry, fear, contempt, happy, neutral (Matsumoto and Ekman, 1988)	2.5 s	M: fMRI D: block design T: indicate gender of face	SP had greater activation in the left medial temporal lobe and the medial frontal cortex to harsh faces
Straube et al. (2004)	10 SP (6f, 4m) 10 HC (6f, 4m) SCID A: 24.1	Angry, neutral (MacBrain Face Stimulus Set) Schematic faces (line drawings)	1 s	M: fMRI D: event-related T: explicit task: indicate type of expression shown; implicit task: indicate if face is photographic or schematic	Compared to HC, SP had greater activation to angry faces in the insula regardless of task, but the amygdala, parahippocampal gyrus, fusiform gyrus, and the superior temporal sulcus showed increased activation during the implicit task only
Amir et al. (2005)	11 SP (8f, 3m) 11 HC (8f, 3m) SCID A: 24	Disgust, neutral (various sources)	4.2 s	M: fMRI D: block design, three consecutive runs T: rate each face for valence	Compared to HC, SP had faster response time to disgust faces in the first and last run; SP had greater activation in the anterior cingulate cortex in two of the three runs
Straube et al. (2005)	9 SP (5f, 4m) 9 HC (5f, 4m) SCID A: 24.2	Angry, happy, neutral (Lundqvist, Flykt and Öhman, 1998)	2 s	M: fMRI D: block design T: passive viewing	SP had higher activation of the insula to angry faces than HC; SP had increased right amygdala activation to angry as well as happy faces; regardless of facial emotion, activation in fusiform gyrus was greater in SP than HC
Kolassa and Miltner (2006)	19 SP (10f, 9m) 19 HC (10f, 9m) 19 spider phobia (9m, 10f) SCID A: 23.2	Angry, happy, neutral (Lundqvist, Flykt and Öhman, 1998)	1 s	M: electroencephalography, heart rate T: indicate gender or emotion	SP had larger N170 amplitudes over posterior–temporal sites to angry faces compared to HC in the emotion identification task only; no difference between groups in P1 and P2 over occipital sites
Phan et al. (2006)	10 SP (5f, 5m) 10 HC (5f, 5m) SCID A: 26.7	Angry, fear, disgust, neutral, sad, happy (Gur et al., 2002) Radios	5 s	M: fMRI D: block design T: indicate expression	Compared to HC, SP had greater amygdala activation to harsh relative to happy faces; activation of the right amygdala to harsh faces correlated with the intensity of social anxiety symptoms in SP
Rossignol et al. (2007)	10 HSA (all f) 10 LSA (all f) FNE A: 20.5	Angry, disgust (Beaupré and Hess, 2006)	500 ms	M: electroencephalography D: faces are morphed T: indicate the rare stimulus in a series of standard stimuli	Groups did not differ in P3b; LSA showed similar N2b for disgust and anger when the rare stimulus differed in intensity, whereas HSA showed reduced N2b activity for anger compared with disgust
Blair et al. (2008)	17 SP (8f, 9m) 17 GAD (11f, 6m) 17 HC (8f, 9m) SCID A: 31.7	Fear, angry, neutral (Ekman and Friesen, 1976)	2.5 s	M: fMRI D: event-related design; faces are morphed to create variations in intensity T: indicate gender	SP showed increased activation of the lateral region of the middle frontal gyrus and the inferior temporal gyrus to angry versus neutral faces, when compared to HC, but not when compared to GAD
Moser et al. (2008)	21 HSA (15f, 6m) 21 LSA (11f, 10m) SPIN	Threatening, reassuring (Pérez-López and Woody, 2001)	500 ms	M: modified Flanker test; electroencephalography D: three faces are shown side by side T: indicate emotion of central face	No differences between groups P2 or N2 activity to threatening faces; compared to LSA, HSA showed an increased P3/LPP activity to threatening faces
Mühlberger et al. (2009)	18 HSA (10f, 8m) 18 LSA (8f, 10m) SPAI A: 23.4	Angry, neutral, fear, happy (Lundqvist, Flykt and Öhman, 1998)	1 s	M: electroencephalography D: natural and artificial faces are shown	No differences between groups on N170; LSA showed higher LPP to emotional compared to neutral faces, whereas HSA did not (not possible to distinguish between natural and artificial faces)
Sewell et al. (2008)	21 (12f, 9m) SIAS A: 21.4	Angry, happy, neutral (various sources)	350 ms	M: oddball task; electroencephalography D: half the faces are inverted T: respond either to a happy or an angry face	Significant correlation between SIAS score and P3 response to ignored, upright angry faces, but not to happy faces
van Peer et al. (2009	20 SP (11f, 9m) SCID A: 32.8	Happy, angry (various sources)	100 ms	M: approach–avoidance, electroencephalography D: cortisol is administered prior to testing	The P150 was increased by cortisol administration
Furmark et al. (2009)	34 SP (20f, 14m) 18 HC (9f, 9m) SCID A: 36.0	Angry, neutral (Ekman and Friesen, 1976)	3 s	M: PET, genotyping D: block design T: passive viewing	No differences in activation of the amygdala between groups; within groups, serotonin-related allelic variation correlated with increased amygdala reactivity to angry faces

fMRI = functional magnetic resonance imaging; FNE = Fear of Negative Evaluation (Watson and Friend, 1969); GAD = generalized anxiety disorder; HC = healthy controls; HSA = high social anxiety; LSA = low social anxiety; PET = positron emission tomography; SCID = Structured Clinical Interview for DSM-IV (First, Spitzer, Gibbon, & Williams, 1995); SIAS = Social Interaction Anxiety Scale (Stangier, Heidenreich, Berardi, Golbs and Hoyer, 1999); SP = social phobia; SPAI = Social Phobia Anxiety Inventory (Turner, Beidel, Dancu and Stanley, 1989); SPIN = Social Phobia Inventory (Connor et al., 2000).

combination with an event-related design may have led to higher variability in responses, possibly obscuring any group differences in activation. Second, although there were no differences in amygdala activation between individuals with social phobia and controls in a positron emission tomography study by Furmark et al. (2009), they did find differences within each group. More specifically, variations in the alleles of two serotonin-related genes (the 5-HT transporter gene and the tryptophan hydroxylase-2 gene) were related to amygdala activation to angry faces in both individuals with social phobia and controls. Thus, in this study, serotonergic function was a stronger predictor of amygdala activation than diagnostic status. Third, although Goldin et al. (2009) did not find significant differences in amygdala activation between individuals with social phobia and controls, they did find that self-report scores of social anxiety correlated positively with amygdala activation in the patients, but not in the control group. The relatively long exposure duration of 6 s used in this study may also have influenced the results. Finally, a study reported increased left amygdala activation to emotional faces in social phobia, but it was not possible to distinguish the effect of positive and negative expressions (Gentili et al., 2008). A final study focused exclusively on activation of the anterior cingulate cortex to disgust expressions and therefore did not directly investigate amygdala activation (Amir et al., 2005).

