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Detection of emotional expressions in rapidly changing facial displays in high- and low-socially anxious women ☆

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Abstract

Facial information and attention to facial displays are distributed over spatial as well as temporal domains. Thus far, research on selective attention to (dis)approving faces in the context of social anxiety has concentrated primarily on the spatial domain. Using a rapid serial visual presentation (RSVP) paradigm, the present study examined the temporal characteristics of visual attention for happy and angry faces in high- ($n = 16$) and low-socially anxious individuals ($n = 17$), to test whether also in the temporal domain socially anxious individuals are characterized by threat-confirming attentional biases. Results indicated that presenting angry faces as the first target (T1) did not aggravate the detection of the emotional expression of the second target (T2). Yet, participants generally showed superior detection of the emotional expression of T2, if T2 was an angry face. Casting doubt on the role of such attenuated attentional blink for angry faces in social anxiety, no evidence emerged to indicate that this effect was relatively strong in high-socially anxious individuals. Finally, the presentation of an angry face as T2 resulted in a relatively hampered identification of a happy-T1. Again, this "backward blink" was not especially pronounced in high-socially anxious individuals. The present anger superiority effects are consistent with evolutionary models stressing the importance of being especially vigilant for signals of dominance. Since the effects were not especially pronounced in high-anxious individuals, the present study adds to previous findings indicating that socially anxious individuals are not characterized by a bias in the (explicit) detection of emotional expressions [Philippot, P., & Douilliez, C. (2005). Social phobics do not misinterpret facial expression of emotion. *Behaviour Research and Therapy, 43*, 639–652].

Keywords: Attentional bias; Temporal attention; Social phobia; Facial expressions; Attentional blink; Emotional expressions

Information processing models of anxiety disorders generally assume that anxious individuals have a tendency to preferentially allocate attention to threatening information (e.g., Williams, Watts, MacLeod, & Mathews, 1997). Since fear of negative evaluation is the key feature of social phobia, cognitive models of

☆Examples of how we modified the slides of the KDEF to remove irrelevant features that may unintentionally influence (facilitate) target detection independent of the emotional expression displayed on the target slides (e.g., prominent shoulders) can be obtained from the first author.

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social phobia propose that social phobic individuals are hypervigilant for social threat cues such as angry, disapproving facial expressions (e.g., Rapee & Heimberg, 1997). In line with this, studies using a dot probe methodology have found that subclinically as well as clinically socially anxious individuals are faster to respond to probes occurring in the spatial location of angry than of neutral or happy faces (Mogg & Bradley, 2002; Mogg, Bradley, & Philippot, 2004; Pishyar, Harris, & Menzies, 2004). Since studies manipulating the exposure duration of the face stimuli only revealed an attentional bias for social threat cues when presented for a relatively short duration (i.e., $\leqslant$500 ms) (Mogg et al., 2004; Pishyar et al., 2004), this attentional bias seems to involve initial orienting rather than maintenance of attention.

Studies using the face-in-the-crowd paradigm provided further evidence for social phobics' selective attention to angry faces. That is, individuals with social phobia were faster in detecting an angry face in a crowd of 12 neutral distractor photographs than nonanxious controls (Gilboa-Schechtman, Foa, & Amir, 1999). A recent study that varied the number of neutral distractors showed that for socially phobic individuals, the detection of (schematic) angry faces was far less influenced by the number of distractors than the detection of (schematic) happy faces. This suggests that the relative efficacy of social phobic individuals to detect angry faces in the face-in-the-crowd paradigm reflects a bias to become aware of angry faces more readily than of positive faces (Eastwood et al., 2005). All in all, the available evidence is consistent with the idea that socially anxious individuals are constantly primed to monitor signals of disapproval. Such a (spatial) selective attention to disapproving facial expressions is likely to be reciprocally involved in the maintenance of social phobics' concerns, as it will logically act in a way to confirm their fear of negative evaluation.

