International Journal of Cognitive Therapy, 6(1), 24–39, 2013

A Bayesian Case-Controls Exploration of the Malleability of Attentional Bias for Threat in Social Phobia

Alexandre Heeren and Pierre Maurage
Université catholique de Louvain, Louvain-la-Neuve, Belgium; Fonds National de la Recherche Scientifique, Brussels, Belgium

Pierre Philippot
Université catholique de Louvain, Louvain-la-Neuve, Belgium

Recent studies have demonstrated that training individuals with a social phobia to attend to non-threat is related to short-term (Amir, Weber, Beard, Bomyea, & Taylor, 2008) as well as long-term decrease in anxiety (e.g., Schmidt, Richey, Buckner, & Timpano, 2009). However, to date, no study has examined the adaptation of this attention bias modification procedure into a single-case design for social phobia. Using an attention training procedure based on a modified dot-probe task, the present single-case study examined whether such procedure enabled a client with a social phobia to reduce attentional biases and to transfer this rehabilitation on anxiety response to a speech performance, social anxiety symptoms severity, and diagnosis of social phobia. Using a Bayesian probabilistic approach, case's performances were compared to a normative sample before, after the treatment, at a 2-month follow-up, at a 6-month follow-up, as well as one year after the treatment. The results suggested the efficacy of the rehabilitation program on the attentional bias for threat cues and the generalization of these beneficial effects to decrease in anxiety symptoms during the 2- and 6-month follow-up period. A significant decrease in both subjective and behavioral anxiety during speech performance was also observed. However, a setback of the attentional bias for threat as well as symptoms of social anxiety was observed at the one-year follow-up.

This work was supported by a grant from the Belgian National Fund for Scientific Research, awarded to Alexandre Heeren (1.1.315.09.F), the Specialized Psychological Consulting Center of the Université catholique de Louvain, and by a Joined Research Grant (ARC 06/11-337) from the Belgian French Community, awarded to Pierre Philippot. We thank Nathalie Lefèvre for her statistical advices. We also thank Claire Philippart and Virginie Peschard for their help in the inter-rater agreement as well as Laetitia Debrauwere for her help in data collection. The authors are also extremely grateful to BJ and all the volunteers who took part to this study.

Address correspondence to Alexandre Heeren at the Institute of Psychological Science, Université catholique de Louvain, Place du Cardinal Mercier, 10, B-1348 Louvain-la-Neuve, Belgium. E-mail: Alexandre.Heeren@uclouvain.be or heeren.alexandre@gmail.com.

Across recent years, evidence has accumulated that anxious individuals, regardless of their type of anxiety, appear to demonstrate attentional biases toward threat (e.g., Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007). For people with social phobia, these cues include threatening facial expressions displaying anger or disgust, and words signifying social threat (e.g., *humiliation*). In probe detection and probe discrimination tasks, individuals with social anxiety or social phobia respond faster to probes replacing these cues than to probes replacing neutral cues, thereby exhibiting an attentional bias for threat that is absent in non-anxious control individuals (e.g., Mogg, Philippot, & Bradley, 2004; Pishyar, Harris, & Menzies, 2004). Recent studies have attempted to dismantle this bias to identify which attention component underlies it. Most of these studies used the modified Posner (1980) spatial cueing task, in which a threat (or non-threat) cue appears on either the left or right side of a computer screen, followed by a probe that either replaces the cue or appears on the other side of the screen (e.g., Amir, Ellias, Klumpp, & Przeworski, 2003; Fox, Russo, Bowles, & Dutton, 2001). These studies show that anxious participants are not faster to respond to probes replacing threat than non-threat cues, but they are slower to respond to probes that appear opposite to threat cues relative to non-threat ones. This pattern of results suggests that anxious participants have difficulty disengaging attention from threat (e.g., Amir et al., 2003), rather than being faster to engage attention to threat.

Attentional bias for threat has clinical consequences. First, its re-emergence predicts return of anxiety at follow-up among patients treated for generalized anxiety (Mogg, Bradley, Millar, & White, 1995) and social phobia (Lundh & Öst, 2001). Second, threat-related bias causally influences vulnerability to social anxiety (Heeren, Peschard, & Philippot, 2012). Such findings have led researchers to investigate whether experimentally reducing the attentional bias for threat (attention training) can reduce social anxiety. Based on the landmark study by MacLeod and colleagues (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002), researchers have used a modified version of the dot-probe paradigm (MacLeod, Mathews, & Tata, 1986) to experimentally reduce attentional bias for threat. In the original version of the dot-probe paradigm, participants viewed two stimuli (e.g., a threatening word/photograph and a neutral word/photograph) presented on a computer screen for approximately 500 ms. Immediately after the pictures had disappeared, a probe replaced one of the stimuli. Participants were requested to respond to the probe as quickly as possible. An attentional bias for threat is demonstrated when participants are faster to respond to the probe when it replaces a threatening stimulus than when it replaces a nonthreatening stimulus, thereby implying that the participant's attention was directed to the location occupied by the threatening stimulus. In attention training, researchers typically modify the original task so that the probe nearly always replaces the neutral stimulus, thereby redirecting subjects' attention to non-threat cues.

