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Does attention bias modification improve attentional control? A double-blind randomized experiment with individuals with social anxiety disorder

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ABSTRACT

People with anxiety disorders often exhibit an attentional bias for threat. Attention bias modification (ABM) procedure may reduce this bias, thereby diminishing anxiety symptoms. In ABM, participants respond to probes that reliably follow non-threatening stimuli (e.g., neutral faces) such that their attention is directed away from concurrently presented threatening stimuli (e.g., disgust faces). Early studies showed that ABM reduced anxiety more than control procedures lacking any contingency between valenced stimuli and probes. However, recent work suggests that no-contingency training and training toward threat cues can be as effective as ABM in reducing anxiety, implying that any training may increase executive control over attention, thereby helping people inhibit their anxious thoughts. Extending this work, we randomly assigned participants with DSM-IV diagnosed social anxiety disorder to either training toward non-threat (ABM), training toward threat, or no-contingency condition, and we used the attention network task (ANT) to assess all three components of attention. After two training sessions, subjects in all three conditions exhibited indistinguishably significant declines from baseline to post-training in self-report and behavioral measures of anxiety on an impromptu speech task. Moreover, all groups exhibited similarly significant improvements on the alerting and executive (but not orienting) components of attention. Implications for ABM research are discussed.

1. Introduction

People with social anxiety disorder (SAD) often exhibit an attentional bias for social-threat cues, such as faces expressing disgust or anger (e.g., Mogg, Philippot, & Bradley, 2004). This bias may causally contribute to increasing anxiety proneness (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002), and thereby figure in the etiology and maintenance of SAD and other anxiety disorders (for a review, see Van Bockstaele et al., 2014). Accordingly, reducing it may have yield clinical benefits.

Inspired by MacLeod et al. (2002), psychologists have used attention bias modification (ABM) procedures to diminish AB and thereby symptoms of SAD (e.g., Amir, Taylor, & Donohue, 2011). To develop an ABM procedure, MacLeod et al. (2002) modified the classic dot-probe paradigm that measures AB (MacLeod, Mathews, & Tata, 1986). In the original dot-probe tasks, participants viewed two stimuli (e.g., a threatening word/photograph and a neutral word/photograph) simultaneously presented in two locations of a computer screen for approximately 500 ms. Immediately thereafter, a probe appeared in the location previously occupied by one of the two stimuli. Participants have to respond to the probe as quickly as possible. An AB was demonstrated when participants respond faster to the probe when it replaces a threatening stimulus than when it replaces a non-threatening stimulus, indicating that their attention was directed to the location occupied by the threatening stimulus. In ABM, researchers typically modify the original task such so that the probe nearly always (e.g., 95% of the trials) replaces the neutral stimulus, thereby redirecting subjects'

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attention to non-threatening cues. In the control condition, there is no contingency between cues and probes. Relative to the control condition, ABM reduces symptoms in people with SAD, as several studies have shown (Amir, Weber, Beard, Bomyea, & Taylor, 2008; Amir et al., 2009; Li, Tan, Qian, & Liu, 2008; Schmidt, Richey, Buckner, & Timpano, 2009). These findings suggest that ABM could have important clinical potential, as it entails a very simple protocol, little contact with a mental health professional, and can be easily disseminated.

However, over the past two years, other studies have reported mixed findings (e.g., Boettcher et al., 2013; Bunnell, Beidel, & Mesa, 2013; Carlbring et al., 2012). Several explanations for these mixed findings have been formulated (Emmelkamp, 2012; Heeren, De Raedt, Koster, & Philippot, 2013; Klumpp & Amir, 2010). For example, training attention, regardless of the direction of the contingency between probes and cues, may bolster top-down attention control in ways that strengthen one's ability to control anxiety. Klumpp and Amir (2010) reported data congruent with this hypothesis. In their experiment, they randomly allocated moderately socially anxious individuals to one of three different conditions: (1) training to attend to non-threat (i.e., ABM), (2) attend to threat, or (3) a control condition in which there was no contingency between cues and probes. After a single-session, individuals who were trained to attend to threat as well as those receiving ABM reported less state anxiety in response to an impromptu speech compared to individuals in the no-contingency control condition.