Thus far, studies on attentional processes in social anxiety primarily focused on the selective allocation of attention during the concurrent presentation of static safe and threatening facial stimuli. Yet, facial expressions in the context of real-time social interactions are highly dynamic and may vary very rapidly from interested/approving to disapproving or even angry and vice versa (see e.g., Goffman, 1967). Germane to this, fundamental research on the temporal domain of visual attention has consistently shown that the ability to identify a particular target is deteriorated when another target is presented within a certain temporal window after the first (e.g., Broadbent & Broadbent, 1987; Raymond, Shapiro, & Arnell, 1992).

The deficit in the identification of the second target has been called the *attentional blink*, referring to the apparent refractory period following the presentation of the first target. Interestingly, this so-called attentional blink was found to be attenuated when a participant's own name was used as the second target (Shapiro, Caldwell, & Sorensen, 1997). Apparently, the interference effects of the first target are attenuated when the second target stimulus is of high personal relevance, presumably because highly salient stimuli have a low threshold for recognition (see also below).

This pattern of findings provides several interesting clues of how the detection of facial expressions in rapidly changing facial displays may inadvertently influence social phobics' perception of (dis)approval in a way to confirm their phobic concerns. First, it can be hypothesized that similar to the visual "cocktail party" effect described above, the threshold for detecting (salient) angry faces in a stream of facial stimuli may be relatively low resulting in an attenuated attentional blink. This effect may be especially pronounced in socially anxious individuals because of their preoccupation with disapproval and negative evaluation by others (cf. Fox, Russo, & Georgiou, 2005). If indeed high-socially anxious individuals would display an attenuated attentional blink for angry faces, this would result in a negatively biased representation of other's evaluations as compared to nonanxious individuals. Therefore, the first aim of the present study was to explore whether the attentional blink is indeed attenuated when disapproving, angry faces appear as the second target stimulus, and whether this effect is especially pronounced in high-anxious individuals.

Second, it might be that the appearance of an angry face (as a first stimulus) may result in a relatively strong deterioration of the detection of a subsequently appearing stimulus (i.e., enhanced attentional blink). In case the second target represents an approving expression, such angry-face-induced attentional blink would result in an underrepresentation of others' approval which, in turn, would logically act in a way to confirm socially anxious individuals' preoccupations with disapproval. Previous research, however, failed to find evidence for such a hampered identification of a second target (a noun) when it was preceded by a salient first target stimulus (own name) (Shapiro et al., 1997; exp. 3). To explain the finding that using a highly salient stimulus (own name) as the first target did not affect the identification of a subsequent target stimulus (a noun), Shapiro et al. (1997) proposed that any first stimulus demands a disproportionate amount of resources, irrespective of prior saliency. Following this account, own names do not so much survive the attentional blink because of successful competition for limited resources but because of an extremely low identification threshold of one's own name. However, although the available evidence strongly suggests that the attentional blink effect is largely independent of the characteristics of the first target stimulus, it may still be that the appearance of a particularly important first stimulus (e.g., an angry face) nevertheless interferes with the identification process of a second target stimulus (e.g., approving face). Therefore, it seems still worthwhile to explore whether the identification of a happy face is deteriorated when it is preceded by the presentation of an angry face.

Thus far, most research on temporal processes in visual attention focused on factors that influence the interfering effects of a preceding stimulus on the correct identification of a subsequently appearing target stimulus. However, in the present context it might also be relevant to consider the potentially interfering effect of a second stimulus on the correct identification of a preceding stimulus. Although mere saliency of the second stimulus has been shown to be insufficient to interfere with the identification process that is initiated by the appearance of the first stimulus (Shapiro et al., 1997; exps. 1 and 2), it might well be that particular stimuli of high survival relevance may successfully compete with preceding stimuli for the cognitive resources that are required for accurate retrieval from visual short-term memory.

