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Attention bias modification for reducing speech anxiety

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ABSTRACT

The mechanisms mediating the anxiolytic effects of attention bias modification (ABM) remain unclear. Accordingly, we randomly assigned speech-anxious subjects to receive four sessions of one of three training conditions: ABM, inverse ABM, and control. In the ABM condition, subjects viewed pairs of photographs of models displaying facial expressions of disgust and joy on a computer screen. Probes always replaced the positive face, and subjects pushed a button to indicate the identity of the probe (E or F) as rapidly as possible. In the inverse condition, the probes always replaced the negative face, and in the control condition, the probes replaced each face type equally often. After four training sessions, all groups exhibited statistically indistinguishable, but significant, reductions on self-report, behavioral, and physiological measures of speech anxiety. Self-report and behavioral measures of attentional control improved likewise. Contrary to early studies, ABM was not superior to control procedures in producing reductions on measures of social anxiety.

Socially anxious people often selectively attend to potentially threatening interpersonal cues (Rapee & Heimberg, 1997). Consider a socially anxious man who drums up the courage to attend a party. Hypervigilant for signs of rejection, he notices guests whose demeanor towards him seemingly signifies contemptuous derision, boredom, or both. Having difficulty disengaging attention from these cues, he ruminates about impending social rejection, and his worsening anxiety culminates in his flight from the party.

Such an attentional bias for threat may incite a negative, self-referential, downward spiral that worsens a person's anxiety proneness. Accordingly, it may figure in the maintenance and perhaps the etiology of anxiety disorders, as emotional Stroop and dot-probe paradigms illustrate (Bar-Heim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). In one version of the original dot-probe paradigm (MacLeod, Mathews, & Tata, 1986), subjects view pairs of photographs of a person displaying a neutral and a threatening facial expression on a computer screen. One picture appears above center screen, whereas the other appears below it. The stimulus pair remains on the screen for 500 ms, and immediately thereafter, a probe appears where one of the faces had been. In this probe discrimination version, the subject presses a button to indicate the identity of the probe (e.g., E or F). An attentional bias for threat occurs when subjects are faster to identify probes that replace the threatening face than probes that replace the nonthreatening face.

If an attentional bias for threat is a causal risk factor for anxiety proneness, then modifying the dot-probe paradigm so that probes consistently follow nonthreatening stimuli should attenuate this bias and reduce anxiety proneness (MacLeod, 1995). Consistent with this hypothesis, a study on undergraduate students showed that training subjects to attend to threatening stimuli increased anxiety proneness, whereas training them to attend to nonthreatening stimuli reduced it (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002).

Extending this work further, clinical researchers have found that such attention bias modification (ABM) programs reduced anxiety symptoms in subjects with social anxiety disorder (Amir et al., 2009; Heeren, Reese, McNally, & Philippot, 2012; Schmidt, Richey, Buckner, & Timpano, 2009). Indeed, Amir et al. (2009) found that 50% of subjects lost the diagnosis after eight sessions of ABM spread over four weeks of training.

Promising results notwithstanding, questions remain about the mechanisms mediating the effects of these programs. For example, repeated exposure to threatening, but nondangerous, stimuli is the core of established behavioral treatments for anxiety disorders, whereas avoidance of these stimuli should impede anxiety reduction (Foa & Kozak, 1986). Accordingly, ABM programs seemingly violate the time-honored exposure principle embodied in our best behavioral therapies. In fact, one study revealed that training subjects to attend to faces expressing disgust was just as effective as training them to attend to emotionally neutral faces (i.e., standard

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ABM); both methods reduced public speaking anxiety (Klumpp & Amir, 2010). These puzzling results raise further questions about the mechanism mediating ABM. Does any kind of training requiring contingency learning bolster executive control over attention, thereby enabling subjects to improve control over their anxiety?

In the experiment reported here, we randomly assigned subjects with public speaking anxiety to one of three groups. All groups viewed pairs of faces, one positive and one negative. The positive face displayed joy, whereas the negative face displayed disgust. In the *ABM* group, probes (E or F) always appeared in the location vacated by the positive face. In the *inverse ABM* group, probes always appeared in the location vacated by the negative face. In the *control* group, probes followed positive and negative faces equally often.

We administered four training sessions sandwiched between pretraining and posttraining assessment sessions that included a speech task yielding self-report, behavioral, and physiological measures of anxiety. At both assessments, subjects completed self-report measures of anxiety, depression, and stress, plus self-report and behavioral measures of attentional control.

Greater reduction on measures of anxiety in the ABM group versus the other groups would be consistent with the hypothesis motivating the development of ABM, namely, that it reduces anxiety proneness via reducing an attentional bias for threat. If the inverse group exhibits greater improvement than the other groups, then this would suggest that training subjects to attend to threat, rather than avoid it, is most beneficial. If both the ABM and inverse groups exhibit more improvement than the control group does, this would suggest that any contingency learning fosters executive control over attention, producing adventitious benefits on anxiety reduction. If all three groups exhibit indistinguishable improvement in anxiety symptoms, then this would suggest an anxiolytic feature common to all three training regimes. Perhaps any attentional task, even one without a contingency between cue type and target, may bolster subjects' ability to control their attention in contexts likely to provoke anxiety. Alternatively, some kind of placebo or positive expectancy effect might be at work.

