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Britton, Gary and Bailey, Helen (2018) Attention bias modification effects on interpretive bias for fear of positive and negative evaluation in social anxiety. Clinical Neuropsychiatry: Journal of Treatment Evaluation, 15 (2). pp. 94-104. ISSN 1724-4935

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Funding

No funding bodies had any input in the design of this study; the collection, analysis and interpretation of data; the writing of the report or in the decision to submit the article for publication.

Conflict of Interest

Gary Britton and Helen Bailey declare they have no conflict of interest.

Informed consent

Informed consent was obtained from all individual participants included in the study.

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Abstract

Cognitive theories of social anxiety include the well-evidenced Fear of Negative Evaluation (FNE), the newer Fear of Positive Evaluation (FPE) and Combined Cognitive Biases hypothesis. Cognitive bias modifications (CBM) have been shown to reduce social anxiety, although research linking CBM to FPE and Combined Cognitive Biases is sparse. A single session of online CBM for attention (CBM-A) to manipulate interpretive bias was utilised, for convenience samples high (n = 42) and low (n = 47) in social anxiety. A visual search face-in-the-crowd paradigm was used, whereby participants saw angry (n = 45) or happy (n = 44) crowd faces, both with neutral target faces. The results show that CBM-A significantly reduces interpretive bias and FNE for participants irrespective of social anxiety level or the emotion of faces shown. The results also show that when happy faces are seen, FPE decreases following CBM-A, but when angry faces are seen, FPE increases following CBM-A. The study provides evidence for home-based self-help therapies for individuals overwhelmed by traditional therapies.

Keywords: Attentional Bias; Cognitive Bias Modification; Fear of Negative Evaluation; Fear of Positive Evaluation; Interpretive Bias; Social Anxiety.

Introduction

Two of the most important early models of social anxiety disorder (SAD; Clark and Wells 1995, Rapee and Heimberg 1997) are largely focused on Fear of Negative Evaluation (FNE; Watson and Friend 1969), whereby those high in social anxiety fear negative appraisals by others, with FNE strongly supported as a central feature of social anxiety in the literature (e.g., Weeks et al. 2005). However, a contemporary theory of social anxiety also includes Fear of Positive Evaluation (FPE; Weeks et al. 2008), whereby those high in social anxiety fear positive appraisals by others. FPE is thought to originate from the anticipation of increased expectations of the socially anxious person in response to the positive performance and therefore greater likelihood of future failure (Weeks et al. 2008) and has been incorporated into an updated model of social anxiety (Heimberg et al. 2010). The novel aspects of the model include the Fear of Positive Evaluation, which is positively correlated to but distinct from Fear of Negative Evaluation (Weeks et al. 2008, Weeks and Howell 2012), and the Combined Cognitive Biases hypothesis (Hirsch et al. 2006).

The Combined Cognitive Biases hypothesis refers to how information processing biases found in SAD interact and influence each other, namely attention bias towards threat relevant stimuli, negative interpretation bias, negative self-view and increased subjective risk (Hirsch and Clark 2004). The Combined Cognitive Biases hypothesis initially focussed on mental imagery of the self and interpretation bias, suggesting that negative self-imagery blocks positive interpretive bias and therefore explains the lack of positive interpretive bias found in social anxiety (Hirsch et al. 2006). The hypothesis also predicts that inducing a more negative interpretive bias via training results in poorer expectations of self-performance (a form of self-view), although this was found for non-socially anxious individuals (Hirsch et al. 2007). Similarly, inducing a negative self-view increases the level of negative interpretive bias in a low socially anxious group (Hirsch et al. 2003) suggesting a bidirectional relationship between the two cognitive biases, albeit for non-socially anxious individuals (Hirsch et al. 2006). Further investigation of the relationships between other cognitive biases is warranted to confirm this aspect of the 2010 model (Heimberg et al. 2010). In addition, FPE has limited associated research (Heimberg et al. 2010), and seemingly none that link FPE and Combined Cognitive Biases specifically, despite the notion that FPE is rooted in concerns about self-performance – one of the cognitive biases. If we accept that negative self-view interacts with and influences interpretive bias as evidenced by Hirsch et al. (2006), it stands to reason that interpretive bias may link to FPE. Therefore, the

current study seeks to address this gap in the literature by investigating the effect on FPE when attention bias is manipulated; as well as confirming the association between cognitive biases by measuring the impact on interpretive bias of an attention bias manipulation, which is a potential treatment for social anxiety.

Recently, implicit forms of computer-based cognitive interventions have been developed to aid in the treatment of SAD, termed Cognitive Bias Modification (CBM), which can be either focused on attention bias modification (CBM-A) or interpretive bias modification (CBM-I). In CBM-A individuals are trained to focus attention away from threat stimuli by being repeatedly exposed to disorder-relevant visual probe tasks. A number of studies have found a significant reduction in both attention bias levels and social anxiety levels from CBM-A (e.g., Amir et al. 2009) including several meta-analyses which suggest a small to moderate effect size (e.g., Bar-Haim et al. 2007) and studies that suggest a medium-term sustained effect (Schmidt et al. 2009). In CBM-I individuals are trained to replace negative interpretations of ambiguous situations with positive interpretations. Similarly to CBM-A, the literature supports the effectiveness of interpretive bias modification for social anxiety (e.g., Amir et al. 2005) and meta-analyses postulate a large effect size for interpretive bias change (Hallion and Ruscio 2011, Menne-Lothmann et al. 2014) with some neurological evidence of interpretive bias in SAD (Moser et al. 2008) as well as cross-cultural evidence (Ishikawa et al. 2012).