Following this, a third way in which "temporal attention" might sustain the overrepresentation of others' disapproval concerns the possibility that the appearance of a disapproving face shortly following the appearance of an approving face not only attenuates the attentional blink (see above), but may also hamper the identification of the initially approving face (i.e., the first target stimulus). That is, by virtue of its importance as a danger signal, a disapproving face may well have prioritized access to the limited cognitive resources that are required for correct identification of visual stimuli during a particular time window, which in turn may interfere with the correct identification of the initially approving expression ("backward blink"). Such a "backward blink" is likely to further consolidate social phobics' idea that others' judgments are relatively often negatively valenced. Therefore, as a third issue, we determined whether the presentation of an angry face as the second target results in a relatively hampered identification of the first target stimulus ("backward blink").

To recapitulate, there is considerable reason to expect that insight in the temporal aspects of the attentional processes involved in the detection of facial expressions may provide important complementary information that may be helpful to further our understanding of the cognitive processes that are involved in social phobia. As a first step, the major purpose of the present study was to generally explore the temporal characteristics of visual attention for approving and disapproving faces. To get some insight into the influence of social anxiety on the visual attention of rapidly changing facial expressions, we tested a group of high- and a group of low-socially anxious individuals. In the present study we adopted the rapid serial visual presentation paradigm (RSVP), which is a procedure that is widely used for examining temporal visual attention.

In short we focused on the following research issues: First, is the attentional blink smaller when angry rather than happy faces are presented as the second target stimulus? Second, is the attentional blink enhanced when an angry rather than a happy face is presented as the first target stimulus? Third, does the presentation of an angry compared to a happy face as the second target results in a relatively hampered identification of the first (happy) target stimulus? As a final issue, we explored whether these anger superiority effects are relatively pronounced in high-socially anxious individuals.

Methods

Participants

Participants were 33 undergraduate women who were recruited from introductory classes of psychology at the University of Groningen. Participants were selected from a larger sample ($N = 463$) on the basis of their scores on the Social Phobia Subscale of the Fear Questionnaire (FQ; Marks & Mathews, 1979) that was part of large-scale screening among all first year psychology students. We formed two groups: a group of low-socially anxious women ($n = 17$, FQ: $M = 7.3$, SD $= 4.1$) and a group of high-socially anxious women ($n = 16$, FQ: $M = 21.5$, SD $= 3.2$). On the day of the experiment, participants also completed the 12-item version of the Fear of Negative Evaluation Scale (bFNE; Leary, 1983) to obtain a more comprehensive description of the sample. Mean scores on the bFNE were 13.0 (SD = 4.5) and 30.6 (SD = 7.5) for low- and high-socially anxious women, respectively. In return for participation they received course credits or 5 Euro.

Apparatus and stimulus materials

Stimuli were presented on a 17 inch computer screen. Stimulus presentation and data acquisition were controlled by an Intel Pentium 2.0 GHz personal computer. As target stimuli we used angry and happy facial expressions from the Karolinska Directed Emotional Faces (KDEF, Lundqvist, Flykt, & Öhman, 1998) Database. We selected 24 male and 24 female faces and included from each of these persons both types of emotional expressions, resulting in 48 happy and 48 angry faces. In addition, we used 299 different neutral faces (as fillers). These stimuli were selected from the AR Face Database (Martinez & Benavente, 1998). All facial stimuli were presented in full color with a resolution of 531 × 720 pixels. All stimuli were carefully edited in a way to reduce the presence of irrelevant features (e.g., shoulders) that may inadvertently influence the results (see below).

