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ORIGINAL ARTICLE

The Causal Role of Attentional Bias for Threat Cues in Social Anxiety: A Test on a Cyber-Ostracism Task

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Abstract Cognitive models of social phobia postulate that attentional biases for threat play an important role in the maintenance of this disorder (e.g., Clark 2001). Consistent with this idea, studies have demonstrated that training social phobics to attend to non-threatening stimuli results in clinical benefits (Amir et al. in J Abnorm Psychol 117:860–868, 2008). However, no study has directly examined the causal status of selective attentional bias in social phobia. The present study explicitly investigated this issue. We used an experimental design similar to MacLeod et al. (J Abnorm Psychol 111:107–123, 2002), which involved two consecutive experimental phases: an attentional bias induction phase and a stress phase. During the attentional bias induction, participants completed modified versions of a dot-probe task; for half of the participants the task was designed to induce a biased attentional response for faces expressing disgust, for the other half, the task induced no bias. Then, all participants were exposed to a task inducing social rejection. Results indicate that the induction of an attentional bias for threatening information resulted in increased anxiety during social rejection. Implications for cognitive models of social phobia are discussed.

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Introduction

Most cognitive models of anxiety pose that selective attention to threat cues contributes to the development and maintenance of emotional disorders (e.g., Mathews and MacLeod 1994; Williams et al. 1997). Selective attention in social anxiety may take the form of attentional bias for internal or external threat cues. Attentional bias for internal threat cues (e.g., negative self-evaluation, physiological symptoms) may contribute to social anxiety by interfering with the ability to process external cues that disconfirm social fears (Clark and Wells 1995). Conversely, excessive attention to external threat cues (e.g., disgust faces) may encourage one to interpret that the environment is more threatening than it actually is, thus promoting anxiety (e.g., Bradley et al. 1998; Mogg and Bradley 1998).

Attention to external threat cues has often been investigated using probe detection and probe discrimination tasks. In these tasks, individuals with social anxiety respond faster to probes replacing threat cues than to probes replacing neutral cues, which demonstrates an attentional bias for threat that is absent in non-anxious individuals (e.g., Mogg et al. 2004; Pishyar et al. 2004). Recent studies have attempted to dismantle this bias to identify which attention component underlies it. Most of these studies used the modified Posner (1980) spatial cueing task in which a threat (or non-threat) cue appears on either the left or right side of a computer screen, followed by a probe that either replaces the cue or appears on the other side of the screen (e.g., Amir et al. 2003; Fox et al.

2001). These studies showed that anxious participants are no faster to respond to probes replacing threat than non-threat cues, but they are slower to respond to probes that appear opposite to threat cues relative to non-threat ones. This pattern of results suggests that, rather than being faster to engage attention to threat, anxious participants experience difficulties in disengaging attention from threat (e.g., Amir et al. 2003). Recent evidence using eye-tracking measures confirms that individuals with social anxiety exhibit difficulties in disengaging their attention from social threat cues (Buckner et al. 2010).

Beyond these cross-correlational studies, recent evidence supports the notion that attentional bias for external threat cues is causally involved in the maintenance of social anxiety. Li et al. (2008) have observed that 7-days of training attention towards positive faces diminished attentional bias for negative faces. Moreover, this training reduced self-reported fear of social interaction. Similarly, Amir et al. (2008) trained, in a single-session, socially phobic individuals either to attend to neutral faces or to perform a control task in which there was no contingency between probes and cues. As compared to the latter condition, the former reduced self-reported anxiety in response to an impromptu speech. Further, using a modified Posner paradigm after attention training, these authors observed that the improvement in the ability to disengage attention from threat mediated the effects of training on anxiety reactivity, and that this decrease in anxiety, in turn, improved speech performance. Recently, Heeren et al. (submitted) have replicated these observations and extended their findings to changes in sympathetic activation to stressors. They observed that change in attentional bias occurring after attention training mediated a reduction in skin conductance reactivity to an impromptu speech. Likewise, Schmidt et al. (2009) have observed that training individuals with social phobia to attend to neutral faces led to a significant reduction in social anxiety and trait anxiety, in comparison to a control group exposed to no contingency between the cues and probe. In this study, the protocol included eight 20-min sessions delivered over a 4-week period (i.e., twice weekly sessions). At a 4-month follow-up, the treatment group had improved further on measures of anxiety. Using a similar design, Amir et al. (2009) have replicated these results.

