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Enhanced avoidance behavior in social anxiety: Evidence from a probabilistic learning task

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Background and objectives: Social phobia is characterized by avoidance of feared social situations. Although avoidance is a central feature of social anxiety, few studies have examined avoidance learning.
Methods: We used a probabilistic instrumental learning paradigm where participants had to learn by trial and error which response led to the disappearance of a neutral or angry face. 20 high socially anxious and 20 non-socially anxious individuals with an average level of social anxiety learned to avoid an angry or a neutral face by choosing one of two cues. Each of the cues led to the disappearance of the face either with high or low reinforcement probability.
Results: Groups learned to choose the more effective cue across trials and did not differ with regard to self-report valence, arousal for the faces or the a posteriori estimated reinforcement probability for both cues. High socially anxious individuals as compared to the controls chose the high probability cue significantly more often and were slower particularly when the neutral face could be avoided. Notably, HSA engaged in more avoidance responding to the neutral as compared to the angry face early on during the experiment.
Limitations: Due to the experimental design, the observed avoidance behavior most likely reflects the motivation for avoidance rather than contingency learning per se.
Conclusions: In social anxiety, neutral faces might be processed as ambiguous social cues and strongly motivate avoidance behavior.

1. Introduction

Avoidance behavior is a core feature of anxiety disorders. Accordingly, avoidance is listed among the primary diagnostic criteria of anxiety disorders in the Diagnostic and Statistical Manual of Mental Disorders-4th Edition (DSM-IV; American Psychiatric Association, 1994). Social phobia (SP) is characterized by avoidance of feared social situations. In addition to passive avoidance behavior, cognitive models of SP posit that socially anxious individuals also rely on subtle in-situation safety behaviors (e.g., avoiding eye contact; Clark & Wells, 1995) which function as active avoidance behavior and are maintained through operant conditioning. The pivotal role of avoidance learning for the maintenance of pathological anxiety has been proposed by one of the earliest learning accounts of pathological anxiety. Mowrer's (1951, 1956) two process theory posits that conditioned threat cues serve as discriminative stimuli for avoidance behavior. Building upon this model, Lovibond and colleagues (Lovibond, Saunders, Weidemann, & Mitchell, 2008) proposed that avoidance reduces the expectancy of an aversive consequence as acquired by classical conditioning. Consistent with these assumptions, an instrumental response that allows to avoid a conditioned fear stimulus during extinction prevents the conditioned response from being extinguished (Lovibond, Mitchell, Minard, Brady, & Menzies, 2009).

Surprisingly little research has focused on the acquisition and performance of avoidance behaviors in SP. Ly and Roelofs (2009) investigated whether individuals high and low in social anxiety, as defined by a median split on a social anxiety measure, differ in the acquisition of an avoidance response, and how this affects the extinction of conditioned fear. Subsequent to an initial classical

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conditioning phase, participants were explicitly instructed that during CS presentation, one or more of four buttons would light up and that they had to press one of these. Only one of the buttons would prevent the US to occur, but this would be always the same throughout the experiment. The instrumental phase entailed avoidable trials, in which a correct button press led to the nonoccurrence of the US, and unavoidable trials, in which the correct response button was not available. Individuals high in social anxiety as compared to low socially anxious participants had higher US expectancies on the very first trial of the instrumental task. This expectancy bias is consistent with previous findings that individuals with social anxiety overestimate negative consequences of neutral or ambiguous social situations as revealed by illusionary correlation paradigms, conditioning experiments or studies on interpretational biases (Hermann, Ofer, & Flor, 2004; Hermann, Ziegler, Birbaumer, & Flor, 2002; Stopa & Clark, 2000). However, Ly and Roelofs (2009) did not observe group differences in the acquisition of the avoidance response. This may be accounted by the experimental design not being sufficiently sensitive to detect differences in avoidance learning. Specifically, there was only one correct button response, which prevented the US with a probability of 100 percent. Interestingly, based on their previous learning experience, the high socially anxious individuals were rather accurate in estimating the US probability once the correct response button was unavailable. By contrast, the low socially anxious individuals underestimated the actual US probability in the nonavoidable trials. In addition, in the Ly and Roelofs (2009) study the US consisted of electrical stimulation combined verbal social rejection. Hence, even low anxious individuals might have been highly motivated to avoid the US possibly contributing to a ceiling effect.