Of the studies that do find increased amygdala activation in social anxiety, some have found activation limited to the left amygdala (Stein et al., 2002; Straube et al., 2004), whereas others have found activation in the right amygdala only (Straube et al., 2005; Phan et al., 2006). This discrepancy is reflected in other research on the role of the amygdala in negative affectivity (for a review, see Davidson, 2002), and it is presently not clear how to explain this (e.g. Phan et al., 2006).

Importantly, Straube et al. (2004) found increased amygdala activation in individuals with social phobia during an implicit rating task only (participants indicated if the face shown was a photo or a line drawing). During an explicit task (participants determined the expression of the face) there was no difference in activation. This effect was due to an increase in activation in controls, rather than a decreased activation in individuals with social phobia. It might be an indication that whereas controls are not influenced by facial expressions, unless directed to pay explicit attention to them, individuals with social phobia are influenced by threatening expressions regardless of task instructions. Another interesting finding in the study by Straube et al. (2004) was that amygdala activation was bilateral during the implicit task, but limited to the left amygdala during the explicit task; an indication that laterality may depend on task conditions, possibly those that engage conscious cognitive processes such as interpretation.

The studies reviewed above also report increased activation to threatening faces in individuals with social phobia in brain regions other than the amygdala. Most consistently, differential activation in the insula, fusiform gyrus, anterior cingulate gyrus, parahippocampal gyrus, and the medial prefrontal cortex is reported. These regions are all part of the brain's network for processing of emotional information, and activation of the amygdala is considered an orienting response towards possible dangerous cues (Davis & Whalen, 2001; Maren, 2005). Amygdala activation has been suggested to increase attentional vigilance by lowering the threshold for activation in sensory systems (Davis & Whalen, 2001). Increased activation of the amygdala consistently seen in patients with social phobia may therefore be an indication of attentional vigilance and an orienting response towards the possible threat.

8.1. Event-related potentials

Event-related potentials (ERPs) generated by electroencephalography (EEG) are believed to reflect cognitive processes including attention (Eimer & Holmes, 2007). In relation to visual processing of faces, a distinction can be made between early (N1/P1, N170), middle (N2/P2), and late (P3) ERPs, which are thought to reflect separable stages of encoding. The early ERPs are believed to originate in posterior visual areas of the brain specialized in face recognition. Specifically, the N170 may be activated exclusively by human faces, while the P1 might reflect visual attention to facial emotion (Eimer & Holmes, 2007; Kolassa & Miltner, 2006). The later P2 component may signal recognition or decision-making processes (Rousselet, Husk, Bennett & Sekuler, 2008), and even later components such as the P3 are believed to reflect attention and memory processes in frontal and temporal/parietal cortex (Polich, 2007).

Recently, several studies using EEG to investigate attentional processing of emotional faces in social anxiety have been published. A number of findings indicate that there are indeed differences in attentional processing of emotional faces between socially anxious participants and controls as indicated by increased amplitudes of early ERPs. Kolassa and Miltner (2006) found that individuals with social phobia showed a larger right-sided N170 in an emotion identification task only, compared to controls and individuals with spider phobia. When participants had to identify gender, there were no differences between groups. They also found that self-reported social anxiety correlated with P1 amplitude. Mühlberger et al. (2009) did not find any differences between high and low socially anxious groups in the N170 to angry faces, but they also did not explicitly tell participants to attend to facial emotion, which may explain this negative result. In relation to the P1 component, they did find that it showed differential amplitude in the two hemispheres in high socially anxious participants only. In a study by van Peer et al. (2009), cortisol administration interacted with social anxiety to produce increases in the P150 response to emotional faces. Although the interaction with emotional valence was not significant, indicating that the P150 response was increased to both happy and angry faces, follow-up analyses showed that the effect was more pronounced for angry faces. Finally, Helfinstein et al. (2008) found larger early negative and positive ERPs in individuals with social phobia compared to controls, but it was unfortunately not possible to distinguish between angry and neutral faces in this study, since they were presented simultaneously. Also, faces were preceded by threatening and neutral prime words, possibly interfering with any effects of the faces themselves.

Investigating the middle latency ERP components, a study by Rossignol, Anselme, Vermeulen, Philippot, and Campanella (2007) had participants detecting the deviant expression in a series of identical expressions. The task was to either detect the deviant emotion (e.g., a disgust face in a series of angry faces) or the deviant intensity (e.g., a high intensity angry face in a series of low-intensity angry faces). Groups differed in a complex pattern on the N2b component, which is thought to be indicative of orienting attention towards novel stimuli. In brief, socially anxious participants showed a reduced N2b to anger compared to disgust, when detecting the deviant intensity, whereas controls did not differ in N2b amplitude. However, when detecting deviant emotion, the pattern was reversed: controls now showed an increase in N2b to disgust compared to anger, whereas socially anxious participants did not differ. Rossignol et al. (2007) take these results to suggest that on the one hand, socially anxious participants are sensitive to subtle changes in the intensity of angry faces, and on the other, they do not disengage their attention as readily from disgust expressions as controls do.

Moser et al. (2008) found that controls showed increased P2 amplitude to positive compared to negative faces, whereas socially anxious participants did not differ in P2 between emotional faces. If the P2 truly does reflect face recognition, this finding may suggest that a positivity bias in recognition is absent in social anxiety. However, this effect of the P2 component was not apparent in the study by Kolassa and Miltner (2006), so the role of the P2 ERP in social anxiety is not entirely clear.