Li, Tan, Qian, and Liu (2008) observed that, in comparison to a control condition, 7 days of attention training toward positive faces diminished attentional bias for negative faces and reduced self-reported fear of social interaction in

individuals with social phobia. Similarly, Amir, Weber, Beard, Bomyea, and Taylor (2008) compared individuals with a social phobia who completed a single session of attention training toward neutral faces to those who completed a control task in which there was no contingency between the probe and the cues. Relative to those who completed the control task, the individuals who underwent attention training reported reduced anxiety in response to an impromptu speech. Moreover, blind raters judged the speeches of those in the attention training group more positively than the speeches of those in the control group. Further, the authors found that changes in attentional biases for threat mediated the effects of the training on anxiety reactivity, and the decrease in anxiety, in turn, improved speech performance. In a recent study, Heeren, Reese, McNally, and Philippot (2012) replicated these findings and extended them to a decrease in skin conductance responses to stressors, suggesting that attention training does not simply decrease the verbal report of anxiety. Likewise, Schmidt, Richey, Buckner, and Timpano (2009) observed that individuals with social phobia who completed eight sessions of attention training toward neutral faces over a 4-week period exhibited a significantly greater reduction in social anxiety and trait anxiety, when compared to individuals who completed a control condition. At a 4-month follow-up, the training group had improved further on measures of anxiety. Using a similar design, Amir, Beard, Taylor, Klump, Elias, Burns, and Chen (2009) recently replicated these results.

Taken together, these studies suggest that reducing attentional bias for threat can reduce social anxiety. However, no study to date has examined the adaptation of an attention training approach within a single-case design in a treatment-seeking sample. Regarding practitioners, this issue is a decisive one. Indeed, although results from randomized controlled trials clearly suggest the efficacy of attention training for social phobia, a critical issue for attention training research is to establish its efficacy beyond the laboratory. This observation should emphasize that the clinical efficiency of attention training is not merely due to a statistical group mean effect (i.e., the effect of attention training would only occur in high-powered statistical design and would not be strong enough to occur in very small-sized sample). This last point is critical for therapist who would implement such procedure in their practice, because they are usually confronted with a single case. Thus, the present article focuses on the malleability of attentional bias for threat in a single case compared to a matched normative sample of healthy controls. To be consistent with previous experimental work (e.g., See, MacLeod, & Bridle, 2009), we delivered the attention training at one session per day over 14 days. We predicted that attention training would result in improvements in attentional bias and mental health in a client currently experiencing social phobia.

DESIGN AND DATA ANALYSIS

An A-B design (Barlow & Hersen, 1984) with follow-up was implemented. During the baseline period, the therapist met the client weekly in order to administer and collect measures. Following baseline, attention training was delivered at one

session per day over a 14-day period. The attention training was delivered via a computer program in the client's home. After the training, outcomes were assessed. Finally, the client returned to the clinical center 2 months, 6 months, and one year after the final training session for assessment of outcomes.

The statistical recommendations for single-case design of Crawford, Garthwaite, and Porter (2010) were followed. A statistical Bayesian approach was used. There has been an explosion of interest in Bayesian statistical methods over the last decades. The main reason for this is the development of numerical techniques, notably Markov Chain Monte Carlo (MCMC) methods that have solved many of the remaining computational problems formally associated with the application of Bayesian analyses. MCMC methods make inferences by generating a large number of observations from the distribution of the data (for a review, see Andrieu, De Freitas, Doucet, & Jordan, 2003). The essential difference between the classical and the Bayesian approaches is that the classical approach treats parameters as *fixed* but unknown whereas, in the Bayesian approach, parameters are treated as *random* variables and hence has probability distribution.

The single-case adaptation of Bayesian methods from Crawford and Garthwaite (2007) was used. First, this procedure provides a Bayesian hypothesis test. It estimates the probability that a member of the normative sample would exhibit a larger difference than the single case, in either direction. Second, this procedure also provides a point estimate of the effect size *(ZCC)* for the difference between the case and the normative sample (Crawford, Garthwaite, & Howell, 2009). Finally, the Bayesian point estimate and 95% confidence interval for the abnormality of the case's score are reported. The point estimate of the abnormality of the case's score is the Bayesian estimated percentage of the normative sample that would obtain a score lower/higher than the case and the interval estimate quantifies the uncertainty over this percentage. Data analysis were made using SingleBayes_ES.exe (Crawford et al., 2010). This program implements Bayesian methods for comparison of a single case's score to scores obtained in a normative sample.

PARTICIPANTS

Case Report

BJ was a right-handed 64-year-old woman, who is unmarried and lived alone in Belgium at the time of testing. She was a retired computer engineer. At the time of testing, she worked as a volunteer with a mentally handicapped person. She came to the Psychology Department Emotional Consulting Center of the Université catholique de Louvain in Belgium with a complaint of fear of negative evaluation during social interaction and avoidance of social interaction. She had (a) no current substance abuse, (b) no current or past heart, respiratory, neurological problems, (c) no current or past use of psychotropic medications, (d) was not currently engaged in any form of psychological or psychiatric treatment, and (e) had

corrected-to-normal vision. We obtained written informed consent for publishing her data.