These results are consistent with the hypothesis that attention bias is causally involved in the maintenance of social anxiety. However, cognitive models also postulate that attentional bias for threat plays a causal role, not only in the maintenance, but also in the installation of social anxiety (e.g., Clark 2001). Only one study has directly assessed the impact of an induced attentional bias on anxiety proneness (MacLeod et al. 2002). Using a dot-probe detection task, MacLeod et al. trained non-anxious participants to attend either to neutral or to threatening stimuli. The task comprised 672 trials in which pairs of words (one threatening and one neutral) appeared on a computer screen. In the attend-to-threat condition, probes replaced threat words (e.g., bomb, dead, nausea, sad), whereas in the attend-to-neutral condition, probes replaced neutral words (e.g., curve, league, journal, aisle). Participants had to press a button as soon as they detected the probe. Relative to those trained to attend to neutral material, participants trained to attend to threat material reported more anxiety and negative mood after performing a stressful anagram task. This result suggests that selective attention for negative information increases anxiety reactivity to an experimental stressor.

However, it is not yet known whether a similar causal relationship between attention to threat and anxiety reactivity also applies to the development of social anxiety. Two aspects of this question require further consideration. First, it remains unclear whether participants who are be trained to attend to socially threatening stimuli (e.g., disgust faces) would show more anxiety during social exclusion specifically, or whether they would also exhibit other changes in mood. Second, the anagram task used by MacLeod et al. (2002) was a very explicit stressor. It might be that a change in processing bias might impact on reactions to the explicit stressors without actually modifying emotional vulnerability to more subtle (or weaker) stressors. Indeed, it has been reported that socially anxious individuals tend to evaluate less explicit (or more ambiguous) information as more threatening than non-anxious controls (e.g., Amir et al. 2005; Stoppa and Clark 2000; Yoon and Zinbarg 2007). Therefore, uncertainty abounds regarding the impact of attentional bias induction on more ambiguous (or less explicit) stressors.

Using an experimental design similar to that used by MacLeod et al. (2002), the present experiment addressed these issues. During the attentional bias inducing phase, participants completed modified versions of a dot-probe task; for half of the participants the task was designed to induce a biased attentional response for faces expressing disgust, for the other half the task induced no bias. Then, all participants performed a task that exposed them to an explicit as well as an implicit social rejection, based on a cyberball task (see below). Attentional biases were also assessed both before and after the attentional bias induction phase. This allowed us to control whether attentional responses to emotional information were indeed systematically altered by the experimental procedure. We predicted that inducing an attentional bias for social threat in healthy people would result in an increase of anxiety during the explicit as well as the implicit social rejection task.

Method

Participants

We recruited 42 Caucasian individuals from a large university community; their characteristics are displayed in Table 1. They were all French speaking. They were invited to take part in the experiment presented as an investigation of the effects of cognitive abilities on mental visualization during a videogame. They were selected using the French version of the Liebowitz Social Anxiety Scale (LSAS; Liebowitz 1987). In order to select non-socially anxious individuals, they all have a LSAS-score below 24 (i.e., the lower quartile of the large university community sample we administered the LSAS). Further, to ensure their that level of social anxiety was extremely low, we computed a one-sample-*t* test testing whether their LSAS score were significantly lower than 81 (i.e., the French-LSAS-mean score among a sample of patients diagnosed as social phobics; Yao et al. 1999). Data confirmed that the mean score of our sample ($M = 13.18$, $SD = 6.23$) was significantly lower than social phobics, t $(41) = -70.59$, $P < .00001$ (one-tailed). In addition, all participants: (1) had no current or past substance abuse, (2) no current or past heart, respiratory, neurological problems, (3) no current or past use of psychotropic medications, (4) were not currently engaged in any form of psychological or psychiatric treatment, and (5) had normal or corrected-to-normal vision. They received compensation (5 euros and a lottery ticket) for their participation. The study conformed to the ethical standards of the American Psychological Association.