The aim of the present study was to investigate whether high socially anxious (HSA) as compared to individuals with an average level of social anxiety (non-socially anxious controls, NSAC) differ in their avoidance behavior in response to social cues of different threat value. Participants underwent a probabilistic avoidance learning task. We adapted a reward learning paradigm (Murray et al., 2008), since there is evidence that reward learning and avoidance learning are associated with similar activation of those brain regions which are involved in the processing of reward (e.g., Delgado, Jou, Ledoux, & Phelps, 2009). Specifically, experienced relief following successful avoidance of an aversive stimulus may be experienced similar to receiving a reward (Seymour et al., 2005). Unlike in previous studies and to target avoidance instead of reward processes (Lovibond et al., 2009; Ly & Roelofs, 2009), participants had to learn by trial and error which behavioral response was most successful in avoiding the potentially threatening social cue, allowing to investigate differences in learning rate and performance of the learned behavior depending on the level of social fear. In order to determine the role of the motivational value of the stimulus to be avoided, faces with an angry and neutral expression were used. Participants chose one of two cues either of which led to the disappearance of the face with a different, stochastically independent probability. HSA were expected to show a higher level of avoidance behavior, i.e. a higher number of choices of the high probability cue. Angry faces function as biologically evolved threat cues (Mineka & Ohman, 2002), HSA show biased processing of angry faces in attentional and memory tasks (Coles & Heimberg, 2005; Staugaard, 2010) compared to non-socially anxious controls. Thus we expected HSA as compared to NSAC to show a heightened avoidance response to angry faces. Furthermore, we also hypothesized heightened avoidance responding in HSA to neutral facial expressions. The latter assumption was based on previous observations that biased processing of social information in individuals with social phobia as compared to healthy controls is also apparent with regard to neutral social cues (e.g., Stevens, Gerlach, & Rist, 2008), which might be perceived as potentially threatening due to their ambiguous nature. In HSA, neutral faces may trigger a fear response and enhanced processing (Amaral, 2002; Birbaumer et al., 1998; Schneider et al, 1999), which may result in a facilitated acquisition and heightened level of avoidance behavior.

2. Method

2.1. Participants

Participants were screened with the Fear of Negative Evaluation Scale (Watson & Friend, 1969; German: Vormbrock & Neuser, 1983). The scale measures fears of negative evaluation in social situations with 20 items (e.g., "I get nervous when I am observed") using a four point Likert rating scale from "1 = does never apply" to 4 "always applies". Those who scored 1 SD above the group mean were considered as HSA, while those scoring within ±1 SD above and below the mean were considered as NSAC, avoiding possible disadvantages of extreme group comparisons as used in previous studies (e.g., Ly & Roelofs, 2009). Extreme group approaches artificially restrict the statistical variance of the sample to the highest and lowest end of the distribution. Hence, conclusions based on significant statistical differences are of limited validity because these differences are likely to result not only from true variance of the group with high, but also from the group at the low end. A more conservative and more valid procedure is to compare a sample from the mid-range of the population to a high scoring group. Although such an approach might decrease statistical power, significant results reliably indicate a true difference between the high scoring group as compared to the average range (for a more detailed discussion of sampling issues and extreme group comparisons see Preacher, Rucker, MacCallum, & Nicewander, 2005). The screening questionnaire was administered as part of an online survey administered to 1500 first year students (all study programs) at the University of Giessen. From each subgroup, i.e. HSA and NSAC according to the FNE criteria, 20 participants were randomly selected and matched according to sex, age and years of education (Table 1). All individuals were interviewed by telephone and participants were excluded if they were currently in treatment for a psychological disorder or taking psychopharmacological medication. Scores on social anxiety measures differed in the expected direction between groups (see Table 1). The obtained FNE scores are in the range that can be expected when sampling high socially anxious participants (Stevens, Gerlach, et al., 2011; Stevens, Rist, & Gerlach, 2011). SPS and SIAS scores reflect clinically relevant social anxiety

Table 1
Sociodemographic and questionnaire data depending on social anxiety status of the participants.

	High socially anxious individuals (HSA) $n = 20$ M (SD)	Non socially anxious controls (NSAC) $n = 20$ M (SD)	F/χ^2
Age	23.2 (2.3)	23.1 (2.7)	.01
Sex	Male: 10 Female: 10	Male: 10 Female: 10	.01
Years of education	13.0 (2.5)	12.5 (2.1)	1.0
Fear of Negative Evaluation Scale	54.8 (9.6)	38.5 (7.3)	13.73**
Social Phobia Scale	18.5 (12.9)	7.7 (5.48)	11.86**
Social Interaction Anxiety Scale	27.30 (12.18)	15.5 (8.52)	12.70**

Note: $^{*}p < .05$.

when compared to the cut-off scores that have been determined for the German versions of the two questionnaires (SPS ≥ 17; SIAS ≥ 26; Stangier, Heidenreich, Berardi, Golbs, & Hoyer, 1999).