Normative Sample

In order to compare the performance of BJ to a normative sample, a matched group was constituted by pairing BJ to participants matched for age (+/- 12 months), gender, education level as well manual laterality, but showing a low level of social anxiety. We recruited 11 females. They were administrated a modified version of the Posner spatial cueing task (assessing attentional bias for threatening stimuli, see below), the State-Trait Anxiety Inventory–Trait version (STAI-Trait; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), the Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996), the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987), the Mini Mental State Examination (MMSE; Crum, Anthony, Basset, & Folstein, 1993), the Attention Self-Assessment (ASA; Coyette, Arno, Leclercq, Seron, Van der Linden, & Grégoire, 1999), and the Mini International Neuropsychiatric Interview (MINI; Lecrubier, Weiller, Bonora, Amorin, & Lépine, 1998). Their characteristics, as well as those of BJ, appear in Table 1. In addition to the absence of a diagnosis of social phobia, all participants: (a) had no current substance abuse, (b) no current or past heart, respiratory, neurological problems, (c) no current or past use of psychotropic medications, (d) were not currently engaged in any form of psychological or psychiatric treatment, and (e) had normal or corrected-to-normal vision. Each participant was tested individually in a quiet room. Participants received compensation (12.5 Euros and a lottery ticket) for their participation. We conducted the study in accordance with the ethical standards of the American Psychological Association. We obtained written informed consent from each participant.

PRE-REHABILITATION ASSESSMENT

Attention Bias Assessment

Materials. The stimuli used for the attention bias assessment task (modified Posner task) were eight disgust (four males and four females) and eight neutral facial expressions (four males and four females). They were selected from the Karolinska Emotional Directed Faces database (Lundqvist, Flykt, & Öhman, 1998), which is a standardized set of emotional expressions. All pictures were adjusted to exclude interference in background stimuli (hair, clothing) so that only the face was presented.

Measure of Attention Bias. For assessing the effects of training on attention to threat cues, BJ was asked to complete a measure of attention bias at baseline and after bias modification. We used a modified version of the Posner spatial cueing task with proportions identical to that reported in Amir et al. (2008). Faces were positioned 4 cm from the top/bottom of the screen, 8 cm from the ipsi-lateral edge, 22.5 cm from the contro-lateral edge, and centered vertically. Each face was 7.5 cm tall by 7.5

cm wide. Disgust or neutral faces appeared in one of two locations on the computer screen (i.e., rectangles located to the right or left of a central fixation cross), thereby directing attention to one of two screen locations (i.e., right or left). After 600 ms, the cue face disappeared, and participants were instructed to detect a probe ("*") that immediately appeared in one of the two locations. The probe remained onscreen until the participant responded, and response latencies were recorded from the onset of the probe to the button press. The intertrial interval from the target offset to the next fixation cross was 1650 ms. On some trials, the cue was valid (i.e., the probe appeared in the same location as the face). On other trials, the cue was invalid (i.e., the probe appeared in the location opposite to the cue face). Participants performed 192 experimental trials, two-thirds of which were validly cued (128 = 8 identities × 2 facial expressions × 2 positions × 4 repetitions), one-sixth were invalidly cued (32 = 8 identities × 2 facial expressions × 2 positions), and one-sixth were uncued. The decision to use these proportions was based on previous research that used the same proportions (Stormark, Nordby, & Hugdahl, 1995). Trial order was randomized for each participant. Participants completed four practice trials (including four neutral faces different from those used during the task) prior to the experimental trials. During the practice trials, participants received feedback regarding the accuracy of their response. Feedback was not provided during the experimental trials. Participants sat approximately 30 cm from the computer screen. In previous research using this task (e.g., Amir et al., 2003), socially anxious participants showed significantly longer response latencies on invalid cued social threat trials compared to non-anxious controls, suggesting that an attentional bias may be due to difficulty in disengaging from threatening stimuli.

Cognitive Evaluation

To ensure that BJ did not show any general cognitive impairment, cognitive formal testing was done. At the Mini Mental State Examination test (Crum, Anthony, Basset, & Folstein, 1993), assessing general cognitive processing (i.e., memory, spatio-temporal orientation, gnosia, praxia, and language), there was no significant difference between BJ and the normative sample. Data appear in Table 1. An ecological measurement of attentional functioning in everyday life, the Attention Self-Assessment (ASA; Coyette, Arno, Leclercq, Seron, Van der Linden, & Grégoire, 1999), was also administrated. The ASA contains 59 questions that assess different aspects of attention (processing speed, tonic alertness, focused attention, divided attention, vigilance, attentional slips, and questions about working memory quality) in everyday situations (e.g., conversation, watching television, reading, personal information). BJ clearly exhibited a good level of general attentional functioning. As shown in Table 1, there was no significant difference between BJ and the normative sample.

TABLE 1. Descriptive Characteristics of the Single-Case to Normative Controls

	Normative Sample		Bayesian Probability		Bayesian Estimated Percentage		Estimated Effect Size
	M	*SD*	Case's score	Probability (two-tailed)	Point	95% CI	ZCC
Age	63.72	1.90	64	.89	55.48%	33.63–76.99	.15
Year of education	18.82	1.60	20	.50	75.19%	52.04–91.83	.74
BDI	9.82	1.60	10	.45	54.19%	31.46–75.91	.11
STAI-Trait	35.27	8.91	42	.24	75.69%	52.60–92.14	.76
ASA	9.09	4.42	7	.33	33.03%	13.87–56.51	.47
MMSE	20.91	.30	30	.39	61.02%	37.76–81.54	.30

Note. BDI = Beck Depression Inventory; STAI-Trait = State-Trait Anxiety Inventory–Trait version; ASA = Attention Self-Assessment; MMSE = Mini Mental State Examination.