Given both attention and interpretive biases are implicated in the aetiology of SAD according to empirically supported cognitive models (Heimberg et al. 2010, Hirsch and Clark 2004) it seems prudent to investigate if these are separate constructs or interrelated with respect to responsiveness to CBM. A small number of studies have linked the two cognitive biases, specifically manipulating interpretation bias towards benign interpretations improved disengagement from threat stimuli (Amir et al. 2010), and improved attentional control (Bowler et al. 2012), and the level of negative interpretations best predicted anxiety symptoms and was correlated to attention bias (Rozenman et al. 2014). Another pilot study combined CBM-A and CBM-I for SAD and found a moderate to large effect size on social anxiety symptoms (Beard et al. 2011). The current study aims to build on this research, whilst focussing on the Bivalent Fear of Evaluation model that covers both Fear of Negative and Fear of Positive Evaluation in SAD (Reichenberger et al. 2015, Weeks and Howell 2012) thereby adding to the literature surrounding the two previously mentioned novel elements of the Heimberg et al. (2010) model. Specifically the research question to be addressed by the current study is: does attentional bias modification in turn affect interpretive bias with

respect to the Bivalent Fear of Evaluation model (Weeks and Howell 2012) for those high and low in social anxiety. As noted above, the effects of an interpretation modification bias on subsequent attention bias has previously been show (e.g., Amir et al. 2010).

With reference to attention bias modification, the face-in-the-crowd paradigm (Hansen and Hansen 1988) has been used with some success to train attention away from a crowd of angry faces towards happy faces (Dandeneau and Baldwin 2004, Dandeneau et al. 2007, Dandeneau and Baldwin 2009). This directly addresses the Fear of Negative Evaluation. There is seemingly no research that seeks to address the Fear of Positive Evaluation in a similar fashion however, thus the current study includes both angry crowds and happy crowds in the attention bias modification since happy faces may be perceived as threatening to those high in social anxiety (Gilboa-Schechtman et al. 1999, Yoon and Zinbarg 2007). Studies have shown that socially anxious individuals have similar latencies when locating neutral faces in happy or angry crowds (Becker et al. 2011, Gilboa-Schechtman et al. 1999, Schmidt-Daffy 2011), suggesting that both types of stimuli (happy or angry) could be perceived as threatening and thus difficult to disengage from for socially anxious individuals and that searching for a neutral face is suitable. Single session implementations of CBM have been shown to be effective (Amir et al. 2010) thus a single session is utilised in the current study, albeit that the effect size is increased if the number of sessions increases (Hallion and Ruscio 2011). A convenience sample will be used since symptoms exist on a continuum (Rapee and Spence 2004) and therefore findings could extrapolate to a clinical sample, without necessitating approaching a vulnerable population. Those low in social anxiety act as a control group in the present study to compare against those high in social anxiety. An ambiguous situations paradigm will be used to measure pre and post-intervention interpretive bias, due to the ecological validity of this method (Menne-Lothmann et al. 2014).

The current study employs a 2 x 2 x 2 factorial mixed measures experimental design, with two between-subjects variables: social anxiety level (High, HSA vs. Low, LSA) and valence of Fear of Evaluation (negative via angry faces vs. positive via happy faces), and time as the within-subjects variable (before vs. after CBM-A). It is hypothesised that:

1: The high social anxiety group will score higher than the low social anxiety group in terms of pre-intervention negative interpretive bias.

2: The negative fear of evaluation group will demonstrate a larger change in interpretive bias and social anxiety scores post-intervention than the positive fear of evaluation group, since the Fear of Negative Evaluation has generally been show to account for more variance in social anxiety scores than the Fear of Positive Evaluation (Weeks et al. 2008, Weeks et al. 2012).

3: Those in the high social anxiety/negative fear of evaluation group will demonstrate a larger change in interpretive bias and social anxiety scores post-intervention than the high social anxiety/positive fear of evaluation group, who in turn will demonstrate a larger change than the low social anxiety/negative fear of evaluation group, who in turn will demonstrate a larger change than the low social anxiety/positive fear of evaluation group.

4: The positive fear of evaluation group will demonstrate a larger change in Fear of Positive Evaluation scores post-intervention than the negative fear of evaluation group.

5: The negative fear of evaluation group will demonstrate a larger change in Fear of Negative Evaluation scores post-intervention than the positive fear of evaluation group.

6: The high social anxiety group will demonstrate a larger change in Fear of Negative Evaluation and Fear of Positive Evaluation scores post-intervention than the low social anxiety group.

Method

Design

The current study is a 2 x 2 x 2 factorial mixed measures experimental design, with the between-subjects variables: social anxiety level (High, HSA vs. Low, LSA) and valence of Fear of Evaluation (negative via angry faces vs. positive via happy faces), and time as the within-subjects variable (before vs. after CBM-A). The dependent variables are interpretive bias score, Fear of Positive Evaluation score, Fear of Negative Evaluation score and social anxiety score. The study consisted of two parts: first a battery of online questionnaires to establish baseline measures and, secondly, a single-session of online cognitive bias modification for attention, directly followed by the same battery of questionnaires from part one to establish levels of change from baseline. Participants were divided into four groups based on the combination of the two between-subject variables, social anxiety level (high or low) and valence of fear (happy or angry faces). Valence of fear was randomly assigned. Since those high in social anxiety have been shown to be more sensitive to stressors (Farmer and Kashdan 2015) which supports the Selective Processing in Anxiety model (Mathews and Mackintosh 1998), possible confounding effects of mood-state were controlled for by measuring state anxiety directly before and after the CBM-A. The difference in state anxiety was included as a covariate in the analysis. The battery of questionnaires before and after CBM-A training included Fear of Negative and Positive Evaluation, social anxiety and interpretive bias measures.

