The Effect of a Single-Session Attention Modification Program on Response to a Public-Speaking Challenge in Socially Anxious Individuals

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Research suggests that individuals with social anxiety show an attention bias for threat-relevant information However, few studies have directly manipulated attention to examine its effect on anxiety. In the current article, the authors tested the hypothesis that an attention modification program would be effective in reducing anxiety response and improving performance on a public-speaking challenge. Socially anxious participants completed a probe detection task by identifying letters (*E* or *F*) replacing one member of a pair of faces (neutral or disgust). The authors trained attention by including a contingency between the location of the neutral face and the probe in one group (Attention Modification Program; AMP). Participants in the AMP group showed significantly less attention bias to threat after training and lower levels of anxiety in response to a public-speaking challenge than did the participants in the Attention Control Condition (ACC) group. Moreover, blind raters judged the speeches of those in the AMP group as better than those in the ACC group. These results are consistent with the hypothesis that attention plays a causal role in the maintenance of social anxiety.

Keywords: social anxiety, attention bias training, change in bias

Research suggests that socially anxious individuals pay particular attention to threat-relevant information (e.g., Hope, Rapee, Heimberg, & Dombeck, 1990; Mathews & MacLeod, 2002, 2005). According to cognitive theories of anxiety, selective attention to negative social cues heightens anxiety and biases judgments of social events, thereby leading to ineffective social behavior. This, in turn, may prevent disconfirmation of fear-related beliefs and maintain social anxiety (e.g., Clark, 2001; Clark & Wells, 1995; Rapee & Heimberg, 1997).

Researchers have used probe detection tasks with faces to examine attention bias to threat in social anxiety. In one version of the dot probe task, participants see two faces, one above the other, on a computer screen. One face is neutral, and the other face is threatening (e.g., anger or disgust). On critical trials, either the upper or the lower face is replaced with a probe (e.g., the letter *E*), and participants are asked to press a button to identify the probe. Faster response latencies in detecting probes replacing threatening faces, compared with response latencies in detecting probes replacing neutral faces, reflect an attention bias toward threatening information.

Several studies have found evidence of an attention bias for threat (i.e., anger or disgust faces) using probe detection tasks in socially anxious individuals and patients diagnosed with social phobia (Mogg & Bradley, 2002; Mogg, Philippot, & Bradley, 2004; Pishyar, Harris, & Menzies, 2004). For example, in two studies Pishyar et al. (2004) found that socially anxious participants demonstrated an attentional bias toward disgust faces but not toward social threat words, relative to nonanxious controls. However, other studies have failed to find evidence for attention bias for threat in social anxiety (Chen, Ehlers, Clark, & Mansell, 2002; Gotlib et al., 2004; Mansell, Clark, Ehlers, & Chen, 1999). Bögels and Mansell (2004) suggested that studies that have paired one face with another face (as opposed to pairing a face with an object such as a chair) and presented faces for 500 ms or less find evidence for attention bias for threat, whereas studies using different parameters do not. However, using these same parameters, at least two studies did not find a significant attention bias for threat in socially anxious individuals (Bradley et al., 1997; Pineles & Mineka, 2005).

One explanation for these inconsistencies is that even when an effect exists (i.e., is nonzero in the population), one would not expect every study of that effect to achieve significant results unless the effect size is very large—an extremely unlikely situation in psychological inquiry. In such cases, it is possible to demonstrate that the average effect size across these studies is significantly different from zero. Five articles have reported six studies examining attention bias to threat in social anxiety using the parameters described above by Bögels and Mansell (2004). We calculated effect sizes based on reported statistics for the interaction of group (socially anxious vs. nonanxious control) by face

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type (threat vs. neutral), or group comparison for attention bias for threat faces. These studies suggest that the average effect size is large and significantly different from zero (Cohen's $d = 1.14$, $z(5) = 3.72$, $p < .01$). Accordingly, we used the parameters suggested by Bögels and Mansell in the current study.

In summary, there is evidence for a relationship between attention bias to threat and social anxiety. However, because these studies have used a correlational design, it is not possible to determine the causal nature of this relationship. Conclusions regarding the causal role of attention bias in the maintenance of anxiety can be made only from research designs in which participants are randomly assigned to conditions and their attention is experimentally manipulated. We now turn to this source of evidence.

To our knowledge, two published studies have examined the effect of attention training on anxiety using the probe detection task. Harris and Menzies (1998) attempted to induce attention bias either toward or away from spider-relevant words in a nonclinical sample. Participants were randomly assigned to one of two attention training conditions. In each condition they saw word pairs comprising a spider-relevant word and a neutral word. In the attention-toward-threat condition, the probe always replaced the spider-relevant words. In the attention-away-from-threat condition, the probe always replaced the neutral words. As expected, after the training tasks the former group was faster in identifying probes replacing novel spider-relevant words, whereas the latter group was faster in identifying probes replacing neutral words. However, training did not generalize to an independent measure of attention bias (i.e., emotional Stroop), nor did it affect self-report of anxiety.