Method

Design

We used a 3 (Group; ABM, inverse, control) × 2 (Assessment; pretraining, posttraining) mixed design. Using an algorithm designed by the second author, we randomly assigned subjects to the ABM, inverse, and control groups. Research assistants (RAs) testing subjects knew what protocol to run (A, B, or C), but only the second author was aware of what protocol corresponded to ABM, inverse, and control training procedures. Hence, the experiment was double blind. Harvard University's Committee on the Use of Human Subjects approved the consent form and the study protocol.

Subjects visited our laboratory six times within four weeks, schedules permitting. The first and sixth visits were for the pretraining and posttraining assessments, respectively. The second, third, fourth, and fifth visits were for training. The assessment visits lasted approximately 60 min, whereas the training visits lasted no longer than 30 min with training per se usually taking between 13 and 15 min. Subjects received $20 per assessment visit and $10 per training visit as honoraria for participating in the study.

Subjects

We recruited speech-anxious subjects through the Harvard University Study Pool, via notices posted in public places in the Boston area, through online postings in the Jobs and Volunteers sections of Craigslist.com, and through online postings in the Quickie Jobs section of Boston University's Student Employment Office website. An RA telephoned potential subjects who had expressed an interest in the study, and conducted a phone screen involving the brief version of Paul's (1966) Personal Report of Confidence as a Speaker (PRCS), validated by Hook, Smith, and Valentiner (2008). This version of the PRCS comprises 12 true/false questions concerning fear of public speaking. The RA invited individuals who scored at least an eight to enroll in the study.

The ABM group consisted of 20 subjects (14 male) whose mean age was 38.2 years (SD = 14.3). Their ethnicities were Caucasian ($n = 12$), African-American/Black ($n = 4$), and other ($n = 4$). The pretraining scores on the self-report version of the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987) indicated that 19 subjects (95%) met or surpassed the optimal cutoff score (30) for identifying patients with social anxiety disorder, whereas the pretraining LSAS scores of 13 subjects (65%) met or surpassed the optimal cutoff score (60) for identifying patients with the generalized subtype of social anxiety disorder (Rytwinski et al., 2009).

The inverse group consisted of 19 subjects (10 male) whose mean age was 34.7 years (SD = 12.8). Their ethnicities were Caucasian ($n = 10$), African-American/Black ($n = 7$), and other ($n = 2$). The pretraining LSAS self-report scores of 19 subjects (100%) met or surpassed the optimal cutoff score for identifying patients with social anxiety disorder, whereas the pretraining LSAS scores of 12 subjects (63%) met or surpassed the optimal cutoff score for identifying patients with the generalized subtype of social anxiety disorder.

The control group consisted of 18 subjects (10 male) whose mean age was 40.0 years (SD = 12.6). Their ethnicities were Caucasian ($n = 11$), African-American/Black ($n = 4$), and other ($n = 3$). The pretraining LSAS self-report scores of 18 subjects (100%) met or surpassed the optimal cutoff score for identifying patients with social anxiety disorder, whereas the pretraining LSAS scores of 13 subjects (72%) met or surpassed the optimal cutoff score for identifying patients with the generalized subtype of social anxiety disorder.

Procedure

Pre and posttraining assessment sessions

The first and sixth visits to the laboratory constituted pretraining and posttraining assessment sessions, respectively. The protocol for both sessions was as follows.

Questionnaires

Upon arrival for the pretraining assessment session, subjects read and signed the consent form. They then completed questionnaires on a desktop computer. Subjects completed the short form of the PRCS again; all scored at least eight, confirming their level of speech anxiety as assessed during the phone screen. Subjects completed the LSAS, the 21-item version (Henry & Crawford, 2005) of the Depression Anxiety Stress Scale (DASS; Lovibond & Lovibond, 1995), and the Attention Control Scale (ACS; Derryberry & Reed, 2002).

Attention network task

Sitting 65 cm from the screen of a desktop computer, subjects next completed the Attention Network Task (ANT; Fan, McCandliss, Sommer, Raz, & Posner, 2002). The ANT yields three reaction time-based measures, each tapping a different aspect of attention: *alerting*, *orienting*, and *executive control*. The first denotes achieving and sustaining a state of alert readiness. The second denotes the selection of information from sensory input. The third denotes overriding attentional conflict, and is the one most relevant to our study.

Prior to the experimental trials, subjects received 24 practice trials and 2 buffer trials. There were 288 experimental trials, and the subject's task was to indicate whether the central target arrow is pointing left or right.

