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# A multi-session interpretation modification program: Changes in interpretation and social anxiety symptoms

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## Abstract

Previous research suggests that socially anxious individuals interpret ambiguous social information in a more threatening manner compared to non-anxious individuals. Recently, studies have experimentally modified interpretation and shown that this subsequently affected anxiety in non-anxious individuals. If similar procedures can modify interpretation biases in socially anxious individuals, they may lead to a reduction in social anxiety symptoms. In the current study, we examined the effect of a computerized Interpretation Modification Program (IMP) on interpretation bias and social anxiety symptoms. Twenty-seven socially anxious individuals were randomly assigned to the IMP or a control condition. Participants completed eight computer sessions over four weeks. The IMP modified interpretation by providing positive feedback when participants made benign interpretations and negative feedback in response to threat interpretations. The IMP successfully decreased threat interpretations, increased benign interpretations, and decreased social anxiety symptoms compared to the control condition. Moreover, changes in benign interpretation mediated IMP's effect on social anxiety. This initial trial suggests that interpretation modification may have clinical utility when applied as a multi-session intervention.

### Keywords

Social anxiety; Interpretation; Information processing; Treatment; Training

## Introduction

Interpretation bias is the tendency to interpret ambiguous information in a threatening manner. An interpretation bias may be particularly influential in individuals with social anxiety because social cues are often ambiguous and thus easily distorted (Clark & Wells, 1995). For example, it is difficult to know if a conversation partner's yawn indicates boredom (threat interpretation) or exhaustion (benign interpretation). Cognitive models (Clark & Wells, 1995; Rapee & Heimberg, 1997), as well as empirical findings (see below) implicate interpretation biases in the maintenance of social anxiety.

A number of studies have supported the role of interpretation bias in social anxiety. Most studies have found that socially anxious individuals favor threat interpretations compared to non-anxious controls (e.g., Amir, Foa, & Coles, 1998; Huppert, Foa, Furr, Filip, & Mathews, 2003; Roth, Antony, & Swinson, 2001; Stopa & Clark, 2000; Voncken, Bogels, & Vries, 2003). Additionally, some studies have found that socially anxious individuals also



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lack a benign interpretation bias exhibited by non-anxious individuals (Constans, Penn, Ihen, & Hope, 1999; Hirsch & Mathews, 1997, 2000). Together, these studies suggest that socially anxious individuals make fewer benign interpretations and more threat interpretations than nonanxious individuals. It is possible that procedures that induce a benign interpretation bias or reduce threat interpretation bias may also reduce social anxiety symptoms.

Cognitive Bias Modification (CBM) procedures are well suited to modify interpretation bias. CBM refers to the experimental modification of cognitive biases, allowing researchers to examine the effect of modification on the constructs of interest (e.g., anxiety, depression, alcohol consumption, body dissatisfaction). For example, Grey and Mathews (2000) used homographs (i.e., words with multiple meanings, e.g., 'mean' can imply 'average' or 'nasty'), to modify interpretation in non-anxious individuals. In one experiment, participants saw homographs followed by target words. Depending on a participant's randomly assigned condition, the target word either implied a threat ('nasty') or a benign ('average') meaning of the homograph ('mean'). Participants decided whether or not the two words were related. When tested later with new homographs, participants in the threat condition were faster to respond to threat interpretations in a lexical decision task. Similarly, participants in the benign condition were faster to respond to benign interpretations. Thus, the procedure successfully induced interpretation biases that generalized to novel stimuli.

Extending these findings, research suggests that inducing different interpretation biases can causally affect anxiety (e.g., Mathews & Mackintosh, 2000; Wilson, MacLeod, Mathews, & Rutherford, 2006). For example, in Wilson et al. (2006), participants completed either a threat or benign interpretation induction and then viewed stressful videos. Participants who received the threat induction displayed significant elevations of state anxiety in response to the stressor, whereas participants in the benign condition did not. These findings suggest that modifying interpretation can affect anxiety reactivity. The effect on state anxiety also suggests that similar procedures could be used to reduce anxiety in anxious individuals.