However, Heeren, Reese, McNally, and Philippot (2012) did not replicate this effect among participants diagnosed with generalized social phobia. In this experiment, participants were randomly assigned to receive four sessions of one of the three conditions mentioned above. They found that, in contrast to the two other conditions, those who were trained to attend to non-threat reported less behavioral and physiological (i.e., skin conductance reactivity) indices of anxiety in response to an impromptu speech, and a decrease in AB. These studies suggest that the processes mediating the impact of ABM on anxiety may be more complicated than commonly assumed. However, it remains unclear whether the benefits apparent in these two studies result from increased executive control over attention as none measured it. More recently, McNally, Enock, Tsai, and Tousian (2013) reported an experiment in which they randomly assigned speech-anxious individuals to one of the three training conditions mentioned above while also including self-report and behavioral measures of executive attention control before and after the training. After four sessions of training, participants, irrespective of group assignment, exhibited significant decreases in self-report, behavioral, and physiological measures of anxiety associated with a speaking task. More importantly, all three training conditions improved attentional control, as indexed through the executive conflict score of the attention network task (ANT; Fan, McCandliss, Sommer, Raz, & Posner, 2002) and the Attentional Control Scale questionnaire (Derryberry & Reed, 2002).

Considering a placebo effect for the widespread clinical benefits, McNally et al. (2013) suggested that the halo of technology embodied in a computerized fix for one's public speaking fear might foster positive expectancies that account for the observed improvement. This interpretation seems plausible as McNally et al. informed participants of the potential therapeutic benefits of training. In contrast, Heeren, Reese, et al. (2012) and Klumpp and Amir (2010) informed participants that the research concerned processes associated with SAD; they did not mention any potential therapeutic benefits.

Further, in contrast to Klumpp and Amir's hypothesis, recent evidence suggests that AB in SAD may result not only from impairment in the executive control of attention, but also from impairment in orienting toward non-emotional stimuli (e.g., Moriya & Tanno, 2009). According to Posner and Petersen (1990), there are three components to attention: alerting, orienting, and executive control. However, even if the ANT evaluates these three independent attentional networks, McNally et al. (2013) only reported data on the change in executive conflict component of the ANT as their hypothesis only concerned executive control. To date, no published study has explored the impact of ABM on all three components of attention.

In the present double-blind experiment, we randomly assigned individuals with a DSM-IV diagnosis of SAD to one of three conditions: (1) attend to non-threat stimuli, (2) attend to threat stimuli, and (3) no-contingency control. Subjects were not told about the possible therapeutic benefits of training. Rather, they were merely informed that the study concerned the cognitive mechanisms underlying social interaction among shy people. We assessed the effects of these procedures on change in AB, on self-report and behavioral measures of anxiety during a speech performance, and on all three attentional networks of the ANT, in contrast to McNally et al. (2013) whose hypothesis concerned only the executive conflict measure of the ANT.

We addressed several issues. If, as Klumpp and Amir (2010) have suggested, attention training is effective because of increased attentional control arising from any contingency-based procedure regardless of the direction of attention, then participants in either the attend to threat or attend to non-threat conditions should exhibit greater improvement than participants in the no-contingency control condition on the executive network of the ANT as well as measures of anxiety. By constrast, if attention training is effective because of attending to non-threat, as Heeren, Reese, et al. (2012) have suggested, then only the participants in the attend to non-threat condition should demonstrate clinical benefits. Finally, if attention training is effective regardless of the presence of a contingency, as McNally et al. (2013) have suggested, all groups should exhibit improvement in the executive network of ANT.

2. Materials and methods

2.1. Participants

We recruited 61 individuals with a primary DSM-IV diagnosis of SAD (American Psychiatric Association, 1994) from the Université Catholique de Louvain community. A total of 445 volunteers responded to our invitation to take part in an investigation of the mechanisms underlying social interaction among shy people. Following screening, 148 individuals who scored above 56 on the self-report version of the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987) were selected. A clinical psychologist then used the French version of the Mini International Neuropsychiatric Interview (MINI; Lecrubier, Weiller, Bonora, Amorin, & Lépine, 1998) to diagnose DSM-IV Axis I disorders.