There were several trial types formed by combinations of these variables: warning cue (no cue, center cue, double cue, or spatial cue), target-arrow location (above or below center screen), target-arrow direction (left or right), and flanker type (neutral lines, congruent arrows, incongruent arrows). There were six repetitions of each trial type. Trials appeared in a random order.

Each trial included five events. First, a fixation cross appeared at the center of the computer screen and remained there throughout the entire trial except on trials when a center cue replaced it.

Second, after an interval varying between 400 and 1600 ms, one of the following events occurred for 100 ms. On some trials (no cue trials), no warning cue appeared (i.e., subjects saw only the fixation cross). On other trials (center cue trials), a single cue appeared (i.e., an asterisk at the center screen replaced the cross); the central fixation cross then once again appeared for 400 ms.

On other trials (double cue trials), a double cue appeared (i.e., one asterisk appeared 3 cm above the cross and one asterisk appeared 3 cm below it). On other trials (single cue trials), a single spatial cue appeared (i.e., one asterisk appeared either 3 cm above or 3 cm below the fixation cross).

Fourth, a central target arrow and four flankers aligned in a row appeared. Two flankers appeared to the left of the central arrow, and two flankers appeared to the right of the central arrow. On some trials, all four flankers were arrows themselves, whereas on the remaining trials each was a short horizontal line. The entire row, consisting of the central target arrow and the four flankers, was 14 cm long, and appeared in white against a gray background. This row appeared either 3 cm above or below the central fixation point on the computer screen. On *neutral* trials, the central target arrow pointed left or right and two flanker lines appeared to its left, and two flanker lines appeared to its right (e.g., — — ← — —). On *congruent* trials, the central target arrow pointed left or right, and the four flanker arrows pointed in the same direction as the central target arrow (e.g., ← ← ← ← ←). On *incongruent* trials, the central target arrow pointed left or right, and the four flanker arrows pointed in the opposite direction from the central target arrow (e.g., → → ← → →).

Fifth, subjects pressed a key as quickly as possible to indicate whether the central target-arrow was pointing left or right. This display remained on the screen for 1700 ms, or until the subject responded. A fixation cross replaced this display such that the interval between the target onset on one trial and the warning cue onset on the following one was 3500 ms.

Subjects completed 24 practice ANT trials and 2 buffer trials. Subjects then completed 288 experimental trials.

We calculated an *attentional conflict index* by subtracting the mean RT for congruent trials from the mean RT for incongruent trials. Hence, the larger the score, the harder it was for the subject to resolve the attentional conflict (i.e., the worse was the subject's attention control).

Applying a Monte Carlo process involving repeated random selection of trials to constitute session halves (see Enock, Hofmann, & McNally, 2013) we computed split-half reliability estimates for the attentional conflict index. Using data from completer subjects collapsed across conditions, we obtained Spearman-Brown corrected *r*s of .80 at pretraining assessment and .76 at posttraining assessment.

Attentional bias assessment

Next, subjects performed a standard probe discrimination task to provide a measure of attentional bias for threat. Trials began with a 500 ms fixation cross that appeared at the center of the computer screen. Immediately thereafter, two color photographs of the same person appeared for 500 ms, one above and one below center screen. One photograph displayed a happy expression, whereas the other displayed a disgust expression. We used 12 different models (six female faces, six male faces) from the NimStim set (Tottenham et al., 2009), and the happy face was always the open-mouthed, exuberant version from this set. Immediately thereafter, a probe (either an E or an F) appeared in the location vacated by either the face on the top or the face on the bottom. Subjects pressed the left button on the mouse to indicate the occurrence of an E, and the right button to indicate the occurrence of an F. The probes followed the facial expressions equally often. Subjects performed 20 practice trials before performing the 192 trials that constituted the task. The practice trials involved four models (two female, two male) different from those for the attentional bias assessment.

We computed a measure of attentional bias for threat by subtracting the subject's mean RT to respond to probes that replaced faces displaying disgust from the mean RT to respond to probes that replaced faces displaying joy. The higher the value, the greater the attentional bias for threat.

Using a method similar to the one for the attentional conflict index, we obtained split-half reliability estimates for the bias scores of $r = .074$ and $r = .035$ for the pretraining and posttraining assessments, respectively.

Speech task

Finally, we asked subjects to present a four-min speech on one of the following topics: Should Massachusetts reinstate the death penalty? Should affirmative action be abolished? Should the United States armed forces leave Afghanistan? Subjects were allowed to choose any of these topics during both assessment sessions.

After spending two minutes using a pen and paper to prepare their presentation, subjects delivered their speech in front of a Flip camera (UltraHD model, 3rd generation) that produced digital recordings for subsequent analyses. Subjects were told that a member of the study team would monitor the speech through a one-way mirror. Before and after the speech, the experimenter asked subjects to rate their level of anxiety on a 1 to 100 scale. Before and after the speech, the experimenter used an Omron automatic blood pressure monitor (Model HEM-711) to obtain digital readings of subjects' heart rate, systolic blood pressure, and diastolic blood pressure.