The above studies demonstrated that a single CBM session can modify interpretation bias and that such modification can affect state anxiety in non-anxious individuals. Mathews, Ridgeway, Cook, and Yiend (2007) extended these findings by increasing CBM from a single session to four sessions and by assessing trait anxiety one week later. High trait anxious individuals completed a CBM program that presented ambiguous scenarios, each resolved in an increasingly positive manner over the four sessions (completed over two weeks). The control group completed only a pre-assessment and post-assessment two weeks later. Results showed that the active group's interpretation was more positive and less negative than the control group at post-assessment. Moreover, one week following the post-assessment the active group had significantly lower trait anxiety scores than the control group, once pretraining scores were partialled out.

To our knowledge, only one study (i.e., Murphy, Hirsch, Mathews, Smith, & Clark, 2007) has examined interpretation modification in socially anxious individuals. In that study, participants who received a benign interpretation induction reported feeling less anxious about a future social situation compared to the control group. This effect on anticipatory anxiety was obtained from a single session of CBM. However, no study has examined the effect of multiple sessions of interpretation modification on symptoms of social anxiety. The changes in trait anxiety observed in Mathews, Ridgeway, Cook, and Yiend (2007) suggest that increasing the number of sessions could lead to changes in social anxiety symptoms.

In summary, evidence from correlational and experimental studies suggests that interpretation bias is involved in the maintenance of social anxiety and that interpretation is

malleable via CBM procedures. With the exception of Murphy et al. (2007), researchers have only modified interpretation bias in non-anxious or generally anxious individuals. Additionally, most previous studies have examined brief effects of a single session of interpretation modification on state anxiety. We currently do not know if interpretation modification procedures will affect social anxiety symptoms in addition to state anxiety.

The current study addresses several of these limitations by examining the effect of interpretation modification on social anxiety symptoms. To this end, we evaluated a computerized Interpretation Modification Program (IMP) designed to change interpretation bias in socially anxious individuals in eight computer sessions delivered twice weekly. In previous interpretation modification programs, researchers have guided participants toward either a threat bias *or* a benign bias. However, because social anxiety involves both a lack of benign bias and the presence of a threat bias, we designed the IMP to guide participants toward making benign interpretations *and* rejecting threat interpretations. We examined the effect of IMP on interpretation bias compared to a control condition. Unlike previous studies that aimed to affect state anxiety, the current study aimed to change symptoms of social anxiety.

We tested four hypotheses: Participants completing the IMP would (a) endorse more benign interpretations than the control group at post-assessment, (b) endorse fewer threat interpretations than the control group at post-assessment, and (c) report fewer social anxiety symptoms than the control group at post-assessment. Moreover, we hypothesized that induced interpretation bias would mediate the effect of group assignment on social anxiety. We examined the above hypotheses in a randomized, double-blind study.

## Methods

### Participants

Participants included 27 students who scored 92 (75th percentile, Gillis, Hagga, & Ford, 1995) or above on the Social Phobia and Anxiety Inventory, Social Phobia Subscale (SPAI-SP; Turner, Beidel, Dancu, & Stanley, 1989). Participants were informed that they would complete self-report and computerized assessments, and perform a computer task on eight occasions. They were also informed that they would be randomly assigned to either an active condition (Interpretation Modification Program (IMP), $n = 13$) that was designed to decrease symptoms of social anxiety or a control condition (Interpretation Control Condition (ICC), $n = 14$) that was not designed to affect their social anxiety. We did not provide any information to participants about how the active condition might reduce social anxiety. Participants received research credit and/or monetary compensation for their time. They received monetary compensation when they had fulfilled their research credit requirement. Thus, some participants received research credit only (IMP, $n = 3$; ICC, $n = 3$); some participants received monetary compensation only (IMP, $n = 7$; ICC, $n = 5$), and some participants received a combination of credit and money (IMP, $n = 3$; ICC, $n = 6$). The sample was predominantly female (93%), Caucasian (78%), with a mean age of 20. Groups did not differ in age, education, or sex ratio ($p$s > .2). Demographic information is presented in Table 1.