Psychopathological Self-Report Assessment

BJ completed the State-Trait Anxiety Inventory (STAI-Trait; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), the Beck Depression Inventory (BDI-II; Beck et al., 1996), and the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987).

The STAI-Trait is a 20-item self-report questionnaire assessing anxiety trait vulnerability. Bruchon-Schweitzer and Paulhan (1993) have reported good psychometric and structural properties of the French adaptation of the scale. BJ showed a low to medium level of anxiety. As shown in Table 1, there was no significant difference between BJ and the normative sample.

The BDI is a 21-item self-report measure of the symptoms of depression. Beck, Steer, and Brown (1998) have reported good psychometric and structural properties of the French adaptation of the scale. BJ presented a low-level of depressive symptoms. As shown in Table 1, there was no significant difference between BJ and the normative sample.

The LSAS is a 24-item scale that measures the anxiety induced by, and the avoidance of, social interaction and performance situations. Yao et al. (1999) and Heeren et al. (2012) have reported good psychometric and structural properties of the French adaptation of the scale. BJ showed a high level of social anxiety. As shown in Table 2, there was a significant difference between BJ and the normative sample.

Semi-Structured Interview

BJ was also administrated the Mini International Neuropsychiatric Interview (MINI; Lecrubier, Weiller, Bonora, Amorin, & Lépine, 1998), a semi-structured interview assessing *DSM-IV* (American Psychiatric Association, 1994) axis I disorders. One assessor administrated the MINI to BJ and all control participants. He had over three years of training in cognitive and behavioral therapy (CBT) and one year of intensive training on using the MINI to make reliable diagnoses.

Responses of BJ on the MINI confirmed the current diagnosis of Generalized Social Anxiety Disorder. A second independent assessor with at least three years of CBT training rated a random portion (i.e., 40%) of the interviews. Inter-rater agreement for the diagnosis was good (k = .96), indicating a very important overlapping between the two ratings.

Speech Task Performance

In order to assess ecological assessment of fear evaluation, we administered a speech task to assess self-report and behavioral responses to a social stressor at baseline, post-training, and follow-up assessment. BJ and control participants began the task, sitting in a chair 30 cm from a computer screen. A set of instructions then appeared and displayed a list of five topics that were widely discussed in the national media at the time of data collection (i.e., global warming, the AH1N1 vaccination program, wearing of the Islamic veil in high-school, alcohol prohibition among minors, the comeback of a former Prime Minister on the national political scene). They were asked to choose one of the five topics. Because BJ performed this task five times, she was not able to select the same topic three times consecutively. The next screen informed participants that they would have to make a two-minute speech about their chosen topic and that their performances would be video-recorded. They were given two minutes 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 in another room. Just before starting the speech, the experimenter asked participants to rate their level of situational anxiety, from 0 (*not anxious*) to 100 (*extremely anxious*), using the Subjective Units of Discomfort Scale (SUDS; Wolpe, 1958). The participant then performed the speech while being video-recorded. Speech performance was rated by two judges with at least three years of CBT training. Speech ratings were scored by the same raters at baseline, post-training, and follow-up. They were blind to clinical condition. The rating scheme was the Behavioral Assessment of Speech Anxiety (BASA; Mulac & Sherman, 1977), which includes 18 molecular categories (e.g., having a clear voice, searching for the words). The total score of these categories has shown excellent concurrent validity with experts' ratings of speech anxiety (Mulac & Sherman, 1977). Inter-rater reliability of the total score was high (BJ and controls, $r = .85$, $p < .05$), suggesting that a mean score of the two raters may be computed.

TREATMENT

Rationale

Attention training procedure was based on a standard probe discrimination task, which was modified to train participants to attend primarily to non-threat cues.

A fixation cross appeared for 500 ms followed either by two facial expressions, a disgust face and a neutral face, presented for 500 ms. Then a probe appeared (i.e., a white arrow), pointing either up or down. The probe remained onscreen until the participant indicated the direction of the arrow by pressing the corresponding button. The inter-trial interval was 1500 ms. The rationale was that a neutral and a threatening face appeared followed by an arrow in the location previously occupied by the nonthreatening face on 95% of the trials.

BJ completed 560 trials in one block. Each of the 70 threatening faces was presented four times, paired with a nonthreatening face of the same individual, in positions that represented all combinations of the locations and probe types. This procedure was repeated two times (i.e., 560 = 70 stimuli × 2 positions × 2 arrow directions × 2 repetitions). The instructions were presented on the computer and were identical for each session. Faces were positioned 4 cm from the top/bottom of the screen, 8 cm from the ipsi-lateral edge, 22.5 cm from the contro-lateral edge, and centered vertically. Each face was 7.5 cm tall by 7.5 cm wide. The attentional training procedure lasted 14 days in total. Over that period, BJ completed a 40-minute training session every day. The computer program was installed on a laptop computer and the training was realized at home.