The late positive ERPs also show some differences in findings. Moser et al. (2008) and Sewell, Palermo, Atkinson and McArthur

(2008) found that the late positive ERPs were related to social anxiety during processing of emotional faces, while a number of other studies have reported negative results: neither Rossignol et al. (2007), van Peer et al. (2009) or Mühlberger et al. (2009) found any effects involving the late positive potential to emotional faces in clinical or subclinical participants. In the study by Mühlberger et al. (2009) it is not possible to distinguish between photographs of real people and artificially created faces, which confound their results. Still, there is not yet convincing evidence that the P3 plays a role in processing of threatening faces in social anxiety. Provided that the late ERPs truly signal elaborate, frontal processes such as memory or judgment, these inconsistencies actually mirror behavioral and self-report data showing that individuals with social anxiety in general do not differ from controls in interpretation and judgment of emotional faces as reviewed in the relevant sections above.

8.2. Summary of brain activation

There is evidence that threatening faces activate the brain's fear network in socially anxious individuals, when compared to low-anxious controls. Specifically, the amygdala shows increased activation across a number of studies. EEG studies show differences between socially anxious individuals and controls that are not restricted to threatening faces, but arise from all faces regardless of their emotional expression. These differences are especially pronounced in early stages of perceptual processing (P1 and N170). Mirroring findings from other methods investigating visual attention, recognition, interpretation, and memory, results regarding the middle (P2) and late (P3) ERP components are less consistent. This may indicate that elaborate cognitive processes are not affected by social anxiety in relation to threatening faces to the same extent as automatic processes.

9. Discussion

This review has investigated perceptual processing of threatening human faces in individuals with clinical and subclinical social anxiety across a large number of studies. A basic assumption within this field is that the human face constitutes a potent social cue, and therefore a threatening expression should elicit specific responses in individuals who fear negative social interaction. Earlier theoretical models of social anxiety have predicted that socially anxious individuals should respond to such cues with increased autonomic reactivity (Öhman, 1986) and biases in attention, memory, interpretation, and judgment (Rapee & Heimberg, 1997). While some of these predictions are supported by the literature reviewed, others are clearly not.

9.1. Visual attention

The most frequently used task in research on visual attention, the dot-probe task, has produced evidence mostly consistent with vigilance for threatening faces in clinical and subclinical social anxiety at very short exposure durations (below 500 ms). There are however, some inconsistencies in findings from the dot-probe task, which cannot be readily explained by methodological differences. It may not be sufficient to rely on reaction time as the only indicator of attentional bias, but rather more direct methods such as EEG and eye tracking could be incorporated into the designs. Most pertinent is a detailed investigation of attentional bias within the 500 ms duration, since eye tracking has shown that shifts in attention can occur during this timeframe. Also, reliability of the dot-probe paradigm should be more thoroughly investigated, as the only studies to have done this have found very poor reliability estimates (Schmukle, 2005; Staugaard, 2009). When reviewing the dot-probe literature, one is left with the intuitive sense that variations in the design rather than individual differences are responsible for some of the variation in results. This interpretation is further corroborated by the fact that the only dot-probe studies reviewed here to find avoidance at the 500 ms exposure duration all come from the same research group. One might speculate that this group could actually be the only one with a reliable dot-probe design—something that only further research will tell. Still, of all the visual attention paradigms reviewed—save for eye tracking—the dot-probe task appears to be the most sensitive to attentional bias in social anxiety.

Other visual attention paradigms, such as the attentional blink task or the emotional Stroop task, have been largely unsuccessful in demonstrating attentional bias in socially anxious individuals compared with controls. One reason might be a low sensitivity in these designs compared with the dot-probe task. A related issue is task demands, since many of these paradigms often rely on interpretation or judgment as the outcome variable and the review clearly demonstrates that there are at best only very subtle effects of social anxiety on these cognitive processes. Future research using novel attentional paradigms could benefit from reducing or even removing these task demands, for example by introducing eye tracking combined with passive viewing, or simple reaction time tasks. The exposure duration should also be as short as possible—preferably shorter than 500 ms—since the hypothesized interference effects may not prevail at longer durations.

9.2. Bodily reactions

There is no evidence that individuals with clinical and subclinical social anxiety show abnormal autonomic reactions to threatening faces, which validates a growing body of research showing that autonomic reactivity does not appear to be affected by social anxiety. Since some studies have shown that individuals with social phobia do not show abnormal autonomic responding to highly stressful tasks (e.g. public speaking, Edelmann & Baker, 2002), it is unlikely that they should show this response to a less stressful stimulus such as a threatening face.

A more promising avenue of research into bodily reactions to threatening faces comes from paradigms that measure emotional–behavioral responses. The approach–avoidance task has shown that socially anxious individuals behaviorally avoid threatening faces at very short exposure durations, and there is some evidence that they also show altered activity of the facial muscles that control frowning and smiling, when presented with threatening faces. The claim is that both types of responses are the result of automatic, unconscious processes (Dimberg & Thunberg, 2007; Heuer et al., 2009; van Peer et al., 2009), something that could be validated by measuring responses to very short or even subliminal presentations of faces. Combining EMG with eye tracking would allow for investigations of online correlations between overt attention and emotional–behavioral responding during longer exposure durations (above 1 s).

Combined with the findings from visual attention, a pattern of early attentional vigilance combined with automatic behavioral reactions is emerging. With some inconsistency, attentional vigilance is mostly directed at threatening faces, whereas behavioral reactions seem to encompass emotional faces regardless of valence. This might indicate that the behavioral reactions occur later in the perceptual process than attentional vigilance.

9.3. Elaborate cognitive processes

Contrary to research using socially threatening words as stimuli, individuals with social phobia do appear to have better memory for threatening faces than non-anxious controls, when they are not anticipating a public speech. Since this conclusion is based on findings from only two studies, replication is needed, explicitly taking the effect of state anxiety into account. Importantly, studies should investigate the mechanism underlying the apparent reduced memory in social phobic participants under threat. Is it because they avoid attending to

the emotionally threatening stimuli and therefore do not encode them as efficiently? Or is it because increased state anxiety interferes with memory on a cognitive level? In answering the first question, studies could benefit from using eye tracking to determine if the patients show attentional bias. The second question may however be better answered by including other types of stimuli in order to see if poorer memory is limited to faces or will also include, for example, situational images with threatening content. Finally, studies could include both clinical and non-clinical socially anxious participants in order to further examine why memory effects are only found in the former.