### Self-report measures

Participants completed self-report measures of anxiety and depression at pre-assessment and post-assessment. The *Social Phobia and Anxiety Inventory* (SPAI; Turner, Beidel, Dancu, & Stanley, 1989) served as the primary outcome measure. The SPAI is a self-report measure that has demonstrated good sensitivity to treatment (Cox, Ross, Swinson, & Direnfeld, 1998), test–retest reliability ($r = .86$), and internal consistency ($\alpha = .96$) (Turner, Stanley,

Beidel, & Bond, 1989). We calculated the Social Phobia subscale (SPAI-SP) and used this score for all analyses. Participants also completed the *State Trait Anxiety Inventory* (STAI; Spielberger, Gorsuch, & Lushene, 1970), and the *Beck Depression Inventory, 2nd Edition* (BDI-II; Beck, Steer, & Brown, 1996).

### Computerized interpretation assessment

Similar to MacLeod, Rutherford, Campbell, Ebsworthy, and Holker (2002), we examined whether changes in cognitive bias would generalize to novel stimuli. To this end, participants completed a computerized interpretation assessment at pre-assessment and post-assessment called the Word Sentence Association Paradigm (WSAP). Each WSAP trial comprised four phases. First, a fixation cross appeared on the computer screen for 500 ms. The fixation cross directed the participants' attention toward the middle of the screen and alerted them that a trial was beginning. Second, a word representing either a threat interpretation (e.g., "embarrassing") or a benign interpretation (e.g., "funny") appeared in the center of the computer screen for 500 ms. Third, an ambiguous sentence (e.g., "People laugh after something you said") appeared and remained on the screen until participants pressed the space bar indicating that they finished reading the sentence. Finally, the computer prompted participants to press '#1' on the number pad if they thought the word and sentence were related or to press '#3' on the number pad if the word and sentence were not related. The next trial began immediately after the participants' response.

Participants completed 76 trials during each assessment.[2] We used two sets of WSAP materials that were matched with respect to the type of social situation depicted. After random assignment, 14 participants received Set A (IMP, $n = 7$; ICC, $n = 7$), and 13 participants received Set B (IMP, $n = 6$; ICC, $n = 7$). All text appeared in black, 12 point font against a gray background (see Appendix for example materials). For each participant, we calculated the percentage of threat trials and benign trials endorsed.

Because the WSAP is a new measure of interpretation bias, we administered this measure to 85 other participants with varying levels of social anxiety. Social anxiety (measured by the SPAI-SP) was correlated with benign endorsement ($r = -.6$, $p < .001$) and threat endorsement ($r = .6$, $p < .001$). In the current study, pre-assessment correlations showed a similar pattern ($r = -.3$, $p = .086$; threat: $r = .2$, $p > .4$). The smaller correlations for the current study are not surprising given our small sample comprised only individuals with high social anxiety.

### Procedure

During the pre-assessment, participants read and signed a consent form, provided basic demographic information, and completed the self-report and computerized assessments. After completing the pre-assessment, eligible participants were randomly assigned to either the IMP or the ICC. Participants completed their assigned computer program individually in the laboratory on eight occasions over four weeks. To ensure that participants and experimenters were blind to the condition, participants clicked on their condition number (given to them in an envelope so that the experimenter could not see) at the beginning of each session, which began their assigned computer program. After completing eight sessions, participants completed a post-assessment that was identical to the pre-assessment. Immediately following the post-assessment, participants indicated which condition they believed they were assigned by circling one of three options: 'treatment', 'control', or 'no

[2]Participants also completed 34 filler trials related to general ambiguous situations. Due to set differences for endorsement of benign interpretations, we did not include data from the filler trials in the primary analyses. However, the expected Time × Group interactions were also significant for these trials [threat: $F(1,25) = 13.00$, $p < .001$, benign: $F(1,25) = 10.78$, $p < .005$]. These filler trials were also included in the IMP and ICC sessions.

idea'. The minimum number of days between the final training session and post-assessment was two [IMP: *M*= 4.4 days (SD =3.8), ICC: *M*=5.2 days (SD =3.5)].

