Moderation and mediation of the effect of attention training in social anxiety disorder

Jennie M Kuckertz, Elena Gildebrant, Björn Liliequist, Petra Karlström, Camilla Väppling, Owe Bodlund, Therése Stenlund, Stefan G Hofmann, Gerhard Andersson, Nader Amir and Per Carlbring

Linköping University Post Print

N.B.: When citing this work, cite the original article.

Original Publication:
http://dx.doi.org/10.1016/j.brat.2013.12.003
Copyright: Elsevier
http://www.elsevier.com/
Postprint available at: Linköping University Electronic Press
http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-104628
Moderation and mediation of the effect of attention training in social anxiety disorder

Jennie M. Kuckertz, Elena Gildebrant, Björn Liliequist, Petra Karlström, Camilla Väppling, Owe Bodlund, Therése Stenlund, Stefan G. Hofman, Gerhard Andersson, Nader Amir, Per Carlbring

ARTICLE INFO

Article history:
Received 4 June 2013
Received in revised form 8 October 2013
Accepted 3 December 2013

Keywords:
Social phobia
Social anxiety disorder
Attention
Treatment
Information processing

ABSTRACT

While attention modification programs (AMP) have shown promise as laboratory-based treatments for social anxiety disorder, trials of internet-delivered AMP have not yielded significant differences between active and control conditions. To address these inconsistencies, we examined the moderational and mediational role of attention bias in the efficacy of attention training. We compared data reported by Carlbring et al. (2012) to an identical AMP condition, with the exception that participants were instructed to activate social anxiety fears prior to each attention training session (AMP + FACT; n = 39). We also compared all attention training groups to an internet-delivered cognitive-behavioral therapy (iCBT) condition (n = 40). Participants in the AMP + FACT group experienced greater reductions in social anxiety symptoms than both active (n = 40) and control (n = 39) groups reported by Carlbring et al., and did not differ in symptom reductions from the iCBT group. Higher attention bias predicted greater symptom reductions for participants who completed AMP, but not for the control group. Moreover, change in attention bias mediated the relationship between AMP group (active condition reported by Carlbring et al. versus AMP + FACT) and change in social anxiety symptoms. These results suggest the importance of interpreting findings related to symptom change in attention training studies in the context of bias effects.

Trial registration: ISRCTN01715124

© 2013 The Authors. Published by Elsevier Ltd. All rights reserved.

Behaviour Research and Therapy 53 (2014) 30–40
For example, Amir et al. (2009) examined the effects of an AMP protocol in socially anxious individuals using a variant of the dot-probe detection task (MacLeod et al., 1986; MacLeod, Rutherford, Campbell, Ebowski, & Holker, 2002). In this study, participants were presented with two faces on a computer screen, one above the other. Face pairs comprised a face with a threatening expression (disgust) and a neutral face. After a brief presentation of the faces, the faces disappeared and one of the two faces was replaced by a probe (i.e., the letter ‘E’ or ‘F’). Participants had to indicate with a left or a right mouse click whether the probe was an ‘E’ or ‘F’. In the active training condition (AMP), the probe always appeared in the location of the neutral face, thus directing participants’ attention away from the threatening face. In the attention control condition (ACC), the probe replaced the neutral face 50% of the time, and replaced the threat face 50% of the time. Amir et al. found that after eight sessions, 50% of the active condition, compared to 14% of the control condition, lost their diagnosis of SAD. Moreover, the active condition experienced significantly improved outcomes relative to the control group on social anxiety symptoms, as measured by the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987).

These results have been replicated in independent laboratories (Heeren, Reese, McNally, & Phillippo, 2012; Schmidt, Richey, Buckner, & Timpano, 2009). Schmidt et al. (2009) found that 72% of participants in the active condition, compared to 11% of participants in the control condition, did not meet diagnostic criteria for SAD after eight sessions of attention training. Heeren et al. (2012) compared the efficacy of three attention training conditions (attend towards positive, control condition, and attend towards threat) on social anxiety symptoms, social anxiety-related behavior, and physiological response to a social stressor. These investigators found that after four sessions of attention training, both the attend toward positive and control conditions displayed significant reductions in social anxiety symptoms from pre- to post-treatment; however, these results were only maintained at follow-up for the attend towards positive group. Moreover, behavioral improvements in social anxiety symptoms and reduced physiological response associated with a speech performance task were only demonstrated for the attend towards positive group.

Despite these initial promising results of attention training, several recent RCTs of attention training for SAD have failed to find expected group differences between the active and control attention training groups (Boettcher, Berger, & Renneberg, 2011; Boettcher, Hasselrot, Sund, Andersson, & Carlbring, 2014; Carlbring et al., 2012; Neubauer et al., 2013). While these studies all demonstrated main effects of time such that participants experienced small to medium reductions in social anxiety symptoms, groups did not differ in symptom reduction as demonstrated in previous studies. What would account for these differing results? First, task differences across studies may have influenced the results. For example, Boettcher et al. (2011) and Neubauer et al. (2013) used different facial stimuli sets than that used by both Amir et al. (2009) and Schmidt et al. (2009). Similarly, it is not clear whether laterality effects may have influenced the null findings obtained by Neubauer and colleagues, as they instructed participants to respond to stimuli by using either their right hand or their left hand, whereas Amir et al. (2009) and Schmidt et al. both instructed participants to use the same hand using a left or a right mouse click. Although these factors are in need of further examination, discrepancies across procedures may have accounted for some of the discrepant results.

Of the issues of replicability and procedural standardization in mind, Carlbring et al. (2012) compared the efficacy of active and control attention training conditions in an internet-delivered attention training protocol, with all other task procedures matched to those used by Amir et al. (2009). Carlbring and colleagues found that while both active and control attention training groups experienced reductions in social anxiety symptoms from pre- to post-treatment, these improvements did not vary by condition.