To obtain a behavioral assessment of speech anxiety and performance, we used a rating system based on Harb, Eng, Zaider, and Heimberg's (2003) adaptation of the Social Performance Rating Scale (SPRS; Fydrich, Chambless, Perry, Buergener, & Beazley, 1998). The SPRS comprises five behaviorally anchored rating scales, each scored from 1 (*very poor*) to 5 (*very good*), that tap *gaze, vocal quality, discomfort, conversational flow, and duration*. Because we asked subjects to speak for four minutes, we omitted the *duration* scale. Therefore, the total score ranged from 4 to 20.

The first and fourth authors calibrated their ratings of speeches by pilot subjects, and the fourth author trained two teams (Team 1 and Team 2) of two RAs to rate the videotaped speeches of the subjects. Raters were unaware of the subject's group, and they were unaware of whether the speech was from the first or second assessment. For each scale, we averaged the scores from the two raters, and we summed these four values to obtain the total scores subjected to analysis. To obtain interrater reliability coefficients, we calculated Pearson *r*s for each team at each assessment point. The reliabilities were as follows: Team 1 pretraining assessment, $r(18) = .903$, $p < .001$; Team 1, posttraining assessment, $r(19) = .901$, $p < .001$; Team 2 pretraining assessment, $r(20) = .850$, $p < .001$; Team 2, posttraining assessment, $r(23) = .576$, $p = .0026$.

Training

The second, third, fourth, and fifth sessions involved training. Each session involved 384 experimental trials identical in format to the probe discrimination task except that probes always followed happy faces in the ABM condition, always followed disgust faces in the inverse condition, and followed the disgust and happy faces equally often in the control condition. For training, we used 12 models (six male, six female) different from those of the aforementioned practice trials and attentional bias assessments.

Results

Overview

We present data on subjects who completed the protocol. Prior to inspecting the data and breaking the blind on group assignment, we excluded subjects for several reasons. Some subjects dropped out before completing the protocol (ABM = 12; inverse = 10; control = 7). The data of two additional inverse subjects were eliminated because of experimenter error in delivering the incorrect training regimen for one subject, and the other because the Harvard University Study Pool identified him as a "professional" subject (i.e., an individual who feigns inclusion criteria for diverse studies to receive monetary compensation). The data of two additional control subjects were eliminated because they failed to perform the task properly (e.g., falling asleep). Finally, after we had tested the first three subjects, we began to inform subjects that a member of the research team would be observing their speech through a one-way mirror. Accordingly, we excluded the first three subjects (ABM = 1, control = 2) from analyses of the speech data, but retained them for the other analyses.

Questionnaires

We submitted the data to 3 (Group; ABM, inverse, control) × 2 (Assessment; pretraining, posttraining) mixed model analyses of variance (ANOVAs) with repeated measurement on the second factor. The means, standard deviations, and 95% confidence intervals appear in Table 1, and the ANOVA results appear in Table 2.

The results were consistent across measures. All groups exhibited statistically significant reductions in all self-report measures of distress, yet the magnitude of these reductions did not differ significantly among the groups. The only hint of a difference occurred for the LSAS; posthoc tests indicated that social anxiety decreased significantly in the inverse group, $t(18) = 2.62$, $p = .017$, and in the control group, $t(17) = 3.95$, $p = .001$, but not in the ABM group, $t(19) = .67$, $p = .51$. Finally, the groups were statistically indistinguishable in their significant improvements on the self-report measure of attentional control.

Speech task: behavioral, self-report, and physiological measures

For the SPRS Total score, all three groups exhibited decreased behavioral signs of anxiety during the speech, evinced by the effect of assessment, $F(1, 48) = 5.59$, $p = .02$. The effect of group, $F(2, 48) = 0.81$, $p = .452$ was nonsignificant, as was the Group × Assessment interaction, $F(2, 48) = 1.68$, $p = .196$.

Because the self-reported anxiety, heart rate, diastolic, and systolic blood pressure measures were taken both before and after each speech, we submitted these data to 3 (Group) × 2 (Assessment) × 2 (Time; before speech, after speech) mixed model ANOVAs with repeated measurement on the second and third factors. The means, standard deviations, and 95% confidence intervals for all speech measures appear in Table 3.

Table 1
Means, standard deviations, and 95% confidence intervals for questionnaire measures of anxiety, depression, stress, and attentional control.