### Interpretation modification program (IMP)

The IMP procedure was identical to the WSAP, except that participants received feedback about their responses. Specifically, after participants responded regarding the relatedness of the word and sentence, the computer provided feedback about their response (see Fig. 1). Participants received positive feedback ("You are correct!") when they responded to benign interpretation trials by pressing #1 ('related') and to threat interpretation trials by pressing #3 ('not related'). Thus, participants received positive feedback when they endorsed benign interpretations or rejected threat interpretations of the ambiguous sentences. Participants received negative feedback ("You are incorrect.") when they responded to threat interpretation trials by pressing #1 ('related') and to benign interpretation trials by pressing #3 ('not related'). Thus, they received negative feedback when they endorsed threat interpretations or rejected benign interpretations. This feedback contingency was intended to reinforce a benign interpretation bias and extinguish the threat interpretation bias. Participants completed 76 training trials in each session. Participants who completed Set A during the WSAP assessment saw Set B during the IMP and vice versa. Thus, participants were assessed with different materials than those seen during the IMP. Each IMP session lasted approximately 10 min.

### Interpretation control condition (ICC)

The ICC was identical to the IMP except that the feedback contingency was lowered to 50%. Specifically, participants received positive feedback when they endorsed threat interpretations on half of the trials and negative feedback when they endorsed threat interpretations for the remaining half of trials. This contingency was the same for benign interpretations. Thus, the control group was reinforced equally for making threat and benign interpretations. The ICC was not intended to change interpretation significantly in either direction.

## Results

All participants completed the pre-assessment and post-assessment. Thus, all analyses are based on 13 individuals in the IMP group and 14 in the ICC group. Groups did not significantly differ in level of social anxiety, depression, state anxiety, trait anxiety, threat interpretation endorsement, or benign interpretation endorsement at pre-assessment ($ps > .1$). Means and standard deviations are presented in Table 2.

### Change in interpretation bias: WSAP

To compare groups, we submitted participants' endorsement of novel threat and benign interpretations to 2(Group: IMP, ICC) ×2(Time: Pre, Post) ANOVAs. Main effects and interactions are presented in Table 2. To follow up the significant interaction we conducted follow-up *t*-tests. For threat interpretations, this analysis revealed that groups did not differ in threat interpretation endorsement at pre-assessment, $t(25) = 0.66$, $p > .05$. At post-assessment, the IMP group endorsed significantly fewer threat interpretations than the ICC group, $t(25) = 5.29$, $p < .001$. Both groups endorsed fewer threat interpretations at post-assessment compared to pre-assessment [IMP: $t(12) = 10.97$, $p < .001$; ICC: $t(13) = 2.26$, $p < .05$].

For benign interpretations, follow-up *t*-tests showed that groups did not differ in benign interpretation endorsement at pre-assessment, $t(25) = 1.90$, $p > .05$. At post-assessment, the IMP group endorsed significantly more benign interpretations than the ICC group, $t(25) =$

4.31, $p$ <.001. The IMP group showed an increase in benign interpretations from pre-assessment to post-assessment, $t(12)= -7.93$, $p < .001$, but the ICC did not, $t(13)= -1.82$, $p > .05$. Thus, both targets of IMP changed in the expected direction, and this change generalized to novel stimuli.

## Change in symptoms

To compare groups, we submitted participants' scores to 2(Group: IMP, ICC) × 2(Time: Pre, Post) ANOVAs.[3] Main effects and interactions are presented in Table 2. To follow up significant interactions we conducted $t$-tests. For social anxiety, $t$-tests showed that groups did not differ in social anxiety at pre-assessment, $t(25) = 0.91$, $p > .05$. At post-assessment, the IMP group reported significantly less social anxiety symptoms than the ICC group, $t(25) = 2.25$, $p < .04$. Both groups reported a significant decrease from pre-assessment to post-assessment in social anxiety [IMP: $t(12) = 5.16$, $p$ <.001; ICC: $t(13)= 4.44$, p =.001]. Paired $t$-test revealed that overall, participants reported a significant decrease from pre-assessment to post-assessment in trait anxiety, $t(26) = 5.13$, $p < .001$, and depression, $t(26) = 4.60$, $p < .001$.