2.2. Avoidance learning task

We modified a probabilistic instrumental learning task (Murray et al., 2008) to examine avoidance learning. Each trial started with a fixation cross for 500 ms. The fixation cross was replaced by a human face, with either a neutral or an angry facial expression, presented in the middle of the screen, and two cues, a triangle and a circle (white color on black screen), which appeared directly above the face. We used the angry and the neutral facial expression of one male and one female model taken from the Karolinska Directed Emotional Faces Set (Lundqvist & Litton, 1998). Male faces were employed as stimuli for the female participants and female faces were employed as stimuli for the male participants. Participants were instructed to choose one of the two presented cues (triangle, circle) to make the face disappear. Each trial entailed a high probability cue (e.g., triangle – 80% probability of reinforcement) and a low probability cue (e.g., circle – 20% probability of reinforcement). The assignment of the shapes as high or low probable cues was counterbalanced across participants. The probabilistic nature of the task is based on the trial structure (see Murray et al., 2008). The face therefore disappeared with a different probability depending on the chosen cue. The probabilities for the high and low cues were independent from one another. Participants indicated their choice by pressing the left or right arrow buttons of the keyboard. Faces and cues were presented for a maximum of 3 s. If participants failed to respond, an "Ooops" appeared in the center of the screen and the next trial began. When participants chose a reinforced cue, the face and the cues disappeared immediately upon button press. When participants chose a non-reinforced cue, the face and the cues remained on the screen until the end of the trial (see Fig. 1). There were 4 blocks with 40 trials each such that the reinforcement probabilities within each block matched the overall probabilities. For half of the participants in each group, the circle served as high probable cue, for the other half it was the triangle. Trials with the neutral and the angry facial expression were administered in a pseudorandomized manner within blocks, ensuring 20 presentations of the neutral and 20 presentations of the angry face in each block. In addition, both groups were matched with regard to the trial sequences of angry and neutral faces. There was no break in between the blocks such that the participants were not aware of the number of blocks.

In order to make the face disappear, participants had to learn by trial and error which of the cues most likely made the face disappear. Participants were not informed about the different reinforcement probabilities, but learned this across trials. They were also unaware that on any given trial, the reinforcement