MacLeod, Rutherford, Campbell, Ebsworthy, and Holker (2002) manipulated attention bias toward general anxiety words. They screened a large pool of participants and selected those individuals who were in the middle third of the distribution of a self-report measure of trait anxiety. In the Attend Threat condition, probes appeared in the position of the threat word on 93% of the trials. In the Attend Neutral condition, probes appeared in the position of the neutral word on 93% of the trials. After the training, the authors induced stress by presenting their participants with a series of unsolvable anagrams and telling them that their videotaped performance would be shown in other classes should they perform particularly well or poorly. MacLeod et al. (2002) found that, after training, participants in the Attend Threat condition showed faster response latencies for detecting probes following threat words than they did for neutral words. Participants in the Attend Neutral condition showed the opposite pattern of results. Moreover, participants in the Attend Threat condition responded more negatively (higher levels of depression and anxiety) to the experimental stressor than did those in the Attend Neutral condition.

Although these results are consistent with the hypothesis that an attention bias toward threat cues confers a vulnerability to heightened negative affectivity in response to stress, an alternative explanation is that obtained differences in anxiety reflect immediate and direct effects of the training task on participants' mood rather than differential vulnerability to stress between groups. To test this alternative explanation, MacLeod et al. (2002) had participants report their levels of anxiety and depression at seven points during the training tasks as well as immediately prior to the experimental stressor. The groups did not differ in their levels of anxiety or depression during the training procedure or prior to the stressor. Thus, the difference between the two groups appears to reflect the creation of differing affective vulnerabilities to stress that endures, at least over a short time, after training. Similar results were obtained in two unpublished studies by this group of researchers (cited in Mathews & MacLeod, 2002) who found that highly trait-anxious students trained to repeatedly direct their attention away from threatening cues over 10 sessions reported a significant reduction in trait anxiety scores from pre- to posttraining. Considered together, these studies provide the strongest support to date for the hypothesis that individual differences in the allocation of attention to threat-relevant and negative information are causally important in mediating vulnerability to negative affectivity. At the practical level, these findings suggest that it may be possible to use such attention training procedures clinically.

More recently, other researchers have used different computerized training procedures to modify attention to threat cues. In a series of studies with undergraduate students, Dandeneau and colleagues demonstrated that repeatedly training participants to locate a single smiling (accepting) face in a grid of frowning (rejecting) faces significantly reduced participants' attention bias toward rejection words on an emotional Stroop task relative to participants who completed a control training task (Dandeneau & Baldwin, 2004; Dandeneau, Baldwin, Baccus, Sakellaropoulo, & Pruessner, 2007). In a subsequent study, Dandeneau, Baldwin, Baccus, Sakellaropoulo, & Pruessner (2007, Study 3a) found that students completing the attention training procedure 5 consecutive days prior to a final exam reported feeling less stressed and more confident about their exam and less anxious immediately after the exam compared with participants in the control condition. Similarly, a second study (Study 3b) demonstrated that attention training completed daily for 1 week by a group of telemarketers (who routinely experience rejection as part of their work) led to higher self-esteem, lower cortisol levels, lower self-reported stress, higher confidence, and improved work performance relative to control participants.

Although the above research is consistent with the hypothesis that change in attention bias can lead to change in anxiety, several issues need further examination. First, because the two conditions in the MacLeod et al. (2002) study actively trained attention (i.e., either toward threat or away from threat), it is not possible to determine whether attention bias to threat can be reduced via probe detection tasks and whether this change decreases anxiety vulnerability. These uncertainties exist because previously observed effects of the dot probe training task might reflect only the capacity to increase attention bias to threat and subsequent anxiety in the "attend threat" condition. Thus, in the current study, we attempted to create a baseline condition in which there was no contingency between the location of the probe and the location of the threat or neutral information.

Second, previous research using the probe detection task to modify attention has relied on catch trials of novel stimuli imbedded within the training task to assess change in attention over the course of training (MacLeod et al., 2002). However, demonstrating a change in bias on the same task used to manipulate attention may be limited in providing support for the hypothesis that the training procedure changed attention processes in general. A more parsimonious explanation for changes in participants' responses to the probe detection task would be that they mastered the task. To

address this issue, it would be necessary to administer an independent measure of attention bias before and after the training. To the extent that this assessment task differed from the training task, we could be assured that the training was effective in changing attention processes. Accordingly, we chose to use a modified version of the Posner paradigm (Posner, 1980) as an independent measure of attention.

Third, it remains to be established whether attention training procedures are capable of modifying attention biases and emotional reactivity in individuals with high levels of social anxiety. Accordingly, we examined the effect of attention training in a sample of individuals with high levels of social anxiety. Finally, MacLeod et al. (2002) evaluated the impact of attention modification on self-reported emotional reactivity. Exclusive reliance on self-report measures prevents ruling out the competing hypothesis that the attention modification procedures influenced the response tendencies or decision rules that participants employed when making judgments about their emotional reactions to the stressor (MacLeod, 1993). To address this issue, we included an independent assessment of participants' behavioral responses during a social stressor (i.e., speech task).