Materials

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

RESULTS

Measure of Attentional Bias

Data Reduction. Before the main analyses, response latencies from the attention bias assessment were prepared following recommendations from Radcliff (1993). First, trials with incorrect responses were excluded (2.12% of the data). Second, latencies less than 100 ms or greater than 2000 ms were eliminated (.02% of trials with correct responses). Third, response latencies over 2 standard deviations below or above each

TABLE 2. Case-Controls Score on Social Anxiety Measures

	Normative sample		Bayesian probability			Bayesian estimated percentage		Estimated effect size
	M	*SD*	Time	Case's score	Probability (one-tailed)	Point	95% CI	Z_{cc}
LSAS	26.55	17.15	**Baseline**	**97**	**< .01**	**99.85**	**98.72–100**	**4.11**
			Post-training	**59**	**.05**	**95.07**	**80.93–99.81**	**1.91**
			Two-month	54	.08	92.29	75.18–99.39	1.61
			Six-month	49	.11	11.93	68.21–98.25	1.31
			One-year	**81**	**< .01**	**99.40**	**95.41–99.99**	**3.20**
BASA	28	17.96	**Baseline**	**101**	**< .01**	**99.85**	**98.63–100**	**4.07**
			Post-training	**73**	**.02**	**98.13**	**89.59–99.99**	**2.51**
			Two-month	50	.13	86.59	66.05–97.72	1.22
			Six-month	55	.09	90.97	72.83–99.09	1.50
			One-year	**90**	**< .01**	**99.60**	**96.71–100.00**	**3.45**
SUDS	15	7.07	**Baseline**	**85**	**< .01**	**99.99**	**100–100**	**9.90**
			Post-training	**35**	**.01**	**98.90**	**92.78–99.99**	**2.83**
			Two-month	25	.10	89.72	70.77–98.76	1.41
			Six-month	27	.07	93.24	76.98–99.56	1.69
			One-year	**70**	**< .01**	**99.99**	**99.99–100.00**	**7.78**

Note. LSAS = Liebowitz Social Anxiety Scale; BASA = Behavioral Assessment of Speech Anxiety; SUDS = Subjective Units of Discomfort Units. A bold font emphasizes a significant difference between BJ and the normative sample.

participant's mean were discarded as outliers (less than .01% of the remaining trials). At baseline, BJ did not differ significantly from the normative sample in error rates, $t(10) = .98, p = .35$ (two-tailed), nor in outliers, $t(10) = .07, p = .94$ (two-tailed).

Change in Attentional Bias. At baseline, as shown in Table 3, it was estimated that 94.81% of the control population would obtain latencies for invalid threat trials lower than BJ (95% CI = 80.28% to 99.78%). The score meets the criteria for a deficit; that is, the null hypothesis, that the score is an observation from the control population, is rejected ($p = .05$, one-tailed). There were no such differences between BJ and normative controls regarding other type of trials. As mentioned above, reaction times for invalid threat trials is related to the capacity to disengage attention from threat.

At post-treatment, it was estimated that 22.38% of the control population would obtain latencies for invalid threat trials lower than BJ (95% CI = 6.68% to 45.20%). *Consistently, the null hypothesis, that the score is an observation from the control population, was not rejected* ($p = .22$, one-tailed). Similar results were found at 2-month follow-up (Bayesian point estimate of percentage = 45.20, $p = .45$, one-tailed) and at 6-month follow-up (Bayesian point estimate of percentage = 53.27, $p = .47$, one-tailed). However, at one-year follow-up, it was estimated that 95.27% of the control population would obtain latencies for invalid threat trials lower than BJ (95% CI = 81.35% to 99.83%). The score meets the criteria for a deficit; that is, the null hypothesis, that the score is an observation from the control population, is rejected ($p < .05$, one-tailed).

TABLE 3. Case-Controls Performance (i.e., Reactions Times) on the Posner Spatial Cueing Task

	Normative sample		Bayesian probability			Bayesian estimated percentage		Estimated effect size
Condition	***M***	***SD***	**Time**	**Case's score**	**Probability (one-tailed)**	**Point**	**95% CI**	**ZCC**
Valid Neutral	605.03	198.71	Baseline	548.72	.40	35.52	15.75–58.94	.40
			Post-training	478.72	.24	24.42	7.92–47.50	.75
			Two-month	499.72	.28	27.52	9.94–50.86	.65
			Six-month	531.42	.33	32.58	13.54–56.06	.49
			One-year	581.32	.41	41.33	20.38–64.45	.24
Valid Disgust	662.16	196.33	Baseline	491.27	.21	21.22	6.01–43.86	.87
			Post-training	487.68	.21	20.75	5.75–43.31	.89
			Two-month	501.29	.23	22.56	6.79–45.40	.82
			Six-month	564.51	32	32.22	13.27–55.69	.50
			One-year	541.27	.28	28.44	10.58–51.83	.87
Invalid Neutral	746.20	219.89	Baseline	777.19	.45	55.24	32.42–76.80	.14
			Post-training	491.27	.14	13.57	2.33–34.13	1.22
			Two-month	590.78	.26	25.71	8.74–48.90	.71
			Six-month	575.33	.24	23.71	7.48–46.71	.78
			One-year	630.19	.31	31.23	12.55–54.70	.53
Invalid Disgust	639.62	130.98	**Baseline**	**884.42**	**.05**	**94.81**	**80.28–99.78**	**1.87**
			Post-training	531.42	.22	22.38	6.68–45.20	.83
			Two-month	662.67	.45	45.20	23.62–68.01	.13
			Six-month	651.09	.47	53.27	30.64–75.13	.09
			One-year	**892.23**	**.04**	**95.27**	**81.35–99.83**	**1.93**

Note. A bold font emphasizes a significant difference between BJ and the normative sample.