## Effect sizes

We calculated between group effect sizes (IMP post – ICC post/pooled SD) for our primary outcome variables. Effect sizes were as follows: threat interpretation endorsement ($d$ = 1.85), benign interpretation endorsement ($d$ =2.35), and social anxiety ($d$ = 0.65).

## Mediation analyses

To test the hypothesis that the IMP exerted its influence on social anxiety through change in interpretation bias, we tested both threat interpretation and benign interpretation as potential mediators. We first examined changes in threat and benign interpretation from pre-assessment to post-assessment as mediators of change in social anxiety symptoms. Additionally, because mediation requires temporal precedence from the independent variable to the mediator and from the mediator to the dependent variable, we also examined interpretation scores at the fifth session (midway through IMP and ICC) as mediators of social anxiety at post-assessment.

We conducted mediation analysis following the procedure described by MacKinnon, Fairchild, and Fritz (2007) and MacKinnon, Lockwood, Hoffman, West, and Sheets (2002). In brief, this procedure tests the product of the coefficients for the effects of (1) the independent variable on the proposed mediators ($\alpha$), and (2) the mediator on the dependent variable when the independent variable is taken into account ($\beta$). This procedure is a variation of the Sobel (1982) test that accounts for the non-normal distribution of the $\alpha\beta$ path through the construction of asymmetric confidence intervals (MacKinnon, Fritz, Williams, & Lockwood, 2007).

Results for change in threat interpretation endorsement revealed that the 95% confidence intervals of $\alpha\beta$ overlapped with zero (lower limit=−.0122, upper limit =.6168), which indicates that change in threat interpretation did not mediate change in social anxiety. The confidence intervals did not overlap with zero for change in benign interpretation endorsement (lower limit= .0650, upper limit = .9172), threat endorsement at the 5th session (lower limit =.0492, upper limit =.7332), and benign endorsement at the 5th session (lower limit =.0750, upper limit= .7681). These analyses provide support for the indirect effect of

[3]We also submitted participants' post-assessment scores to ANCOVAs, controlling for pre-assessment scores. The results from these analyses did not differ from the repeated measurement analyses.

the IMP on social anxiety symptoms through an increase in benign interpretation and partial support for change in threat.

To examine whether change in benign interpretation would independently mediate change in social anxiety, we conducted the mediation analysis a second time, taking into account change in threat interpretation. This analysis revealed that change in benign interpretation was still a significant mediator, (lower limit =.0586, upper limit = .8771). To explore this issue in a different way, we entered group, change in threat interpretation, and change in benign interpretation into a regression model to predict change in social anxiety. This analysis revealed that change in benign interpretation was a significant predictor of change in social anxiety, β= .56, $p < .04$. Change in threat interpretation was a marginal predictor, β = .39, $p = .075$. Group assignment was not a significant predictor, β= .29, $p > .3$.

### Condition assignment

We examined the number of participants in each group who correctly identified their condition assignment. For the IMP group, six participants correctly identified that they received the active condition; five incorrectly believed they received a control condition; and two participants were not sure. For the ICC group, five participants correctly identified that they received a control condition; zero participants believed they received an active condition; and nine participants were not sure. We then examined differences between participants who were aware of their condition and participants who were not aware. In the ICC group, participants who knew they received the control condition were significantly older, $t(12) = 2.20$, $p < .05$, and marginally more socially anxious at baseline, $t(12) = 2.10$, $p = .058$, than participants who did not know. There were no other differences between these groups ($p$s > .2).