Contrary to what might be expected, threatening faces do not appear to engage biases in interpretation, expectancy, or judgment in socially anxious individuals. An explanation for these consistently negative findings may stem from the characteristics of the stimuli themselves. Static photographs might actually be considered "safe" stimuli in that they do not respond to the beholder, nor would the beholder expect to have to interact with the person in the photo. One interesting avenue of research would therefore be to use stimuli with a higher personal relevance to the participants. For example, participants could be informed that the photographs shown represent people that they would later be expected to socialize with. Lundh and Öst (1996) did something along these lines, in that they asked participants to rate unfamiliar faces as to how critical they appeared to them. In this study, individuals with social phobia recognized more faces previously rated as critical, whereas controls tended to recognize more faces previously rated as accepting. The difference between this study and those reviewed above is that through assigning a rating to each face, the faces may have acquired a more personal meaning to the participants, which may in turn have affected elaborate cognitions.

9.4. Central nervous system correlates

Neuroimaging research is generally consistent with the theoretical proposition that social anxiety is predominantly affecting perception of threatening faces at very early stages of processing. The amygdala shows increased activation in individuals with social phobia, even during implicit tasks (when participants do not need to pay explicit attention to the emotional expressions). Differences in processing of threatening faces in socially anxious and non-anxious participants are detected as early as around 100 ms after stimulus onset, as shown by EEG studies. The field could benefit from research that explicitly seeks to unravel the potential hemispheric asymmetry of emotion perception suggested in some studies. Also, replication and further exploration of the effect of varying task demands on activation could be investigated. Finally, looking at quantitative or qualitative differences in activation patterns between socially anxious participants with a clinical or a non-clinical status might shed important light on the neurobiological basis for pathological fear.

9.5. Concluding comments

The tendency across multiple designs and methods is for shorter exposure durations to produce effects specific to threatening faces in individuals with social anxiety. These effects include attentional vigilance, behavioral avoidance, and activation of limbic and extrastriate visual areas. When exposure durations allow for more elaborate processing of the facial stimuli, the difference between socially anxious individuals and controls becomes increasingly unreliable. The medial prefrontal cortex and association areas are activated and cognitive effects tend to be more sporadic, while generalizing to all emotional expressions regardless of their valence. Finally, when tasks call for highly elaborated processes such as interpretation and judgment of facial stimuli, differences practically disappear. As suggested, this time course may be related to the stimuli themselves, since the threat value of a static photograph can be expected to quickly dissipate, once consciousness catches up to the automatic responses after a few hundred milliseconds. There is some evidence that overt attention as measured with eye tracking and emotional–behavioral responses may prevail for much longer durations (several seconds). However, there is no detailed knowledge of what transpires during these longer intervals or what it means to a person with social anxiety in terms of experiencing the faces. Finally, of the 74 studies reviewed, only five have looked at other clinical disorders besides social phobia, and they have not provided consistent evidence for a specificity of threatening faces to social anxiety. This important theoretical issue should be further examined in the future.

Threatening human faces do engage perceptual processes in people with social anxiety, but not for very long, since consciousness most likely eliminates the bias.

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References

Alden, L. E., & Taylor, C. T. (2004). Interpersonal processes in social phobia. *Clinical Psychology Review. Special Issue: Social Phobia and Social Anxiety*, *24*(7), 857–882.
Alpers, G. W., & Gerdes, A. B. M. (2007). Here is looking at you: Emotional faces predominate in binocular rivalry. *Emotion*, *7*(3), 495–506.
American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed . Washington, DC: APA.
Amir, N., Beard, C., Taylor, C. T., Klumpp, H., Elias, J., Burns, M., et al. (2009). Attention training in individuals with generalized social phobia: A randomized controlled trial. *Journal of Consulting and Clinical Psychology*, *77*(5), 961–973.
Amir, N., Klumpp, H., Elias, J., Bedwell, J. S., Yanasak, N., & Miller, L. S. (2005). Increased activation of the anterior cingulate cortex during processing of disgust faces in individuals with social phobia. *Biological Psychiatry*, *57*(9), 975–981.
Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin*, *133*(1), 1–24.
Beaupré, M. G., & Hess, U. (2006). An in-group advantage for confidence in emotion recognition judgments: the moderating effect of familiarity with the expressions of out-group members. *Personality and Social Psychology Bulletin*, *32*, 16–26.
Birbaumer, N., Grodd, W., Diedrich, O., Klose, U., Erb, M., Lotze, M., et al. (1998). fMRI reveals amygdala activation to human faces in social phobics. *NeuroReport*, *9*, 1223–1226.
Blair, K., Shaywitz, J., Smith, B. W., Rhodes, R., Geraci, M., Jones, M., et al. (2008). Response to emotional expressions in generalized social phobia and generalized anxiety disorder: Evidence for separate disorders. *The American Journal of Psychiatry*, *165*(9), 1193.
Bögels, S. M., & Mansell, W. (2004). Attention processes in the maintenance and treatment of social phobia: Hypervigilance, avoidance and self-focused attention. *Clinical Psychology Review. Special Issue: Social Phobia and Social Anxiety*, *24*(7), 827–856.
Bradley, B. P., Mogg, K., Falla, S. J., & Hamilton, L. R. (1998). Attentional bias for threatening facial expressions in anxiety: Manipulation of stimulus duration. *Cognition and Emotion*, *12*(6), 737–753.
Bradley, B. P., Mogg, K., Millar, N., & Bonham-Carter, C. (1997). Attentional biases for emotional faces. *Cognition & Emotion*, *11*(1), 25–42.
Brown, T. A., Di Nardo, P. A., & Barlow, D. H. (1994). *Anxiety disorders interview schedule for DSM-IV*. Albany, NY: Graywind Publications.
Campbell, D. W., Sareen, J., Stein, M. B., Kravetsky, L. B., Paulus, M. P., Hassard, S. T., et al. (2009). Happy but not so approachable: The social judgments of individuals with generalized social phobia. *Depression and Anxiety*, *26*(5), 419–424.
Chen, Y. P., Ehlers, A., Clark, D. M., & Mansell, W. (2002). Patients with generalized social phobia direct their attention away from faces. *Behaviour Research and Therapy*, *40*(6), 677–687.
Clark, B. M., Siddle, D. A., & Bond, N. W. (1992). Effects of social anxiety and facial expression on habituation of the electrodermal orienting response. *Biological Psychology*, *33*(2), 211–223.
Clark, D. M., & Wells, A. (1995). A cognitive model of social phobia. In R. G. Heimberg, M. R. Liebowitz, D. A. Hope, & F. R. Schneier (Eds.), *Social Phobia: Diagnosis, Assessment, and Treatment* (pp. 69–93). New York, NY, US: Guilford Press.
Clark, D. M., & McManus, F. (2002). Information processing in social phobia. *Biological Psychiatry*, *51*(1), 92–100.
Coles, M. E., & Heimberg, R. G. (2005). Recognition bias for critical faces in social phobia: A replication and extension. *Behaviour Research and Therapy*, *43*(1), 109–120.
Connor, K. M., Davidson, J. R., Churchill, L. E., Sherwood, A., Foa, E., & Weisler, R. H. (2000). Psychometric properties of the Social Phobia Inventory (SPIN). New self-rating scale. *British Journal of Psychiatry*, *176*, 379–386.
D'Argembeau, A., Van der Linden, M., Etienne, A., & Comblain, C. (2003). Identity and expression memory for happy and angry faces in social anxiety. *Acta Psychologica*, *114*(1), 1–15.