Measure	Group		
	ABM	Inverse	Control
PRCS-1	9.8 (1.2) [9.2, 10.4]	10.6 (1.2) [10.0, 11.1]	10.4 (1.3) [9.8, 11.0]
PRCS-2	7.7 (2.7) [6.3, 9.1]	8.7 (3.5) [7.1, 9.9]	8.3 (3.1) [6.8, 9.8]
LSAS-1	71.1 (26.1) [58.1, 84.1]	82.1 (34.2) [68.7, 95.5]	75.2 (26.1) [61.4, 88.9]
LSAS-2	68.8 (29.9) [53.7, 84.0]	70.3 (42.6) [54.7, 85.8]	59.4 (26.3) [43.5, 75.4]
DASS-A-1	18.2 (10.1) [13.8, 22.6]	21.6 (12.2) [16.1, 27.1]	19.0 (11.0) [13.9, 24.1]
DASS-A-2	12.6 (8.7) [8.8, 16.4]	18.8 (13.0) [13.0, 24.6]	13.8 (10.6) [8.9, 18.7]
DASS-D-1	16.2 (7.4) [13.0, 19.4]	17.6 (13.2) [11.7, 23.5]	16.6 (11.7) [11.2, 22.0]
DASS-D-2	9.7 (5.8) [7.2, 12.2]	12.6 (14.0) [6.3, 18.9]	12.6 (10.9) [7.6, 17.6]
DASS-S-1	21.0 (8.5) [17.3, 24.7]	22.5 (11.9) [17.1, 27.9]	20.7 (11.4) [15.4, 26.0]
DASS-S-2	15.0 (8.8) [11.1, 18.9]	19.6 (12.8) [13.8, 25.4]	15.2 (12.0) [9.6, 20.8]
DASS-T-1	55.4 (21.4) [46.0, 64.8]	61.7 (34.5) [46.4, 72.2]	56.2 (30.1) [42.3, 70.1]
DASS-T-2	37.3 (19.7) [28.7, 45.9]	51.0 (37.0) [34.3, 67.6]	41.6 (31.7) [27.0, 68.6]
ACS-1	48.2 (6.6) [45.3, 51.1]	42.6 (10.0) [38.1, 47.1]	47.2 (7.9) [43.6, 50.8]
ACS-2	48.4 (6.9) [45.4, 51.4]	45.0 (11.2) [40.0, 50.0]	50.1 (7.5) [46.6, 53.6]

Notes. PRCS = Personal Report of Confidence as a Speaker (short form, range: 0–12); LSAS = Liebowitz Social Anxiety Scale (range: 0–144); DASS = Depression, Anxiety, Stress Scales (short form, A = Anxiety [range: 0–21], D = Depression [range: 0–21], S = Stress [range: 0–21], T = Total score [range: 0–63]); ACS = Attention Control Scale (range: 20–80); 1 = Pretraining, 2 = Posttraining. Standard deviations are in parentheses; confidence intervals are in brackets.

Table 2
Group × assessment analyses of variance for questionnaire measures of anxiety, depression, stress, and attentional control.

Source	*df*	*F*	*p*
PRCS			
(A) Group	2	1.44	.24
(B) Assessment	1	22.37	.001
A × B (interaction)	2	0.02	.984
LSAS			
(A) Group	2	0.42	.657
(B) Assessment	1	18.85	.001
A × B (interaction)	2	3.10	.053
DASS-Total			
(A) Group	2	0.68	.512
(B) Assessment	1	28.83	.001
A × B (interaction)	2	0.66	.522
DASS-Anxiety			
(A) Group	2	1.18	.316
(B) Assessment	1	18.64	.001
A × B (interaction)	2	0.74	.481
DASS-Depression			
(A) Group	2	0.68	.512
(B) Assessment	1	28.83	.001
A × B (interaction)	2	0.66	.522
DASS-Stress			
(A) Group	2	0.58	.561
(B) Assessment	1	18.41	.001
A × B (interaction)	2	0.71	.495
ACS			
(A) Group	2	2.15	.127
(B) Assessment	1	5.82	.02
A × B (interaction)	2	1.28	.286

Notes. The *df* = 54 for the error term for all tests.

The results were generally consistent (see Table 4). All groups exhibited statistically significant reductions from pretraining to posttraining on self-reported anxiety, diastolic blood pressure, and systolic blood pressure, and a trend for heart rate. The magnitude of these reductions did not differ among the groups. Finally, all groups had significantly lower heart rates after their speeches than before their speeches at both pretraining to posttraining assessments.

Additional analyses

Attentional bias index

For attentional bias for threat, the effects of assessment, $F(1, 53) = 2.161$, $p = .147$, and group, $F(2, 53) = 2.196$, $p = .121$, were nonsignificant. However, the Assessment × Group interaction fell just short of significance, $F(2, 53) = 2.913$, $p = .063$. The pattern of means implies that the inverse group exhibited an attentional bias for positive faces, and training eliminated this bias (See Table 5). Notably, none of the groups exhibited an attentional bias for threat at either assessment point.

Table 3
Means, standard deviations, and 95% confidence intervals for self-report, behavioral, and physiological measures of anxiety during public speaking.