Discrepant findings have sparked discussion questioning the utility of this intervention (Emmelkamp, 2012). More specifically, these discrepant results raise questions regarding why, how, when, and where attention training is effective for individuals with SAD. These questions translate directly into what are the mediators and moderators of response in AMP. The premises of AMP are (a) individuals with social anxiety demonstrate an attentional bias towards threat, and (b) AMP can successfully reduce this attentional bias which in turn will result in a reduction in social anxiety symptoms. One of the advantages of AMP is that questions regarding mechanism of change as well as moderators of response can be readily examined (Maric, Wiers, & Prins, 2012). Unfortunately, these basic questions are not always systematically tested in attention training studies, rendering the interpretation of results difficult.

However, several research groups have tested questions of moderating and mediating factors involved in AMP. For example, there is some evidence to suggest that attention training is most effective for individuals who present with an attention bias for threat at pre-treatment. Amir, Taylor, and Donohue (2011) found that initial level of attention bias at pre-treatment moderated the relationship between assigned attention training condition (active, control) and improvement in social anxiety symptoms.

Researchers have also tested the hypothesis that the mechanism involved in attention training is reduction in attention bias towards threat. Amir et al. (2009) conducted formal mediation analyses showing that change in attention bias mediated the relationship between treatment condition (active, control) and reduction in social anxiety. Similarly, Heeren et al. (2012) found that change in attention bias mediated the relationship between treatment condition and change in physiological reactivity from pre- to post-treatment, as well as fear of negative evaluation from post-treatment to follow-up. Given the theoretical rationale of attention training as well as the results of reported mediational analyses, change in attention bias appears to be an important mechanism involved in AMP and thus studies that fail to demonstrate this change in bias would not be expected to find changes in symptoms. Consistent with this hypothesis, the three studies that failed to find an effect of AMP on symptoms also failed to show an effect of training on attention bias (Boettcher et al., 2011; Carlbring et al., 2012; Neubauer et al., 2013).

One obvious difference between studies that found attention training efficacious and those that failed to find these effects is the location of training (laboratory versus internet). However, it seems unlikely that the location of training would in itself affect the efficacy of this treatment. For example, internet-delivered CBT (iCBT) for SAD has been found to be equally effective as traditional therapist-delivered CBT for SAD (Andrews, Davies, & Titov, 2011; Hedman et al., 2011), although it is also the case that iCBT includes exposures completed outside the home. However, a second related factor, i.e., the amount of naturalistic fear activation that is incorporated into various studies based on location of study (laboratory versus at home) may have influenced the results. Indeed, as some have suggested (Boettcher et al., 2011; Carlbring et al., 2012), perhaps the act of participating in laboratory trials is anxiety-provoking for socially anxious participants and serves as a form of passive exposure, or facing one’s fears, as participants may be putting themselves in situations that involve interacting with authority figures, being supervised by research assistants, and answering personal and sensitive questions outside the safety and comfort of their homes. These naturalistic exposures are unlikely to
account for the effect of the treatment in laboratory-based studies, as in those studies participants in the control condition also experienced the same naturalistic exposures. However, these exposures may have interacted with the active ingredient in AMP, change in bias, to produce the obtained results.

In the current study we aimed to address these questions by exploring potential mechanisms and explanatory factors that may be involved in the efficacy of AMP for social anxiety. To focus on procedural replicability, mechanism of action, and moderators, we began by comparing the data reported by Carlbring et al. (2012) and included two additional groups. This allowed us to retain all factors that were included in the Carlbring et al. study (e.g., sample population, method of assessments, attention training task procedures). The new groups tested two specific questions. First, to test the hypothesis that fear activation may be a critical component in attention training we asked participants to complete an activity that would activate one’s social anxiety prior to each session of the attention modification program (AMP + fear activation; AMP + FACT). Second, to examine whether a similar sample of participants could benefit from social anxiety treatment delivered via internet in a home-based setting, we included an iCBT condition. Several studies have found large effects of therapist-guided iCBT for SAD (e.g., Andersson, Carlbring, & Furmark, 2012), and this was regarded as a credible bona fide treatment comparison. Data from these conditions (iCBT, AMP + FACT) were combined with data from the two conditions (AMPonly, ACC) reported by Carlbring et al. (2012) for analyses in order to systematically compare groups.

Method

Design

The overall design of this study was a 4 (Group: AMPonly, ACC, iCBT, AMP + FACT) × 3 (Time: pre-assessment, post-assessment, follow-up) mixed design. In the current study, participants were randomized to receive either iCBT (n = 40) or AMP + FACT (n = 39). Participants from Carlbring et al. (2012) were randomized to receive either AMPonly (n = 40) or ACC (n = 39). Participants in all groups completed pre-assessment self-report measures at baseline on the phone and using the internet. Participants in the iCBT condition were instructed to complete nine sessions of iCBT, and participants in the attention training conditions were instructed to complete eight attention training sessions. Following treatment, participants in both groups again completed all self-report measures. Finally, participants were assessed at four month follow-up to assess maintenance of treatment gains.

Participants

Participants were recruited via media advertisements during the winter of 2009 (Carlbring et al., 2012) or spring of 2011 (current study), which directed participants to a website that contained information about social anxiety symptoms, CBT, promising results from previous studies of attention training for SAD (Amir et al., 2009; Schmidt et al., 2009), ethical issues, internet security, a description of the study personnel, and information about signing up for the treatment trial. Interested participants completed an application form and a computerized screening battery consisting of the Social Phobia Screening Questionnaire (SPSQ; Furmark et al., 1999), Montgomery and Åsberg Depression Rating Scale self-report version (MADRS–SR; Svanborg & Åsberg, 1994), the remaining outcome measures (see instruments below), and several additional questions regarding current and past treatments. Inclusion criteria were identical across both trials (listed in Carlbring et al., 2012). The SAD diagnosis was evaluated by a telephone interview using diagnostic questions from the SAD section of the SCID–I. Individuals who failed to meet the inclusion criteria were sent an individual encrypted message with advice on how and where to seek more appropriate help.