RSVP task

To measure participants' ability to detect emotional expressions in rapidly changing facial displays we used an RSVP task (e.g., Martens, Wolters, & van Raamsdonk, 2002). In the present setup there were always two targets, T1 and T2, and 14 nontargets (distractors). All targets were emotional facial expressions and all distractors were neutral facial expressions. The distractors were presented in a rotated (180°) format. There were 2 (T1: happy or angry) × 2 (T2: happy or angry), that is, four different combinations of T1 and T2 stimuli. The male and female faces were balanced across the target combinations. Each trial consisted of a rapid serial temporal presentation of 16 stimuli. Each stimulus was presented for 120 ms. T1 was presented on a fixed random position in the stream (position 6, 7, or 8) with the restriction that each type of T1 was equally often presented in a certain position. T2 stimuli were also presented in a fixed random order with the restriction that each type of T2 was equally often presented 2, 3, and 8 positions following each type of T1. In the present setup there were 2 (T1: angry or happy) × 2 (T2: angry or happy) × 3 (Lags: 2, 3, or 8), that is, 12 different types of trials. Each type of trial was presented 16 times. The total number of 192 trials were presented in four similar blocks of 48 trials (each type of trial was presented 4 times within each block) with a 30 s break following each block to reduce the influence of fatigue and problems with participants' concentration. Each trial started with a fixation cross (500 ms). The RSVP task took about 25 min. To familiarize participants with the experimental task we started with 12 practice trials.

Procedure

Individuals were tested individually in a sound attenuated room. Before the experiment proper, the experimenter instructed the participants that it was their task to detect the number of unrotated faces that were presented within a stream of rapidly changing facial displays on the computer screen. It was explained that they should indicate their responses via the response box. We used a response box with five buttons on which they could indicate both how many faces they had detected (0, 1, or 2) and what the emotional expression was on each of these faces (angry or happy). All relevant instructions also appeared on the initial computer screens. During the practice trials, participants could ask for additional information if their task was not sufficiently clear. Following the practice stage, the experimenter left the experimental room, and the actual experiment started. At the end of the experimental procedure, participants were invited to complete the FQ and the bFNE (allowing us to check the validity of the selection procedure). Following this, they were debriefed and thanked for their participation.

Data reduction and analysis

To examine the interfering influence of T2 on the accurate detection of T1 as a function of emotional expression, the percentage of accurate identifications of T1 were subjected to a 2 Emotion-T1 (happy vs.

angry) × 2 Emotion-T2 (happy vs. angry) × 3 Lag (2 vs. 3 vs. 8) × 2 Group (high vs. low socially anxious) ANOVA with only the last factor being a between subjects factor.

To test whether the attentional blink varies as a function of the emotional expression of T1 and T2, we subjected the percentage correct identifications of T2 (given a correct identification of T1) to a similar 2 Emotion-T1 (happy vs. angry) × 2 Emotion-T2 (happy vs. angry) × 3 Lag (2 vs. 3 vs. 8) × 2 Group (high vs. low socially anxious) ANOVA with only the last factor being a between subjects factor.

Results

Interference effects of T2 on correct identification of T1

Mean number of correct identifications of T1 is shown in Table 1 as a function of the emotional expressions of T1 and T2, Lag, and level of social anxiety.

A 2 Emotion-T1 (happy vs. angry) × 2 Emotion-T2 (happy vs. angry) × 3 Lag (2 vs. 3 vs. 8) × 2 Group (high vs. low socially anxious) ANOVA revealed no significant main effect of Group indicating that overall both groups showed a similar accuracy in identifying T1 ($F(1,31) = 2.20$, $p = 0.15$, $\eta^2 = 0.07$). There was no main effect of Lag ($F(2,30) = 1.33$, $\eta^2 = 0.08$), indicating that correct identification of T1 was independent of the time-lag between T1 and T2. Most important for the present context, there was a significant main effect of Emotion-T2, indicating that participants were relatively inaccurate when T2 displayed an angry face ($F(1,31) = 7.26$, $p = 0.01$, $\eta^2 = 0.19$), mean percentage of accurate identification being 89.6% and 91.3% for the angry- and happy-T2, respectively. This effect appeared independent of social anxiety ($F(1,31) < 1$, $\eta^2 = 0.002$). It was most pronounced for Lag 2 and virtually absent for Lag 8 as is evidenced by a borderline significant Emotion-T2 by Lag interaction ($F(2,30) = 3.18$, $p = 0.05$, $\eta^2 = 0.18$). Accordingly, posthoc t tests indicated that the influence of T2 was significant for Lag 2 ($t(32) = 2.67$, $p < 0.05$), but not for Lag 3 ($t(32) = 1.7$, n.s.), nor for Lag 8 ($t(32) < 1$). The interfering influence of an angry-T2 was especially pronounced for trials depicting a happy-T1 as was evidenced by a significant Emotion-T1 by Emotion-T2 interaction ($F(1,31) = 32.88$, $p < 0.01$, $\eta^2 = 0.52$). Subsequent analyses indicated that there was no difference between congruent trials (i.e., happy-T1 and happy-T2 vs. angry-T1 and angry-T2) ($t(32) = 1.11$, $p > 0.1$), whereas a significant difference was evident between both types of incongruent trials (happy-T1 and angry-T2 vs. angry-T1 and happy-T2) ($t(32) = 2.96$, $p < 0.05$), indicating that correct identification of T1 was especially hampered when an angry-T2 followed a happy-T1. Finally, there was a main effect of Emotion-T1 ($F(1,31) = 5.67$, $p < 0.05$, $\eta^2 = 0.16$), indicating that, overall, participants were more often correct when T1 displayed an angry than when T1 displayed a happy facial expression, which means being 91.8% and 88.7%, respectively (see also Table 1).