To investigate whether attention bias to threat is causally involved in the maintenance of social anxiety, we examined the effect of a single attention training session similar to that described by MacLeod et al. (2002) in reducing anxiety response to a social stressor in individuals with social anxiety. Consistent with earlier work (MacLeod et al., 2002), we predicted that, compared with the Attention Control Condition (ACC), the Attention Modification Program (AMP) would decrease attention bias toward threat, lower anxiety, and improve social performance during a stressor.

Method

Participants

Participants comprised 94 (AMP = 47; ACC = 47) individuals recruited from an undergraduate pool with an advertisement for "individuals with difficulty giving speeches." Participants were further screened on the basis of their Liebowitz Social Anxiety Scale (LSAS) score (Liebowitz, 1987) and invited to participate if they scored greater than 26 on this measure. This procedure resulted in a mean LSAS score of 47.1 (SD = 19.4) for our participants, placing their mean LSAS score more than three standard deviations above the mean for individuals with no Axis-I diagnosis (M = 10.2, SD = 9.3; Fresco et al., 2001; Rinck & Becker, 2005).

Design

The design of the study was a 2 (Group: AMP, ACC) × 3 (Time: pretraining, posttraining, poststressor) with repeated measurement on the second factor.

Materials and Tasks

Self-report measures. All participants completed the following questionnaires: Spielberger State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), LSAS (Self-report version; LSAS-SR; Liebowitz, 1987), and Beck Depression Inventory–II (BDI-II; Beck, Steer, & Brown, 1996).

Behavioral assessment. All participants completed an impromptu speech (see the *Procedure* section for details of this task). We asked judges, blind to condition, to rate each participant's speech. We were interested in the quality of the speech, hypothesizing that if the AMP was effective in reducing anxiety, then the speeches by participants in the AMP group would be rated as better than those in the ACC group. We assessed participants' performance on the speech using a measure of public-speaking performance previously used by Rapee and Lim (1992). This measure comprises 12 specific aspects of performance (e.g., kept eye contact with audience, had a clear voice) and 5 global aspects of performance (e.g., kept audience interested, generally spoke well). Each item is rated on a 5-point scale from 0 (*not at all*) to 4 (*very much*), and items are either positively or negatively worded to reduce response bias. Scores are calculated by reversing appropriate items and summing the items, such that higher scores signify better performance. This scale has been shown to have good internal consistency (r = .84; Rapee & Lim, 1992). The judges in the current study were trained for reliability by viewing speeches from participants not included in the current study and discussing their ratings. Once consensus was reached on the training videos, two judges independently rated each video from the current study using the rating system described above. Interrater reliability was high (r = .81). We therefore averaged judges' ratings to provide a single index of speech performance.

Attention bias modification stimuli. The faces used in the Attention Bias Modification Task (modified dot probe task) were selected from a standardized set of emotional expressions used in previous research on emotion (Matsumoto & Ekman, 1989). The set includes faces of eight individuals (four male, four female) displaying disgust and neutral expressions. We chose disgust faces for two reasons. First, previous research on facial expressions and social anxiety has used disgust because this expression generally implies an aversion or rejection (e.g., Pishyar et al., 2004; Rozin, Lowery, & Ebert, 1994). Because rejection is a central concern to individuals with social anxiety (American Psychiatric Association, 1994), disgust may be more related to the concerns of individuals with social anxiety than with other negative emotions (Yoon & Zinbarg, 2007). Second, pilot work in our lab asking socially anxious individuals, generally anxious individuals, and nonanxious controls to rate the valence of two negative emotions (anger and disgust) suggests that, compared with both nonanxious controls and generally anxious individuals, socially anxious individuals rated disgust expressions as more negative than angry expressions.

Attention bias assessment stimuli. The stimuli used for the Attention Bias Assessment Task (modified Posner task) were eight social threat words (e.g., *embarrassed, stupid, humiliated*) and eight neutral words (e.g., *dishwasher, tile, hanger*). These words have been used in previous attention bias research in social anxiety (Amir, Elias, Klumpp, & Przeworski, 2003; Asmundson & Stein, 1994). We used words, rather than pictures, in the assessment trials to reduce further any materials effect responsible for the effect of training.

Probe detection task: Attention Bias Modification Task. The probe detection task used to train attention was a variation of the dot probe paradigm developed by MacLeod, Mathews, and Tata (1986). Each probe detection trial began with a fixation cross (+) presented in the center of the monitor for 500 ms. Immediately

following termination of the fixation cue, the computer presented two faces of the same individual against a gray background, one face on top and one on bottom, separated by 1.5 cm between the bottom of the top image and the top of the bottom image. The faces were positioned 3 cm from the top of the screen; both faces were centered horizontally and 17.5 cm from the left edge of the screen. Each face was 3.75 cm tall by 5 cm wide. The program that presented the stimuli was written in Delphi (Borland, Inc., 2005) for this experiment.