Measures

Questionnaires

The French version of the Trait Anxiety Inventory (STAI-Trait; Spielberger et al. 1983) is a 20-item self-report questionnaire assessing anxiety trait vulnerability. Bruchon-Schweitzer and Paulhan (1993) have reported good psychometric and structural properties of the French adaptation of the scale. Cronbach's alpha in the current sample was .87.

Table 1 Participants' characteristics as a function of group allocation

	Attend-to-threat condition	Control condition
n	21	21
Age	22.17 (3.93)	22.11 (3.41)
% female	55.6	50.0
Years of education	15.94 (1.39)	15.78 (1.06)
BDI-II	5.29 (.94)	4.33 (1.59)
STAI-T	35.14 (1.66)	36.86 (1.51)
NBS	38.69 (6.02)	37.89 (6.87)
LSAS	12.02 (6.61)	14.33 (6.22)

SD in parentheses

BDI-II beck depression inventory-II, *STAI-T* spielberger state-trait anxiety inventory-trait, *NBS* need to belong scale, *LSAS* liebowitz social anxiety scale

The French version of the Beck Depression Inventory (BDI-II; Beck et al. 1996) is a 21-item self-report measure of the symptoms of depression. Beck et al. (1996) have reported good psychometric and structural properties of the French adaptation of the scale. Cronbach's alpha in the current sample was .80.

The French version of the Need to Belong scale (Leary et al. 2007; French version: Kuppens and Yzerbyt 2011) is a 10-item self-report measure assessing the need to belong (Leary et al. 2007). Kuppens and Yzerbyt (2011) have reported good psychometric properties of the French version. Cronbach's alpha in the current sample was .84.

The LSAS is a 24-item scale that assesses a range of social interaction and performance situations that individuals with social phobia may fear and/or avoid. Yao et al. (1999) and Heeren et al. (submitted) have reported good psychometric and structural properties of the French adaptation of the scale. Cronbach's alpha in the current sample was .88.

Visual Analogue Scale

To assess the level of negative mood and anxiety states at baseline, at post-inducing and during the stress phase, participants completed two visual analogue scales on a computer. Each scale consisted of a 740-pixel horizontal line. One was an anxiety scale anchored from *relaxed* to *anxious* and the other was a mood scale anchored from *happy* to *depressed*. Previous studies on attention bias modification have used similar scales (e.g., MacLeod et al. 2002). To complete theses scales, participants used the mouse to move a cursor along the line corresponding to their current state. This yielded a score between 0 and 740 pixels, depending on which point on the line was selected. For each response, the presentation order of the scales and localization of the anchor label (i.e., from happy to relaxed vs. from relaxed to happy) were randomised.

Measure of Attention Bias

For assessing the effects of training on attention to threat cues, participants were asked to complete an independent measure of attention bias at baseline and after bias induction. We used a modified version of the Posner spatial cueing task identical to that reported in Amir et al. (2008, 2010). Regarding the stimuli, eight social threat words (e.g., stupid, humiliation, embarrassed) and eight neutral words (e.g., book, radiator, procession) were used. These proportions were based on previous studies on attentional bias in social anxiety (e.g., Amir et al. 2003). Words types were matched on frequency and usage in French (Lambert and Chesnet 2001; New et al. 2001). There was no significant difference in word length between social threat and neutral words, t (14) = .44, $P > .66$, $d = .23$. We used words, rather than faces, in the assessment trials in order to show that the effects of training with one type of stimulus can be generalized to another type of stimulus.

During the task, words were presented in lowercase (5–8 mm in height) white letters against a black background in the centre of the screen. Socially threatening or neutral cue words appeared in one of two locations on the computer screen (i.e., rectangles located to the right or left of a central fixation cross), thereby directing attention to one of two screen locations (i.e., right or left). After 600 ms, the cue word disappeared, and participants were instructed to detect a probe ("*") that immediately appeared in one of the two locations. The probe remained onscreen until the participant responded, and response latencies were recorded from the onset of the probe to the button press. The inter-trial interval from the target offset to the next fixation cross was 1,650 ms. On some trials, the cue word was valid (i.e., the probe appeared in the same location as the cue word). On other trials, the cue word was invalid (i.e., the probe appeared in the location opposite to the cue word).