Participants

Meta-analyses have shown a moderate effect size for cognitive bias modification (d = 0.45, Van Bockstaele et al. 2014) therefore in order to provide a power of 0.8 for analysis and assuming significance is set to $\alpha = 0.05$, a sample size of 20 participants per between-subjects condition was required, totalling 80 participants (Friendly 2015). An opportunity sample of participants were recruited via online social media and via the University of Derby research participation scheme. Those recruited from the research participation scheme were awarded participation credit for completing the study. Participants had to declare they were over 18, and not part of a vulnerable population. There was no upper age limit. A total of 95 participants completed part one of the study, with average age 37.92 years (SD = 8.58), 28.4% males, 67.4% females, 4.2% gender not specified. Of these participants, 89 completed part two of the study (drop-out rate = 6.3%), yielding a final sample with ages ranging from 18 years to 78 years old, average age 38.58 years (SD = 8.37), 29.2% males, 68.5% females, 2.2% gender not given, with 86% residing in the UK. High or low social anxiety group was defined by the median Leibowitz Social Anxiety Scale – Self Report version (LSAS-SR) score from part one (median = 39), whereby those higher than the median were

classified as high, and those at or below the median were classified as low, as per previous studies (Helfinstein et al. 2008). The mean LSAS-SR scores before CBM-A (males = 36.9, females = 41.9) are comparable to other internet based studies of convenience (as opposed to clinical) samples (e.g., males = 42.2, females = 45.7; Caballo et al. 2013).

Ethical approval for the current study was obtained from University of Derby. All procedures were performed in accordance with the ethical standards of the British Psychological Society and with the 1964 Helsinki declaration and its later amendments.

Materials

Fear of Negative Evaluation was measured using the Brief Fear of Negative Evaluation Scale (BFNES; Leary 1983). The BFNES had good reliability in the current study ($\alpha = .89$).

Fear of Positive Evaluation was measured using the Fear of Positive Evaluation Scale (FPES; Weeks et al. 2008). The FPES had good reliability in the current study ($\alpha = .88$).

Social anxiety was measured using the LSAS-SR (Baker et al. 2002).This method has been deemed appropriate and reliable for online delivery (Hedman et al. 2010). The LSAS-SR had excellent reliability in the current study ($\alpha = .95$).

Interpretive bias was measured using the Ambiguous Social Situations Interpretation Questionnaire (ASSIQ; Stopa and Clark 2000). This measure has been successfully used in computer-based studies with a number of days between pre and post-test measurement (Bowler et al. 2012, Salemink et al. 2009). In the current study the average number of days between pre and post-test measurement was 8.72 days, which is comparable to the average number of days reported by Bowler et al. (2012: 8 days) and shorter than the average number of days reported by Salemink et al. (2009: 20 days). The ASSIQ questionnaire consists of descriptions of 14 social situations and 10 control situations. Using the ranking question scores, the AASIQ showed excellent reliability in the current study ($\alpha = .91$). Both open-ended and ranking-style responses

from the ASSIQ were used in the current study. Open-ended responses were coded in accordance to predetermined categories from the scale author into negative social, negative non-social, anxiety related, neutral and unclassifiable. A 1-0 indicator variable was generated for each question and each response category, and then summed for each participant such that there is one variable for negative social responses, one for negative non-social responses, and so on. Coding of open-ended responses was validated by a second rater coding data from 7 participants from each of the emotion groups (happy and angry faces). Overall, raters agreed in 93.7% of cases. In cases where raters disagreed, each case was discussed in turn and agreement reached for the final data set.

To control for possible mood-state influences on results, a visual analogue scale for anxiety level that has been shown as reliable for online deployment (Abend et al. 2014) was used directly before and directly after the CBM-A training. This was a sliding scale with the question "How anxious do you feel right now?" where participants could select any level between "calm" at one end of the scale and "anxious" at the other end of the scale. The survey software converted the point selected into a numerical value between 0 and 100, where higher values indicated greater state-anxiety.

For the CBM-A training, a face-in-the-crowd paradigm was used (Hansen and Hansen 1988), with 4 x 4 grids of faces as per previous studies (Dandeneau and Baldwin 2004, Dandeneau et al. 2007, De Voogd et al. 2014) showing either 15 happy expressions and one neutral expression or 15 angry expressions with one neutral expression. Participants were required to find the neutral face in the crowd as quickly as possible. Repeated focus away from emotive faces and towards neutral faces is theorised to help dampen attention biases. The grids measured 8cm (width) x 10.5cm (height) on a standard 16-inch laptop monitor. These stimulus presentations were not standardised, such that they would appear the same size regardless of variations in participant's monitor size and screen resolution. Participants were required to click one of the expressions using their laptop or other device in order to indicate their response. Each grid showed 8 female faces, and 8 male faces. The face with the neutral expression changed person and position on each trial. The pictures of faces were used with kind permission from the Karolinska Directed Emotional Faces (KDEF; Lundqvist et al. 1998) and includes males and females between the ages of 20 and 30 years old with no beards, moustaches, earrings or eye-glasses and limited make-up. All pictures were on a grey background with actors wearing grey t-shirts, with faces angled straight. See figure 1 for an example of each grid. All materials were deployed using Qualtrics software.

Fig 1: Examples of 4 x 4 grids of faces. Left hand side: grid of angry faces with one neutral target face. Right hand side: grid of happy faces with one neutral target face.