In addition to the presence of a DSM-IV diagnosis of Social Anxiety Disorder, all participants had to fulfill several inclusion criteria: (a) no current substance abuse or dependence, (b) no current heart, respiratory, neurological problems, or use of psychotropic medications, (c) no current psychological or psychiatric treatment, and (d) normal or corrected-to-normal vision. These criteria were assessed via questionnaire. Sixty-two participants met the DSM-IV diagnosis of Social Anxiety Disorder; 41 had the generalized subtype, and 21 had the specific subtype. One declined our invitation to participate, and so 61 participants enrolled in the study; their characteristics are displayed in Table 1. We obtained written informed consent from each participant. Each participant was tested individually in a quiet room and all sessions occurred in the same laboratory. The study was approved by the Ethical Committee of the Université Catholique de Louvain (UCL, Belgium), and conducted according to the Declaration of Helsinki. Participants received financial compensation (15 Euros) for their participation.

Table 1
Participants' characteristics as a function of training allocation (SD in parentheses).

	Attend to threat ($n = 21$)	Attend to non-threat ($n = 22$)	No-contingency ($n = 18$)	F or χ^2	p
Age	28.48 (11.08)	24.41 (7.24)	24.72 (8.68)	1.28[a]	.29
%Female/%Male	81.00/19.00	88.90/11.10	72.70/27.30	1.64[b]	.44
Years of education	16.81 (2.80)	16.18 (2.65)	15.39 (2.25)	1.45[a]	.24
BDI-II	13.33 (8.72)	12.59 (7.73)	14.78 (7.01)	.387[a]	.68
STAI-T	47.43 (9.75)	47.82 (7.48)	42.89 (7.40)	2.07[a]	.14
LSAS	71.57 (11.38)	73.41 (10.21)	78.22 (11.79)	1.83[a]	.17

Note: Attend to threat, training to attend to threatening material; attend to non-threat, training to attend to neutral material; no-contingency, training without contingency between cues and probes; BDI-II, Beck Depression Inventory-II; STAI-T, Spielberger State-Trait Anxiety Inventory-Trait; LSAS, Liebowitz Social Anxiety Scale.
[a] Value for $F(2, 58)$.
[b] Value for $\chi^2(2, N = 61)$.

2.2. Materials

2.2.1. Attention training stimuli

We randomly selected 70 face pairs without hairlines (35 men, 35 women) from the Karolinska Emotional Directed Faces database (Lundqvist, Flykt, & Öhman, 1998), which is a standardized set of emotional expressions. In accord with most previous ABM studies, the faces displayed either threatening (i.e., disgust) or neutral facial expressions.

2.2.2. AB assessment stimuli

To assess AB, we used eight French social threat words (stupid, humiliation, embarrassed, shame, mockery, foolish, idiot, rejection) and eight neutral words (book, radiator, spoon, tree, computer, procession, piano, towel), matched on frequency of usage in French (New, Pallier, Ferrand, & Matos, 2001) and similar to those in previous research (Heeren, Lievens, & Philippot, 2011; Heeren, Peschard, & Philippot, 2012). The threat and neutral words did not differ in length, $t(14) = 0.44$, $p > .66$, $d = 0.23$. We used words, rather than faces, in the assessment trials to test whether the effects of training with one type of stimulus generalize to another type.

2.3. Measures

2.3.1. Questionnaires

Participants were screened via the self-report version of the LSAS (Liebowitz, 1987), and they also completed the Trait Anxiety Inventory (STAI-T; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), and the Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996) at the beginning of the first training session. The LSAS is a 24-item scale that measures anxiety and avoidance of social interaction and performance situations. The STAI-T is a 20-item self-report questionnaire assessing anxiety proneness. The BDI is a 21-item self-report measure of symptoms of depression. We used the validated French versions of these scales (LSAS, Heeren, Maurage, et al. (2012); BDI-II, Beck et al., 1996; STAI-T, Bruchon-Schweitzer & Paulhan, 1993).

2.3.2. Measure of AB

For assessing effects of training on attention to threat cues, we asked participants to complete an independent measure of AB at baseline and post-training. We used a modified version of the spatial cueing task identical to that used by others (e.g., Amir et al., 2008; Julian, Beard, Schmidt, Powers, & Smits, 2012). Words were presented in lowercase white letters (5–8 mm in height) against a black background, in the center of the screen. On each trial, the word appeared in a rectangle to the left or right of the central fixation cross, thereby directing attention to the left or right. After 600 ms, the cue word disappeared, and an asterisk (the probe) appeared in one of the two locations.

The probe remained on the screen until the participant responded, and the computer recorded this response latency each trial. The inter-trial interval, from target offset to the next fixation cross, was 1650 ms. On some trials, the cue word was valid (i.e., the probe appeared in the same location as the cue word), whereas on others the cue word was invalid (i.e., the probe appeared in the location opposite to the cue word).