Measure	Group		
	ABM	Inverse	Control
SPRS-1	9.0 (2.4)	10.5 (3.6)	10.2 (2.4)
	[7.6, 10.4]	[9.2, 11.9]	[8.8, 11.7]
SPRS-2	10.3 (2.7)	10.5 (3.7)	11.3 (2.7)
	[8.8, 11.8]	[9.0, 11.9]	[9.8, 12.9]
AnxB-1	56.0 (25.3)	69.8 (20.5)	62.5 (17.1)
	[45.9, 66.1]	[59.7, 80.0]	[51.8, 73.2]
AnxB-2	45.3 (19.2)	52.9 (30.2)	46.4 (18.3)
	[34.2, 56.4]	[41.9, 64.0]	[34.7, 58.2]
AnxA-1	55.4 (24.6)	71.1 (28.8)	57.8 (15.8)
	[44.1, 66.8]	[59.8, 82.5]	[45.8, 69.8]
AnxA-2	44.8 (27.8)	55.7 (32.8)	45.3 (22.5)
	[31.4, 58.1]	[42.3, 69.0]	[31.1, 59.5]
HR-B-1	75.7 (11.0)	73.1 (11.0)	72.6 (12.6)
	[70.2, 81.1]	[67.6, 78.6]	[66.8, 78.4]
HR-B-2	70.1 (9.6)	71.2 (10.5)	72.2 (13.0)
	[64.9, 75.3]	[65.9, 76.4]	[66.6, 77.7]
HR-A-1	73.2 (8.8)	72.9 (12.7)	70.7 (12.4)
	[67.6, 78.8]	[67.5, 78.4]	[65.0, 76.4]
HR-A-2	67.6 (7.8)	68.6 (9.5)	72.8 (14.0)
	[62.4, 72.8]	[63.5, 73.6]	[67.4, 78.1]
SysB-1	132.9 (14.3)	127.3 (20.5)	124.5 (14.4)
	[125.0, 140.9]	[119.4, 135.3]	[115.8, 133.2]
SysB-2	123.3 (11.8)	120.0 (14.3)	121.9 (13.8)
	[117.0, 129.6]	[113.7, 126.3]	[115.0, 128.8]
SysA-1	133.1 (16.3)	128.9 (18.5)	127.7 (12.6)
	[125.4, 140.8]	[121.3, 136.6]	[119.3, 136.1]
SysA-2	127.8 (12.7)	120.0 (16.8)	122.8 (12.4)
	[121.0, 134.5]	[113.3, 126.7]	[115.4, 130.2]
DiaB-1	85.6 (10.1)	78.8 (12.0)	79.9 (4.7)
	[81.0, 90.1]	[74.2, 83.4]	[74.8, 84.9]
DiaB-2	80.9 (11.0)	74.2 (9.2)	78.3 (7.1)
	[76.5, 85.4]	[69.7, 78.6]	[73.5, 83.2]
DiaA-1	84.8 (12.1)	79.2 (11.1)	79.5 (9.6)
	[79.6, 90.1]	[74.0, 84.5]	[73.7, 83.6]
DiaA-2	81.0 9.8	74.9 (11.0)	78.4 (9.1)
	[76.2, 85.8]	[70.2, 79.7]	[73.2, 83.6]

Notes. SPRS-1 = Social Performance Rating Scale – Pretest; SPRS-2 = Social Performance Rating Scale – Posttest; AnxB-1 = anxiety before speaking – pretest; AnxB-2 = anxiety before speaking – posttest; AnxA-1 = anxiety after speaking – pretest; AnxA-2 = anxiety after speaking – posttest; HR-B-1 = heart rate before speaking – pretest; HR-B-2 = heart rate before speaking – posttest; HR-A-1 = heart rate after speaking – pretest; HR-A-2 = heart rate after speaking – posttest; SysB-1 = systolic blood pressure before speaking – pretest; SysB-2 = systolic blood pressure before speaking – posttest; DiaB-1 = diastolic blood pressure before speaking – pretest; DiaB-2 = diastolic blood pressure before speaking – posttest; DiaA-1 = diastolic blood pressure after speaking – pretest; DiaA-2 = diastolic blood pressure after speaking – posttest. Standard deviations are in parentheses; confidence intervals are in brackets.

Attentional conflict index

For the attentional conflict index scores, all three groups exhibited significant improvement, evinced by the effect of assessment, $F(1, 49) = 37.83$, $p < .001$. The effect of group, $F(2, 49) = 1.289$, $p = .285$ was nonsignificant, as was the Group × Assessment interaction, $F(2, 49) = 0.621$, $p = .541$. The means, standard deviations, and 95% confidence intervals appear in Table 5.

Predictors of reduction in speech anxiety and social phobia

We tested whether better executive control at the pretraining assessment (ACS and the attentional conflict index) predicted reduction in speech anxiety and social phobia (PRCS and LSAS). (Prediction of clinical improvement entails a positive correlation between scores on the ACS and reductions in the PRCS and LSAS, whereas it entails a negative correlation between scores on the attentional conflict index and reductions in the PRCS and LSAS.) Neither measure significantly predicted reductions in speech anxiety: ACS, $r(55) = .089$, $p = .511$; attentional conflict index, $r(51) = .141$, $p = .312$. Neither measure significantly predicted reductions in social phobia: ACS, $r(55) = .171$, $p = .203$; attentional conflict index, $r(51) = -.035$, $p = .803$.