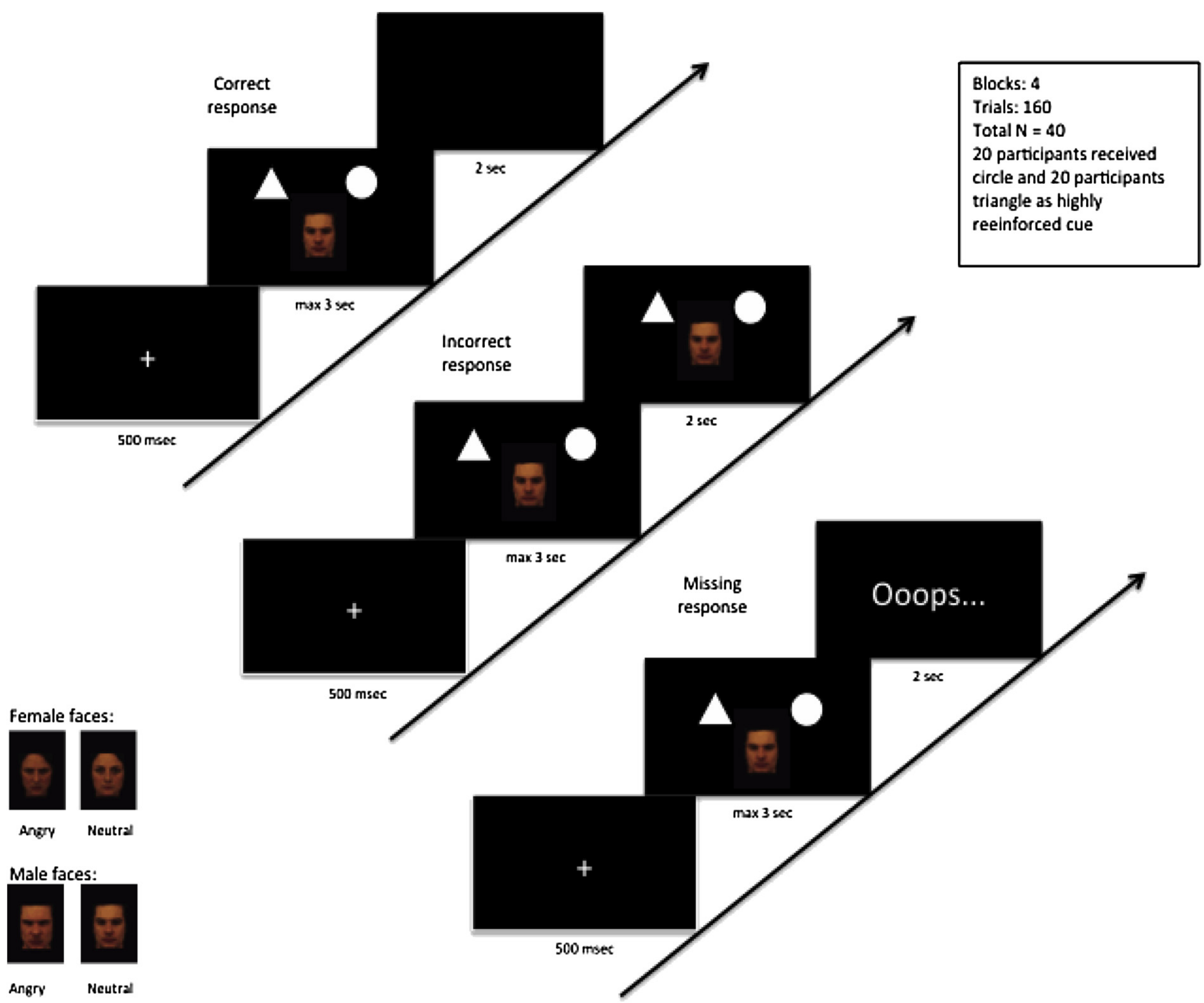

Fig. 1. Trial structure and stimuli used in the learning task.

probabilities of the two cues were independent. Instructions for the task were as follows: "In this game you will see two shapes and a face on the screen. You have to choose the triangle or the circle. Depending on which shape you choose, the face will disappear or stay on the screen. At first you will not know which shape to choose, so you have to guess, but by the end you will have learned, through trial and error, which shape to choose to make the face disappear. Please respond as fast as possible".

2.3. Procedure

When participants arrived at the laboratory, they gave informed consent, completed the questionnaires and were given written instructions about the computer task. All stimuli were presented on a 72 Hz, 22-inch color monitor. The experiment was programmed using Presentation software (www.neurobs.com), measuring reaction time and cue choice. After the learning task, participants rated valence (1 = highly unpleasant; 9 = highly pleasant) and arousal (1 = not arousing at all; 9 = highly arousing) of the faces using the Self-Assessment Manikin (Bradley & Lang, 1994). Participants also estimated the reinforcement probability for each cue, i.e. they estimated how often (in percent) pressing the cue was followed by either face disappearing (e.g., "Rate the probability that when choosing the circle the angry face disappeared"). The study was approved by the local ethics committee.

2.4. Data analysis

In a first step, we checked whether all participants had learned the contingency. Specifically, successful learning was defined as a difference in estimated post-hoc contingency between the high and low probability cue of 40% and a difference in the number of choices of the high vs. the low probability cue of 8 (i.e. 40%). None of the participants had to be excluded due to non-learning. The main outcome variables were the number of choices of and the mean reaction time to the high probability cue depending on the valence of the face. The number of choices to the low probably cue were not analyzed given that these are complementary to the number of choices of the high probability cue. Number of choices and reaction time data were analyzed using a group (HSA vs. NSAC) × emotion (angry vs. neutral face) × time (block 1–4) repeated measures ANOVA. The mean RTs for each participant and each stimulus class were calculated after elimination of values above or below two standard deviations (less than 3% of trials; Ratcliff, 1993). Valence and arousal ratings were analyzed using group × emotion repeated measures ANOVAs. Differences in the estimated reinforcement probability for the high and low probability cue were analyzed using group × emotion × probability (high vs. low probability cue) repeated measures ANOVAs. Significant interactions of all ANOVAs were followed up by simple main effects. For multiple comparisons between blocks, Bonferroni corrected comparisons (overall $p = .05$) were used. Statistical tests were conducted with an alpha level of $p = .05$. Effect sizes are reported using partial eta squares (η_p^2) or Cohen's *d*.