In the IMP group, participants who knew they received the active condition had significantly larger changes in threat interpretation, $t(11) = 2.30$, $p < .05$, changes in benign interpretation, $t(11) = 2.41$, $p < .04$, and marginally larger changes in social anxiety, $t(11) = 2.11$, $p = .059$. There were no other significant differences between these groups ($p$s > .2).

## Discussion

As expected, the IMP successfully modified interpretation bias in socially anxious individuals. The IMP group endorsed more benign interpretations and fewer threat interpretations at post-assessment than the ICC group. Thus, both types of interpretation showed the expected change as a result of IMP, and these changes generalized to novel test stimuli. These results converge with Murphy et al. (2007), who showed that inducing a benign interpretation bias in socially anxious participants affected ratings of both benign and negative interpretations. This is the first study to show that utilizing corrective feedback can also modify benign and threat interpretations.

Our primary aim was to evaluate the effect of IMP on social anxiety symptoms. Results supported our hypothesis, as participants completing the IMP were less socially anxious compared to the ICC group at post-assessment. Symptom reduction occurred after only eight, 10-min computer sessions with no therapist contact. The between group effect size for the SPAI-SP ($d = 0.65$) is promising. However, these results may not readily translate to patient populations.

The ICC group also showed a significant reduction in threat interpretation endorsement from pre-assessment (65%) to post-assessment (49%). This reduction was likely due to the 50% threat/50% benign feedback contingency received by the ICC. Thus, the ICC could be characterized as a diluted version of the IMP. The ICC group also showed a 15% reduction

in social anxiety symptoms compared to a 30% reduction in the IMP group. Since none of the ICC participants believed they received the active condition, changes in this group were not likely due to demand effects. The reduction in the ICC could have been due to the reduction in threat interpretation endorsement. It may also reflect a non-specific response to receiving attention from an experimenter on eight occasions. Finally, the reduction may also reflect regression to the mean, as participants were selected for having high scores on the SPAI-SP.

Our final hypothesis examined mediators of change in the current study. Changes in benign interpretation endorsement, as well as benign and threat endorsement levels at the 5th session (approximately mid-procedure), mediated the effect of group on social anxiety symptoms. These results are consistent with our hypothesis that changing interpretation biases would lead to a reduction in social anxiety symptoms. Change in threat interpretation was not a significant mediator. However, regression analyses revealed that change in threat was a marginal predictor ($p$= .075) of change in social anxiety, when change in benign interpretation and group were included in the model. Thus, the current study may be underpowered to detect the relationship between change in threat interpretation and change in social anxiety.

These findings suggest that inducing a benign bias and reducing a threat bias may lead to reductions in social anxiety. However, the current study cannot determine whether both types of bias require modification in order to affect social anxiety. Previous CBM studies that only induced a benign bias showed that targeting benign interpretations was sufficient to affect general anxiety symptoms (e.g., Mathews, Ridgeway, Cook, & Yiend, 2007). However, future research should compare the effects of paradigms that induce a benign bias, reduce threat bias, or both to determine which mechanisms are important for affecting social anxiety.

There are several potential mechanisms of change in the current study. If IMP successfully changed interpretation bias, participants may have started interpreting ambiguous cues in their daily life differently, leading to less anxiety and decreased avoidance. However, alternative explanations should also be considered. For example, IMP may have caused participants to generate more positive images of themselves in social situations while completing the task. Alternatively, IMP may have illuminated participants' negative interpretive style and encouraged them to challenge their thinking patterns, similar to cognitive restructuring. Identifying the mechanisms of change will be important for future research aiming to enhance the effects on social anxiety.

Durability of induced interpretation bias has received little attention. To date, examination of the durability of interpretation bias change has been limited to 24 hours for single-session CBM (Yiend, Mackintosh, & Mathews, 2005) and one week for four session CBM (Mathews, Ridgeway, Cook, & Yiend, 2007). One would expect that eight sessions of interpretation modification would induce longer lasting changes in interpretation bias. In the current study, effects on interpretation bias and social anxiety symptoms lasted a minimum of two days and up to one week. However, we did not examine long-term durability. Future research examining the maintenance of induced interpretation biases is needed for theoretical and clinical reasons. It will be important theoretically to determine whether CBM procedures induce changes that fundamentally alter the cognitive processes that maintain social anxiety or if they simply prime transient response patterns. Should IMP be used clinically, it will be important to determine whether short-term CBM induces long-term interpretation change or if long-term change requires the repeated administration of CBM.