As evident from the CONSORT flowchart (Fig. 1), of the 234 individuals who were assessed for eligibility 79 were subsequently included and randomized to either the AMP + FACT or iCBT conditions. A CONSORT chart for the AMPonly and ACC groups is presented by Carlbring et al. (2012), in which 112 participants were assessed and 79 were randomized. Demographic data on all included participants are presented in Table 1. Interviewers were blind to condition.

Treatment

Attention training conditions

Participants in the attention training conditions completed a 4-week computerized treatment protocol consisting of eight sessions of attention training delivered twice weekly (see Amir et al., 2009 and Carlbring et al., 2012 for details). The training stimuli consisted of 16 pictures from eight different individuals (four male, four female) with either a disgust or neutral expression. These faces were selected from a standardized facial stimuli set (Matsumoto & Ekman, 1989). In brief, participants saw two faces simultaneously presented on the computer screen for 500 ms, one above the other. The faces then disappeared, and a probe (the letter ‘E’ or ‘F’) appeared in place of either picture. Participants were instructed to respond as to whether the probe was an ‘E’ with a left mouse click or ‘F’ with a right mouse click. The probe appeared on the screen until participants responded. Trials consisted of either a disgust–neutral picture pairing (80% of trials) or a neutral–neutral picture pairing (20%). Each session consisted of 160 trials. Participants in the attention training conditions were encouraged to complete the trainings on Tuesdays and Thursdays. They received an email and an SMS reminding them to complete the training (and fear activation activities, for the AMP + FACT group only) on the training days. If a session was missed, participants received a reminder the following day sent via email and SMS. The participants could only complete the training sessions between 5 AM and 11 PM, and were instructed to complete the sessions with at least one day between sessions.

AMPonly (data from Carlbring et al., 2012)

In trials consisting of a disgust face and neutral face (80%) the probe always appeared in the location of the neutral face, thus training participants to attend to neutral rather than threat stimuli.

ACC (data from Carlbring et al., 2012)

In the ACC condition, the probe replaced the neutral face and disgust face with equal frequency for trials consisting of both disgust and neutral faces.

AMP + FACT (data from current study)

Participants in the AMP + FACT group completed the same attention training program as the AMPonly group (see above). Additionally, to increase the level of naturalistic exposures that are incorporated into the attention training program, participants were asked to challenge themselves with a social anxiety oriented task immediately prior to completing each attention training session. For example, these tasks might include placing a difficult phone call or walking past a crowded room of people. Hence, we asked participants to participate in an anxiety provoking activity immediately prior to the training session.
Participants randomized to the iCBT condition completed a treatment protocol adapted from a previously evaluated self-help manual for SAD (Andersson et al., 2006; Furmark et al., 2009), comprising 186 pages divided into nine lessons adapted for use over the internet. The introductory module described SAD and facts about CBT. Modules 2–4 described a cognitive model for SAD and introduced cognitive restructuring. Modules 5–7 introduced exposure exercises. Modules 8 and 9 focused on social skills and relapse prevention. The manual was originally released as a self-help book for the Swedish market (Furmark, Holmström, Sparthan, Carlbring, & Andersson, 2006), but has also been modified for internet use in several previous randomized trials of iCBT (for a review see Andersson & Carlbring, 2011). However, the iCBT was modified from previous versions in that extra modules specifically targeting low mood and/or panic symptoms were added to complement the treatment for 11.4% of the participants expressing at least subclinical levels of these problems in the diagnostic interview. In addition, we added a component that generally encouraged increased physical exercise, which continued simultaneously with the above modules for the length of treatment. Participants were asked to complete one module every week, i.e., a 9-week treatment period. Each module consisted of information and exercises and ended with a short quiz to self-monitor adherence. Participants were also asked to complete 3–6 essay questions in a weekly email correspondence with their internet therapist. Each of the two therapists spent on average 15 min per patient per week totaling in 135 min per patient for the duration of the iCBT.
Table 1
Demographic description of the participants at pre-treatment.

<table>
<thead>
<tr>
<th></th>
<th>AMPonly (n = 40)</th>
<th>ACC (n = 39)</th>
<th>AMP + FACT (n = 39)</th>
<th>iCBT (n = 40)</th>
<th>Total (N = 158)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>26 (65.0)</td>
<td>28 (71.8)</td>
<td>27 (69.2)</td>
<td>25 (62.5)</td>
<td>106 (67.1)</td>
</tr>
<tr>
<td>Male</td>
<td>14 (35.0)</td>
<td>11 (28.2)</td>
<td>12 (30.8)</td>
<td>15 (37.5)</td>
<td>52 (32.9)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>35.1 (13.3)</td>
<td>38.0 (12.0)</td>
<td>42.0 (13.3)</td>
<td>39.5 (12.0)</td>
<td>38.6 (12.8)</td>
</tr>
<tr>
<td>Education (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not completed high school</td>
<td>1 (2.5)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>1 (2.5)</td>
<td>2 (1.3)</td>
</tr>
<tr>
<td>Completed high school</td>
<td>7 (17.5)</td>
<td>5 (12.8)</td>
<td>2 (5.1)</td>
<td>2 (5.0)</td>
<td>16 (10.1)</td>
</tr>
<tr>
<td>Completed college</td>
<td>10 (25.0)</td>
<td>12 (30.8)</td>
<td>9 (23.1)</td>
<td>10 (25.0)</td>
<td>41 (25.9)</td>
</tr>
<tr>
<td>Completed vocational school</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>5 (12.8)</td>
<td>4 (10.0)</td>
<td>9 (5.7)</td>
</tr>
<tr>
<td>Ongoing university studies</td>
<td>1 (2.5)</td>
<td>0 (0.0)</td>
<td>5 (12.8)</td>
<td>6 (15.0)</td>
<td>12 (7.6)</td>
</tr>
<tr>
<td>Completed university studies</td>
<td>21 (52.5)</td>
<td>22 (56.4)</td>
<td>18 (46.2)</td>
<td>17 (42.5)</td>
<td>78 (49.4)</td>
</tr>
<tr>
<td>Marital status (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married with children</td>
<td>5 (12.5)</td>
<td>5 (12.8)</td>
<td>20 (51.3)</td>
<td>14 (35.0)</td>
<td>44 (27.8)</td>
</tr>
<tr>
<td>Living alone but in a relationship, with children</td>
<td>6 (15.0)</td>
<td>0 (0.0)</td>
<td>3 (7.5)</td>
<td>8 (20.0)</td>
<td>17 (10.8)</td>
</tr>
<tr>
<td>Living alone but in a relationship, without children</td>
<td>12 (30.0)</td>
<td>6 (15.4)</td>
<td>1 (2.6)</td>
<td>2 (5.0)</td>
<td>21 (13.3)</td>
</tr>
<tr>
<td>Single with children</td>
<td>1 (2.5)</td>
<td>6 (15.4)</td>
<td>3 (7.7)</td>
<td>5 (12.5)</td>
<td>15 (9.5)</td>
</tr>
<tr>
<td>Single without children</td>
<td>10 (25.0)</td>
<td>10 (25.6)</td>
<td>11 (28.2)</td>
<td>8 (20.0)</td>
<td>39 (24.7)</td>
</tr>
<tr>
<td>Other</td>
<td>1 (2.5)</td>
<td>0 (0.0)</td>
<td>1 (2.6)</td>
<td>2 (5.0)</td>
<td>4 (2.5)</td>
</tr>
</tbody>
</table>