3. Results

3.1. Number of choices of the high probability cue

The repeated measures ANOVA revealed a significant group × emotion × block interaction ($F(3, 40) = 3.2$, $p = .03$; $\eta_p^2 = .21$), an interaction of emotion and group ($F(1, 40) = 5.9$, $p = .02$; $\eta_p^2 = .13$), a main effect of block ($F(3, 40) = 16.3$, $p < .001$; $\eta_p^2 = .57$) and a main effect of group ($F(1, 40) = 6.0$, $p = .01$; $\eta_p^2 = .14$; Fig. 1a, b). The three way interaction was first followed up by group × block repeated measures ANOVAs for each emotional condition. For the neutral face, both groups gradually learned to choose the high probability cue (linear trend: $F(1, 40) = 25.06$, $p < .001$; $\eta_p^2 = .41$; main effect block: $F(3,40) = 15.9$, $p < .001$; $\eta_p^2 = .46$). Furthermore, the HSA chose the high probability cue significantly more often compared to NSAC (Main effect Group (1, 40) = 10.8, $p = .002$; $\eta_p^2 = .22$), across blocks. In the angry face condition, both groups chose the high probability cue increasingly more often across blocks (linear trend: $F(1, 40) = 21.06$, $p < .001$; $\eta_p^2 = .35$; main effect block: $F(3, 40) = 11.49$, $p < .001$; $\eta_p^2 = .49$). Similar to the neutral face condition, the HSA choose the high probability cue more often than the NSAC, yet this difference did not reach statistical significance (Main effect Group (1, 40) = 1.8, $p = .17$; $\eta_p^2 = .05$; see Fig. 1b). In neither condition, the group × block interaction effect reached significance. Second, we followed up the three way interaction with an emotion × block repeated measures ANOVA for each group separately. In the NSAC, only the linear trend for block was significant ($F(1, 20) = 20.45$, $p < .001$; $\eta_p^2 = .43$), revealing that NSAC chose the high probable cue more often across blocks. For HSA, the analysis revealed a significant emotion × block interaction ($F(3, 20) = 5.11$, $p = .01$; $\eta_p^2 = .47$). While there was no significant increase in number of avoidance responses across blocks cue in the neutral condition (all *p*'s comparing choices from one block to the following > .05), HSA increasingly avoided the angry faces condition across blocks (all *p*'s comparing choices from one block to the following < .01). Finally, the responses between angry and neutral faces differed in the first three blocks (*p*'s ≤ .01) but not in the fourth block ($p > .5$).

3.2. Reaction time in response to the high probability cue

Reaction time (RT) decreased in both groups over time, as indicated by a trend for a main effect of block ($F(3, 40) = 21.06$,

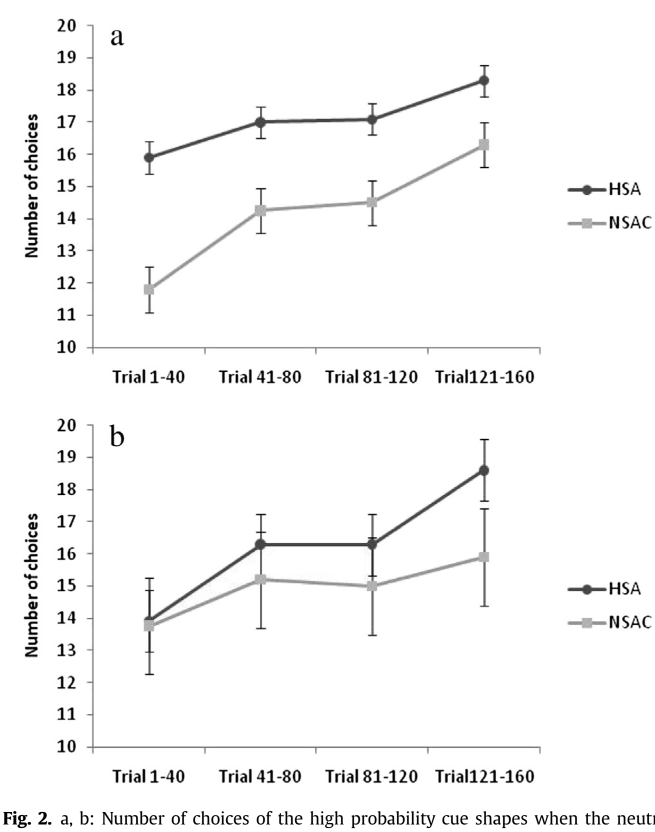

Fig. 2. a, b: Number of choices of the high probability cue shapes when the neutral face (a) or the angry face (b) was presented in high socially anxious and non-socially anxious control participants across blocks 1–4.