Participants performed 192 experimental trials, two-thirds of which were validly cued (128 = 8 words × 2 word types × 2 word positions × 4 repetitions), one-sixth were invalidly cued (32 = 8 words × 2 word types × 2 word positions), and one-sixth were uncued (32 = 8 words × 2 word types × 2 word positions). The decision to use these proportions was based on previous research that used the same proportions (Stormark et al. 1995). Trial order was randomised for each participant.

Participants completed four practice trials (including four neutral words) prior to the experimental trials. During the practice trials, participants received feedback regarding the accuracy of their response. Feedback was not provided during the experimental trials. Participants sat approximately 30 cm from the computer screen. In previous research using this task (e.g., Amir et al. 2003), socially anxious participants showed significantly longer response latencies on invalid cued social threat trials compared to non-anxious controls, suggesting that an attentional bias may be due to difficulty in disengaging from threatening stimuli.

Social Rejection Task

Cyberball (e.g., Williams 2007) is a virtual ball-tossing task in which participants are told they are playing with two others participants connected over the Intranet, although the other "players" are, in fact, computer generated. Participants are informed that it does not matter who throws or catches, but rather, that they should use the animated ball-toss game to assist them in visualizing the other player. The cover story is meant to assure participants that not getting the ball has no detrimental effects on their performance in the experiment. The time taken by each of the computer-generated players to make their decision and throw the ball was varied each turn to increase the believability that they were "real" participants.

Each participant was submitted to three different conditions during the Cyberball task: the inclusion condition, the explicit ostracism condition, and the implicit ostracism condition. During the inclusion condition, the probability that participants would be thrown the ball was 67%. During the explicit ostracism condition, the probability that participants would be thrown the ball was 0%. During this condition, participants saw that the two others players were still playing together. During the implicit ostracism condition, the probability that participants would be thrown the ball was again 0%. However, during this condition, participants did not see that the two others players were still playing, instead, a screen appeared indicating that there was a technical problem involving a network transitory disconnection. This last condition was added to assess the differential effects of emotional responding to an explicit versus implicit social exclusion condition. Indeed, Eisenberger et al. (2003) previously reported that regardless of whether ostracism was intentional or not, it was associated with increased activation of the dorsal anterior-cingulate cortex among healthy participants, a region of the brain that shows activation during, among others, exposure to loss of social connections (e.g., Lieberman 2007).

Each condition lasted for 50 throws, except the implicit ostracism condition, which presented the technical problem for 60 s. To avoid a carry-over effect, the order of the two ostracism conditions were counter-balanced across participants. Computerized visual analogue scales (see emotional assessment) were used to record the degree to which each procedure served to elevate levels of anxiety. Emotional reactivity was assessed before and after the attentional bias induction phase, just prior to the cyberball task, and after each condition of the cyberball task.

Attention Bias Modification

Material

We randomly selected 70 Caucasian face pairs without hairlines (35 men, 35 women) from the Karolinska Emotional Directed Faces database (Lundqvist et al. 1998), which is a standardized set of emotional expressions.

The faces displayed either threatening (i.e., disgust) or neutral facial expressions. We chose disgust faces as threat cues for several reasons. First, disgust conveys a message of aversion or rejection (e.g., Rozin et al. 1994), a central concern of individuals with social phobia (American Psychiatric Association 1994). Second, previous studies have found that socially anxious individuals exhibit an attentional bias toward disgust faces (Pishyar et al. 2004). Finally, previous studies supporting the effectiveness of attention training programs in reducing attentional bias towards threat cues in social anxiety have used faces expressing disgust as threatening stimuli. We thus used disgust faces to remain consistent with previous work.

Bias Modification Task

Attentional bias was induced using a standard probe discrimination task, which was modified to train participants either to attend primarily to threat cues, or to attend equally to threat and neutral cues. For both conditions, a fixation cross appeared for 500-ms followed either by two facial expressions, a disgust face and a neutral face, presented for 500 ms. Then a probe appeared (i.e., a white arrow), pointing either up or down. The probe remained onscreen until the participant indicated the direction of the arrow by pressing the corresponding button. The inter-trial interval was 1,500 ms.