Measures

Social anxiety disorder
The Liebowitz Social Anxiety Scale self-report version (LSAS-SR; Cox, Ross, Swinson, & Drienfeld, 1998) was the primary outcome measure for this study. This widely-used 24-item measure of social anxiety symptoms is adapted from the original clinician-administered version (Liebowitz, 1987) and has shown good psychometric properties in self-report form (Baker, Heinrichs, Kim, & Hofmann, 2002; Fresco et al., 2001). We also examined social anxiety symptoms using the Social Phobia Scale (SPS; Mattick & Clarke, 1998) and the Social Interaction Anxiety Scale (SIAS; Mattick & Clarke, 1998). These measures have sound psychometric properties when administered via internet (Hedman et al., 2010).

Secondary outcome measures
To assess general anxiety and quality of life, participants completed the Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988) and the Quality of Life Inventory (QOLI; Frisch, Cornell, Villanueva, & Rezliff, 1992), which measures satisfaction in 17 domains of life. These measures have also demonstrated good psychometric properties when administered via internet (Carlbring et al., 2013; Thorndike et al., 2009).

Attention bias (AMPonly, ACC, AMP + FACT conditions only)
In order to assess changes in attention bias, we calculated an attention bias score for the first and last training sessions. These scores represent the difference between trials in which both neutral and disgust faces were presented and trials in which participants saw two neutral faces (D – N trials minus N – N trials; Amir et al., 2011; Koster, Crombez, Verschueren, & De Houwer, 2004; Salemink, van den Hout, & Kindt, 2007). Participants with an attention bias towards threat would have longer response latencies for trials in which the probe replaces a neutral picture in the presence of a threat picture, relative to trials in which no threat is present (N – N trials). Thus, higher bias scores reflect greater attention bias towards threat.1

1 Because the AMP conditions by definition had twice as many trials compared to ACC in which the probe replaced the neutral face in the presence of threat, we calculated bias scores in the AMP groups using only the first half of these trials. Thus, bias scores for all groups were calculated based on an identical number of trials (64 D – N trials and 32 N – N trials, or 96 trials in total).

Procedure
Participants were assigned treatment group (AMP + FACT or iCBT for the current study; AMPonly or ACC for Carlbring et al., 2012) by an online true random-number service independent of the investigators. Participants completed all self-report measures (LSAS-SR, SPS, SIAS, BAI, and QOLI) before the start of the treatment, and again ten weeks after commencing the training. Immediately following the training phase, we used a clinical global impression of improvement (CGI-I) scale to rate participants on a 7-point scale (Guy, 1976) after a telephone interview with a blind assessor who had no earlier contact with the participants and no knowledge of group to which they had been randomly allocated. Finally, to examine maintenance of treatment gains, participants again completed all measures four-months following the post-training assessment. This procedure was approved by the regional ethics committee and informed consent was obtained from all participants via surface mail.

Statistical analyses
We first compared groups on demographic and clinical characteristics at pre-treatment using t tests and chi-squared analyses. Demographic variables that differed between groups at pre-treatment were included as covariates in initial overall analyses, but were dropped from further analyses where they did not appear in any interactions with the factors of interest.
To examine effects on our treatment outcome measures of social anxiety, we submitted scores from the LSAS-SR, SPS, SIAS, BAI, and QOLI to a 4 (Group: ACC, AMPonly, AMP + FACT, iCBT) × 2 (Time: pre, post) Multivariate Analysis of Covariance (MANCOVA), controlling for demographic variables that differed at pre-treatment. Group differences at post-treatment for each social anxiety measure were examined separately using an Analysis of Covariance (ANCOVA), controlling for pre-treatment scores. Significant effects of group were followed up with Tukey’s HSD post-hoc comparisons. Maintenance of treatment gains from pre- to follow-up assessments was assessed in the same method as pre- to post-differences.

Group differences on secondary outcome variables (general anxiety, quality of life) were assessed with an ANCOVA for each measure at both post-treatment and follow-up assessment, controlling for pre-treatment scores and demographic variables that differed between groups. Significant effects of group were examined with Tukey’s HSD post-hoc comparisons using pre-treatment adjusted scores at post-treatment and at follow-up.
We examined clinical significance by using chi-squared tests to determine whether diagnostic status and CGI-I scores differed between groups at post-treatment and follow-up assessments.

We examined the role of attention bias at pre-treatment using moderation analyses of the association between change in social anxiety symptoms and attention training condition (AMP groups, ACC). We also conducted mediation analyses to examine the role of attention bias change as mediating differences between social anxiety change for the AMP + FACT and AMPonly groups.

Analyses were completed on an intent-to-treat basis with the exception of clinical significance analyses, for which we examined a completer sample.