$p = .069$; $\eta_p^2 = .18$; Fig. 2a, b). Moreover, a significant group × emotion interaction effect was obtained ($F(3, 40) = 5.5$, $p = .02$; $\eta_p^2 = .13$). Compared to the NSAC, HSA showed significantly longer RTs for neutral faces ($t(38) = -2.1$, $p = .045$; $d = .60$), but not for angry faces ($t(38) = -1.3$, $p = .2$; $d = .36$). Comparing reactions to emotional faces within groups, HSA were slower to neutral compared to angry faces ($t(19) = 2.92$; $p = .01$). However, NSACs did not show any differences between emotions ($t(19) = -.31$; $p = .75$) (Fig. 3).

3.3. Valence and arousal ratings and probability estimates

There were no significant differences between groups with regard to perceived valence and arousal of the two faces (all p's > .1). Angry faces as compared to neutral faces were rated as more negative ($F(1,40) = 125.38$, $p < .001$; $\eta_p^2 = .73$) and more arousing ($F(1,40) = 84.75$, $p < .001$; $\eta_p^2 = .69$) in both groups. Groups did not differ with regard to the estimated reinforcement probability of the high and low probability cue in the neutral and the angry face condition (p's > .1; Table 2). As we used male faces for female participants and vice versa, we tested for differences in self-report rating between male and female participants, but no comparison yielded statistically significant results (valence neutral: male = 4.51 (1.37); female = 4.92 (1.99); valence angry: male = 7.32 (.97); f = 7.5 (.98); arousal neutral: male = 3.14 (.88); female = 3.0 (1.01); arousal angry: male = 7.7 (1.63); female = 7.9 (1.55) probability neutral: male = 70.4 (16.46); female = 71.48 (12.28); probability angry: male = 71.1 (20.01); female = 70.3 (13.39), all p's > .1).

4. Discussion

We used a probabilistic instrumental learning task to determine whether a high level of social anxiety is associated with greater to

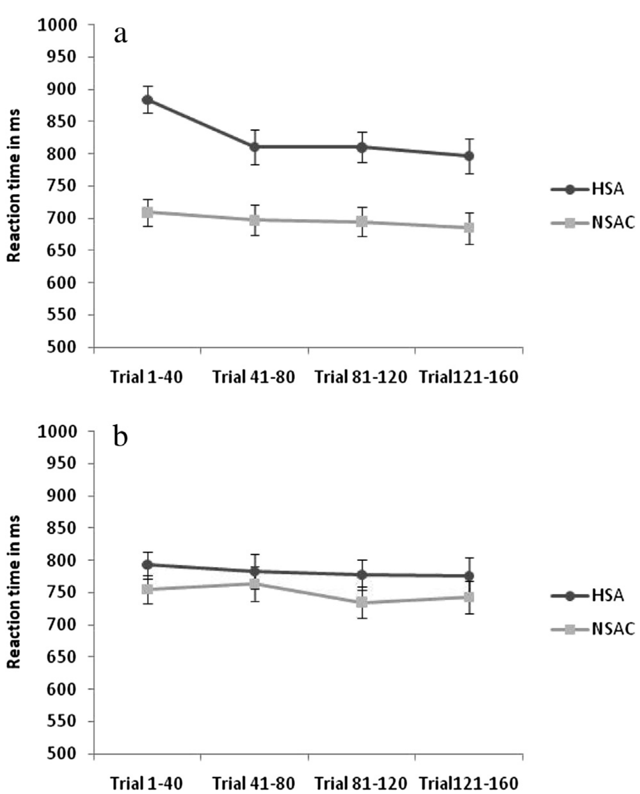

Fig. 3. a, b: Reaction times for the high probability cue when the neutral face (a) or the angry face (b) was presented in the high socially anxious and non-socially anxious control participants for blocks 1–4.

Table 2
Valence, arousal and probability ratings for the high probability cue of high socially anxious (HSA) participants and non-socially anxious controls (NSAC) after the computer task.

	HSA		NSAC	
	Angry	Neutral	Angry	Neutral
Valence (1–9)	7.55 (.83)	4.6 (1.59)	7.45 (.83)	4.5 (1.43)
Arousal (1–9)	7.1 (1.5)	3.2 (1.5)	5.9 (1.73)	3.25 (1.6)
Probability (0–100%)	62.05 (23.3)	72.10 (17.58)	72.3 (13.8)	70.55 (16.35)

Note: Probability refers to the estimated probability that choosing the high probability cue led to the disappearance of the face.

proneness to acquire an avoidance response to socially relevant stimuli depending on the aversiveness of these stimuli. With the objective of making a presented neutral or angry face disappear from the screen, both HSA and NSAC successfully learned to choose the cue associated with a high probability over the low probability cue. The HSA and NSAC groups, however, differed in terms of their avoidance responses to neutral facial expressions with HSA choosing the high probability cue significantly more often. Furthermore, when comparing learning curves within groups, both groups gradually engaged in more avoidance responses to the angry faces, but HSA showed a consistent and high avoidance response across all four blocks. Finally, HSA also showed longer reaction times in the neutral condition compared to NSAC, which might be an indication of greater demands on information processing associated with neutral social information.