Table 1
Mean (SE) percentage of correct identifications of T1 as a function of the emotional expression of T1 and T2, Lag, and social anxiety

	High anxious		Low anxious	
	Angry-T2	Happy-T2	Angry-T2	Happy-T2
Lag 2				
Angry-T1	91.0 (2.3)	84.0 (4.0)	98.2 (2.3)	93.1 (3.9)
Happy-T1	78.5 (4.0)	93.8 (2.1)	86.4 (3.9)	93.8 (2.1)
Lag 3				
Angry-T1	90.6 (2.5)	89.9 (3.0)	95.9 (2.4)	93.8 (2.9)
Happy-T1	88.7 (3.4)	92.2 (2.4)	83.8 (3.3)	94.5 (2.4)
Lag 8				
Angry-T1	92.2 (2.1)	85.2 (3.4)	95.3 (2.1)	94.2 (3.3)
Happy-T1	82.4 (3.7)	88.2 (2.6)	92.3 (3.6)	93.8 (2.6)

Attentional blink

Mean percentage of correct identifications of T2 (given accurate identification of T1) are displayed in Table 2.

A 2 Emotion-T1 (happy vs. angry) × 2 Emotion-T2 (happy vs. angry) × 3 Lag (2 vs. 3 vs. 8) × 2 Group (high vs. low socially anxious) ANOVA revealed a no significant main effect of Group indicating that there was no convincing difference between high- and low-socially anxious individuals' ability to identify the emotional expression of T2 ($F(1,31) = 3.00$, $p = 0.09$). In addition, there was a main effect of Lag ($F(2,30) = 234.9$, $p < 0.05$, $\eta^2 = 0.94$), indicating that participants showed an attentional blink when the time-lag between T1 and T2 was small (Lags 2 and 3), whereas the blink almost disappeared when the time-lag was large (Lag 8) (see Table 2). Most important for the current context there was a main effect of Emotion-T2 ($F(1,31) = 23.71$, $p < 0.05$, $\eta^2 = 0.43$). As can be seen in Table 2, this effect indicates that, overall, the percentage correct identifications were larger for angry ($M = 48.1\%$) than for happy ($M = 41.5\%$) expressions. This angry superiority effect varied as a function of lag as is evidenced by significant Emotion-T2 by Lag interaction ($F(2,30) = 6.20$, $p < 0.05$, $\eta^2 = 0.29$). As can be seen in Table 2, the effect was relatively large for Lag 3, and similarly small for Lags 2 and 8. Meanwhile, posthoc t tests indicated that for all Lags the effect was significant. For Lag 2 ($t(32) = 2.4$, $p < 0.05$), for Lag 3 ($t(32) = 4.9$, $p < 0.05$), and for Lag 8 ($t(32) = 2.1$, $p < 0.05$). In addition, there was a tendency suggesting that the anger superiority effect was most pronounced in low-anxious participants, yet the Emotion-T2 by Group interaction did not reach the conventional level of significance ($F(1,13) = 3.8$, $p = 0.06$, $\eta^2 = 0.11$). Furthermore, there was evidence of a congruency effect: accurate detection of T2 was enhanced when a congruent emotional expression was displayed on T1 ($F(1,31) = 59.97$, $p < 0.05$, $\eta^2 = 0.66$). This congruency effect was similar for both groups ($F(1,31) < 1$, $\eta^2 = 0.01$). Finally, there was no main effect of Emotion-T1 ($F(1,31) < 1$, $\eta^2 = 0.01$), indicating that the type of facial expression presented during T1 did not generally influence the magnitude of the attentional blink.