After presentation of the faces for 500 ms, a probe (either the letter *E* or the letter *F*) appeared in the location of one of the two faces. Participants were instructed to decide if the letter was an *E* or an *F* by pressing the corresponding button (left or right) on the computer mouse. The probe remained on the screen until participants responded, after which the next trial began. Participants were informed about the importance of completing the task as quickly as possible without sacrificing accuracy. In previous research using this paradigm, we have found participants' average accuracy to be 95% or greater.

Participants saw a total of 160 trials that comprised various combinations of probe type (*E* or *F*), probe position (top or bottom), face type (neutral or disgust), and person (four male and four female faces).

AMP. In the AMP condition, on trials in which participants saw one neutral face and one disgust face, the probe always replaced the neutral face. Of the 160 trials, 32 included only neutral faces: 2 (probe type) × 2 (probe position) × 8 (person). The remaining 128 trials included one neutral face and one disgust face: 2 (disgust face position) × 2 (probe type) × 8 (person) × 4 (repetition). On trials including a disgust face, it appeared in the top position 50% of the time. With these specifications in place, although there was no specific instruction to direct attention away from disgust faces, on 80% of the trials the position of the disgust face predicted the position of the probe (i.e., in the location opposite the disgust face). On the remaining 20% of the trials, participants saw neutral–neutral face pairs.

ACC. The ACC was identical to the AMP condition except that during the presentation of the trials in which a disgust face was present, the probe appeared with equal frequency in the position of disgust and neutral face. Of the 160 trials, 32 included only neutral faces: 2 (probe type) × 2 (probe position) × 8 (person). The remaining 128 trials included one neutral face and one disgust face: 2 (disgust face position) × 2 (probe type) × 2 (probe position) × 8 (person) × 2 (repetition). On trials in which a disgust face was present, it appeared in the top position 50% of the time. Overall, of the 160 trials, 64 (40%) were neutral–disgust with the probe following the disgust face, 64 (40%) were neutral–disgust with the probe following the neutral face, and the remaining 32 (20%) included two neutral faces as in the AMP. Thus, neither disgust nor neutral faces had signal value with regard to the position of the probe.

Attention bias assessment. To assess the effect of training on participants' attention to threat cues, we asked participants to complete an independent measure of attention bias before and after training. We chose to use a modified version of the Posner paradigm (Posner, 1980) identical to that reported by Amir et al. (2003), using eight social threat and eight neutral word cues. Words were presented in lowercase (3–5 mm in height), white letters against a black background in the center of a CrystalScan

SVGA color monitor connected to a Gateway 2000 P200 Pentium computer. Participants were instructed to begin each trial by focusing on a central fixation cross located between two rectangles. The inboard edge of each rectangle was positioned 1 cm to either side of the fixation point and 10.5 cm from the top of the screen. A cue word positioned centrally in either of the two rectangles (3.75 cm from the middle of the screen) then appeared, thereby directing the participant's attention to one of two screen locations (right or left). Words remained on the screen for 600 ms. After the cue word disappeared, a probe appeared in one of the two rectangles on the screen, and participants were instructed to press one of two mouse buttons indicating the position of the probe (right or left). The probe remained on the screen until the participant responded (or after 3 s if the participant failed to make a response), and response latencies were recorded from the onset of the probe to the button press. The intertrial interval 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 (the probe appeared in the location opposite the cue word). Participants saw 192 trials in random order; two thirds (128) were valid trials (8 words × 2 word types × 2 word position × 4 repetitions), one sixth (32) were invalid trials (8 words × 2 word types × 2 word position), and one sixth (32) were uncued trials (8 words × 2 word types × 2 word position). In previous research using this paradigm (Amir et al., 2003), socially anxious participants demonstrated significantly longer response latencies than did nonanxious controls for cues following invalid social threat words, suggesting that a bias may be due to difficulty disengaging from threatening stimuli. Yiend and Mathews (2001) found similar results in individuals scoring high on a trait anxiety measure.

Procedure

Participants were randomly assigned to either the AMP or the ACC. The participants and the research assistants working with the participants were blind to the participants' condition. The instructions for the probe detection task were presented on the computer and were identical for both conditions.

Participants first completed a demographics questionnaire, STAI (Trait version), BDI-II, LSAS-SR, and the first of three STAI (State version) measures. Next, they were asked to complete the Attention Bias Assessment Task, which provided a baseline index of attention bias. Participants then completed the attention training task (AMP or ACC). After completing the computer task, participants completed the second STAI–State to assess the direct effect of the training task on participants' mood.