Procedure

Participants were recruited via online social media or the University of Derby research participation scheme. In each case a link to part one of the study was made available. Upon clicking on the link, participants were presented with an invitation to participate and the informed consent screen, where they were told the study was about

social anxiety and were given anticipated completion times for part one and part two (25 and 40 minutes respectively). Participants were also informed they would be requested to complete part two approximately a week after part one.

Following completion of the informed consent screen, participants were asked to provide age and gender details, and continued on to complete the LSAS-SR, BFNES, FPES and the ASSIQ. All participants completed the scales in the same order. After approximately a week the necessary sample size had been collected. Participants' data was scored to enable assignment to the low or high social anxiety conditions. Participants were then assigned to either the happy or angry faces conditions. Once group allocations had been made, participants were emailed a link to the appropriate version of part two of the study, where there was a happy faces grid version or an angry faces version.

Once participants clicked on the link to part two of the study, they were presented with information about part two and thanked for their time. Participants were requested to complete part two in one sitting, which consisted of firstly the visual analogue scale question pertaining to state-anxiety levels, secondly the CBM-A which involved 112 trials of finding the neutral face in the grids, thirdly the visual analogue scale again and fourthly the four scales completed in part one. The CBM-A trials were broken down into 4 blocks of 28 grids, with rest breaks allowed between blocks. The block order was randomised between participants using Qualtric's built-in feature. Participants were not permitted to move on from a grid until only the neutral face had been selected, to ensure the training was effective. The number of trials was determined by considering a range of research utilising the face-in-the-crowd paradigm, and taking the smallest number of trials found to be effective in two meta-analyses of CBM-A (Beard et al. 2012, Hakamata et al. 2010). Immediately prior to the CBM-A trials a grid of all the neutral faces was shown to familiarise individuals with the targets, together with instructions on how to complete the CBM-A. Participants were not informed of the number of trials beforehand, to avoid distressing participants and minimise drop-out. Once the CBM-A was complete, state anxiety was captured and the four scales were presented. After the data capture was complete, participants were presented with a debrief form.

Analytic Strategy

After part one and part two data had been combined and scored, initial exploratory data analysis was undertaken to test for assumptions of normality. Normality can be assumed unless otherwise reported. Outliers were removed on the basis of z-scores prior to each individual analysis of covariance (ANCOVA) being performed. The criteria used from removal was +/- 2 standard deviations from the mean (Field 2009). Following this the hypotheses surrounding the moderating effects of CBM-A on interpretive bias for the interactions between high and low social anxiety and happy and angry faces were tested via a mixed measures ANCOVA with the open-ended ASSIQ scores before and after CBM-A forming the within-subjects measure, level of social anxiety (high or low) and emotion of faces seen (happy or angry) forming the between-subjects measures, and difference in state-anxiety before and after CBM-A forming the covariance measure. An initial multivariate analysis of covariance was not conducted prior to the individual ANCOVAs as the primary focus of this study is to examine the effects of the independent variables outlined on each of the dependent variables separately, and therefore multivariate effects are not of particular interest to the aims of the current paper. To further investigate the effects of CBM-A this analysis was repeated firstly by substituting the open-ended ASSIQ scores for the ASSIQ ranking scores before and after as the repeated measure, secondly substituting the LSAS-SR scores before and after, thirdly by substituting the BFNES before and after, fourthly by testing the FPES before and after.

Results

See table 1 for means (and standard deviations) for each dependent variable by social anxiety level. An initial analysis of overall differences (for all participants) before and after CBM-A for the dependent variables was undertaken by paired samples t-tests, which showed significant reductions in interpretive bias (as measured by both ASSIQ open ended questions, $t(88) = 3.83$, $p < .001$, and ASSIQ ranking questions, $t(88) = 2.33$, $p < .022$) and Fear of Negative Evaluation ($t(88) = 3.05$, $p = .003$). Non-significant differences were found for social anxiety level and Fear of Positive Evaluation.

INSERT TABLE 1 HERE.

State Anxiety

As a precursor to the main analyses, to test whether state-anxiety levels differ between groups and between times (before and after CBM-A) and therefore whether this is a valid construct to include as a covariate in later analyses, a 2 x 2 x 2 mixed measures ANOVA was performed, with state-anxiety rating as the dependent variable, time (before CBM-A, after CBM-A) as the within-subjects variable, and social anxiety level (HSA, LSA) and emotion of faces (Happy, Angry) as the between-subjects variables. A borderline significant main effect of time with a small effect size (Cohen 1988) was found ($F(1,85) = 3.14$, $p = .08$, $d = .19$), suggesting that across all groups state anxiety levels increased following CBM-A. A main effect of social anxiety level was found with a small to moderate effect size ($F(1,85) = 11.86$, $p = .001$, $d = .35$) where the mean state anxiety score was higher for the HSA group than the LSA group. This suggests that state anxiety remains different between high and low socially anxious groups before and after CBM-A. These results warrant including state anxiety difference as a covariate in further analyses, given the previously alluded to difference in sensitivities to stressors for those high in social anxiety (Farmer and Kashdan 2015, Mathews and Mackintosh 1998).