**Results**

**Pre-treatment analyses**

Groups did not differ on age, $F(3, 154) = 2.08, p = .106$, gender, $\chi^2(3) = 0.93, p = .818$, or initial level of social anxiety [LSAS-SR: $F(3, 154) = 0.29, p = .836$; SPS: $F(3, 154) = 0.69, p = .558$; SIAS: $F(3, 154) = 1.88, p = .136$]. Unexpectedly, groups differed on level of education, $\chi^2(15) = 25.71, p = .04$, and marital status, $\chi^2(18) = 63.96, p < .001$. See Table 1 for detailed demographic information and Table 2 for pre-treatment means and standard deviations for symptom measures.

**Treatment adherence**

Attention training conditions

Compliance was high for each of the attention training conditions (AMP + FACT: $M = 8.15, SD = 1.74$; AMPonly: $M = 7.73, SD = 1.26$; ACC: $M = 8.62, SD = 2.15$), with some participants completing more than the scheduled eight sessions. Attention training groups did not significantly differ in the number of sessions completed, $F(2, 115) = 2.56, p = .082$. In the AMP + FACT group, participants self-activated their social anxiety as instructed before approximately half of their attention training sessions ($M = 4.09, SD = 2.87$).

**iCBT**

The number of participants completing all modules of iCBT was lower than attention training completion rates. At post-treatment assessment, 32% of participants randomized to the iCBT condition had completed all nine modules as scheduled. The average number of modules completed was 5.7 ($SD = 3.2$). It should be noted that all iCBT participants were given the remaining modules at post-treatment to complete at their own pace as 74.8% of participants stated that nine weeks was not enough time for the extensive material and exercises that they had to complete in the iCBT group.

**Effect of treatment on social anxiety symptoms**

LSAS-SR scores for each time point are presented in Fig. 2. We first submitted LSAS-SR, SPS, and SIAS scores simultaneously to a 4 (Group: ACC, AMPonly, AMP + FACT, iCBT) × 2 (Time: pre, post) MANCOVA. Because groups differed in education and marital status at baseline, these variables were included as covariates. There were significant main effects of time, $F(1, 152) = 15.50, p < .001, \eta^2_p = .09$, and group, $F(3, 152) = 3.70, p = .013, \eta^2_p = .07$, that were modified by a significant Group × Time interaction, $F(3, 152) = 9.46, p < .001, \eta^2_p = .16$. Marital status and education did not interact with any other factors and were thus dropped from further analyses. We then conducted a separate ANCOVA for each measure of social anxiety to examine the effect of attention group on social anxiety scores at post-treatment, controlling for pretreatment scores. These analyses revealed significant effects of group for all measures [LSAS-SR: $F(3, 153) = 13.50, p < .001, \eta^2_p = .21$; SPS: $F(3, 153) = 6.77, p < .001, \eta^2_p = .12$; SIAS: $F(3, 153) = 11.12, p < .001, \eta^2_p = .18$]. For each measure of social anxiety, we utilized Tukey’s HSD post-hoc comparisons to examine group differences in post-treatment means, adjusted for pretreatment. Across all measures, significantly lower anxiety scores were found for AMP + FACT compared to AMPonly, iCBT compared to AMPonly, AMP + FACT compared to ACC, and iCBT compared to ACC ($ps < .03$). No significant differences were found across any measures when comparing iCBT with AMP + FACT or AMPonly with ACC ($ps > .27$).

**Follow up analyses**

To assess maintenance of treatment gains, we again submitted LSAS-SR, SPS, and SIAS scores simultaneously to a 4 (Group: ACC, AMPonly, AMP + FACT, iCBT) × 2 (Time: pre-training, post-training, and follow up) MANCOVA. Post-treatment and follow up means based on intent-to-treat analyses with last observation carried forward.

![Fig. 2. Liebowitz Social Anxiety Scale-Self Report (LSAS-SR) scores at pre-training, post-training, and follow up assessments. Post-treatment and follow up means based on intent-to-treat analyses with last observation carried forward.](image-url)
AMPOnly, AMP + FACT, iCBT) × 2 (Time: pre, follow-up) MANCOVA, controlling for marital status and level of education. There were significant main effects of time, \(F(1, 152) = 9.57, p < .002, \eta^2_p = .06, \) and group, \(F(3, 152) = 5.41, p = .001, \eta^2_p = .10, \) that were modified by a significant Group × Time interaction, \(F(3, 152) = 16.00, p < .001, \eta^2_p = .24. \) Marital status and education did not interact with group or time and were dropped from further analyses. Consistent with our pre- to post-treatment analyses, we then conducted separate ANCOVAs for each measure of social anxiety to examine the effect of treatment group on social anxiety scores at follow up, controlling for pre-treatment scores. These analyses again revealed significant effects of group for all measures [LSAS-SR: \(F(3, 153) = 27.26, p < .001, \eta^2_p = .35; \) SPS: \(F(3, 153) = 9.55, p < .001, \eta^2_p = .16; \) SIAS: \(F(3, 153) = 14.33, p < .001, \eta^2_p = .22. \) Tukey’s HSD post-hoc comparisons revealed significantly lower social anxiety scores across all measures for AMP + FACT compared to AMPOnly, iCBT compared to AMPOnly, AMP + FACT compared to ACC, and iCBT compared to ACC (ps < .002). No significant differences were found across any measures when comparing iCBT with AMP + FACT or AMPOnly with ACC (ps > .16).

**Effect of treatment on secondary outcome measures**

To examine the effects of treatment on our secondary outcome measures of anxiety and quality of life, we submitted post-treatment BAI and QOLI scores to separate ANCOVAs, controlling for scores at pre-treatment as well as marital status and level of education. There were significant effects of group for both BAI, \(F(3, 151) = 5.14, p = .002, \eta^2_p = .09, \) and QOLI, \(F(3, 151) = 3.95, p = .010, \eta^2_p = .07. \) Tukey’s HSD post-hoc comparisons for pre-treatment adjusted BAI scores at follow up revealed lower levels of anxiety for the iCBT and AMP + FACT groups compared to the AMPOnly group (p < .001 and p = .040, respectively). No other comparisons reached significance (ps > .11). For QOLI scores, post-hoc comparisons revealed significant differences when comparing ACC with AMP + FACT (p = .001) and with iCBT (p = .024), with the AMP + FACT and iCBT groups reporting higher quality of life compared to the ACC group. The AMP + FACT group reported a marginally higher quality of life compared to the AMPOnly group (p = .071).