Darwin, C. (1872). *The Expression of the Emotions in Man and Animals.* London: Murray.
Davidson, R. J. (2002). Anxiety and affective style: Role of prefrontal cortex and amygdala. *Biological Psychiatry*, *51*(1), 68–80.
Davidson, R. J., Marshall, J. R., Tomarken, A. J., & Henriques, J. B. (2000). While a phobic waits: Regional brain electrical and autonomic activity in social phobics during anticipation of public speaking. *Biological Psychiatry*, *47*(2), 85–95.
Davis, M., & Whalen, P. J. (2001). The amygdala: Vigilance and emotion. *Molecular Psychiatry*, *6*(1), 13–34.
de Jong, P. J., Koster, E. H. W., van Wees, R., & Martens, S. (2009). Emotional facial expressions and the attentional blink: Attenuated blink for angry and happy faces irrespective of social anxiety. *Cognition & Emotion*, *23*(8), 1640–1652.
de Jong, P. J., & Martens, S. (2007). Detection of emotional expressions in rapidly changing facial displays in high- and low-socially anxious women. *Behaviour Research and Therapy*, *45*(6), 1285–1294.
de Jong, P. J., Merckelbach, H., Bögels, S., & Kindt, M. (1998). Illusory correlation and social anxiety. *Behaviour Research and Therapy*, *36*(11), 1063–1073.
Dimberg, U. (1997). Social fear and expressive reactions to social stimuli. *Scandinavian Journal of Psychology*, *38*(3), 171–174.
Dimberg, U., & Christmanson, L. (1991). Facial reactions to facial expressions in subjects high and low in public speaking fear. *Scandinavian Journal of Psychology*, *32*(3), 246–253.
Dimberg, U., & Thunberg, M. (2007). Speech anxiety and rapid emotional reactions to angry and happy facial expressions. *Scandinavian Journal of Psychology*, *48*(4), 321–328.
Edelmann, R. J., & Baker, S. R. (2002). Self-reported and actual physiological responses in social phobia. *The British Journal of Clinical Psychology*, *41*(1), 1–14.
Eimer, M., & Holmes, A. (2007). Event-related brain potential correlates of emotional face processing. *Neuropsychologia*, *45*(1), 15–31.
Ekman, P. (1973). Cross-cultural studies of facial expressions. In P. Ekman (Ed.), *Darwin and Facial Expression*. New York: Academic Press.
Ekman, P., & Friesen, W. (1976). *Pictures of facial affect.* Palo Alto, CA: Consulting Psychologists Press.
Etkin, A., & Wager, T. D. (2007). Functional neuroimaging of anxiety: A meta-analysis of emotional processing in PTSD, social anxiety disorder, and specific phobia. *The American Journal of Psychiatry*, *164*(10), 1476–1488.
First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (1995). *Structured Clinical Interview for DSM-IV Axis I Disorders, Patient Edition (SCID-I/P, Version 2.0).* New York: Biometrics Research Department, New York State Psychiatric Institute.
Foa, E. B., Gilboa-Schechtman, E., Amir, N., & Freshman, M. (2000). Memory bias in generalized social phobia: Remembering negative emotional expressions. *Journal of Anxiety Disorders*, *14*(5), 501–519.
Frewen, P. A., Dozois, D. J. A., Joanisse, M. F., & Neufeld, R. W. J. (2008). Selective attention to threat versus reward: Meta-analysis and neural-network modeling of the dot-probe task. *Clinical Psychology Review*, *28*(2), 307–337.
Frischen, A., Eastwood, J. D., & Smilek, D. (2008). Visual search for faces with emotional expressions. *Psychological Bulletin*, *134*(5), 662–676.
Furmark, T., Henningsson, S., Appel, L., Åhs, F., Linnman, C., Pissiota, A., et al. (2009). Genotype over-diagnosis in amygdala responsiveness: Affective processing in social anxiety disorder. *Journal of Psychiatry & Neuroscience*, *34*(1), 30–40.
Garner, M., Mogg, K., & Bradley, B. P. (2006). Fear-relevant selective associations and social anxiety: Absence of a positive bias. *Behaviour Research and Therapy*, *44*(2), 201–217.
Garner, M., Mogg, K., & Bradley, B. P. (2006). Orienting and maintenance of gaze to facial expressions in social anxiety. *Journal of Abnormal Psychology*, *115*(4), 760–770.
Gentili, C., Gobbini, M. I., Ricciardi, E., Vanello, N., Pietrini, P., Haxby, J. V., et al. (2008). Differential modulation of neural activity throughout the distributed neural system for face perception in patients with social phobia and healthy subjects. *Brain Research Bulletin*, *77*(5), 286–292.
Gilboa-Schechtman, E., Erhard-Weiss, D., & Jeczemien, P. (2002). Interpersonal deficits meet cognitive biases: Memory for facial expressions in depressed and anxious men and women. *Psychiatry Research*, *113*(3), 279–293.
Gilboa-Schechtman, E., Foa, E. B., & Amir, N. (1999). Attentional biases for facial expressions in social phobia: The face-in-the-crowd paradigm. *Cognition & Emotion*, *13*(3), 305–318.
Gilboa-Schechtman, E., Presburger, G., Marom, S., & Hermesh, H. (2005). The effects of social anxiety and depression on the evaluation of facial crowds. *Behaviour Research and Therapy*, *43*(4), 467–474.
Glass, C. R., Merluzzi, T. V., Biever, J. L., & Larsen, K. H. (1982). Cognitive assessment of social anxiety: Development and validation of a self-statement questionnaire. *Cognitive Therapy and Research*, *6*, 37–55.
Goldin, P. R., Manber, T., Hakimi, S., Canli, T., & Gross, J. J. (2009). Neural bases of social anxiety disorder: Emotional reactivity and cognitive regulation during social and physical threat. *Archives of General Psychiatry*, *66*(2), 170–180.
Gotlib, I. H., Kasch, K. L., Traill, S., Joormann, J., Arnow, B. A., & Johnson, S. L. (2004). Coherence and specificity of information-processing biases in depression and social phobia. *Journal of Abnormal Psychology*, *113*(3), 386–398.
Gur, R. C., Sara, R., Hagendoorn, M., Marom, O., Hughett, P., Turner, T., et al. (2002). A method for obtaining 3-dimensional facial expressions and its standardization for use in neurocognitive studies. *Journal of Neuroscience Methods*, *115*, 137–143.
Heinrichs, N., & Hofman, S. G. (2001). Information processing in social phobia: A critical review. *Clinical Psychology Review*, *21*(5), 751–770.
Helfinstein, S. M., White, L. K., Bar-Haim, Y., & Fox, N. A. (2008). Affective primes suppress attention bias to threat in socially anxious individuals. *Behaviour Research and Therapy*, *46*(7), 799–810.
Herman, J. P., Ostrander, M. M., Mueller, N. K., & Figueiredo, H. (2005). Limbic system mechanisms of stress regulation: Hypothalamo-pituitary-adrenocortical axis. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, *29*, 1201–1213.