Participants were exposed to 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; e.g., Stormark, Nordby, & Hugdahl, 1995). Trials were presented in a different random order for each participant. Amir, Elias, Klumpp, and Przeworski (2003) found that socially anxious participants showed significantly longer response latencies on invalid cued social threat trials compared to non-anxious controls on this task, suggesting that AB may reflect difficulty disengaging from threatening stimuli.

2.3.3. Attentional network task (ANT)

The ANT was administered to determine the efficiency of three independent attentional networks: alerting, orienting, and executive control (Fan et al., 2002). Participants had to determine as quickly and as accurately possible the direction of a central arrow (the target) located in the middle of a horizontal line projected either at the top or at the bottom of the screen. They responded by pressing the corresponding button (left or right) on the keyboard. Each target was preceded by either no cue, a center cue (an asterisk replacing the fixation cross), a double cue (two asterisks, one appearing above and one below the fixation cross), or a spatial cue (an asterisk appearing above or below the fixation cross and indicating the location of the upcoming target). Moreover, flankers appeared horizontally on each side of the target. There were three possible flanker types: either two arrows pointing in the same direction as the target (congruent condition), two arrows pointing in the opposite direction of the target (incongruent condition), or two dashes (neutral condition). Each trial had the following structure: (1) a central fixation cross (random duration between 400 and 1600 ms); (2) a cue (100 ms); (3) a central fixation cross (400 ms); (4) a target and its flankers, appearing above or below the fixation cross (the target remained on the screen until the participant responded or for 1700 ms if no response occurred); (5) a central fixation cross [lasting for 3500 ms minus the sum of the first fixation period's duration and the reaction time (RT)]. RT (in milliseconds) and accuracy (percentage of correct responses) were recorded for each trial.

The ANT task comprised 288 trials, divided in three blocks of 96 trials each (with a short break between blocks). There were 48 possible trials, based on the combination of four cues (no cue, center cue, double cue, spatial cue), three flankers (congruent, incongruent, neutral), two directions of the target arrow (left, right) and two localizations (upper or lower part of the screen). Trials were presented in a random order and each possible trial was presented twice within a block.

2.3.4. Speech task

We administered a speech task to assess self-report and behavioral measures of anxiety at baseline and post-training. Each participant began the task sitting in a chair 30 cm from a computer screen. A set of instructions then appeared on the screen and informed participants that they would have to make a 2-min speech concerning controversial topics widely discussed in the Belgian media, and that their performance would be video recorded. Two topics (abortion and legalization of cannabis) were randomly counterbalanced between times of assessment. They were given 2 min to prepare and a sheet of paper to write down their notes; however, they were told that they would not be allowed to use these notes during the speech. After participants had prepared their speech, they were directed to stand in front of a video camera. Just before the speech, the experimenter asked participants to rate, using *Subjective Units of Discomfort Scale* (SUDS; Wolpe, 1958), their level of situational anxiety from 0 (*not anxious*) to 100 (*extremely anxious*). The participant then performed the speech while being video recorded. Two clinical psychologists, blind to training condition, used the Behavioral *Assessment of Speech Anxiety* (BASA; Mulac & Sherman, 1974) method to rate the speech of the participant. The BASA includes 18 molecular categories (e.g., having a clear voice, searching for the words), and the mean score of these categories has excellent concurrent validity with experts' ratings of speech anxiety (Mulac & Sherman, 1974). Interrater reliability of the total score was high ($r = .65$, $p < .001$ at baseline; $r = .75$, $p < .001$ at post-training). Accordingly, we averaged the scores of the two raters. The same two raters assessed both the baseline and post-training speeches of a participant.

2.4. Attention training

Attention training consisted of a standard probe discrimination task, modified to train participants either to attend primarily to non-threat cues, to threat cues, or to no-contingency training (control condition). For all conditions, a fixation cross appeared for 500 ms in the center of the screen, followed by two facial expressions of the same person, a disgust expression and a neutral one, presented for 500 ms. A probe appeared (i.e., the letter E or F), replacing one of the faces. It remained on the screen until the participant indicated its identity by pressing the corresponding key. The inter-trial interval was 1500 ms.