The current study demonstrates that it is feasible to translate CBM procedures to a multi-session, intervention format. Future research should examine methods of enhancing the effects of IMP on anxiety. Larger effects may be necessary for clinical samples and might be obtained by increasing the number of sessions or adding psychoeducation. Adding self-imagery instructions to the IMP might enhance effects on mood (e.g., Holmes, Mathews, Dalgleish, & Mackintosh, 2006). Finally, using different materials during each session could strengthen the IMP's effects. In the current study, each session presented the same stimuli. We might expect that introducing new stimuli would help generalize changes in interpretation to real life situations or keep participants better engaged in the task. However, it is also possible that the repetition of the same stimuli in each session caused the process of accepting benign interpretations and rejecting negative interpretations to become less effortful.

The influence of awareness of training contingencies has received little attention in CBM research. To our knowledge, only one study has examined this issue. Salemink, van den Hout, and Kindt (2007a) compared positive interpretation training and negative interpretation training in a non-anxious sample. Participants read ambiguous stories that ended positively or negatively, depending on their assigned condition. At the end of the experiment, the authors assessed whether participants had explicitly learned a rule about the emotional valence of the training stimuli by asking participants to rate how negatively or positively the stories ended. In the positive training condition, 93% of the participants indicated that the stories ended positively, and 88% of the negatively trained participants indicated that the stories ended negatively.

We did not comprehensively assess participants' explicit awareness of the training contingencies in the current study. However, the IMP group's changes in endorsement levels suggest that participants became aware of the "rules." Moreover, IMP participants who were aware that they received an active condition showed greater changes in interpretation bias. Awareness of training contingencies may affect results differently, depending on the paradigm used. Thus, future research should assess awareness levels, as well as manipulate awareness to explore whether awareness affects anxiety response. For example, awareness manipulations could inform researchers about the utility of providing a rationale to participants prior to completing CBM. It is possible that providing a rationale would enhance effects of the IMP because it could decrease participants' negative reaction to receiving negative feedback. Alternatively, if CBM effects are superior when achieved outside participants' awareness, a rationale might interfere.

Finally, future research is needed to compare the existing methods of modifying interpretation bias. The current paradigm differed from previous studies because it used feedback to manipulate interpretation, rather than limiting participants' exposure to a particular type of interpretation. Thus, future studies are needed to determine which CBM procedure, or combination of procedures, is most efficacious in changing interpretation and anxiety symptoms.

Although our findings are promising, there are several limitations of the current study. First, this initial trial of IMP comprised a small, analogue sample. Replication in a larger and more diverse clinical sample is necessary before any conclusions can be made about the clinical utility of IMP for Social Phobia. However, our participants' baseline SPAI-SP scores were comparable to those reported in treatment outcome studies (e.g., Cox et al., 1998; Hofmann, Moscovitch, Kim, & Taylor, 2004), and thus it is possible that our results would generalize to clinical samples.

Second, we did not include all possible control groups. The current control group was identical to the IMP in all aspects, except for the feedback contingency. We chose this type of control condition in an attempt to isolate a specific mechanism (i.e., feedback contingency). However, future studies might include different control conditions, such as a no feedback condition, wait-list, or relaxation condition, to ensure that group differences are not influenced by the type of control condition. Third, we relied exclusively on self-report measures in this initial trial and did not include a behavioral assessment (e.g., speech challenge). Including additional types of assessments would provide more information about clinically meaningful change.

The possibility of demand effects must be considered. Participants were aware that they could have been assigned to an active condition designed to reduce social anxiety, and they received research credit and/or monetary compensation. However, less than half of IMP participants believed they received the active condition. Additionally, studies that have manipulated interpretation and not informed participants of the purpose of the task have also found effects on anxiety (e.g., Wilson et al., 2006). Thus, experimental demand is not likely the only explanation for the current results. However, future research should include behavioral assessments that are less susceptible to demand effects than self-report measures.