However, the greater the magnitude in improvement on the ACS from pretraining assessment to posttraining assessment, the greater the reduction in social phobia on the LSAS, $r(55) = .506$, $p < .001$, whereas this correlation was nonsignificant for the reduction in speech anxiety on the PRCS, $r(55) = .138$, $p = .306$. In contrast, the correlation between the magnitude in improvement on the attentional conflict index and the reduction in social phobia and speech anxiety was nonsignificant, LSAS: $r(50) = .028$, $p = .845$, PRCS: $r(50) = -.102$, $p = .470$.

Table 4
Group × assessment × time ANOVAs for self-reported anxiety and physiological measures before and after the speech.

Source	*df*	*F*	*p*
Anxiety			
(A) Group	2	1.87	.166
(B) Assessment	1	27.22	.001
A × B (interaction)	2	0.39	.678
(C) Time	1	0.04	.853
A × C (interaction)	2	0.29	.750
B × C	1	0.26	.614
A × B × C	2	0.10	.908
Heart rate			
(A) Group	2	0.02	.979
(B) Assessment	1	3.06	.087
A × B (interaction)	2	1.47	.240
(C) Time	1	4.57	.038
A × C (interaction)	2	0.45	.638
B × C	1	0.00	.986
A × B × C	2	1.48	.239
Systolic blood pressure			
(A) Group	2	0.89	.419
(B) Assessment	1	17.96	.001
A × B (interaction)	2	0.77	.470
(C) Time	1	2.50	.121
A × C (interaction)	2	0.19	.825
B × C	1	0.03	.958
A × B × C	2	1.15	.326
Diastolic blood pressure			
(A) Group	2	2.49	.093
(B) Assessment	1	12.82	.001
A × B (interaction)	2	1.12	.334
(C) Time	1	0.02	.961
A × C (interaction)	2	0.16	.855
B × C	1	0.09	.762
A × B × C	2	0.01	.994

Note. For all tests, the error term $df = 49$ for anxiety and $df = 48$ for physiological measures because of missing data. Time = before speech and after speech.

Table 5
Means, standard deviations, and 95% confidence intervals for the attentional bias index and the attentional conflict index.

Measure	Group		
	ABM	Inverse	Control
ABI-1	−1.8 (15.3)	−14.5 (14.7)	−1.3 (14.2)
	[−8.4, 4.8]	[−21.5, −7.5]	[−8.3, 5.7]
ABI-2	−2.9 (10.5)	−0.7 (15.6)	−1.6 14.8)
	[−9.0, 3.3]	[−7.2, 5.8]	[−8.1, 4.9]
ACI-1	121 (38)	136 (54)	121 (30)
	[102, 140]	[115, 157]	[101, 142]
ACI-2	94 (33)	119 (52)	100 (29)
	[76, 112]	[99, 138]	[82, 119]

Notes. ABM = Attention Bias Modification; ABI = Attentional Bias Index; ACI = Attentional Conflict Index; 1 = Pretraining, 2 = Posttraining. Standard deviations are in parentheses; confidence intervals are in brackets. All data are in milliseconds.

At pretraining assessment, the correlation between the two measures of executive control, greater scores on the ACS and lower scores on the attention conflict index, was nonsignificant, $r(51) = .026$, $p = .852$. Improvement on the two measures of executive control was nonsignificant, $r(50) = -.067$, $p = .644$.

Finally, the greater the reduction in attentional bias for threat from pretraining assessment to posttraining assessment, the lower the posttraining speech anxiety (PRCS) and social phobia (LSAS) scores, respectively, $r(54) = -.323$, $p = .015$, $r(54) = -.303$, $p = .023$. However, reduction in attentional bias was nonsignificantly correlated with reduction in speech anxiety and social phobia scores, respectively, $r(54) = .214$, $p = .114$, $r(54) = .141$, $p = .301$.

Discussion

Irrespective of their group assignment, subjects who completed four sessions of training exhibited statistically significant reductions on self-report, behavioral, and physiological measures of anxiety while delivering their speech at the posttraining assessment relative to the pretraining assessment. Moreover, the three groups likewise reported statistically indistinguishable and significant reductions on questionnaires tapping speech anxiety, anxiety, stress, depression, and social phobia. Furthermore, all three groups exhibited statistically indistinguishable and significant improvements on self-report and behavioral measures of executive control of attention. Surprisingly, all three training procedures were equally successful, except that the ABM group failed to exhibit a significant decline on the LSAS, whereas the other two groups did.