Discussion

Facial information and attention to facial displays are distributed over spatial as well as temporal domains (cf. Shapiro et al., 1997). Thus far, research on selective attention to angry faces has concentrated primarily on the spatial domain. By and large these studies have shown that during concurrent presentation of static happy and angry faces, socially anxious individuals display a bias to initially orient to angry faces (i.e., threat cues) (e.g., Mogg et al., 2004), and to become more easily aware of angry than of happy faces (Eastwood et al., 2005). These earlier findings in the spatial domain are consistent with cognitive models of social phobia that propose that socially anxious individuals show enhanced selective attention to threat cues, such as facial expressions of disapproval or criticism (e.g., Rapee & Heimberg, 1997). The present study represents a first attempt to investigate the temporal characteristics of visual attention for approving and disapproving faces in

Table 2
Mean (SE) percentage correct identifications of T2 as a function of the emotional expression of T1 and T2, Lag, and social anxiety

	High anxious		Low anxious	
	Angry-T2	Happy-T2	Angry-T2	Happy-T2
Lag 2				
Angry-T1	14.1 (6.0)	4.7 (3.8)	25.9 (5.8)	9.1 (3.7)
Happy-T1	9.1 (5.5)	14.1 (5.8)	23.5 (5.3)	24.0 (5.6)
Lag 3				
Angry-T1	42.4 (7.7)	14.1 (6.5)	59.7 (7.4)	22.3 (6.3)
Happy-T1	17.8 (6.8)	29.2 (7.9)	34.9 (6.6)	43.5 (7.7)
Lag 8				
Angry-T1	83.2 (3.9)	78.4 (4.8)	94.2 (3.8)	86.2 (4.6)
Happy-T1	81.8 (4.9)	84.2 (3.9)	90.9 (4.8)	88.7 (3.7)

the context of rapidly changing facial displays. To explore whether also in the temporal domain socially anxious individuals are characterized by threat-confirming attentional biases we tested a group of high- and a group of low-socially anxious individuals.

The major results of the present study can be summarized as follows: first, participants showed an attenuated attentional blink when the second target was an angry face, and no evidence emerged to suggest that this anger superiority effect was especially pronounced in high-socially anxious individuals. Second, the presentation of an angry face as the first target stimulus did not result in a relatively enhanced attentional blink compared to happy faces. Finally, the presentation of an angry face as the second target resulted in a relatively hampered identification of the first (happy) target stimulus. This "backward blink" was not especially pronounced in high-socially anxious individuals.

Attentional blink

Fundamental research on visual cognition has consistently shown that the ability to identify a particular target is deteriorated when another target is presented within a certain temporal window after the first (e.g., Raymond et al., 1992). In line with this general finding and supporting the validity of the present approach, the present results indicated that participants' correct identification of the emotional expression of T2 was less than 25% for Lag 2, somewhat higher but still well below 50% for Lag 3, whereas the rate of correct identification for Lag 8 came close to 90%.