**Follow up analyses**

We conducted separate ANCOVAs for BAI and QOLI scores to examine group differences at follow up, controlling for pre-treatment scores, marital status, and level of education. These analyses revealed significant effects of group for both BAI, \(F(3, 151) = 6.01, p = .001, \eta^2_p = .11, \) and QOLI, \(F(3, 151) = 4.64, p = .004, \eta^2_p = .08. \) Examining Tukey’s HSD post-hoc comparisons for BAI pre-treatment adjusted follow up scores, the AMP + FACT and iCBT groups demonstrated significantly lower anxiety scores, relative to the AMPOnly group (p = .001 and p < .001, respectively). No other comparisons for anxiety scores were significant (ps > .15). For QOLI scores, post-hoc comparisons revealed higher reported quality of life for the AMP + FACT group compared to the ACC (p < .001) and AMPOnly (p = .001) groups. The iCBT group also reported significantly larger scores than the ACC group (p = .047).

**Clinical significance**

Groups significantly differed on diagnostic status at post-treatment, \(\chi^2 (3) = 12.95, p = .005. \) At post-treatment 12 of 39 (30.8%) participants in the AMP + FACT group and 12 of 40 (30.0%) participants in the iCBT group no longer met criteria for a diagnosis of SAD according to the SPSQ, compared to 2 of 39 (5.1%) participants in the ACC group and 4 of 37 (10.8%) participants in the AMPOnly group.²

We found the following significant results when examining CGI-I scores at post-treatment, \(\chi^2 (15) = 34.61, p = .003: \) very much improved or much improved (ACC: 23.1%, AMPOnly: 8.1%; AMP + FACT: 42.4%, iCBT: 57.1%), minimally improved or no change (ACC: 74.4%, AMPOnly: 89.2%, AMP + FACT: 57.6%, iCBT: 37.1%), and minimally worse or much worse (ACC: 2.6%, AMPOnly: 2.7%, AMP + FACT: 0.0%, iCBT: 5.7%).³

In summary, as reported by Carlbring et al. (2012), our analyses indicate that the AMPOnly group did not differ from ACC in terms of symptom change for social anxiety. However, we also included a third AMP + FACT group from a similar population with identical training instructions to Carlbring et al., with the exception that in the AMP + FACT group, participants were asked to self-activate one’s anxiety prior to attention training sessions. Our results indicate that the AMP + FACT group demonstrated significantly improved social anxiety outcomes relative to either the AMPOnly or ACC groups. Moreover, the AMP + FACT group did not differ from the iCBT group on social anxiety outcome. To examine why the same treatments (e.g., AMPOnly versus AMP + FACT) would differ on social anxiety outcome, we conducted further analyses exploring differences in attention bias among ACC, AMPOnly, and AMP + FACT groups.

**Attention bias**

We examined bias at pre-treatment and change in bias for the AMP + FACT, AMPOnly, and ACC groups. All three groups exhibited a significant attention bias towards threat at pre-treatment, examined as a t test comparison to zero [AMP + FACT: \(M = 48.15, SD = 95.80, t(38) = 3.14, p = .003; \) AMPOnly: \(M = 20.94, SD = 43.31, t(39) = 3.06, p = .004; \) ACC: \(M = 25.57, SD = 70.72, t(38) = 2.26, p = .030. \)] Groups did not significantly differ on their attention bias scores at pre-treatment, \(F(2, 115) = 1.56, p = .214. \) The AMP + FACT group demonstrated a significant decrease in bias from pre-post treatment, \(M = 51.25, SD = 101.68, t(38) = 3.15, p = .003, \) as did the ACC group, \(M = 56.09, SD = 171.60, t(38) = 2.04, p = .048. \) The AMPOnly group did not demonstrate a reduction in bias, \(M = 14.02, SD = 53.31, t(39) = 1.66, p = .104. \)

Prior research has indicated that attention bias at pre-treatment moderates the relationship between attention training treatment condition and symptom improvement (Amir et al., 2011). Furthermore, because the AMP + FACT group demonstrated a significant reduction in attention bias whereas the AMPOnly group did not, we considered the mediational role of attention bias change in explaining differences in social anxiety symptom change between the AMP + FACT and AMPOnly groups. In light of prior research and the present attention bias findings, we conducted formal moderation and mediation analyses to address inconsistencies in symptom improvements between the groups reported by Carlbring et al. (2012) and the AMP + FACT group added in the current study.

**Moderation analyses**

We examined the effect of bias at pre-treatment as a moderator of the relationship between AMP and ACC conditions and change in social anxiety scores. To remain consistent with prior research (Amir et al., 2011), we combined participants from the AMP + FACT

² Post-treatment diagnostic data were not available for three participants in the AMPOnly group.
³ CGI-I data were not available for six participants in AMP + FACT group, five participants in the iCBT group, and three participants in the AMPOnly group.
and AMPonly groups to form a single AMP combined group. A regression model predicting change in LSAS-SR scores from pre- to post-treatment from group (AMPcombined, ACC), bias at pre-treatment, and their interaction (Group × Bias) accounted for a significant proportion of variance in LSAS-SR change scores, $R^2 = 0.07$. $F(3, 114) = 3.00, p = .033$. Specifically, the interaction of Group × Bias was a significant predictor of change in LSAS-SR scores, $\beta = -0.69, t = -2.52, p = .013$. Split-group correlations indicated that for the AMP combined group, higher bias at pre-treatment was associated with greater reduction in LSAS-SR scores, $r(79) = 0.33, p = .003$, whereas no such relationship was present for the ACC group, $r(39) = -0.17, p = .309$. This interaction is represented by Fig. 3. We also conducted regions-of-significance analyses using the Johnson–Neyman technique (Johnson & Neyman, 1936) from the program PROCESS (Hayes, 2012). These analyses indicated that for participants with bias scores greater than 88.65 ms to the highest value observed (460 ms), participants who completed AMP experienced significantly greater reductions in LSAS-SR compared to the ACC group, whereas for participants with a bias less than −99.54 to the lowest values observed (−183 m), the ACC group was associated with greater reductions in LSAS compared to participants who completed AMP.