Heuer, K., Rinck, M., & Becker, E. S. (2007). Avoidance of emotional facial expressions in social anxiety: The approach–avoidance task. *Behaviour Research and Therapy*, *45*(12), 2990–3001.
Hirsch, C. R., & Clark, D. M. (2004). Information-processing bias in social phobia. *Clinical Psychology Review. Special Issue: Social Phobia and Social Anxiety*, *24*(7), 799–825.
Hofmann, S. G., & Barlow, D. H. (2002). Social phobia (social anxiety disorder). In D. H. Barlow (Ed.), *Anxiety and its Disorders: The Nature and Treatment of Anxiety and Panic* (pp. 454–476)., 2nd ed. New York, NY: Guilford Press.
Horley, K., Williams, L. M., Gonsalvez, C., & Gordon, E. (2004). Face to face: Visual scanpath evidence for abnormal processing of facial expressions in social phobia. *Psychiatry Research*, *127*(1), 43–53.
Hunter, L. R., Buckner, J. D., & Schmidt, N. B. (2009). Interpreting facial expressions: The influence of social anxiety, emotional valence, and race. *Journal of Anxiety Disorders*, *23*(4), 482–488.
Joormann, J., & Gotlib, I. H. (2006). Is this happiness I see? biases in the identification of emotional facial expressions in depression and social phobia. *Journal of Abnormal Psychology*, *115*(4), 705–714.
Juth, P., Lundqvist, D., Karlsson, A., & Öhman, A. (2005). Looking for foes and friends: Perceptual and emotional factors when finding a face in the crowd. *Emotion*, *5*(4), 379–395.
Klumpp, H., & Amir, N. (2009). Examination of vigilance and disengagement of threat in social anxiety with a probe detection task. *Anxiety, Stress, and Coping*, *22*(3), 283–296.
Kolassa, I., & Miltner, W. H. R. (2006). Psychophysiological correlates of face processing in social phobia. *Brain Research*, *1118*(1), 130–141.
La Greca, A. M., & Lopez, N. (1998). Social anxiety among adolescents: Linkages with peer relations and friendships. *Journal of Abnormal Child Psychology*, *26*, 83–94.
Lange, W., Heuer, K., Reinecke, A., Becker, E. S., & Rinck, M. (2008). Inhibition of return is unimpressed by emotional cues. *Cognition & Emotion*, *22*(8), 1433–1456.
Lange, W., Keijsers, G., Becker, E. S., & Rinck, M. (2008). Social anxiety and evaluation of social crowds: Explicit and implicit measures. *Behaviour Research and Therapy*, *46*(8), 932–943.
Langner, O., Becker, E. S., & Rinck, M. (2009). Social anxiety and anger identification: Bubbles reveal differential use of facial information with low spatial frequencies. *Psychological Science*, *20*(6), 666–670.
Leary, M. R. (1983). A brief version of the Fear of Negative Evaluation Scale. *Personality and Social Psychology Bulletin*, *9*, 371–375.
Ledley, D. R., & Heimberg, R. G. (2006). Cognitive vulnerability to social anxiety. *Journal of Social & Clinical Psychology. Special Issue: Cognitive Vulnerability to Psychological Disorders*, *25*(7), 755–778.
Liebowitz, M. R. (1987). Social phobia. *Modern Problems of Pharmacopsychiatry*, *22*, 141–173.
Li, S., Tan, J., Qian, M., & Liu, X. (2008). Continual training of attentional bias in social anxiety. *Behaviour Research and Therapy*, *46*(8), 905–912.
Lundh, L., & Öst, L. (1996). Recognition bias for critical faces in social phobics. *Behaviour Research and Therapy*, *34*(10), 787–794.
Lundqvist, D., Flykt, A., & Öhman, A. (1998). *The Karolinska Directed Emotional Faces—KDEF [CD-ROM].* Stockholm, Sweden: Department of Clinical Neuroscience, Psychology section, Karolinska Institutet.
Mansell, W., Clark, D. M., & Ehlers, A. (2003). Internal versus external attention in social anxiety: An investigation using a novel paradigm. *Behaviour Research and Therapy*, *41*(5), 555–572.
Mansell, W., Clark, D. M., Ehlers, A., & Chen, Y. (1999). Social anxiety and attention away from emotional faces. *Cognition & Emotion*, *13*(6), 673–690.
Maren, S. (2005). Building and burying fear memories in the brain. *The Neuroscientist*, *11*(1), 89–99.
Marks, I. M., & Mathews, A. M. (1979). Brief standard self-rating for phobic patients. *Behaviour Research & Therapy*, *17*, 263–267.
Martinez, A. M., & Benavente, R. (1998). *The AR Face Database.* CVC Technical Report #24 June.
Marsh, A. A., Kozak, M. N., & Ambady, N. (2007). Accurate identification of fear facial expressions predicts prosocial behavior. *Emotion*, *7*(2), 239–251.
Matsumoto, D., & Ekman, P. (1988). *Japanese and Caucasian facial expressions of emotion (JACFEE) [Slides].* San Francisco, CA: Intercultural and Emotion Research Laboratory, Department of Psychology, San Francisco State University.
Mattick, R. P., & Clarke, J. C. (1998). Development and validation of measures of social phobia scrutiny fear and social interaction anxiety. *Behaviour Research and Therapy*, *36*, 455–470.
Mauss, I. B., Wilhelm, F. H., & Gross, J. J. (2004). Is there less to social anxiety than meets the eye? Emotion experience, expression, and bodily responding. *Cognition & Emotion*, *18*(5), 631–662.
Mazurski, E. J., & Bond, N. W. (1993). A new series of slides depicting facial expressions of affect: A comparison with the pictures of facial affect series. *Australian Journal of Psychology*, *45*(1), 41–47.
Merckelbach, H., Van Hout, W., Van den Hout, M. A., & Mersch, P. P. (1989). Psychophysiological and subjective reactions of social phobics and normals to facial stimuli. *Behaviour Research and Therapy*, *27*(3), 289–294.
Mogg, K., & Bradley, B. P. (1999). Some methodological issues in assessing attentional biases for threatening faces in anxiety: A replication study using a modified version of the probe detection task. *Behaviour Research and Therapy*, *37*, 595–604.
Mogg, K., & Bradley, B. P. (2002). Selective orienting of attention to masked threat faces in social anxiety. *Behaviour Research and Therapy*, *40*(12), 1403–1414.
Mogg, K., Philippot, P., & Bradley, B. P. (2004). Selective attention to angry faces in clinical social phobia. *Journal of Abnormal Psychology*, *113*(1), 160–165.
Montagne, B., Schutters, S., Westenberg, H. G. M., van Honk, J., Kessels, R. P. C., & de Haan, E. H. F. (2006). Reduced sensitivity in the recognition of anger and disgust in social anxiety disorder. *Cognitive Neuropsychiatry*, *11*(4), 389–401.