In the attend-to-threat condition, a neutral and a threatening face appeared followed by an arrow in the location previously occupied by the threatening face on 95% of the trials. In the control condition, there was no contingency between the face cues and probes.

Participants completed 560 trials in one block. Each of the 70 threatening faces was presented four times, paired with a non-threatening face of the same individual, in positions that represented all combinations of the locations and probe types. This procedure was repeated 2 times (i.e., 560 = 70 stimuli $\times$ 2 positions $\times$ 2 arrow directions $\times$ 2 repetitions). The instructions were presented on the computer and were identical for both conditions. Faces were positioned 4 cm from the top/bottom of the screen, 8 cm from the ipsi-lateral edge, 22.5 cm from the contro-lateral edge, and centred vertically. Each face was 7.5 cm tall by 7.5 cm wide.

General Procedure

The procedure was based on a previous study examining the effect of a single-session of attention bias modification on reactivity to a social stressor (Amir et al. 2008). Participants were randomly assigned to one of the two attention training conditions ($n_{\text{attention-to-threat}} = 21$, $n_{\text{control}} = 21$). Using a computerized randomization system, the participants and the experimenters were blind to condition. Participants first completed a demographic questionnaire, the STAI (Trait version), NBS, and BDI-II as well as visual analogue scales assessing mood and anxiety. Next, they completed the modified Posner spatial cueing task, which provided a baseline index of attention bias. Participants then completed the bias induction task. After completing the training, participants again filled in the visual analogue scales to assess the immediate effect of the training task on participants' mood and anxiety. Next, participants again completed the modified Posner spatial cueing task to examine the influence of attention training on an independent measure of attention bias. Finally, participants performed the cyberball task. They also completed the visual analogue scale immediately after each condition of the cyberball task. At the end of the procedure, participants were fully debriefed. The possibility to remove the induced bias, using the reverse procedure, was proposed to participants who were in the attend-to-threat condition.

Results

Group Characteristics

Preliminary analyses indicated no significant differences among the groups at baseline on STAI-Trait, $t\ (40) = .76$, $P > .45$, $d = .24$, NBS, $t\ (40) = .401$, $P > .69$, $d = .13$, BDI-II, $t\ (40) = .52$, $P > .60$, $d = .16$, LSAS, $t\ (40) = 1.21$, $P > .23$, $d = .38$. Both groups were similar in terms of age, $t\ (40) = .63$, $P > .53$, $d = .20$, gender, χ^2 (1, N = 42) = 1.62, $P > .20$, and years of education, $t\ (40) = 1.39$, $P > .17$, $d = .44$. Means and standard deviations for each variable of each group appear in Table 1.

Compliance Monitoring of the Training Task

The output of the attention modification task was investigated to check compliance with the task instructions (errors and outliers). Participants made very few errors on the training task ($M = 1.09\%$, $SD = .23$) and there were few outliers ($M = 1.12\%$, $SD = .08$). The different conditions did not differ with regard to the number of erroneous responses or outliers (all Ps $> .30$). Further, these results also suggest that participants were compliant to the attention modification task.

Independent Measure of Attentional Bias

Data Reduction

Trials with errors were excluded (.52% of the data). Data more than 2.5 standard deviations below or above the participant's mean were discarded as outliers (1.2% of the data). At baseline, both groups did not differ significantly in error rates, t (40) = .70, $P > .48$, $d = .22$.

Change in Attentional Bias

We subjected response latencies to a 2 (Groups: Attend-to-threat, Control) × 2 (Time: Baseline, after bias induction) × 2 (Validity: valid, invalid) × 2 (Word Type: threat, neutral) analysis of variance (ANOVA) with repeated measurement on the last three factors. Due to a leptokurtic distribution, a logarithmic transformation was used. The ANOVA revealed a significant Group x Time x Word Type x Validity interaction, F (1, 40) = 4.14, $P < .05$, $\eta_p^2 = .10$. To follow-up this four-way interaction, we computed separate Group × Time × Validity ANOVAs for social threat and neutral words. For the neutral words, the Group × Time × Validity interaction was not significant, F (1, 40) = .08, $P > .77$, $\eta_p^2 < .01$. For threat words, the three-way interaction was significant, F (1, 40) = 7.52, $P < .01$, $\eta_p^2 = .16$. To follow-up this interaction, we conducted separate Group × Time ANOVAs for valid and invalid threat trials. Analyses only revealed a significant Time × Condition interaction for invalid trials, F (1, 40) = 14.20, $P < .01$, $\eta_p^2 = .26$.