ASSIQ: Open Ended Questions (OEQ)

Three outliers were identified and removed from the data using z-scores. A 2 x 2 x 2 mixed methods analysis of covariance was then performed, with ASSIQ open ended negative social scores as the dependent variable, time as the within-subjects variable (before CBM-A, after CBM-A), and two between-subject variables: level of social anxiety (HSA, LSA) and emotion of faces shown (Happy, Angry), and the difference in state-anxiety from the start to the end of the CBM-A as the covariate. There was a significant main effect of time with a moderate effect size ($F(1,81) = 18.64$, $p < .001$, $d = .43$) where the mean score dropped after CBM-A across all groups, suggesting that manipulating attention bias does decrease interpretive bias for both high and low socially anxious participants, regardless of the face-type they were exposed to. There was a significant main effect of social anxiety level with a small to moderate effect size ($F(1,81) = 9.65$, $p = .003$, $d = .33$) where the mean score was higher for the high social anxiety group than the low social anxiety group. This means that a significant difference in interpretive bias exists when we ignore time for the high and low socially anxious groups. There was no main effect for emotion of faces shown, no effect of the covariate and no significant interaction effects between social anxiety level, emotion or time, indicating that CBM-A is as effective on interpretive bias for high and low socially anxious groups and whether happy or angry faces are seen. It may be suggested that the differences found in the negative social scores before and after CBM-A are simply indicative of participants performing a distracting task between interpretive bias

measurements, therefore comparing the control questions (n = 10) to the social questions (n = 14) provides insight into the nature of the effect of the CBM-A. Performing a 2 x 2 x 2 mixed measures ANOVA with difference in open ended score (before CBM-A - after CBM-A) as the dependent variable, question type (Control, Social) as the within-subjects variable, and level of social anxiety (HSA, LSA) and emotion of faces (Happy, Angry) as the between-subject variables, showed a significant main effect of question type with a small effect size ($F(1,82) = 5.19$, $p = .03$, $d = .24$) where the mean difference in score was higher for the social questions than the control questions. This suggests there was a bigger change in interpretive bias for the social questions than the control questions following the CBM-A. No other main effects or interaction effects were significant in this supplementary analysis. See table 2 below for mean and standard deviations for open ended question scores by type.

INSERT TABLE 2 HERE.

ASSIQ: Ranking Questions

Five outliers were removed from the data due to high z-scores. A 2 x 2 x 2 mixed methods ANCOVA was performed, with ASSIQ ranking social scores as the dependent variable, time as the within-subjects variable (before CBM-A, after CBM-A), and level of social anxiety (HSA, LSA) and emotion of faces shown (Happy, Angry) as between-subject variables, and state-anxiety difference as the covariate. There was a main effect of time, with a moderate effect size ($F(1,79) = 27.82$, $p < .001$, $d = .51$) where the mean score dropped after CBM-A across all groups. This indicates interpretive bias decreased for all groups following the CBM-A on both types of measure (open ended and rankings). There was a main effect of level of social anxiety with a small to moderate effect size ($F(1,79) = 10.91$, $p = .001$, $d = .35$) where HSA group mean was higher than the LSA group mean, which suggests a significant difference in interpretive bias between high and low social anxiety groups when time and emotion of faces are ignored. There was no main effect for emotion of faces, no effect of the covariate and no significant interaction effects of time, emotion or level of social anxiety. To further the analysis into the nature of the change in interpretive bias following CBM-A, the control ranking question scores were compared to the social ranking scores by a 2 x 2 x 2 mixed measures ANOVA with difference in ranking score (before CBM-A - after CBM-A) as the dependent variable, question type (Control, Social) as the within subjects

variable, and level of social anxiety (HSA, LSA) and emotion of faces (Happy, Angry) as between-subject variables. This analysis showed no significant main effects or interaction effects. Table 2 shows the mean differences and standard deviations for control and social questions for the ranking style questions.

LSAS-SR

Two outliers were removed from the data due to large z-scores. A 2 x 2 x 2 mixed methods ANCOVA was performed with LSAS-SR score as the dependent variable, time (before CBM-A, after CBM-A) as the within-subjects variable, social anxiety level (HSA, LSA) and emotion of faces (Happy, Angry) as between-subject variables, and difference in state anxiety as the covariate. A main effect of social anxiety level was found with a large effect size ($F(1,82) = 89.78$, $p < .001$, $d = .72$), although this is not meaningful due to stratification. There was a borderline result for an interaction between time and level with a small effect size ($F(1,82) = 3.26$, $p = .075$, $d = .2$) where there was a small decrease in social anxiety levels for those in the HSA group following CBM-A, with no decrease evident for those in the low LSA group. No other main effects, interactions, or covariate effects were close to significance. Table 3 shows the mean differences in LSAS-SR scores between pre and post CBM-A. Following the analysis up with simple effects analysis where LSAS-SR difference (LSAS-SR before – LSAS-SR after) was the dependent variable, and level of social anxiety and emotion of faces seen were the between-subjects variables, showed a non-significant difference between HSA and LSA groups for those seeing angry faces, but a borderline significant difference between HSA and LSA groups for those seeing happy faces ($F(1,83) = 3.45$, $p = .067$). This suggests that for those high in social anxiety, the CBM-A reduced the level of social anxiety for those seeing happy faces when compared to those seeing happy faces but low in social anxiety.

BFNES

Three outliers were removed from the data prior to inferential analysis. A 2 x 2 x 2 mixed methods ANCOVA was performed with BFNES score as the dependent variable, time (before CBM-A, after CBM-A) as the within-subjects variable, social anxiety level (HSA, LSA) and emotion of faces (Happy, Angry) as between-subjects variables, and difference in state anxiety as the covariate. There was a main effect of time with a small to moderate effect size ($F(1,81) = 8.02$, $p = .006$, $d = .3$) where the mean BFNES score decreased after CBM-A, indicating Fear of Negative Evaluation decreases following attention bias modification for all groups regardless of social anxiety

level or face-type seen. There was a main effect of level with a moderate effect size ($F(1,81) = 16.31$, $p < .001$, $d = .41$) where the mean score was higher for the HSA group than the LSA group, which means a significant difference between high and low socially anxious groups for Fear of Negative Evaluation when time and emotion of faces are ignored. There was no main effect of emotion of faces and no significant interaction effects between time, level or emotion, and no significant effect of the covariate. The size of difference in BFNES scores was similar for HSA and LSA groups (see table 3 below), so no follow up analysis was conducted.