Because the control group improved just as much as the ABM group did, our findings are inconsistent with the theory motivating the development of ABM. Because the control group improved just as much as the inverse group did, our findings are likewise inconsistent with the theory motivating inverse therapies.

What, then, explains our findings? Two possibilities come immediately to mind. One possibility concerns regression to the mean. People suffering from fear of public speaking might enroll in studies such as ours when they are most distressed. Random yet beneficial experiences in their lives might result in their scores drifting downward toward the population mean over the course of the study, producing the illusion that improvements were attributable to the training regimes. Although we did not include a waitlist or no-treatment control group in this study, we did so in another ABM experiment (Enock et al., 2013). In this other study, socially anxious subjects in the ABM and control groups exhibited statistically indistinguishable and significant reductions in social anxiety, and greater than those of subjects in the waitlist group. Taken together these, studies suggest that regression to the mean seems unlikely to explain our current findings.

Another possibility is that the placebo effect explains the widespread benefits enjoyed by all three groups. However, the placebo effect is a conceptual placeholder. Invoking it is a gesture acknowledging ignorance of the operative mechanism and does little more than affirm the failure of the ABM and inverse hypotheses to explain the results. Perhaps the halo of technology embodied in a computerized fix for one's public speaking fear fostered positive expectancies that account for the improvements that occurred.

Another possibility is that anyone who took the trouble to commute to our laboratory for six visits might be favorably inclined to rate themselves as clinically improved, as the theory of cognitive dissonance would predict (Festinger & Carlsmith, 1959). In fact, ABM rivals the task of Festinger and Carlsmith – repeatedly filling, emptying, and refilling trays with spools – to produce boredom in subjects. Our modest honorarium, plus the desire to overcome one's fear of public speaking, was insufficient to prevent notable numbers of dropouts in all three conditions. Accordingly, subjects who managed to stay the course and complete the entire protocol might have been precisely those most likely to report themselves as markedly improved. On the other hand, cognitive dissonance notwithstanding, subjects did improve on physiological and behavioral measures of public speaking fear, not just on self-report measures of distress. However, repeated exposure to the speaking task itself might have produced this genuine improvement. The pretraining speech was likely more stressful than the posttraining one.

One hint about a possible mechanism emerged from the predictor analyses. The greater the degree of improvement in attentional control, as measured by the ACS, the greater the reduction in social phobia, as measured by the LSAS. This suggests that subjects who completed training – any training – reported subjective improvement in their attentional control that correlated with reductions in their social phobia scores. However, the RT, behavioral measure of executive control did not predict such improvements, and nor did it correlate with the ACS – a finding corroborating that of Reinholdt-Dunne, Mogg, and Bradley (2009).

ABM aims to reduce an attentional bias for threat in anxious people, yet our three groups of subjects did not exhibit such a bias, on average, at either assessment session. Moreover, split-half reliability analyses at each assessment session revealed negligible reliability coefficients ($rs < .08$), raising questions about the stability of the standard attentional bias index.

In contrast to the studies cited in the Introduction, ours failed to confirm the superiority of ABM over other procedures for reducing social anxiety. Yet our study is consistent with other ABM experiments. Several studies have shown significant pre-post reductions in no-contingency control groups that were just as great as reductions in the ABM condition (Boettcher, Berger, & Renneberg, 2012; Carlbring et al., 2012; Enock et al., 2013; Neubauer et al., 2013). In each of these failures to replicate the superiority of ABM, subjects did training remotely via the Internet or via their smartphones in the study of Enock et al. However, failures to replicate are not confined to training done remotely. The present experiment is the third laboratory-based, multi-session study failing to show superiority of ABM over control training in socially anxious subjects (Bunnell, Beidel, & Mesa, 2013; Sawyer et al., 2013). Another single-session, laboratory-based study failed to provide differentially favorable results of ABM (Julian, Beard, Schmidt, Powers, & Smits, 2012). The investigators tested whether exercising on a treadmill might bolster attentional control, thereby augmenting the effects of a single-session of ABM on attentional bias and reactivity to a speech challenge. Julian et al.

randomly assigned socially anxious subjects to one of four groups: exercise plus ABM, rest plus ABM, exercise plus control, and rest plus control. The results showed that ABM, relative to the control training, did not reduce attentional bias for threat, nor did it reduce reactivity to the speech threat, contrary to the findings of Amir, Weber, Beard, Bomyea, and Taylor's (2008) single-session ABM intervention for speech anxiety.

Testing whether ABM would augment the effects of standard CBT for social phobia, Rapee et al. (2013) randomly assigned patients to receive CBT with either daily ABM training at home or control training at home. At the end of 12 weeks, both CBT groups evinced marked improvement on multiple measures, including a speech challenge. However, the group receiving ABM did no better than did group receiving control training.

In summary, our study adds to the growing database bearing on the varied efficacy of ABM. Although socially anxious subjects often do improve with ABM, they often improve likewise with control training. Investigators need to identify the variables that determine when ABM outperforms control training.

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