Moser, J. S., Huppert, J. D., Duval, E., & Simons, R. F. (2008). Face processing biases in social anxiety: An electrophysiological study. *Biological Psychology*, *78*(1), 93−103.
Mühlberger, A., Wieser, M. J., Herrmann, M. J., Weyers, P., Troger, C., & Pauli, P. (2009). Early cortical processing of natural and artificial emotional faces differs between lower and higher socially anxious persons. *Journal of Neural Transmission*, *116*(6), 735−746.
Mullins, D. T., & Duke, M. P. (2004). Effects of social anxiety on nonverbal accuracy and response time I: Facial expressions. *Journal of Nonverbal Behavior*, *28*(1), 3−33.
Musa, C. Z., & Lépine, J. P. (2000). Cognitive aspects of social phobia: A review of theories and experimental research. *European Psychiatry*, *15*(1), 59−66.
Nowicki, S., Jr., & Carton, J. (1993). The measurement of emotional intensity from facial expressions; the DANVA FACES 2. *Journal of Social Psychology*, *133*, 749−751.
Öhman, A. (1986). Face the beast and fear the face: Animal and social fears as prototypes for evolutionary analyses of emotion. *Psychophysiology*, *23*, 123−145.
Paul, G. (1966). *Insight versus desensitization in psychotherapy: An experiment in anxiety reduction.* Palo Alto, CA: Stanford University Press.
Pérez-López, J. R., & Woody, S. R. (2001). Memory for facial expressions in social phobia. *Behaviour Research and Therapy*, *39*(8), 967−975.
Phan, K. L., Fitzgerald, D. A., Nathan, P. J., & Tancer, M. E. (2006). Association between amygdala hyperactivity to harsh faces and severity of social anxiety in generalized social phobia. *Biological Psychiatry*, *59*(5), 424−429.
Philippot, P., & Douilliez, C. (2005). Social phobics do not misinterpret facial expression of emotion. *Behaviour Research and Therapy*, *43*(5), 639−652.
Pineles, S. L., & Mineka, S. (2005). Attentional biases to internal and external sources of potential threat in social anxiety. *Journal of Abnormal Psychology*, *114*(2), 314−318.
Pishyar, R., Harris, L. M., & Menzies, R. G. (2004). Attentional bias for words and faces in social anxiety. *Anxiety, Stress & Coping: An International Journal*, *17*(1), 23−36.
Pishyar, R., Harris, L., & Menzies, R. (2008). Responsiveness of measures of attentional bias to clinical change in social phobia. *Cognition & Emotion*, *22*(7), 1209−1227.
Polich, J. (2007). Updating p300: An integrative theory of P3a and P3b. *Clinical Neurophysiology*, *118*(10), 2128−2148.
Putman, P., Hermans, E., & van Honk, J. (2004). Emotional stroop performance for masked angry faces: It's BAS, not BIS. *Emotion*, *4*(3), 305−311.
Rapee, R. M., & Heimberg, R. G. (1997). A cognitive–behavioral model of anxiety in social phobia. *Behaviour Research and Therapy*, *35*(8), 741−756.
Richards, A., French, C. C., Calder, A. J., Webb, B., Fox, R., & Young, A. W. (2002). Anxiety-related bias in the classification of emotionally ambiguous facial expressions. *Emotion*, *2*(3), 273−287.
Roelofs, K., van Peer, J., Berretty, E., de Jong, P., Spinhoven, P., & Elzinga, B. M. (2009). Hypothalamus–pituitary–adrenal axis hyperresponsiveness is associated with increased social avoidance behavior in social phobia. *Biological Psychiatry*, *65*(4), 336−343.
Rossignol, M., Anselme, C., Vermeulen, N., Philippot, P., & Campanella, S. (2007). Categorical perception of anger and disgust facial expression is affected by non-clinical social anxiety: An ERP study. *Brain Research*, *1132*, 166−176.
Rothbart, M. K., Ahadi, S. A., & Evans, D. E. (2000). Temperament and personality: Origins and outcomes. *Journal of Personality and Social Psychology*, *78*, 122−135.
Rousselet, G. A., Husk, J. S., Bennett, P. J., & Sekuler, A. B. (2008). Time course and robustness of ERP object and face differences. *Journal of Vision*, *8*(12), 1−18.
Schmidt, N. B., Richey, J. A., Buckner, J. D., & Timpano, K. R. (2009). Attention training for generalized social anxiety disorder. *Journal of Abnormal Psychology*, *118*(1), 5−14.
Schmukle, S. C. (2005). Unreliability of the dot-probe task. *European Journal of Personality*, *19*(7), 595−605.
Schofield, C. A., Coles, M. E., & Gibb, B. E. (2007). Social anxiety and interpretation biases for facial displays of emotion: Emotion detection and ratings of social cost. *Behaviour Research and Therapy*, *45*(12), 2950−2963.
Schultz, L. T., & Heimberg, R. G. (2008). Attentional focus in social anxiety disorder: Potential for interactive processes. *Clinical Psychology Review*, *28*(7), 1206−1221.