FPES

There were no outliers in the data, so all cases were used for analysis ($n = 89$). A mixed methods 2 x 2 x 2 ANCOVA was performed, using FPES score as the dependent variable, time (before CBM-A, after CBM-A) as the within-subjects variable, social anxiety level (HSA, LSA) and emotion of faces (Happy, Angry) as the between-subjects variables, and difference in state anxiety as the covariate. There was no main effect of time and no main effect of emotion of faces. There was a main effect of level of social anxiety with a moderate effect size ($F(1,84) = 19.4$, $p < .001$, $d = .43$) where the mean FPES score was higher for the HSA group than LSA group, suggesting that the HSA and LSA groups remain different on Fear of Positive Evaluation when time and emotion of faces are ignored. There was a significant interaction effect of emotion of faces and time with a small effect size ($F(1,84) = 4.1$, $p = .05$, $d = .22$), where mean FPES score decreased following CBM-A for happy faces, and increased following CBM-A for angry faces. This indicates that where happy faces are seen, Fear of Positive Evaluation decreases following CBM-A, but where angry faces are seen Fear of Positive Evaluation increases following CBM-A. No other interaction effects were significant, and the covariate was non-significant. The mean differences in FPES scores can be seen in table 3 below.

INSERT TABLE 3 HERE.

Discussion

The current study aimed to reinforce the previously found link between different cognitive biases in social anxiety, and to expand upon the involvement of the Fear of Positive Evaluation in social anxiety and responsiveness to a single-session of online cognitive bias manipulation. Stratifying participants based on their Liebowitz Social Anxiety Scale scores provided the expected difference in interpretive bias, Fear of Positive Evaluation and Fear of Negative Evaluation where the highly socially anxious group had higher scores on the three measures at baseline than those low in social anxiety. Overall there was a significant effect of the single session of CBM-A whereby interpretive bias was reduced, furthermore Fear of Negative Evaluation also decreased. This possible causal role of attention bias modification on changes in interpretive bias and Fear of Negative Evaluation represents a novel finding. Previous research has implicated explicit forms of attention training with a reduction in Fear of Negative Evaluation (Donald et al. 2014) where the patient is taught to focus on the task at hand rather than the self. The current study suggests there may also be an impact on FNE when an implicit form of therapy is used (CBM-A). There was also some evidence of a facial-emotion dependent outcome on Fear of Positive Evaluation, where those who saw angry faces showed an increase in FPE post CBM-A, and those who saw happy faces saw a reduction in FPE. This represents new information in addition to the existing literature.

The hypothesis that the highly socially anxious group would exhibit more change in interpretive bias than the group low in social anxiety was not supported, as both groups had similar (significant) reductions in levels of negative interpretive bias for social situations. This potentially links studies of clinical (e.g., Amir et al. 2009) and non-clinical populations (e.g., Dandeneau et al. 2007) that have shown CBM-A to be effective, since approximately 26% of the HSA group reached clinical levels of generalised social anxiety on the LSAS-SR before CBM-A (n = 12 with LSAS-SR > 60). The lack of difference between those high and low in social anxiety in responsiveness to CBM-A also possibly reinforces the notion that social anxiety exists on a continuum (Rapee and Spence 2004) thereby everyone has an element of social anxiety so in turn everyone is responsive to treatment. The open-ended social questions showed a greater reduction in negative interpretive bias post-treatment than the control questions. This suggests the CBM-A paradigm used of face-in-the-crowd is suitably disorder congruent to be effective for social anxiety specifically, as posited by others (Clarke et al. 2013, Pergamin-Hight et al. 2015). Fear of Negative and Positive Evaluation showed higher levels in the high social anxiety group before and after CBM-A, when compared to the low social anxiety group and no significant difference in magnitude of change across groups. The Bivalent Fear of Evaluation theory (Weeks and Howell 2012) therefore

holds for the current study, as those high in social anxiety do have higher fear of evaluation. There was a small but approaching significant reduction in social anxiety levels (from the LSAS-SR) for those high in social anxiety following the CBM-A, with no difference for the low social anxiety group. The small change in LSAS-SR scores is likely linked to the passive nature of CBM-A as other studies have shown that treatments are more effective when a disorder specific stressor is applied, such as being videoed (MacLeod et al. 2002). Since multiple sessions have also been shown to be more effective than single sessions (Hallion and Ruscio 2011) this may also explicate the small change in SAD symptoms.