Change in Social Anxiety

LSAS. At baseline, as shown in Table 2, it was estimated that 99.85% of the control population would obtain a score lower than BJ (95% CI = 98.72% to 100%). The score meets the criteria for a deficit; that is, the null hypothesis, that the score is an observation from the control population, is rejected ($p < .01$, one-tailed). Similar difference was found at post-treatment (Bayesian point estimate of percentage = 95.07, $p < .05$, one-tailed). At 2-month and 6-month follow-up assessments, the null hypothesis, that the score is an observation from the normative sample, was not rejected ($p > .05$, one-tailed). At one-year follow-up, however, the null hypothesis was rejected ($p < .01$, one-tailed).

Semi-Structured Interview. At baseline and post-treatment, BJ met the *DSM-IV* criteria of Specific Social Phobia on the MINI. At both 2-month follow-up and 6-month follow-up, she did not meet the criteria for Specific Social Phobia. However, at one-year follow-up, she met the criteria.

Change in Responses to Speech Task

SUDS. As shown in Table 2, it was estimated that 99.99% of the control population would score lower than BJ and the null hypothesis, that the score is an observation from the control population, was rejected ($p < .05$, one-tailed). Similar difference was found at post-treatment (Bayesian point estimate of percentage = 98.90%, $p < .05$, one-tailed). However, at both 2-month and 6-month follow-up assessment, the null hypothesis, that the score is an observation from the normative sample, was not rejected (respectively, $p = 10$ and $p = .07$, one-tailed). At one-year follow-ups, the null hypothesis was rejected ($p < .05$, one-tailed).

BASA. As shown in Table 2, it was estimated that 99.85% of the control population would obtain a score lower than BJ and the null hypothesis, that the score is an observation from the normative sample, was rejected ($p < .01$, one-tailed). Similar difference was found at post-treatment ($p < .02$, one-tailed). However, at both 2-month and 6-month follow-up, the null hypothesis, that the score is an observation from the normative sample, was not rejected ($p = .13$ and $p = .09$, respectively). Again, at one-year follow-ups, the null hypothesis was rejected ($p < .05$, one-tailed).

DISCUSSION

The primary purpose of this study was to examine whether an attention training procedure could be successfully applied, in a regular clinical setting, for a client with social phobia. In accordance to our prediction, the results of this single-case study suggest that individuals who suffer from social phobia may benefit from an attention training procedure, at least up to six months post-treatment. First, as compared to the normative sample, BJ exhibited, after training, shorter latencies to identify probes during invalid threat trials. As mentioned above, previous works have shown that reaction time for invalid threat trials is related to the capacity to

disengage attention from socially threatening words (e.g., Amir et al., 2003). We may therefore infer that the present training targeted the difficulty in disengaging attention from threat. This finding is consistent with Heeren, Lievens, and Philippot (2011) who demonstrated that the difficulty in disengaging attention from disgust faces play a causal role in the maintenance of social phobia. Furthermore, the present design included an independent measure of attention bias which is a spatial cueing task rather than a dot-probe task. That demonstrated that changes in attention generalized to a different measure of attention bias and to a novel set of stimulus. This observation suggests that the training exerts a general impact on the selective processing of the categories of information from which the present training stimuli were drawn.

Second, our study showed that the attention training program had a beneficial effect transferred to some of the client's daily life situation. At 2-month and 6-month follow-up, significant improvement was evidenced in the ecological situation of speech (i.e., behavioral and subjective responses). BJ also reported that certain changes had taken place regarding her social anxiety, as disclosed in the LSAS score. In addition, regarding criteria of Social Phobia, the MINI semi-structured interview revealed the absence of *DSM-IV* diagnosis of Social Phobia at 2-month and 6-month follow-up. These findings revealed that, in the present case, improvement in the ability to disengage attention from threat first occurred, and that this beneficial effect then transferred to the client's daily life.

At a clinical level, this study adds to a growing empirical literature revealing the efficacy of computerized attention training procedures in reducing clinical symptoms in individuals who suffer from social phobia (Amir et al., 2008, Amir et al., 2009, Li et al., 2008; Schmidt et al., 2009). Although the extent of training is modest, totaling no more than a 40-minute period per day over 14 days, and minimal therapist contact, clinical benefits occurred on measures of subjective and behavioral anxiety during a speech performance as well as on self-reported measures of social phobia. Further, the 6-month follow-up assessment revealed maintenance of these benefits. However, these benefits disappeared at one-year follow-up. One cannot exclude that environmental factors (e.g., events, stress, work) have engendered that return of fear. However, it should be noted that the present study is the first one including a follow-up assessment more than four months after treatment (e.g., Schmidt et al., 2009). In that way, it remains difficult to interpret the relapse of BJ at one-year follow-up. In order to solve this issue, future randomized controlled trials should include a one-year follow-up assessment. Future studies might also examine the benefit of including boosting sessions between the 6-month and the one-year follow-up.