Although both groups did not differ in their performance at baseline, t (40) = .50, $P > .62$, $d = .16$, a comparison Student t test computed on reaction times to threat invalid trials at post-training showed a significant difference between groups, t (40) = 2.50, $P < .02$, $d = .79$. Participants from the Control Condition showed no significant differences from baseline to after bias induction, t (20) = 2.08, $P > .05$. For participants from the attend-to-threat condition, there was a significant increase in reaction times for threat invalid trials from baseline to post-training, t (20) = 3.51, $P < .01$. Data appear in Table 2.

Emotional Responses to the Social Exclusion Task

We subjected responses from the visual analogue scale to a 2 (Groups: Attend-to-threat, Control) × 5 (Time: Baseline, post-training, social inclusion, explicit ostracism, implicit ostracism) multivariate analysis of variance (MANOVA) for mood and anxiety responses as the dependent variables. Values more than 2.5 standard deviations below or above the mean were discarded as outliers (.71% of the data). Groups did not differ significantly in outliers rates, t (40) = .59, $P > .56$, $d = .18$.

The MANOVA revealed a significant multivariate main effect of Time, Wilks' $\lambda = .18$, F (8, 310) = 52.07, $P < .01$, $\eta_p^2 = .57$, and a significant Group × Time interaction, Wilks' $\lambda = .89$, F (8, 310) = 2.39, $P < .02$, $\eta_p^2 = .06$. Univariate output showed, for mood scale, there was only a main effect of Time, F (4, 156) = 169.32, $P < .001$, $\eta_p^2 = .81$. As showed in Fig. 1, there were significant decreases in mood during the explicit ostracism condition as well as the implicit ostracism condition of the cyberball task for both between-subject conditions.

For anxiety scale, there was a significant main effect of Time, F (4, 156) = 16.33, $P < .01$, $\eta_p^2 = .30$, qualified by a significant Group × Time interaction, F (4, 156) = 4.29, $P < .01$, $\eta_p^2 = .10$. As showed in Fig. 2, participants from both conditions reported a significant increase in anxiety from both baseline to explicit and implicit ostracism conditions. However, although the groups did not differ in their scores at baseline, t (40) = .59, $P > .77$, $d = .19$, after bias induction, t (40) = .23, $P > .82$, $d = .07$, as well as during the social inclusion condition of the Cyberball, t (40) = .58, $P > .56$, $d = .18$, there were significant differences between groups in the explicit ostracism condition, t (40) = 2.56, $P < .02$, $d = .81$, and in the implicit ostracism condition, t (40) = 2.18, $P < .05$, $d = .69$. As shown in Fig. 2, participants who were trained to attend-to-threat reported significantly more anxiety during both

Table 2 Means of response latencies in ms by group on the spatial cueing task

Trials		Condition			
		Attend-to-threat		Control	
Validity	Material	Baseline	Post-training	Baseline	Post-training
Valid	Neutral	369.33 (62.04)	366.33 (67.85)	373.64 (38.59)	345.59 (37.58)
	Threat	388.93 (50.19)	368.26 (72.67)	377.00 (46.74)	337.29 (34.11)
Invalid	Neutral	397.14 (58.38)	402.07 (70.35)	414.72 (54.06)	395.87 (49.73)
	Threat	405.79 (67.17)	437.02 (70.62)*	414.51 (58.56)	390.86 (57.90)

SD in parentheses

"*" indicates a significant difference between pre- and post- training in that group according to paired t test comparisons. For all types of measures, there were no significant differences in baseline between groups according t test comparisons