Next, participants completed a second Attention Bias Assessment Task to enable us to examine the influence of attention training on an independent measure of attention bias. Finally, participants completed a behavioral assessment of social anxiety (speech). They were told that their speech would be video-recorded so that it could later be rated by a graduate student for its quality. They were then presented with a list of five topics (abortion, corporal punishment, seatbelt laws, nuclear power, and the American health system; Hofmann, Newman, Ehlers, & Roth, 1995) and asked to choose any one of the five topics. They were given 2 min to prepare and a piece of paper to write down their notes; however, they were told that they would not be able to use

these notes during the speech. At the end of the 2-min preparation period, the topic sheet and scratch paper were collected, and the participants were instructed to stand in a designated area in front of a video camera. The experimenter then began recording the participant's speech. The behavioral assessment ended after 5 min or when the participant stated that he or she wanted to stop. After completing the behavioral assessment task, participants completed the third STAI–State. The participants were then debriefed.

Results

Groups did not differ on demographic or self-report measures of social anxiety, general anxiety, or depression at pretraining (ps > .2). Table 1 summarizes these results.

Speech Topic and Length

Groups did not differ in their choice of topic. The most commonly selected topic in both groups was abortion (AMP = 49%, ACC = 51%), followed by seatbelts (AMP = 36%, ACC = 31%) and nuclear power (AMP = 7%, ACC = 2%). The remaining topics accounted for less than 5% of the speeches. Groups did not differ in speech length (M = 2 min, 53 s, SD = 1.40 vs. M = 2 min, 46 s, SD = 1.37, for AMP and ACC, respectively).

Change in Attention Bias

We first eliminated response latencies for inaccurate trials. Inaccurate trials consisted of trials in which the probe was presented on the left side and the participant pressed the button corresponding to the right side, or vice versa. This procedure resulted in the elimination of 1% of the trials. In addition, response latencies less than 50 ms and greater than 1,200 ms were considered outliers and were also eliminated from the analysis. These ranges were determined on the basis of the inspection of the data through box plots and resulted in the elimination of 1% of the trials.

Figure 1 presents participants' performance on the Attention Bias Assessment Task before and after training. We submitted participants' response latencies to a 2 (Group: AMP, ACC) × 2 (Word Type: social threat, neutral) × 2 (Time: pretraining, post-

training) × 2 (Validity: valid, invalid) analysis of variance (ANOVA) with repeated measurement on the last three factors.

This analysis revealed a significant interaction of Group × Time × Word Type × Validity, $F(1, 92) = 5.0$, $p < .03$. To follow-up this four-way interaction, we conducted separate Group × Time × Validity ANOVAs for social threat and neutral words. The three-way interaction was significant for social threat words, $F(1, 92) = 5.6$, $p < .02$, but not for neutral words ($p > .3$). To follow-up this three-way interaction for social threat, we conducted separate Group × Time ANOVAs for valid social threat and invalid social threat words. For valid social threat words, the interaction was not significant ($p > .3$). For invalid social threat words, this analysis revealed a significant interaction of Time × Group, $F(1, 92) = 5.1$, $p < .03$. Follow-up paired t tests revealed that both groups became faster on invalid social threat words from pre- to posttraining, $t(46) = 5.1$, $p < .001$ versus $t(46) = 2.1$, $p < .05$, for AMP and ACC, respectively. Simple effects of group revealed that although groups did not differ in their response latency to invalid social threat words before training, $t(92) = 0.93$, $p = .44$, the AMP group was significantly faster in its response latency to invalid social threat words than the ACC group at posttraining, $t(92) = 1.99$, $p < .05$.

Anxiety Response

Self-report. Means and standard errors for the self-report measure of anxiety (i.e., STAI–State) are depicted in Figure 2.

We submitted participants' anxiety scores to a 2 (Group: AMP, ACC) × 3 (Time: pretraining, posttraining, postspeech) ANOVA with repeated measurement on the second factor. This analysis did not reveal a main effect of group, $F(1, 92) = 2.3$, $p = .13$. However, there was a significant main effect of time, $F(2, 184) = 51.4$, $p < .001$, that was modified by a significant interaction of Group × Time, $F(2, 184) = 3.9$, $p < .02$.

Simple effects of time revealed that both the AMP group, $F(2, 92) = 13.4$, $p < .001$, and the ACC group, $F(2, 92) = 41.9$, $p < .001$, showed differences in anxiety across the three time points. Paired t tests within the AMP group revealed that anxiety at Time 1 did not differ from anxiety at Time 2, $t(46) = 0.20$, $p = .85$. However, Time 3 anxiety was higher than Time 2 anxiety, $t(46) = 4.1$, $p < .001$, and Time 1 anxiety, $t(46) = 4.1$, $p < .001$. In the ACC group, anxiety at Time 1 did not differ from anxiety at Time 2, $t(46) = 0.53$, $p = .60$. However, Time 3 anxiety was higher than Time 2 anxiety, $t(46) = 6.6$, $p < .001$, and Time 1 anxiety, $t(46) = 7.3$, $p < .001$.