In the attend-to-non-threat condition, the probe replaced the non-threatening (neutral) face on 95% of the trials. In the attend-to-threat condition, the probe replaced the threatening (disgust) face on 95% of the trials. In the control condition, the probe replaced the each face on 50% of the trials (i.e., there were no contingency between cues and probes).

Participants completed 560 trials in one block. Each of the 70 threatening faces appeared 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 × 2 positions × 2 arrow directions × 2 repetitions). The instructions were presented on the computer and were identical for all the conditions. Faces were positioned 4 cm from the top/bottom of the screen, 8 cm from the ipsilateral edge, 22.5 cm from the contralateral edge, and centered vertically. Each face was 7.5 cm high and 7.5 cm wide.

2.5. General procedure

The procedure consisted of two sessions of ABM, separated by one day. Participants were randomly assigned to one of the three conditions via a computerized randomization system. The participants and the experimenters were blind to condition. Participants first completed a demographic questionnaire, the STAI (Trait version), and the BDI-II. We then administered the modified spatial cueing task, which provided a baseline index of attention bias, the ANT, and the speech task. Next, participants completed the two training sessions, each lasting about 30 min. After completing the second session, participants completed the second ANT as well as the second modified spatial cueing task. Finally, participants were invited to complete the second speech task. Participants were debriefed at the end of the experiment.

3. Results

3.1. Data reduction

3.1.1. Spatial cueing task

Following Ratcliff's (1993) recommendations, we addressed outliers and errors in the RT tasks as follows. First, trials with incorrect responses were excluded (0.77% of trials at baseline; 1.02% of trials post-training). Second, RTs lower than 200 ms or greater than 2000 ms were removed from analyses (0.27% of trials at baseline; 0.22% of trials at post-training). Third, RTs of more than 1.96 *SD* below or above each participant's mean for each experimental condition were excluded as outliers (0.80% of trials at baseline; 0.83% of trials of the data at post-training).

3.1.2. ANT

We excluded data from trials with incorrect responses (0.80% of trials at baseline; 0.75% of trials at post-training), RTs lower than 200 ms or greater than 2000 ms (0.41% of trials at baseline; 0.37% of trials at post-training), and RTs exceeding 1.96 *SD* below or above each participant's mean for each experimental condition (0.26% of remaining trials at baseline; 0.23% at post-training). Following Fan et al. (2002), we computed the *alerting* effect by subtracting the mean (i.e., RT or accuracy score) for double cue trials from the mean for no cue trials (No cue–Double cue); the *orienting* effect by subtracting the mean for spatial cue trials from the mean result for center cue trials (Center cue–Spatial cue); and the *executive conflict* effect by subtracting the mean for congruent trials (summed across cue types) from the mean for incongruent trials (Incongruent–Congruent). For both alerting and orienting effects, greater subtraction scores for RT (and lower for accuracy) indicated greater efficiency. In contrast, greater subtraction scores for RT (and lower for accuracy) on executive conflict indicated increased difficulty with executive control of attention (Fan, McCandliss, Fossella, Flombaum, & Posner, 2005).

3.2. Group equivalence

As shown in Table 1, the groups did not differ at baseline on the STAI-trait, BDI-II, or LSAS, and were indistinguishable in terms of age, gender, and years of education.

3.3. Change in AB

We subjected RTs to a 3 (Condition) × 2 (Time: Baseline, post-training) × 2 (Validity: valid, invalid) × 2 (Word Type: Social threat, neutral) analysis of variance (ANOVA) with repeated measurement on the last three factors. The ANOVA revealed a significant Condition × Time × Validity interaction, $F(2, 58) = 3.10$, $p < .05$, $\eta_p^2 = .10$. There was no Condition × Time × Validity × Word Type interaction, $F(2, 58) = .65$, $p > .52$, $\eta_p^2 = .02$, nor a Condition × Time × Word Type interaction, $F(2, 58) = .72$, $p > .49$, $\eta_p^2 = .02$.

To probe the significant interaction, we computed separate Condition × Time ANOVAs for valid and invalid trials separately. For valid trials, this analysis revealed a main effect of Time, $F(1, 58) = 9.08$, $p < .005$, $\eta_p^2 = .13$, but no significant Time × Condition interaction, $F(2, 58) = 2.00$, $p > .14$, $\eta_p^2 = .06$. For invalid trials, there was no Time effect, $F(1, 58) = .91$, $p > .34$, $\eta_p^2 = .01$, nor a Time × Condition interaction, $F(2, 58) = 2.15$, $p > .12$, $\eta_p^2 = .07$. As depicted in Table 2, these results suggest a decrease in RT for valid trials from baseline to post-training, regardless of the experimental condition.