* $P < .01$

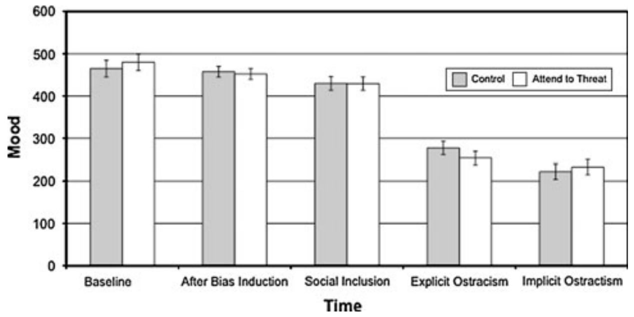

Fig. 1 Visual analogue mood scale ratings as a function of group allocation. *Error bars* represent standard error of the mean

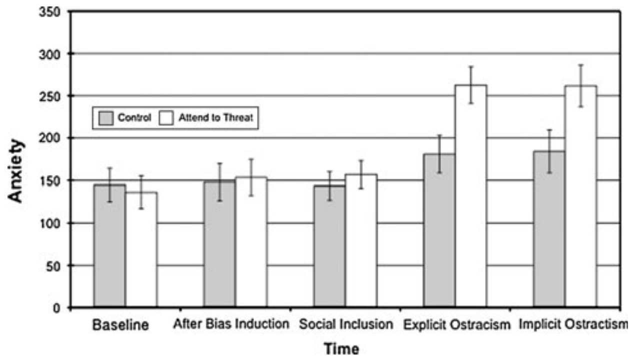

Fig. 2 Visual analogue anxiety scale ratings as a function of group allocation. *Error bars* represent standard error of the mean

explicit and implicit ostracism than those from the Control Condition.

Discussion

The main aim of this study was to explore whether an attentional bias for external threat cues plays a causal role in social anxiety. As predicted, the anxiety induced by social exclusion was significantly more intense for participants trained to attend to threat cues relative to those in the control condition. Specifically, during the cyberball game, participants from the former condition reported more anxiety during the explicit as well as during implicit social exclusion conditions. These findings converge with previous studies suggesting that attention bias modification procedures can affect anxiety vulnerability (e.g., Amir et al. 2008; MacLeod et al. 2002). Moreover, this study goes further in being the first to directly assess the causal role of attentional bias to external threat cues in the development of anxiety to social stressors. The present results clearly suggest that attentional biases affect anxiety proneness even when social exclusion is implicit and unintentional, hence supporting the notion that selective attention to threatening social stimuli plays a causal role in anxiety vulnerability to implicit and explicit social stressors (Clark 1999; Clark and Wells 1995; Rapee and Heimberg 1997). At a more general level, these observations are consistent with the clinical cognitive model tenet that attentional bias to threat plays a causal role in the development of emotional vulnerability (e.g., Beck 1995; Foa et al. 1993).

Nevertheless, as such, these observations alone cannot fully support the conclusion that the change in vulnerability to social exclusion can confidently be attributed to the selective attentional processing resulting from the bias induction. As argued by MacLeod et al. (2009, p. 94), the successful induction of the target cognitive change must be confirmed by demonstrating predicted performance changes on a cognitive task reliably measuring the cognitive process of interest. In the present case, this condition is satisfied. Indeed, as compared to control participants, those trained to attend to threat exhibited a greater reduction in latency for identifying probes during invalid threat trials. As mentioned above, previous work (e.g., Amir et al. 2003) showed that reaction times for invalid social threat is related to the capacity to disengage attention from socially threatening stimuli. We may therefore, conclude that the experimental manipulation induced a difficulty in disengaging from threat and resulted in increased vulnerability to social rejection.

Regarding the Cyberball, the main effect of Time for both mood and anxiety during the explicit as well as implicit social exclusion is congruent with previous accounts. Former studies have provided ample evidence that cyberball-based ostracism increases self-reported distress among healthy participants (e.g., Leary et al. 1995; Sommer et al. 2001; Williams et al. 2000; Zadro et al. 2004). We may therefore, conclude that our experimental induction of social exclusion produced the desired effects.