Relative to negative facial expressions, neutral facial expressions are ambiguous as to the type of social information they convey. Neutral facial expressions may therefore promote avoidance behavior particularly in HSA as they are perceived as potentially threatening. Evidence supporting this view is provided by neurobiological findings that reveal a hyperexcitable frontolimbic fear circuitry (including the amygdalae) in HSA, which is easily activated by socially relevant stimuli, even if they are not highly threatening per se (Amaral, 2002). More specifically, neutral faces have been shown to elicit significantly more pronounced amygdala activation in individuals with social phobia than controls (Birbaumer et al., 1998; Cooney, Atlas, Joormann, Eugene, & Gotlib, 2006). Interestingly, our results support the notion that social anxiety is associated with a heightened proneness to avoid neutral social cues. Also, higher levels of social anxiety have been associated with a more pronounced priming effect of a neutral face on the subsequent processing of an angry face, suggesting that neutral faces are interpreted similar to angry faces (Yoon & Zinbarg, 2008). These findings correspond well with the interpretation bias that individuals with social anxiety show when confronted with ambiguous social scenarios or information (Constans, Penn, Ihen, & Hope, 1999; Stopa & Clark, 2000). However, as we used only two cues (triangle and circle) in both experimental conditions, it might be possible that the participants did not have to learn for the angry and neutral face separately, what might be the response most likely resulting in the removal of the face. Using the same cues for both faces is beneficial as the actual choice of the cues is mainly influenced by the motivational value associated with the face shown in any given trial. Indeed, the present design is likely to have assessed mainly the motivation to avoid rather than the actual acquisition of an avoidance response. Clearly, learning about the contingency between a certain behavioral response and its consequence is not the same as being motivated to actually engage in this behavior. Compared to emotional faces, neutral faces are highly ambiguous, especially if their motivational value is behaviorally relevant. For example, in healthy individuals, only when having to decide whether to approach or avoid but not when having to discriminate between faces, reaction times are significantly longer for neutral than for happy or angry faces (Blasi et al., 2009). The threat-related heightened ambiguity of the neutral faces in HSA was mirrored here by the significantly longer reaction times as compared to the NSAC. Consistent with our results, individuals with SP have been shown to need more time when evaluating ambiguous facial crowds consisting of approving and disapproving faces as compared to disapproving crowds (Gilboa-Schechtman, Presburger, Marom, & Hermesh, 2005). Of course, prolonged reaction times to neutral faces might be interpreted as a speed-accuracy trade off in individuals high in social anxiety. Yet, such a strategy would also be in line with the interpretation of a different motivational value of neutral faces in individuals with HSA compared to non-anxious controls.

By contrast, angry faces represent biologically evolved fear-relevant stimuli that presumably automatically activate the fear system and promote avoidance behaviors (Mineka & Ohman, 2002). As a consequence, potential differences between HSA and NSAC with regard to avoidance behavior may be diminished because NSAC are also highly motivated to avoid such stimuli. Ly and Roelofs (2009) also found that HSA did not avoid classically conditioned social threat cues more frequently than low socially anxious individuals. Similarly, studies using a dot-probe paradigm with an inter-stimulus interval greater than 500 ms which allows for the testing of attentional avoidance also suggest that individuals with high levels of social anxiety do not necessarily engage in strategic avoidance of angry faces (Stevens, Rist, & Gerlach, 2009, 2011). Here, similar to the neutral face condition, HSA also chose the high probable cue more often than the NSAC, though the effect size for this difference was only small and did not reach statistical significance. This smaller between-group difference in avoidance behavior for angry faces is most likely accounted for by the NSAC's greater avoidance behavior in the angry face than in the neutral face condition. Furthermore, HSA showed consistently high avoidance responses to the neutral faces across blocks, whereas their avoidance behavior to angry faces nearly increased across trials, similar to the NSACs' response pattern. Interestingly, no differences between groups were obtained for self-reported valence and arousal of the faces. This is in line with other studies, which did not reveal any differences between individuals with SP and healthy controls when explicitly evaluating the valence of faces (Philippot & Douilliez, 2005). It suggests a dissociation between the self-reported aversiveness of the faces and actual avoidance behavior which depends on the implicit threat value of the stimulus which is avoided. This result underlines the beneficial use of probabilistic tasks which use a behavioral response to indirectly probe the actual reinforcement value of a stimulus rather than primarily relying on verbal self-report. Importantly, the post-hoc estimate of the reinforcement probability for both cues did not differ between groups despite the HSA actually choosing the high probable cue more often than the NSAC, especially when a neutral face was to be avoided. It should be noted that both groups were not instructed in advance about any difference in reinforcement probabilities between the cues. Our findings suggest that explicit contingency knowledge and explicit cue expectations may not be sufficiently sensitive measures to detect differences in avoidance behaviors. This could explain why between group differences have not been observed in a previous study entailing a priori information about the reinforcement contingency (Ly & Roelofs, 2009).