3.4. Change in attention network components

We subjected RTs to a 3 (Condition) × 2 (Time: Baseline, post-training) × 3 (Attentional Network: Alerting, Orienting, Executive control) ANOVA with repeated measurement on the last two factors. The ANOVA revealed a main effect of Time, $F(1, 58) = 4.40$, $p < .05$, $\eta_p^2 = .07$, and a significant Time × Attentional Network interaction, $F(1, 58) = 16.19$, $p < .0001$, $\eta_p^2 = .22$. There was no Condition × Time × Attentional Network interaction, $F(2, 58) = .26$, $p > .77$, $\eta_p^2 = .02$. To explore this significant interaction, we computed separate paired *t*-tests for each attention network separately, regardless of the experimental condition. These analyses revealed that participants exhibited significant improvement, from baseline to post-training, in the Alerting network, $t(60) = 2.21$, $p < .05$, and in the Executive Control network, $t(60) = 3.88$, $p < .05$. There was no significant change for the Orienting network, $t(60) = 1.89$, $p > .07$. Results are shown in Table 2.

3.5. Change in emotional reactivity to speech task

For the SUDS and BASA data, we computed separate 3 (Condition) × 2 (Time: Baseline, post-training) ANOVAs with repeated measurement on the last factors. For the SUDS ratings, the ANOVA revealed a main effect of Time, $F(1, 58) = 29.03$, $p < .0001$, $\eta_p^2 = .33$, but no significant Time × Condition interaction, $F(2, 58) = 0.29$, $p > .75$, $\eta_p^2 = .01$. For the BASA scores, again, the ANOVA revealed a main effect of Time, $F(1, 58) = 19.76$, $p < .01$, $\eta_p^2 = .27$, but no significant Time × Condition interaction, $F(2, 58) = 2.13$, $p > .13$, $\eta_p^2 = .08$. As depicted in Fig. 1, all groups exhibited a significant decrease in both self-reported and behavioral measures of anxiety to the impromptu speech from baseline to post-training.

3.6. Additional analyses

As several studies suggest, improvement in attention control may be related to the change in emotional reactivity to the speech task, we computed Pearson correlation coefficients between the former (i.e., post-training minus baseline score) and latter variables (i.e., post-training minus baseline score) for both the SUDS and BASA measures and both the executive and the alerting components of the ANT. However, the correlations were neither significant for the executive component [$r_s(61) < .20$, $p_s > .29$] nor the alerting component of attention [$r_s(61) < .30$, $p_s > .23$].

4. Discussion

We had two purposes in this study. First, we sought to investigate the influence of the presence and the direction of a contingency between cues and probe during training on changes in AB for threat as well as on self-reported and behavioral measures of anxiety in response to an impromptu speech among subjects with a DSM-IV diagnosis of SAD. Second, we aimed to explore the impact of ABM on all three components of attention, not only for the executive component (cf. McNally et al., 2013).

Consistent with McNally et al.'s (2013) findings, all three groups exhibited statistically indistinguishable reductions from baseline to post-training in self-reported and behavioral measures of anxiety associated with the impromptu speech. Moreover, our study

Table 2
Mean performances for the spatial cueing task (in millisecond) and the attention network task (differential index in millisecond) as a function of training conditions and time (SD in parentheses).

Outcome	Cue validity	Word type	Attend to threat		Attend to non-threat		No-contingency	
			Baseline	Post-training	Baseline	Post-training	Baseline	Post-training
Spatial cueing task	Valid	Neutral	421.11 (60.48)	405.54 (80.40)	402.73 (72.35)	363.33 (55.92)	411.64 (60.87)	400.78 (60.53)
		Threat	425.93 (62.22)	405.22 (80.35)	413.82 (88.58)	365.24 (52.91)	412.12 (72.95)	407.97 (79.29)
	Invalid	Neutral	441.66 (85.33)	464.01 (87.89)	433.45 (130.50)	403.89 (50.04)	476.70 (153.11)	450.04 (84.93)
		Threat	443.05 (82.50)	475.22 (92.82)	445.34 (142.93)	398.45 (72.56)	481.47 (158.97)	448.01 (105.69)
Attention network task	**Network**							
	Alerting		40.18 (25.23)	49.46 (25.80)	47.81 (24.55)	53.17 (23.51)	41.26 (19.63)	47.24 (24.49)
	Orienting		48.21 (28.60)	46.64 (28.99)	51.00 (21.99)	46.56 (17.76)	37.72 (21.23)	36.57 (22.87)
	Executive		97.00 (32.16)	91.54 (31.87)	113.02 (38.19)	95.59 (32.84)	100.72 (35.57)	83.70 (30.62)