Previous research has shown that the deterioration of correct identification of T2 was less pronounced when participants' own names rather than neutral nouns or others' names were presented during T2 (Shapiro et al., 1997). Apparently, the interference effects of the first target are attenuated when the second target stimulus is a highly salient stimulus, probably because saliency may lower the threshold of detecting a particular stimulus. Interestingly, the present results indicated that angry faces similarly resulted in a diminished attentional blink. This generally lowered threshold of detecting signals of social threat is in accordance with evolutionary models proposing that there is a premium on a relatively efficient detection of facial displays signaling social dominance and disapproval (e.g., Öhman, Lundqvist, & Estevez, 2001; Trower & Gilbert, 1989).

Meanwhile, the present finding that this anger superiority effect was not especially pronounced in high-socially anxious individuals casts doubts on the idea that an enhanced ability to (explicitly) identify social threat cues in rapidly changing facial displays is involved in the generation and/or maintenance of social phobics' anxious concerns. It should be acknowledged, however, that the present study was underpowered for reliably detecting more subtle differences between high- and low-socially anxious individuals. Therefore, it cannot be ruled out that our failure to find an enhanced ability to detect angry faces in high-anxious individuals is due to insufficient statistical power. However, the present pattern of findings indicating that if anything high-anxious individuals showed worse rather than better performance in detecting angry faces compared to low-anxious individuals renders this explanation not very plausible. So it seems safe to conclude that socially anxious individuals are not characterized by a relatively enhanced anger superiority effect. Meanwhile, future studies using a larger sample size are necessary to test whether the present tendency suggesting that socially anxious individuals may even be characterized by a relatively weak rather than a relatively strong angry superiority effect represents a robust phenomenon.

The present absence of a relatively strong anger superiority effect in socially anxious individuals is consistent with previous studies failing to find an enhanced ability in socially anxious individuals to discriminate between threatening and safe facial expressions (e.g., Winton, Clark, & Edelmann, 1995). Similarly, recent research convincingly showed that socially phobic individuals are not characterized by a superior ability to (explicitly) decode facial expressions of anger or disgust (Philippot & Douilliez, 2005). Germane to the present finding that high-anxious individuals tended to be even less successful in explicitly identifying angry faces in a stream of rapidly changing displays than low-anxious individuals, the study of Philippot and Douilliez (2005) found that the higher the participants' level of social anxiety, the more the difficulty they reported to experience with the decoding task, especially with respect to the emotional expressions of anger and disgust. Both findings point to the possibility that socially anxious individuals have more rather than less difficulty with accurately identifying nonverbal signals of social threat than nonanxious individuals (see Becker & Rinck, 2004, for conceptually similar findings in the context of spider fear).

Together the available evidence seems to indicate that social anxiety is not characterized by explicit biases that facilitate the detection of facial threat cues. Meanwhile, it might still be that an implicit bias to detect threatening facial expressions is involved in social anxiety. One way to test the presence of an implicit anger superiority effect would be to use angry faces in the stream of distractors. If indeed socially anxious individuals would be characterized by a relatively strong implicit bias to detect social threat cues, this would lead to an inflation of the attentional blink effect.

Influence of T1 on the attentional blink

In neither low- nor high-socially anxious participants evidence emerged to indicate that the presentation of an angry face as T1 resulted in an inflated attentional blink. Thus, the appearance of a social threat signal does not seem to deteriorate the detection of subsequent safe facial displays. The absence of such influence of T1's saliency on the attentional blink is consistent with earlier work using participants' own names as the (highly salient) T1. Although presenting the participant's name as a T2 stimulus clearly attenuated the blink, presenting their name as the T1 stimulus did not affect the detection of subsequent T2 stimuli. One explanation for the absence of T1's saliency on the attentional blink could be that any first stimulus demands a disproportionate amount of resources, irrespective of prior saliency (Shapiro et al., 1997). Following this, the attenuation of the attentional blink when the own name was used as the *second* stimulus was not so much due to successful competition for limited resources, but to the extremely low identification threshold of one's own name. The present findings are consistent with this account, and suggest that the attenuated attentional blink for angry faces is due to a relatively low threshold for recognition.