Importantly, the convergence of the clinical measures across the different times of assessment should be noted. This finding is critical because it suggests that the benefits of attention training during the 2- and 6-month follow-up were not merely the mirror of error measurement or bias due to self-report assessment. In addition, consistent with a central tenet of several cognitive models of social anxiety that information-processing biases may cause the disorder, social anxiety symptoms decreased when attentional bias for threat disappeared and the relapse

occurred when attentional bias reappeared. This latter observation is clearly consistent with previous accounts noting that the re-emergence of attentional biases for threat after a behavioral therapy predicts the return of anxiety at follow-up among patients treated for generalized anxiety (Mogg et al., 1995) and social phobia (Lundh & Öst, 2001).

Regarding implications for treatments, the present findings suggest that clients may benefit from clinical intervention specifically targeting the ability to disengage attention from threat-related stimuli. At this end, computerized training may be delivered, such as the procedure used in the present article. Likewise, as suggested by Wadlinger and Isaacowitz (2011), mindfulness training may be also used. Indeed, a consensus emerges to suggest that such training might promote effective emotion regulation through the improvement of the ability to disengage attention from threat-related cues and thoughts (e.g., Chiesa & Serretti, 2010; Heeren & Philippot, 2011; Heeren, Van Broeck, & Philippot, 2009).

The present study has limitations. First, one cannot exclude that the improvement may be attributed to spontaneous recovery. Second, because of clinical constraints, the person who administered the training was not blind to the hypothesis of the present study. We could therefore not completely protect against a Rosenthal effect (e.g., Rosenthal & Rosnow, 1997), that one's beliefs and expectations can have influence on the phenomenon under investigation. Finally, given recent evidence that generalized anxious individuals, regardless of their type of anxiety, appear to demonstrate attentional biases toward threat (e.g., Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007), future experiments should examine whether the result underlying the current study generalizes to other anxiety disorders.

In conclusion, the present findings suggested the efficacy of the rehabilitation program on the attentional bias for threat cues and the generalization of these beneficial effects to daily life during the 2- and 6-month follow-up period. A significant decrease in both subjective and behavioral anxiety during speech performance was also observed. Although a setback of the clinical condition of the client was observed at the one-year follow-up, the present data suggest that attention training might be a suitable clinical intervention for social phobia.

REFERENCES

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders (4th ed.)*. Washington, DC: Author.

Amir, N., Beard, C., Taylor, C. T., Klumpp, H., Elias, J., Burns, M., & Chen, X. (2009). Attention training in individuals with generalized social phobia: A randomized controlled trail. *Journal of Consulting and Clinical Psychology, 77*, 961-973.

Amir, N., Ellias, J., Klumpp, H., & Przeworski, A. (2003). Attentional bias to threat in social phobia: Facilitated processing of threat or difficulty disengaging attention from threat? *Behaviour Research and Therapy, 41*, 1325-1335.

Amir, N., Weber, G., Beard, C., Bomyea, J., & Taylor, C. T. (2008). The effects of a single-session attention modification program on response to a public-speaking challenge in socially anxious individuals. *Journal of Abnormal Psychology, 117*, 860-868.

Andrieu, C., De Freitas, N., Doucet, A., &, Jordan, M. (2003). An introduction to MCMC for machine learning. *Machine Learning, 50*, 5-43.

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M., & van Ijzendoorn, M. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin, 133*, 1-24.

Barlow, D. H., & Hersen, M. (1984). *Single case experimental designs: Strategies for studying behavior chance (2nd ed.)*. New York: Allyn & Bacon.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Beck Depression Inventory (BDI) manual (2nd ed.)*. San Antonio, TX: Psychological Corporation. French adaptation, 1998, Paris, France: Editions du Centre de Psychologie Appliquée.

Bruchon-Schweitzer, M., & Paulhan, I. (1993). *Adaptation francophone de l'inventaire d'anxiété Trait-Etat (Forme Y) de Spielberger.* Paris, France: Editions du Centre Psychologie Appliquée.

Chiesa, A., & Serretti, A. (2010). A systematic review of neurobiological and clinical features of mindfulness meditations. *Psychological Medicine, 40*, 1239-1252.

Coyette, F., Arno, P., Leclerq, M., Seron, X., Van der Linden, M., & Grégoire, J. (1999). Questionnaire d'auto-évaluation de l'Attention (QAA). Unpublished manuscript, Centre de Revalidation Neuropsychologique des Cliniques Universitaires Saint-Luc, Brussels, Belgium.

Crawford, J. R., & Garthwaite, P. H. (2007). Comparison of a single case to a control or normative sample in neuropsychology: Development of a Bayesian approach. *Cognitive Neuropsychology, 24,* 343-372

Crawford, J. R., Garthwaite, P. H., & Howell, D. C. (2009). On comparing a single-case with a control sample: An alternative perspective. *Neuropsychologia, 47*, 2690-2695.

Crawford, J. R., Garthwaite, P. H., & Porter, S. (2010). Point and interval estimates of effect size for the case-controls design in neuropsychology: Rationale, methods, implementations, and proposed reporting standards. *Cognitive Neuropsychology, 27*, 245-260.

Crum, R. M., Anthony, J. C., Basset, S. S., & Folstein, M. F. (1993). Population-based norms for the mini-mental state examination by age and educational level. *Journal of the American Medical Association, 269*, 2361-2391.

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General, 130,* 681-700.

Heeren, A., Lievens, L., & Philippot, P. (2011). How does attention training work in social phobia: Disengagement from threat or re-engagment to nonthreat? *Journal of Anxiety Disorders, 25,* 1108-1115.