Notes: Attend to threat, training to attend to threatening material; attend to non-threat, training to attend to neutral material; no-contingency, training without contingency between cues and probes; alerting, alerting network; orienting, orienting network; executive, executive network.

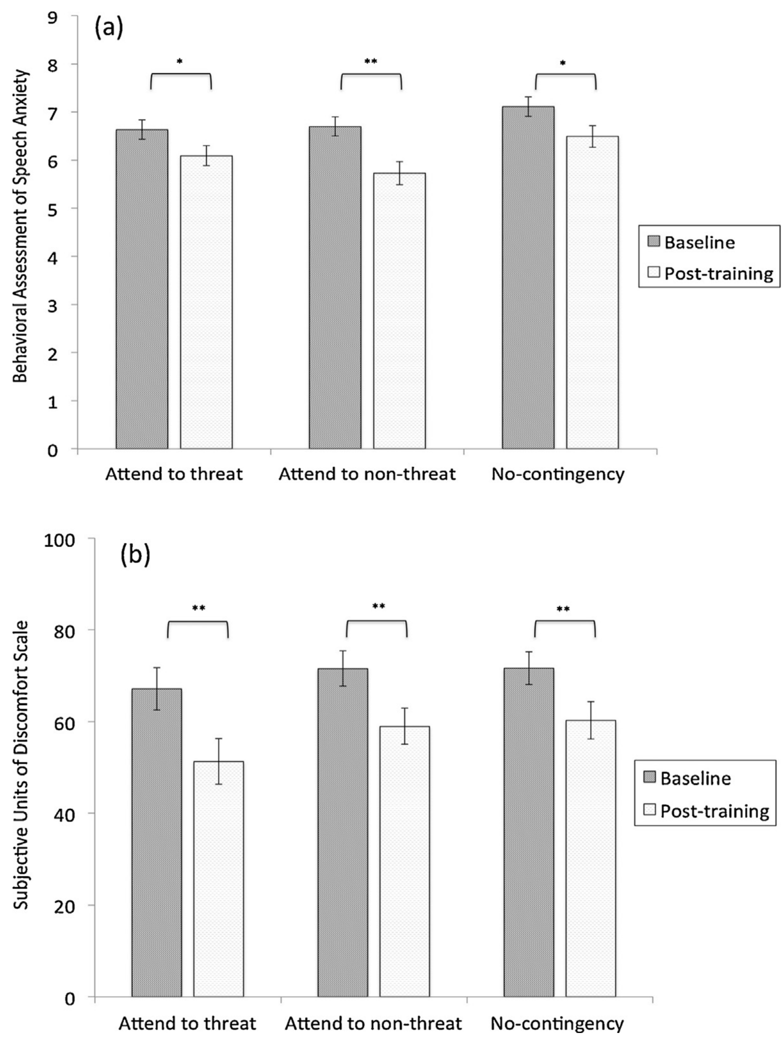

Fig. 1. Change in anxiety reactivity to the impromptu speech challenge as a function of training condition and time. *Note*: scores for the Subjective Units of Discomfort Scale appear on the lower part (b). The upper part (a) depicts the scores for the Behavioral Assessment of Speech Anxiety (mean of the two raters). Error bars represents standard errors of the mean. *$p < .05$; **$p < .01$.

replicates this effect in participants with a DSM-IV diagnosis of SAD who were unaware of the potential anxiolytic benefits of training. Our results are also consistent with randomized controlled trials that reported significant reductions in anxiety symptoms in SAD subjects in the non-contingency group that were just as great as those in the ABM group (e.g., Boettcher, Berger, & Renneberg, 2012; Julian et al., 2012). Interestingly, another study revealed that socially anxious subjects randomized to either ABM or no-contingency conditions exhibited indistinguishably large reductions in anxiety symptoms, and larger reductions than exhibited by participants randomized to a wait-list group (Enock, Hofmann, & McNally, 2014). We also observed improvements on both the executive conflict and the alerting components of attention, regardless of training condition, consistent with Klumpp and Amir's (2010) suggestion that training increases attentional control, irrespective of a contingency, and this may enable increased control over anxious thoughts.