The hypothesis that angry faces would provide more pronounced changes for Fear of Negative Evaluation, and happy faces would provide more pronounced changes for Fear of Positive Evaluation was partially supported as Fear of Positive Evaluation decreased following CBM-A with the presentation of happy faces, but where angry faces were seen Fear of Positive Evaluation increased following attention bias modification. The converse was not found for Fear of Negative Evaluation, however. The reduction in interpretive bias was similar when angry and happy faces were shown, and there was no difference between those seeing happy and those seeing angry faces at baseline or post-treatment. This suggests that exposure to emotional faces may be effective, regardless of the type of emotion shown as found in other studies (e.g., Gilboa-Schechtman et al. 1999), albeit contested by further studies that found either a preference for angry faces (Hansen and Hansen 1988) or happy faces (Juth et al. 2005) in both socially anxious and healthy populations. This pattern held for the Fear of Negative Evaluation, social anxiety scores (LSAS-SR) and for state anxiety, whereby there were no differences before or after or in the magnitude of change for happy or angry faces. However, there was a significant difference between happy and angry conditions for the Fear of Positive Evaluation where if happy faces were seen, then Fear of Positive Evaluation reduced, whereas seeing angry faces resulted in an increased Fear of Positive Evaluation. This is believed by the authors to be novel finding and potentially strengthens Fear of Positive Evaluation as a cornerstone of social anxiety symptomatology. A reduction in FPE following training to disengage from happy faces may indicate that happy faces are threatening (Becker et al. 2011) and CBM-A training is effective. Fear of Negative Evaluation has been found to be consistently associated with increased social anxiety (Gilboa-Schechtman et al. 1999, Ishikawa et al. 2012, Klumpp and Amir 2009, Miskovic and Schmidt 2012, Mogg et al. 2004, Schmidt-Daffy 2011), and seems to account for more of the variance in social anxiety than FPE (e.g., Weeks et al. 2008), therefore a single session of online CBM-A may not be powerful enough to disengage attention from negatively threatening (angry) faces. Potentially, repeatedly

exposing individuals to crowds of angry faces may reinforce the Fear of Negative Evaluation, rather than extinguish the fear. Given negative faces have been associated with heightened FPE (Sluis and Boschen 2014), and that there is some question about whether the chosen target of a neutral face is perceived as neutral or mildly threatening (Lange et al. 2012), it stands to reason that we might expect an increase in FPE for the angry faces condition.

The hypothesis that highly socially anxious individuals seeing angry faces would show the largest reductions in interpretive bias post CBM-A, followed by HSA and happy faces, then LSA and angry faces, and finally LSA and happy faces was not supported. However, mean difference scores for the social open-ended questions for the LSA and happy group were notably lower than the other three conditions combined (.27 versus .62 respectively) albeit not statistically significant. The trend towards significance involving this effect further strengthens the argument that negatively threatening faces are most potent, and that happy faces may only be perceived as threatening to those high in social anxiety as found in one study that correlated avoidance of happy faces to severity of social anxiety (Gotlib et al. 2004) and a second that found identical results using eye tracking techniques (Horley et al. 2004). There was a significant difference found in the simple effects analysis between LSAS-SR scores for the HSA and LSA groups for happy faces seen, whereby participants high in social anxiety seeing happy faces had a significant reduction in social anxiety symptoms compared to the participants low in social anxiety seeing happy faces. This may be interpreted as providing further strength to the argument that only those high in social anxiety would be affected by the happy faces condition due to their elevated levels of Fear of Positive Evaluation.

There are a number of limitations with the current study. Firstly, the current study directly compared training away from either angry faces or happy faces and did not employ a control group. Whilst we have concluded here that post-training group differences are due to modifications in attention, the possibility that differences are due to some other non-specific effect of the task cannot be discounted. Secondly, in the current study attention bias was not measured either pre-training or post-training. It is therefore not possible to show that training was effective in terms of reducing attention bias, or to explore any between group differences in terms of attention bias post-training. The authors of the present study did not include a measure of attention bias due to the extensive past literature showing an effect of CBM-A on reducing attention bias (e.g., Amir et al. 2009, Amir et al. 2008, Dandeneau and Baldwin 2004, Dandeneau and Baldwin 2009, Dandeneau et al. 2007, De Voogd et al. 2014, Kuckertza et al. 2013, Li et al. 2008, Sluis and Boschen 2014, Taylor et al. 2010, Taylor et al. 2011). However, it is of note that recent CBM-A literature (e.g., Cristea et al. 2015, Clarke et al.

2014, MacLeod and Grafton 2016) has raised concerns that existing CBM-A tasks do not seem to be able to reliably change attentional bias. In this light, it would seem advisable for future studies looking at CBM-A tasks to include a measure of attention bias to ensure that the task has successfully reduced attention bias. Thirdly, as previously discussed, research has found that when a stressor is applied to a cognitive training paradigm the results are more pronounced, which was not utilised in the current study as online deployment of CBM-A meant participants could complete the training in a setting of their choice thereby making application of a disorder-congruent stressor difficult. Furthermore, the online deployment meant participants could start and stop the CBM-A at will, which undoubtedly impedes the effectiveness of the training. However, the average time taken to complete part 1 (27 minutes) and part 2 (43 minutes) of the present study would suggest most participants completed the respective parts in one sitting. Insufficient rigour in the CBM-A process would be rectified in a laboratory setting, however, it may be suggested that should CBM-A be deployed as part of a home-based self-help programme for social anxiety. The current study is ecologically valid and shows there may be gains to this approach. Some results may have failed to reach significance due to a small differential between the low and high social anxiety groups, since a convenience sample was used as opposed to a clinical sample. Replication of the study for a clinical sample versus healthy controls would be beneficial. Moreover, many studies have suggested depression mediates severity of social anxiety (e.g., Bowler et al. 2012) but this was largely ignored in the current study due to a convenience sample being utilised. Finally, the study suffers from a limitation often found when using a primarily undergraduate sample, an under-representation of male participants compared to female participants.