Simple effects of group revealed that groups did not differ in anxiety prior to training, $t(92) = 0.86$, $p = .60$, or after training, $t(92) = 0.83$, $p = .65$. However, the AMP group had lower anxiety scores than the ACC group after the speech, $t(92) = 2.2$, $p < .03$.

Independent ratings. Examining judges' rating of the speeches, we found that participants in the AMP group received higher ratings (indicating superior performance; Rapee & Lim, 1992) on their speeches than those in the ACC group (M = 50.8, SD = 5.4 vs. M = 47.8, SD = 5.9, for AMP and ACC, respectively), $t(92) = 2.8$, $p < .007$.

Mediational Analyses

To conduct mediational analyses, we computed an attention bias score by subtracting response latencies for invalid social threat

Table 1
Demographics and Questionnaire Data

Variable	Group	
	AMP	ACC
% female	49	53
Age	19 (1.9)	19 (1.2)
Education, years	14 (1.2)	14 (1.3)
BDI-II	9.3 (7.2)	11.1 (8.1)
LSAS-SR	45.0 (20.2)	48.1 (18.2)
STAI-T	40.6 (10.4)	41.9 (12.2)

Note. Values in parentheses represent standard deviations. AMP = Attention Modification Program; ACC = Attention Control Condition; BDI-II = Beck Depression Inventory–II; LSAS-SR = Liebowitz Social Anxiety Scale–Self-report; STAI-T = Spielberger State-Trait Anxiety Inventory–Trait.
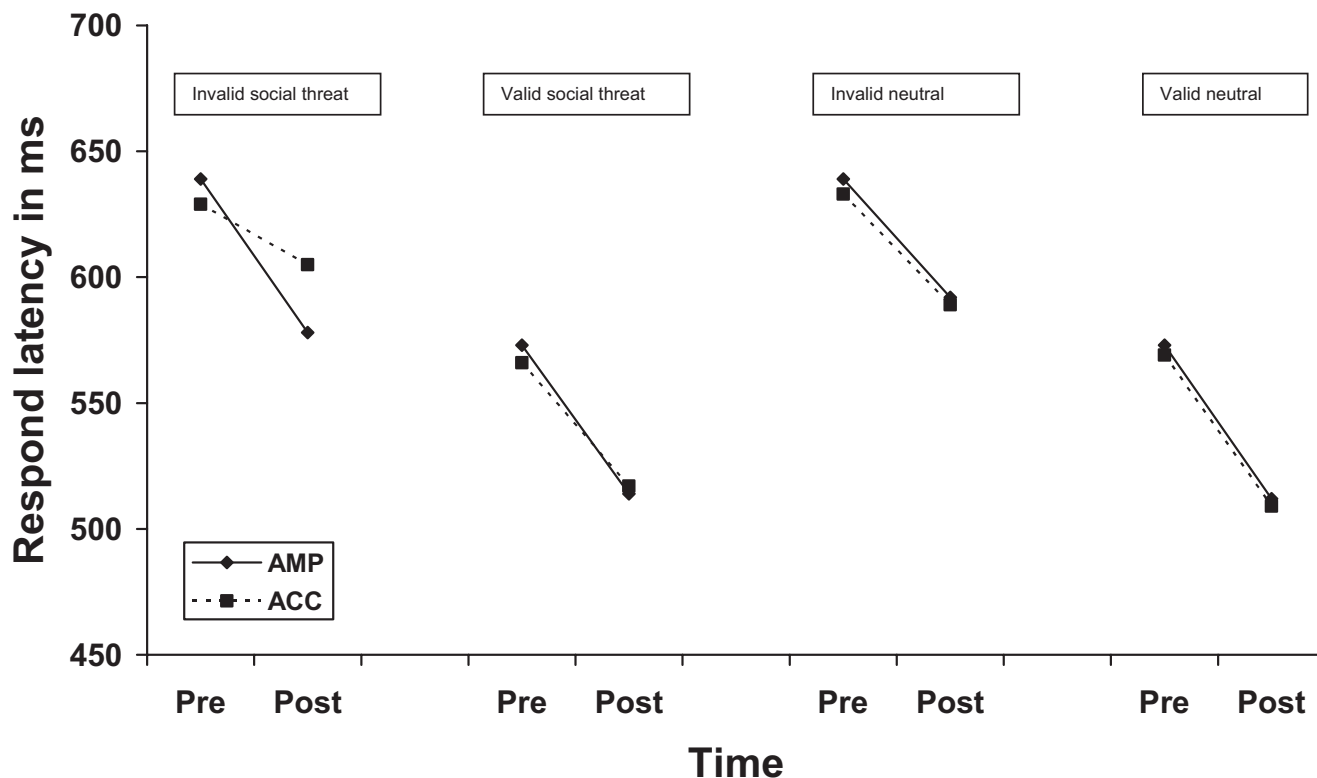
Figure 1. Response latencies on the Attention Bias Assessment Task. AMP = Attention Modification Program; ACC = Attention Control Condition.