**Mediation analyses**

We also hypothesized that change in attention bias would mediate the association between AMP groups (AMP + FACT vs. AMPonly) and reduction in social anxiety symptoms, as measured by the LSAS-SR. To establish temporal precedence of the mediator, we examined whether change in bias from pre- to post-treatment mediated the relationship between AMP condition and symptom change from pre- to follow-up assessment. Following the procedure outlined by Preacher and Hayes (2004) we tested the products of (1) the independent variable (Group: AMP + FACT, AMPonly) to the mediator (bias change pre- to post-treatment) ($\alpha$ path: unstandardized beta $= -37.23, SE = 18.20$), and (2) the mediator to the dependent variable (change in LSAS-SR scores pre- to follow-up) when the independent variable is taken into account ($\beta$ path: unstandardized beta $= 0.04, SE = 0.02$). This procedure is a variation on the Sobel (1982) test that accounts for the non-normal distribution of the $z/\beta$ path through bootstrapping procedures (number of resamplings = 5000). Results revealed that the 95% confidence interval of the indirect path ($z/\beta$) did not overlap with zero for reduction in social anxiety symptoms (lower limit $= -4.34$, upper limit $= -0.04$), indicating a mediation effect. Thus, the difference in attention bias scores from pre- to post-treatment mediated the relationship between AMP groups and reduction in social anxiety symptoms.

**Discussion**

In an effort to replicate prior attention training procedures and explain discrepancies between studies, we compared data from the study examining AMPonly versus ACC reported by Carlbring et al. (2012) with two additional conditions. We added an AMP + FACT condition to test the hypothesis that fear activation prior to attention training sessions would increase the efficacy of AMP. To examine whether participants from this sample were able to benefit from at-home treatment, we also included an iCBT condition. Treatment for all conditions was administered via internet.

As reported in Carlbring et al. (2012), AMPonly and ACC groups did not vary differentially for reductions in social anxiety symptoms. However, the AMP + FACT group experienced significantly greater reductions in social anxiety than either the AMPonly or ACC group. Moreover, the AMP + FACT group was equally efficacious as the iCBT group in reduction of social anxiety symptoms. These differences were retained at follow up assessment.

Together, our data suggest that AMP is effective, but that initial attention bias moderated the relationship between treatment condition and symptom improvement, with higher attention bias for participants completing AMP associated with greater reductions in social anxiety whereas initial bias and symptom reductions were not related in the ACC group. This is consistent with previous research conducted by Amir et al. (2011) and also with the data reported by Boettcher et al. (2011), who found that participants did not present with an initial attention bias nor did they experience differential symptom improvements as a result of treatment group. Thus, attention training may not be an effective intervention for individuals who do not have an attention bias towards threat.

Our data also suggest that participants must experience a decrease in attention bias as a result of AMP in order for this intervention to be effective. As such, these data suggest that future studies should consider using this factor (i.e., change in bias as a result of training) as a necessary manipulation check of the intervention. To the extent that the purported mechanism is not affected, null findings would indeed support the hypothesis that attention bias change is a necessary pre-condition for attention bias modification programs.

Given that participants in both AMP groups were recruited from the same population, using the same inclusion criteria, and trained with the same AMP task, why would the AMP + FACT group experience a change in bias while the AMPonly group did not? We included instructions in the AMP + FACT group to engage in an anxiety provoking situation immediately prior to each attention training session. There is theoretical justification to believe that anxious individuals’ attention biases are strongest when in the presence of social anxiety provoking situations. For example, a socially anxious individual may show stronger preferential attention processing of threat-related stimuli (i.e., frowning or bored faces) while giving a speech to a group of people than when that individual is alone at home. Neubauer et al. (2013) discuss the possibility that laboratory based attention training may be more effective based on the activation of fear schemata, thus influencing presence of attention bias. From this perspective, it may be less meaningful to affect change in one’s
attention bias when one does not have a significant attention bias to begin with. Moreover, it may be difficult to transfer enhanced threat disengagement learned in the absence of real-life social stressors to improved threat disengagement in real-life settings. Thus, a goal of attention training might be to enhance one’s ability to disengage from threat when one’s social anxiety fears are activated. However, existing literature regarding the effect of state anxiety on attention bias is mixed (e.g., Amir et al., 1996; Garner, Mogg, & Bradley, 2006; Mansell, Ehlers, Clark, & Chen, 2002). For example, some research using the emotional Stroop paradigm suggests that anxious individuals are better able to suppress attention biases when exposed to high stress conditions (Amir et al., 1996). Continued research in this area is needed to determine the effect of state anxiety on the efficacy of attention training.

Is it possible that participants in the AMP + FACT group experienced their gains because of the exposure alone? Although we cannot test this hypothesis because we did not include an exposure only condition, there are at least two reasons why this is not a likely possibility. First, participants conducted exposures 50% of the time during a relatively short treatment duration (four weeks). Therefore, it is unlikely that two weeks of self-conducted exposure would have had a significant impact on participants’ anxiety. Second, formal exposures conducted in the context of CBT are planned by a therapist and involve developing a hierarchy of systematic exposures to the feared objects, as well as ensuring that the client remains in the anxiety provoking situation until fear subsides or the client learns that nothing catastrophic will happen. Indeed, the iCBT condition differed from the instructions to activate fear in the AMP + FACT condition in that participants were provided with an explanation of cognitive restructuring prior to beginning exposures, were given the rationale for habituation and elimination of safety behaviors, and communicated with their internet therapist regarding completed exposures. Conversely, short, unsystematic exposures are what patients engage in with little relief in their daily lives, in large part due to self-focused attention bias towards threatening beliefs before, during, and after a social encounter, which in turn prevents processing of disconfirming (i.e., benign) evidence (Clark & Wells, 1995).