At a fundamental level, the present findings highlight two major points. First, regarding the nature of the attentional biases sustaining emotional vulnerability, the observed changes in the spatial cueing task bolster the argument that the difficulty in disengaging attention from threat is causally involved in the development of social anxiety (e.g., Amir et al. 2003; Heeren et al. 2011). Fox et al. (2001) propose that the ability to disengage from threat cues may serve as a protective factor from anxiety reactivity, whereas an inability to effectively disengage from threat may serve to maintain or increase anxiety. They postulate that the tendency to dwell on threat cues may contribute to maladaptive rumination. According to Buckner et al. (2010), in the case of social anxiety, it may be that the difficulty in disengaging attention from social threat increases the tendency of socially anxious individuals to engage in maladaptive rumination, which may in turn activate memories of prior experiences of negative evaluation. Furthermore, it may also be that the difficulty in disengaging attention from threat results in constant anxiety by creating a vicious cycle in which anxiety is increased as the individual dwells on the social threat. Consistent with these notions, the present data reveal that training individuals to attend to threat reduces their ability to disengage their attention from it and clearly leads to a significant increase in anxiety during a social rejection task. Future research is needed to evaluate the possibility that this type of bias induction increases anxiety because it generates the vicious cycle (e.g., negatively skewed judgements of social events) mentioned above.

Second, regarding the nature of the emotional stressor, our findings suggest that attentional bias for threat contributes to the increase of anxiety during both explicit and implicit social rejection. This suggests that emotional change during social rejection, even if unintentional (i.e., the implicit social ostracism condition), comes from a modified perception of threat early in the appraisal process. According to Gross' model (2002), if attention acts as an initial filter on the processing of environmental cues, then modulating selective attention to threat would be expected to allow for modified processing of other types of social information and modified the perception of threat early in the appraisal process. Further, as supported by White et al. (2011), preferentially allocating attention towards threat cues may cause a negative interpretative bias because subsequent processing resources may favour threat-related interpretation. As demonstrated by these authors, when individuals are faced with ambiguous stimuli, an anxiety-related interpretation may be readily accessed when attention has been consistently directed to threat cues. Consistent with this rationale, participants who were trained to attend to threat cues reported more anxiety not only during the explicit but also during the implicit ostracism condition. Future studies should further examine these potential mediating mechanisms.

At a clinical level, the present data are consistent with recent developments in cognitive bias modification (e.g., Hakamata et al. 2010) demonstrating that the attention bias for threatening stimuli can be manipulated and that these modifications are related to emotional changes. Further, the present data suggest that attentional biases play a causal role not only in the maintenance of the disorder but also in the development of anxiety during social exclusion. Therefore, the current results clearly suggest that using attention training as a prophylactic intervention before the development of social phobia might be useful. Future studies should further investigate this question.

The present study has limitations. First, the sample size is small, which provides limited power to conduct statistical analysis. Second, we used a single-item measure to assess self-reported change in anxiety. Future studies should use reliable measures of self-reported state anxiety (e.g., STAI-state). Third, we used only self-reported measure of mood and anxiety. Future research should incorporate other measures, such as skin conductance reactivity, heart rate and cortisol release. Fourth, we used a spatial cueing task as a measure of attention bias. Mogg et al. (2008) have argued that the spatial cueing task may not provide unambiguous evidence for delayed disengagement, as there may be a confound between delayed disengagement and a generic slow-down effect caused by the presence of threat. Although this limits the conclusions that can be drawn from this task, Cisler and Olatunji (2010) recently found that disengagement difficulty in the spatial cueing task remained in anxious individuals when statistically controlling for generic response slowing, suggesting that this task confound does not explain difficulties in disengagement. Fifth, it should be noted that, to our knowledge, there was no study examining whether Cyberball increase anxiety among socially anxious individuals. Therefore, although the perception of social rejection precisely targets the core construct of social anxiety, to ensure that the present finding generalize to individuals with elevated social anxiety, future experiment should ensure that these latter exhibit increased anxiety during both explicit and implicit ostracism conditions. Finally, given recent evidence that anxious individuals, regardless of their type of anxiety, appear to demonstrate attentional biases towards threat (e.g., Bar-Haim et al. 2007), future experiments should examine whether the result underlying the current study generalizes to vulnerability for other anxiety disorders.

In conclusion, the current findings provide support for the proposal that attentional bias to external threat cues plays a role in the development of social anxiety. The adverse consequences of inducing an attentional bias to threat cues in terms of increased anxiety during social rejection, even if implicit, were evident in individuals who are within the normal range for social anxiety.

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