Heeren, A., Maurage, P., Rossignol, M., Vanhaelen, M., Peschard, V., Eeckhout, C., & Philippot, P. (2012). The self-report version of the Liebowitz Social Anxiety Scale (LSAS): Psychometric properties of the French version. *Canadian Journal of Behavioural Science*, *44*, 99-107.

Heeren, A., Peschard, V., & Philippot, P. (2012). The causal role of attentional bias to threat cues in social anxiety: A test on a cyber-ostracism task. *Cognitive Therapy and Research, 36,* 512-521.

Heeren, A., & Philippot, P. (2011). Changes in ruminative thinking mediate the clinical benefits of mindfulness. *Mindfulness, 2*, 8-13.

Heeren, A., Reese, H. E., McNally, R. J., & Philippot, P. (2012). Attention training toward and away from threat in social phobia: Effects on subjective, behavioral, and physiological measures of anxiety. *Behaviour Research and Therapy*, *50,* 30-39.

Heeren, A., Van Broeck, N., & Philippot, P. (2009). The effects of mindfulness training on executive processes and autobiographical memory specificity. *Behaviour Research and Therapy, 47*, 403-409.

Lecrubier, Y., Weiller, E., Bonora, L. I., Amorin, P., & Lépine, J.-P. (1998). *French adaptation of the Mini International Neuropsychiatric Interview (MINI 5.0.0.)*. Internal report, Unité INSERM 302. Hôpital de la Salpétrière, Paris, France.

Li, S. W., Tan, J. Q., Qian, M. Y., & Liu, X. H. (2008). Continual training of attentional bias in social anxiety. *Behaviour Research & Therapy, 46*, 905-912.

Liebowitz, M. R. (1987). Social phobia. *Modern Problems of Pharmacopsychiatry, 22,* 141-173.

Lundh, L. G., & Öst, L. G. (2001). Attentional bias, self-consciousness and perfectionism in social phobia before and after cognitive-behaviour therapy. *Scandinavian Journal of Behaviour Therapy, 30*, 4-16.

Lundqvist, D., Flykt, A., & Öhman, A. (1998). The Karolinska Directect Emotional Faces–KDEF [CD-ROM]. Departement of Clinical Neuroscience, Psychology section, Karolinska Institute, Stockholm, Sweden.

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 95*, 15-20.

MacLeod, C., Rutherford, E., Campbell, L., Ebsworthy, G., & Holker, L. (2002). Selective attention and emotional vulnerability: Assessing the causal basis of their association through the experimental manipulation of attentional bias. *Journal of Abnormal Psychology, 111*, 107-123.

Mogg, K., Bradley, B. P., Millar, N., & White, J. (1995). A follow-up study of cognitive bias in generalized anxiety disorder. *Behaviour Research Therapy, 33*, 927-935.

Mogg, K., Philippot, P., & Bradley, B. P. (2004). Selective attention to angry faces in clinical social phobia. *Journal of Abnormal Psychology, 113*, 160-165.

Mulac, A., & Sherman, R. (1977). Behavioral assessment of speech anxiety. *Quarterly Journal of Speech, 60*, 134-143.

Pishyar, R., Harris, L. M., & Menzies, R. G. (2004). Attentional bias for words and faces in social anxiety. *Anxiety Stress and Coping, 17*, 23-36.

Posner, M. I. (1980). Orienting of attention. *Quarterly Journal of Experimental Psychology, 32,* 3-25.

Radcliff, R. (1993). Methods for dealing with reaction time outliers. *Psychological Bulletin, 114,* 510-532.

Rosenthal, R., & Rosnow, R. L. (1997). *People studying people: Artifacts and ethics in behavioral research*. New York: Freeman.

Rozin, P., Lowery, L., & Ebert, R. (1994). Varieties of disgust faces and the structure of disgust. *Journal of Personality and Social Psychology, 66*, 870-881.

Schmidt, N. B., Richey, J. A., Buckner, J. D., & Timpano, K. R. (2009). Attention training for generalized social anxiety disorder. *Journal of Abnormal Psychology, 118*, 5-14.

See, J., MacLeod, C., & Bridle, R. (2009). The reduction of anxiety vulnerability through the modification of attentional bias: A real-world study using a home-based cognitive bias modification procedure. *Journal of Abnormal Psychology, 118*, 65-75.

Spielberger, D. C., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory (STAI)*. Palo Alto, CA: Consulting Psychology Press.

Stormark, K. M., Nordby, H., & Hugdahl, K. (1995). Attentional shifts to emotionally charged cues: Behavioural and ERP data. *Cognition and Emotion, 9*, 507-623.

Wadlinger, H. A., & Isaacowitz, D. M. (2011). Fixing our focus: Training attention to regulate emotion. *Personality and Social Psychology Review, 15*, 75-102.

Wolpe, J. (1958). *Psychotherapy by reciprocal inhibition*. Stanford, CA: Stanford University Press.

Yao, S. N., Note, I., Fanget, F., Albuisson, E., Bouvard, M., Jalenques, I., & Cottraux, J. (1999). Social anxiety in social phobics: Validation of Liebowitz's social anxiety scale—French version. *Encephale-Revue De Psychiatrie Clinique Biologique Et Therapeutique, 25*(5), 429-435.