When being exposed to every day social interactions, individuals with social anxiety may be particularly prone to terminate a social encounter or to engage in safety behaviors, even if the situation is not particularly threatening. Such avoidance prevents exposure to social situations and therefore interferes with extinction, hence maintaining pathological anxiety (Lovibond et al., 2009). In addition to cognitive restructuring and targeting distorted interpretations of neutral social situations, our study emphasizes the importance of interventions focusing on the reduction and prevention of avoidance and safety behaviors. When individually tailoring treatment and preventing relapse, it is important to address avoidance behavior that occurs not only in a priori threatening, but also ambiguous situations that are not necessarily perceived as strongly anxiety provoking by the patient.

Regarding possible limitations of the study, we did not include an online measure of expectancy that either button press would stop the display of the face (Lovibond, 2004). However, such measures are typically not included in probabilistic learning tasks as the actual choice closely reflects the expected outcome with regard to the target behavior, i.e. the end of the presentation of the face (Murray et al., 2008). Furthermore, using opposite sex faces in order to increase the induced anxiety response might threaten the internal validity of the experimental task. A potentially differential influence of male and female facial expressions should be tested more thoroughly by showing female and male faces to all participants and evaluate differences in learning depending on the sex of the facial expression. Yet, it should be noted that male and female participants did not differ in their self-report ratings of the different faces, thus making it rather unlikely that the use of opposite sex faces may have seriously reduced the internal validity of the experimental manipulation. Moreover, by comparing HSAs to individuals with average levels of anxiety, we may have limited the magnitude of the to-be expected between-group effect size, thus potentially limiting statistical power. However, we felt that it was important to avoid the disadvantages of extreme group sampling strategies which heavily relies on differences between either (i.e. upper and the lower) extreme group and the group average (cf., Preacher et al., 2005). By comparing high socially anxious participants to those with an average level of social anxiety, the observed differences in avoidance behavior can be attributed to the elevated level of social anxiety rather than on differences between particularly low and high levels of social anxiety. As suggested by the significant group $\times$ emotion $\times$ block interaction and the obtained between-group effect sizes in either face condition, there was sufficient power to detect at least a moderate sized effect. Finally, additional studies are needed that, due to their experimental design, allow to disentangle more clearly between the learning of reinforcement contingencies and motivation-dependent performance of avoidance behavior which in the present study was not possibly. Accordingly, it would be interesting to use a design allowing to unravel win-stay/lose-shift decision patterns in future studies. A related issue concerns the potentially confounding influence of participant's motivation for a speedier completion of the whole experiment by terminating the presentation of the emotional faces. It should be noted, however, that there was little evidence for participants becoming faster in responding across blocks, which provides rather little support for such a hypothesis.

In summary, our results show for the first time that social anxiety is associated with an increased proneness to avoid ambiguous socially relevant stimuli. Socially anxious individuals chose the avoidance response more readily although they did not overestimate the actual reinforcement contingency for the high and low probability cue. Interestingly, the avoidance response to neutral faces was higher in HSA compared to NSAC in all blocks but did not increase over time. Hence, the motivation to avoid ambiguous social stimuli might be higher in individuals with social anxiety. These individuals may engage in subtle avoidance behaviors even in neutral daily social interactions. The maintenance of pathological social anxiety may be accounted for by the combined effect of delayed acquisition of extinction memory and, at the same time, by a higher proneness to engage in avoidance behaviors not only in threatening, but also ambiguous social situations. It is particularly intriguing that socially anxious individuals may learn such avoidance behaviors rather implicitly. Heightened avoidance was associated with increased social anxiety, underlining the importance of targeting avoidance and safety behaviors in the treatment of social anxiety.

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