Further to the suggestions for improvements to the current study, future investigation around other CBM paradigms would be beneficial for developing a suite of home-based self-help programmes for those with social anxiety disorder, which may be especially important due to the social interaction difficulties associated with SAD. For example, the dot-probe task has been adapted to use faces for social anxiety with some success (e.g., Amir et al. 2009) which may indicate a combination of visual search and dot-probe tasks could be used to provide the same end-result of a reduction in cognitive biases but with less patient fatigue. Additionally, consideration of the combination of attention bias and interpretive bias modifications as opposed to only CBM-A or CBM-I warrants further investigation to better understand the Combined Cognitive Biases theory (Hirsch et al. 2006) and explore whether there is any incremental benefit to combining CBM-A and CBM-I, since meta-analyses have shown interpretive bias modification to yield a larger effect size than attention bias modification (e.g., Hallion and Ruscio 2011), and a pilot study of combined CBM-I and CBM-A

suggested notable gains (Beard et al. 2011). A small number of studies have also investigated the effectiveness of computerised cognitive behaviour therapy (cCBT) in contrast to CBM (Bowler et al. 2012, Kuckertza et al. 2013, Mobini et al. 2014), which may provide another tool for a home-based treatment suite for those who have social anxiety. Wider consideration of the application of cCBT and CBM to other conditions such as agoraphobia may also yield useful results, due to symptoms of the disorder that would possibly prevent an individual seeking help outside the home. Providing an evidence-based suite of home based self-help therapies may provide many individuals with the first step towards a healthier existence.

Conclusion

In conclusion, the current study provides an important step towards better understanding of how the cognitive biases found in social anxiety interact and respond to implicit manipulation, and how they relate to the specific fears of evaluation. Attentional bias modification provides significant reductions in interpretive bias after just one online session. Fear of Positive Evaluation has a unique relationship with emotion of faces shown in the attention bias modification, thereby adding weight to this cognitive theory of social anxiety. The ecological validity in the context of developing a home-based self-help programme is supported in the current study, and paves the way for future studies to further develop this idea.

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	High Social Anxiety				Low Social Anxiety			
	Angry (*n* = 21)*		Happy (*n* = 21)*		Angry (*n* = 24)*		Happy (*n* = 23)*	
Variable	Before CBM-A	After CBM-A	Before CBM-A	After CBM-A	Before CBM-A	After CBM-A	Before CBM-A	After CBM-A
ASSIQ: Open ended neg social	3.05 *(3.10)*	2.50 *(3.00)*	3.02 *(3.25)*	2.38 *(3.32)*	1.26 *(1.98)*	0.61 *(2.49)*	1.32 *(1.67)*	1.04 *(2.06)*
ASSIQ: Rankings social	1.65 *(0.51)*	1.52 *(0.53)*	1.63 *(0.53)*	1.50 *(0.50)*	1.25 *(0.35)*	1.19 *(0.40)*	1.41 *(0.38)*	1.23 *(0.26)*
LSAS-SR	58.42 *(22.66)*	57.79 *(22.75)*	56.67 *(15.23)*	53.67 *(16.90)*	25.08 *(9.32)*	26.20 *(10.86)*	25.39 *(9.51)*	27.09 *(14.35)*
BFNES	41.80 *(9.01)*	40.60 *(8.99)*	41.24 *(8.42)*	39.81 *(8.99)*	31.67 *(8.83)*	30.54 *(9.70)*	35.29 *(11.17)*	32.81 *(12.13)*
FPES	37.57 *(14.19)*	40.19 *(17.02)*	32.24 *(13.81)*	33.43 *(10.90)*	19.67 *(17.02)*	23.29 *(15.12)*	24.09 *(17.80)*	20.91 *(17.18)*

Table 1: Means (*and standard deviations*) for each dependent variable by social anxiety level, emotion of faces seen and time. ASSIQ = Ambiguous Social Situations Interpretations Questionnaire; LSAS-SR = Liebowitz Social Anxiety Scale – Self Report version; BFNES = Brief Fear of Negative Evaluation Scale; FPES = Fear of Positive Evaluation Scale. *number of participants before outliers removed; figures shown are after outliers were removed.

Type of question\situation	High Social Anxiety		Low Social Anxiety	
	Happy (*n* = 21)	Angry (*n* = 21)	Happy (*n* = 24)	Angry (*n* = 23)
Open Ended Social	0.64 *(1.16)*	0.74 *(1.73)*	0.57 *(1.75)*	0.46 *(1.22)*
Open Ended Control	0.19 *(0.81)*	0.07 *(0.78)*	0.33 *(1.02)*	0.31 *(0.86)*
Ranking Social	0.17 *(0.28)*	0.13 *(0.29)*	0.08 *(0.38)*	-0.03 *(0.37)*
Ranking Control	0.12 *(0.22)*	0.09 *(0.15)*	0.06 *(0.29)*	0.01 *(0.25)*

Table 2: Mean difference scores *(and standard deviations)* before and after CBM-A for open ended and ranking style questions.

	High Social Anxiety		Low Social Anxiety	
Measure	Happy (*n* = 21)	Angry (*n* = 21)	Happy (*n* = 24)	Angry (*n* = 23)
LSAS-SR	3.00 *(8.47)*	0.63 *(10.41)*	-1.70 *(8.09)*	-1.13 *(6.57)*
BFNES	1.43 *(3.60)*	1.20 *(5.61)*	2.48 *(5.95)*	1.13 *(3.64)*
FPES	-1.19 *(7.65)*	-2.62 *(9.22)*	3.17 *(10.35)*	-3.63 *(8.76)*

Table 3: Mean score differences before and after CBM-A (*and standard deviations*) for remaining dependent variable by social anxiety level, emotion of faces seen and time. LSAS-SR = Liebowitz Social Anxiety Scale – Self Report version; BFNES = Brief Fear of Negative Evaluation Scale; FPES = Fear of Positive Evaluation Scale.