The context of the exposures in the AMP + FACT group was akin to these naturalistic exposures. Therefore, it is unlikely that these few fear activation activities would by themselves produce the reduction of social anxiety symptoms. However, the fear activation activities may have been necessary for the AMP to take effect thus implying an interactive effect of self-exposure and AMP.

We do, however, acknowledge that it may be possible to derive some therapeutic benefit from placing oneself in social situations in an unstructured or informal way, potentially accounting for some of the benefits seen in the attention training conditions in the current study. This is consistent with gains found in ACC groups in which participants activated their fears via coming to the laboratory to complete sessions (Amir et al., 2009; Heeren et al., 2012; Schmidt et al., 2009). Nevertheless, the fact that these effect sizes were small, and that AMP in laboratory studies yielded significantly greater reductions in symptoms, suggest that exposure alone did not fully account for the obtained benefits.

We intentionally provided limited instructions for fear activation activities in the AMP + FACT group so as to separate them from the more formal, structured exposures introduced in iCBT. However, it is possible that the lack of detailed instruction resulted in reduced compliance rates (i.e., only completed before 50% of AMP sessions) and that the effects of AMP + FACT may have been more pronounced if a greater emphasis was placed on fear activation when introduced to participants.

Our study has limitations. Though participants were recruited from the same population using the same recruitment techniques and inclusion/exclusion criteria, participants were randomized into two separate trials conducted at different time points. While the first trial included a control group comparing AMPonly with ACC, the second trial consisted of two active treatment conditions. Therefore, it is possible that participants in the AMP + FACT group experienced improved outcomes relative to the AMPonly group as a result of treatment expectancy effects. Moreover, by only including these particular groups we were only able to answer certain questions (effect of fear activation plus attention training) and not others (effect of fear activation alone). As our primary symptom severity measure (i.e., LSAS-SR) was based on self-report rather than clinician rating, caution should be noted when interpreting results and comparing to studies that utilized the clinician-rated LSAS.

Another limitation concerns comparability of treatment duration. While the CBT protocol was designed to be completed in four weeks, iCBT modules were spread over nine weeks. This design was selected in order to maximize comparability of each treatment condition with previous studies. At post-assessment, participants in the iCBT condition had completed an average of 5.7 of the nine modules (SD = 3.2), and the majority reported that they did not feel that there was enough time allotted to complete all modules. Post-treatment assessments for both groups were made at 10 weeks following treatment initiation, regardless of whether all sessions had been completed. However, participants in the iCBT group continued to have access to treatment materials and were able to finish their sessions after the post-treatment assessment. As participants in the iCBT condition may not have finished treatment by the post-assessment, it may be unfair to compare this time point for the iCBT group with the results from the significantly shorter CBT protocol. Completion rates for the iCBT condition in the current study were slightly lower than in previous studies using identical iCBT protocols, although these studies have found nine weeks a reasonable time frame to examine the effects of iCBT (e.g., Andersson et al., 2006; M = 7.5 modules completed; Furmark et al., 2009; M = 7.35 and 6.41 modules completed for Trials 1 and 2, respectively). Despite lower completion rates within an identical time frame in the current study, decreases in social anxiety symptoms at post-treatment for the current study were comparable to previous studies in which a higher number of modules were completed (LSAS change: current study, M = 25.55; Andersson et al., 2006; M = 22.9; Furmark et al., 2009; M = 20.32 and 29.73 for Trials 1 and 2, respectively). Moreover, the finding that the iCBT and AMP + FACT groups did not differ on outcome at follow-up is important given that the iCBT groups had access to remaining modules following the post-treatment period, whereas participants in the AMP + FACT condition did not have continued access to the training program.

Though we attempted to establish temporal precedence of our mediator by examining pre- to post-treatment change in attention bias as mediating the relationship between condition and pre-treatment to follow-up change in social anxiety symptoms, this approach is limited in its ability to make causal inferences. Ideally, to establish temporal precedence the mediator and dependent variable should be measured at multiple points throughout the active course of treatment so as to pinpoint when variables are changing in relation to each other (Maric et al., 2012). Our method of bias calculation offers the advantage over other bias measures (e.g., MacLeod et al., 1986) in that we had the capability of measuring bias continually throughout training sessions without relying on the presence of trials in which the probe replaces threat stimuli, which are absent in AMP. Unfortunately, however, we did not assess anxiety level throughout treatment, therefore limiting our analyses. Future research would benefit from weekly assessment of anxiety level. Additionally, more sophisticated data analytic methods such as growth curve or structural equation modeling may be more powerful for conducting longitudinal
mediation analyses using multiple assessment points (Selig & Preacher, 2009).

These limitations notwithstanding, our results suggest that AMP as a self-directed treatment can be equally effective as other home-based treatments, such as iCBT, which has been shown to be an efficacious treatment for SAD across a number of studies (e.g., Andersson et al., 2006, 2012; Berger, Hohl, & Caspar, 2009; Botella et al., 2010; Carlbirg, Gunnarsdóttir, et al., 2007; Tillfors et al., 2011; Titov, Andrews, Schweencke, Drobn, & Einstein, 2008). This is consistent with research showing that a similar form of cognitive bias modification, interpretation training, is equally effective as computerized CBT in reducing social anxiety symptoms (Bowler et al., 2012). Moreover, our data suggest that a number of factors should be considered when interpreting the results of attention training trials. Specifically, AMP may only be successful for individuals who possess an attention bias for threat, and for individuals who experience a reduction in attention bias. Thus, researchers should report modulatory and mediational analyses in their studies and interpret their findings related to symptom change in the context of bias effects.

Acknowledgements

This study was made possible by a generous grant from the Swedish Research Council for Health, Working Life and Welfare (FAS 2009-0222).

References