trials from invalid neutral trials on the Attention Bias Assessment Task after training. To test the hypothesis that the AMP exerted its influence on anxiety vulnerability and behavioral performance through attention bias to threat, we conducted mediation analysis following the procedure described by MacKinnon and colleagues (MacKinnon, Fairchild, & Fritz, 2007; MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). In brief, this procedure tests the product of the coefficients for the effects of (a) the independent variable (group: AMP, ACC) to the mediator (attention bias after training; alpha), and (b) the mediator to the dependent variable (change in state anxiety scores from pre- to postspeech; speech performance) when the independent variable is taken into account (beta). This procedure is a variation on the Sobel (1982) test that accounts for the nonnormal distribution of the alpha–beta path through the construction of asymmetric confidence intervals (MacKinnon, Fritz, Williams, & Lockwood, 2007). Our results indicated that the 95% confidence intervals of the indirect path (alpha–beta) did not overlap with zero for change in state anxiety (lower limit = .015, upper limit = .203) and observer-rated speech performance (lower limit = .004, upper limit = .166). Finally, to examine whether the impact of attention training procedure on speech performance was directly mediated by attention bias or whether attention bias influenced anxiety reactivity, which, in turn, influenced speech performance, we conducted additional mediation analyses demonstrating that speech performance was mediated by change in anxiety (lower limit = .05, upper limit = .159). These findings are consistent with the hypothesis that attention

training had an indirect effect on reduction in anxiety reactivity through reduction in attention bias, and this change in anxiety then improved speech performance.

Discussion

Attention training was effective in reducing attention bias to threat as well as anxiety response to a social challenge. The training effect on anxiety was evident on a self-report measure in addition to observers' ratings of the speeches. Because groups did not differ in their level of anxiety posttraining, we conclude that the difference between the two groups at postspeech reflects the creation of differing affective vulnerabilities to stress, at least over a short time. This finding converges with previous research suggesting that attention training procedures affect vulnerability to anxiety (MacLeod et al., 2002). The current work expands the extant literature, however, by demonstrating the effectiveness of attention modification procedures in individuals with high levels of social anxiety and by demonstrating the generalization of attention bias change to an independent measure of attention and through the use of an independent assessment of behavioral response to a stressor.

What are the possible mechanisms for the amelioration of anxiety? The most parsimonious explanation supported by the present data is that the AMP task may have successfully allowed the participants to disengage their attention from threat-relevant information. If anxious individuals direct their attention toward threat
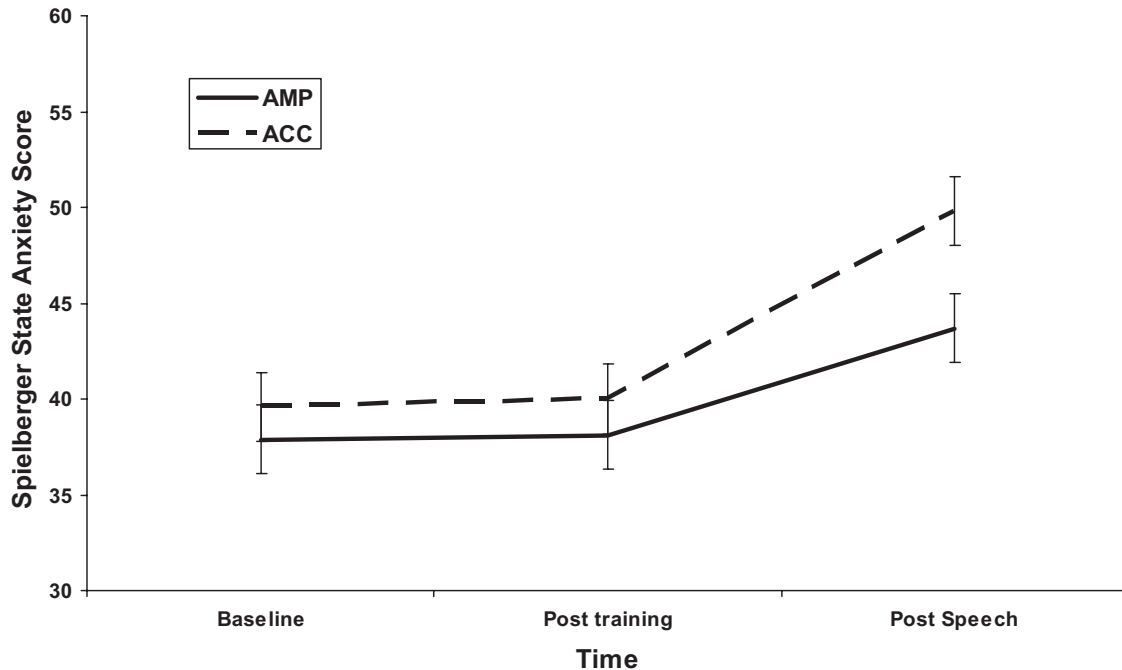
Figure 2. State anxiety scores in the Attention Modification Program (AMP) and Attention Control Condition (ACC) groups. Error bars represent standard error of the mean.

relevant information, and if this attention bias is causally involved in the maintenance of anxiety, then any procedure that normalizes this bias should also reduce anxiety symptoms. Consistent with this hypothesis, participants in the AMP group showed a greater reduction than did controls in their response latency to identify probes during invalid social threat trials of the Attention Bias Assessment Task after training. These findings suggest that the AMP facilitated participants' ability to disengage their attention from social threat cues. Moreover, attention bias toward social threat at posttraining mediated both change in anxiety from before to after the speech task and independent ratings of participant speech performance.