However, we failed to replicate the findings of Amir et al. (2008, 2009) on the spatial cueing task. That is, all groups had faster RTs post-training irrespective of the valence of cues, suggestive of a practice effect alone. There are various potential explanations for our failure to replicate Amir et al.'s findings. First, our participants failed to exhibit an AB at baseline, and Amir et al. (2011) reported found that ABM is most potent with anxious people who exhibit this bias. A comparison between RTs for threatening words on invalid versus valid trials indicated no difficulty disengaging from threat cues at baseline, and hence no AB, $t(60) = 1.04$, $p = .30$. Moreover, participants were not faster to respond to threat than non-threat cues on valid trials $t(60) = 1.28$, $p = .20$, thereby exhibiting no AB indexed by facilitated attention to threat. We then reran all the analyses with AB at baseline as a covariate, but the results were essentially unchanged. Second, improvement in top-down regulation of executive attention may produce clinical benefits (Bomyea & Amir, 2011). All groups exhibited this improvement, suggesting that higher-order cortical structures, such as the prefrontal cortex and its functionally related structures (e.g., anterior cingulate cortex), down-regulate emotion-relevant limbic structures (Miller & Cohen, 2001). For instance, prefrontal cortex and related structures are critically involved in down-regulating amygdala processing during extinction learning (e.g., Myers & Davis, 2007; Quirk, Garcia, & Gonzalez-Lima, 2006). Moreover, merely training executive attention (without emotional stimuli) decreased anxiety in sub-clinical participants (Bomyea & Amir, 2011). On the other hand, nonsignificant correlations between change in anxiety and executive control run counter to this interpretation. Third, exposure to threat faces may have anxiolytic effects in all groups. Yet this cannot explain why ABM has reduced anxiety more than control procedures did in previous studies.

The present findings do not support previous studies showing that ABM outperforms control conditions (e.g., Amir et al., 2009;

Li et al., 2008). In contrast, they suggest that attention training may help alleviate SAD regardless of the presence of a contingency. Taken together, the conclusions of the present study combined with those from previous studies imply that ABM is not yet ready for wide-scale dissemination as a mainstream treatment, nor should it yet be directly marketed to mental health consumers. As pointed out by Clarke, Notebaert, and MacLeod (2014), as is the case for any new psychological intervention, an early objective for researchers prior to disseminating it, must be to optimize capacity to modify the target process, namely, AB for threat.

The present study has several limitations. First, we did not collect follow-up data. As such, one cannot determine whether the effects we observed were more than transient. Second, the fact that our participants did not exhibit an AB at baseline could be considered as a strong limitation that may have hampered the possibility to detect AB changes. Indeed, if reduction in AB mediates the anxiolytic effects of ABM, then such clinical benefits presuppose elevated AB at baseline (Eldar et al., 2012). On the other hand, if ABM works via heightened attentional control, not reduction in AB per se, then the absence of AB at baseline would not preclude anxiolytic effects of ABM. Our findings also raise questions about how common AB is among SAD individuals. It is possible that people develop SAD via pathways other than through AB. It is also possible that extant procedures for assessing AB are insufficiently reliable to detect attentional biases for threat (see McNally et al., 2013; Schmukle, 2005). Finally, we did not evaluate the participants' views on the two topics for the speech task (abortion; marijuana legalization). Accordingly, we cannot determine whether the performance of those who felt strongly about these issues might have been influenced by the intensity of their views. However, the absence of a significant difference between the topic chosen for the speech task on both BASA and SUDS at baseline and post-training ($ts < 1.61$, $ps > .11$) tends to rule out this hypothesis. Future studies should further explore this issue.

In conclusion, the present findings adds to small but growing literature indicating that the mechanisms driving ABM in SAD may be more complicated that initially assumed. Although ABM often reduces SAD symptoms, we found similar improvements among participants exposed to a reverse contingency and to a no-contingency condition. Further, the present study was the first to assess the impact of attention training on the three attention networks assessed by the ANT. Participants exhibited, regardless of the training they received, an improvement on the alerting and executive components of attention. Future studies are needed to identify the moderators influencing when ABM outperforms control conditions.

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