Sewell, C., Palermo, R., Atkinson, C., & McArthur, G. (2008). Anxiety and the neural processing of threat in faces. *NeuroReport*, *19*(13), 1339−1343.
Sheehan, D. V., Lecrubier, Y., Harnett-Sheehan, K., Amorim, P., Janavs, J., Weiller, E., et al. (1998). The Mini International Neuropsychiatric Interview (M.I.N.I.): The development and validation of a structured diagnostic psychiatric interview. *Journal of Clinical Psychiatry*, *59*(20), 22−33.
Silvia, P. J., Allan, W. D., Beauchamp, D. L., Maschauer, E. L., & Workman, J. O. (2006). Biased recognition of happy facial expressions in social anxiety. *Journal of Social & Clinical Psychology*, *25*(6), 588−602.
Sposari, J. A., & Rapee, R. M. (2007). Attentional bias toward facial stimuli under conditions of social threat in socially phobic and nonclinical participants. *Cognitive Therapy and Research*, *31*(1), 23−37.
Stangier, U., Heidenreich, T., Berardi, A., Golbs, U., & Hoyer, J. (1999). Die Erfassung sozialer Phobie durch die Social Interaction Anxiety Scale (SIAS) und die Social Phobia Scale (SPS) (Assessment of social phobia by the Social Interaction Anxiety Scale and the Social Phobia Scale). *Zeitschrift für Klinische Psychologie*, *28*, 28−36.
Staugaard, S. R. (2009). Reliability of two versions of the dot-probe task using photographic faces. *Psychology Science Quarterly*, *51*(3), 339−350.
Stein, M. B., Goldin, P. R., Sareen, J., Zorrilla, L. T. E., & Brown, G. G. (2002). Increased amygdala activation to angry and contemptuous faces in generalized social phobia. *Archives of General Psychiatry*, *59*(11), 1027−1034.
Stevens, S., Rist, F., & Gerlach, A. L. (2009). Influence of alcohol on the processing of emotional facial expressions in individuals with social phobia. *The British Journal of Clinical Psychology*, *48*(2), 125−140.
Stevens, S., Gerlach, A. L., & Rist, F. (2008). Effects of alcohol on ratings of emotional facial expressions in social phobics. *Journal of Anxiety Disorders*, *22*(6), 940−948.
Straube, T., Kolassa, I., Glauer, M., Mentzel, H., & Miltner, W. H. R. (2004). Effect of task conditions on brain responses to threatening faces in social phobics: An event-related functional magnetic resonance imaging study. *Biological Psychiatry*, *56*(12), 921−930.
Straube, T., Mentzel, H., & Miltner, W. H. R. (2005). Common and distinct brain activation to threat and safety signals in social phobia. *Neuropsychobiology*, *52*(3), 163−168.
Turner, S. M., Beidel, D. C., Dancu, C. V., & Stanley, M. A. (1989). An empirically derived inventory to measure social fears and anxiety: The Social Phobia and Anxiety Inventory. *Psychological Assessment: A Journal of Consulting and Clinical Psychology*, *1*, 35−40.
van Peer, J. M., Spinhoven, P., van Dijk, J. G., & Roelofs, K. (2009). Cortisol-induced enhancement of emotional face processing in social phobia depends on symptom severity and motivational context. *Biological Psychology*, *81*(2), 123−130.
Vrana, S. R., & Gross, D. (2004). Reactions to facial expressions: Effects of social context and speech anxiety on responses to neutral, anger, and joy expressions. *Biological Psychology*, *66*(1), 63−78.
Watson, D., & Friend, R. (1969). Measurement of social-evaluative anxiety. *Journal of Consulting and Clinical Psychology*, *33*, 448−457.
Weierich, M., Treat, T., & Hollingworth, A. (2008). Theories and measurement of visual attentional processing in anxiety. *Cognition & Emotion*, *22*(6), 985−1018.
Willems, L. F. M., Tuender de Haan, H. A., & Defares, P. B. (1973). En schaal om sociale angst te meten. *Nederlands Tijdschrift voor de Psychologie*, *28*, 415−422.
Willoughby, R. R. (1932). Some properties of the Thurstone Personality Schedule and a suggested revision. *Journal of Social Psychology*, *3*, 401−424.
Winton, E. C., Clark, D. M., & Edelmann, R. J. (1995). Social anxiety, fear of negative evaluation and the detection of negative emotion in others. *Behaviour Research and Therapy*, *33*(2), 193−196.
Yoon, K. L., Joormann, J., & Gotlib, I. H. (2009). Judging the intensity of facial expressions of emotion: Depression-related biases in the processing of positive affect. *Journal of Abnormal Psychology*, *118*(1), 223−228.
Yoon, K. L., & Zinbarg, R. E. (2007). Threat is in the eye of the beholder: Social anxiety and the interpretation of ambiguous facial expressions. *Behaviour Research and Therapy*, *45*(4), 839−847.
Zald, D. H. (2003). The human amygdala and the emotional evaluation of sensory stimuli. *Brain Research Reviews*, *41*(1), 88−123.