Because the effects of the AMP were observed not only in participants' emotional responsiveness to the speech task but also in their behavioral performance as rated by independent assessors, our findings are consistent with the hypothesis that selective attention to threat heightens anxiety and may lead to ineffective social behavior (e.g., Clark, 2001; Clark & Wells, 1995; Rapee & Heimberg, 1997). The use of an independent assessment of participants' response to the speech suggests that the AMP did not simply modify the response tendencies of participants when making judgments about their emotional reactions to the speech task. Considered together, these findings support cognitive models of social phobia (e.g., Clark, 2001; Clark & Wells, 1995; Rapee & Heimberg, 1997) that hypothesize that selective attention to threatening social information may be causally involved in the maintenance of pathological social fear.

A growing empirical literature suggests that anxiety is associated with deficits in attentional control, which is argued to result from an undue influence of the stimulus-driven (bottom-up) attention system at the expense of the goal-directed (top-down) atten-

tion system in the presence of threat-relevant cues (see Eysenck, Derakshan, Santos, & Calvo, 2007). Moreover, attention bias toward threat is moderated by individual differences in attention control, such that anxious participants with poor attentional control have difficulty disengaging their attention from threat, whereas those with good attentional control are comparatively better in shifting attention away from threat (Derryberry & Reed, 2002). To the extent that attention acts as an initial gate on the processing of social cues, then improving one's ability to control attention in the presence of threatening stimuli may facilitate processing of other types of more benign social information. By repeatedly learning to disengage attention from threat cues during the training, participants in the AMP group may have been better able to turn their attention away from similar negative cues in the context of the laboratory social stressor and thereby process less threatening aspects of the situation (e.g., Mathews & MacLeod, 2002).

Although this single-session attention training procedure was not intended as an intervention for individuals with clinical levels of anxiety, an extended version of this protocol may prove useful as a treatment for social anxiety. A large body of research suggests that various forms of cognitive behavioral therapies are effective in treating a range of anxiety-related conditions, including social phobia (e.g., Clark et al., 2006; Heimberg et al., 1998). A central component of these treatments is repeated exposure to fear-provoking stimuli. This exposure is designed to allow the client to experience a reduction in anxiety (i.e., habituate) and test the hypothesis that feared stimuli may not be as threatening as initially predicted. Contrary to this model of anxiety reduction, our training directed participants' attention away from threatening cues. At first glance this may appear to stand in contrast to the goal of exposure,

namely to facilitate emotional processing of threat-relevant stimuli by attending to it (e.g., Foa, Huppert, & Cahill, 2006).

A review of the extant empirical literature, however, paints a more complex picture. Although some studies have found that attentional focus during exposure facilitates fear reduction (e.g., Grayson, Foa, & Steketee, 1982; Kamphuis & Telch, 2000), others have found that distraction produces greater fear reduction (e.g., Grayson, Foa, & Steketee, 1986; Oliver & Page, 2003, 2008). These results suggest that not all forms of attention avoidance are antitherapeutic and that avoidance may indeed facilitate the effect of exposure under certain conditions (see Craske et al., 2008; Rachman, Radomsky, & Shafran, 2008, for reviews). This issue is of considerable theoretical and clinical importance and requires greater empirical attention in the future.

Our study has limitations. For example, we did not collect follow-up data on our participants. As such, it is not possible to determine whether group differences were long-lasting or simply a transient effect of the attention training procedure. Additionally, participants' level of social anxiety was in the moderate range, and we did not administer a clinical interview to determine diagnostic status. Therefore, we cannot generalize these results to individuals with a diagnosis of social phobia. It is possible that more training trials would be necessary to induce similar changes in attention and anxiety in clinical samples. Moreover, groups' speech lengths did not differ. Therefore, it may be that a more intensive training (e.g., increased number of trials, more training sessions) is required to observe group differences for some indices of anxiety (i.e., speech length). Finally, it will be important for future research to explore the use of alternative attention control conditions in anxious populations.

The above limitations notwithstanding, this study demonstrates the first attempt to manipulate attention bias in a socially anxious sample. Our results provide support for the causal role of attention bias in the maintenance of social anxiety. Moreover, the present study suggests that attention training procedures have the potential to be used as interventions for reducing clinical levels of anxiety (e.g., Amir, Beard, Cobb, & Bomyea, in press). We are currently testing a multisession version of the present procedure as an intervention for social anxiety.

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