Influence emotional expression of T2 on correct identification of T1

Research in the temporal domain of visual attention has concentrated predominantly on individuals' ability to detect the second target if it is presented within a certain temporal window of the first. In other words, most studies focused on the interference effects of the first target stimulus on the accurate identification of the second target and on the factors that modulate these interference effects (such as saliency). Yet, in the context of ongoing social interactions, the potentially interfering influence of the second target (e.g., angry face) on the correct identification of the first (e.g., happy face) may also be of substantial importance. That is, if indeed threatening facial displays result in a deterioration of the correct identification of preceding displays, this may result in a biased overrepresentation of disapproving facial displays.

In line with this idea, the present results indicated that the presentation of angry faces as T2 indeed interfered more strongly with the accurate identification of happy facial expressions, than happy faces as T2 interfered with the detection of angry facial expressions (as T1). This interfering effect was especially pronounced when both displays were presented in close proximity (i.e., Lags 2 and 3) and was virtually absent for the relatively long time-lag that was used in the present setup (Lag 8). Apparently, social threat cues more readily survive the competition for entry to (or retrieval from) the short-term visual buffer in which the facial information is stored before retrieval (e.g., Shapiro, Raymond, & Arnell, 1994). So it appears that angry faces not only have a low threshold of identification (attenuating the attentional blink), but also a prioritized access to the limited cognitive resources that are required for correct identification of visual stimuli during a particular time window (inducing a ''backward blink'').

This ''backward blink'' cannot be attributed to mere saliency effects of the second stimulus (e.g., angry faces), as similar interference effects on the identification of T1 were absent in earlier work of Shapiro et al. (1997) presenting own names as the T2. Perhaps then it is the importance (survival value) of angry faces as being a danger signal that eventually resulted in privileged access of angry faces to the visual short-term memory system. The relatively high similarity between angry and happy faces (at least compared to own names and nouns) may have further added to the present interference effects of T2 on the identification of T1.

The finding that the ''backward blink'' effect is especially pronounced when the T2 is an angry face is again in accordance with evolutionary models stressing the importance of being especially vigilant for signals of dominance (e.g., Öhman, 1986). No evidence emerged to suggest that the interference effects of angry-T2's would be especially pronounced in high-anxious individuals. Thus, these findings further add to the conclusion that socially anxious individuals are not characterized by a bias in the explicit detection of emotional expressions. However, again it should be acknowledged that the present failure to find between group differences might be due to lack of statistical power cannot be ruled out. Yet, the effect size of the relevant interaction effect is so minimal (i.e., $\eta^2 = 0.002$) that power analysis indicates that it would require an unrealistically large number of participants to obtain statistically significant differences. Following this, it seems not very likely that the absence of this between group effect simply reflects insufficient statistical power.

Some comments are in order with respect to the methodology of the present study. First, we focused on three different time-lags (Lags 2, 3, and 8). Therefore, it can not be ruled out that a somewhat different pattern would emerge when other time-lags would have been used. Since the anger superiority effects appeared most pronounced for Lag 3 it would be interesting to add Lags 4 and 5 in future studies, to get a more comprehensive picture of the temporal characteristics of individuals' ability to detect emotional expressions in rapidly changing displays. Second, we only included angry and happy facial expressions. Therefore, it is not possible to conclude on the basis of the present data whether the anger superiority effects are due to a relatively efficient detection of angry faces, a relatively inefficient detection of happy faces, or to both. Further research including neutral targets in addition to happy and angry faces is necessary to differentiate between these possibilities. Third, the present study exclusively relied on female participants. Therefore, it remains to be seen whether similar results will emerge in men. Finally, the present study examined the attentional blink phenomena in an analog sample. Although previous research on attentional bias revealed similar results in analog groups and clinically diagnosed social phobic individuals (e.g., Mogg & Bradley, 2002; Mogg et al., 2004), the fact that different patterns between analog and clinical groups may arise with respect to attentional blink phenomena cannot be ruled out. Therefore, it would be important to replicate this study in a treatment seeking sample that complies to the DSM diagnosis of social phobia.

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