Finally, we did not include an independent measure of interpretation bias. Thus, it is not clear whether the IMP actually changed interpretation processes or if participants simply learned a rule that they applied to a specific task. This is an important distinction, as previous studies that have included independent measures of interpretation have not found that changes in interpretation on a training task generalized to a different task (e.g., Salemink, van den Hout, & Kindt, 2007b).

These limitations notwithstanding, the current results have potential clinical applications. Changes in interpretation bias are often observed after cognitive-behavioral treatment for Social Phobia (e.g., Franklin, Huppert, Langer, Leiberg, & Foa, 2005). One application of IMP may be to enhance or accelerate changes in interpretation bias during CBT (e.g., IMP disseminated as homework assignment). Similar to all computerized interventions, IMP may reduce clinician time and could be disseminated in various settings (e.g., primary care clinic via computers in waiting or exam rooms, self-help via the Internet). Because cognitive biases are implicated in many domains of psychopathology, the translation of CBM methodology into interventions may prove useful for numerous disorders.

## References

Amir N, Foa EB, Coles ME. Negative interpretation bias in social phobia. Behavior Research and Therapy. 1998; 36:945–958.

Beck, AT.; Steer, RA.; Brown, GK. Manual for the Beck depression inventory-II. San Antonio, TX: Psychological Corporation; 1996.

Clark, D.; Wells, A. A cognitive model of social phobia. In: Heimberg, R.; Liebowitz, M.; Hope, D.; Schneider, R., editors. Social phobia: Diagnosis, assessment, and treatment. New York: Guilford Press; 1995. p. 69-93.

Constans J, Penn D, Ihen G, Hope D. Interpretive biases for ambiguous stimuli in social anxiety. Behavior Research and Therapy. 1999; 37:643–651.

Cox B, Ross L, Swinson R, Direnfeld D. A comparison of social phobia outcome measures in cognitive-behavioral group therapy. Behavior Modification. 1998; 22:285–297. [PubMed: 9670801]

Franklin M, Huppert J, Langner R, Leiberg S, Foa E. Interpretation bias: a comparison of treated social phobics, untreated social phobics, and controls. Cognitive Therapy and Research. 2005; 29:289–300.

Gillis MM, Haaga DAF, Ford GT. Normative values for the Beck anxiety inventory, fear questionnaire, Penn State worry questionnaire, and social phobia and anxiety inventory. Psychological Assessment. 1995; 7:450–455.

Grey S, Mathews A. Effects of training on interpretation of emotional ambiguity. The Quarterly Journal of Experimental Psychology. 2000; 53A:1143–1162. [PubMed: 11131817]

Hirsch C, Mathews A. Interpretive inferences when reading about emotional events. Behavior Research and Therapy. 1997; 35:1123–1132.

Hirsch C, Mathews A. Impaired positive inferential bias in social phobia. Journal of Abnormal Psychology. 2000; 109:705–712. [PubMed: 11195994]

Hofmann SD, Moscovitch DA, Kim H, Taylor AN. Changes in self-perception during treatment of social phobia. Journal of Consulting and Clinical Psychology. 2004; 72:588–596. [PubMed: 15301643]

Holmes E, Mathews A, Dalgleish T, Mackintosh B. Positive Interpretation Training: Effects of Mental Imagery versus Verbal Training on Positive Mood. Behavior Therapy. 2006; 37:237–247. [PubMed: 16942975]

Huppert JD, Foa E, Fur JM, Filip JC, Mathews A. Interpretation bias in social anxiety: a dimensional perspective. Cognitive Therapy and Research. 2003; 27:569–577.

MacKinnon DP, Fairchild AJ, Fritz MS. Mediation analysis. Annual Review of Psychology. 2007; 58:593–614.

MacKinnon DP, Fritz MS, Williams J, Lockwood CM. Distribution of the product confidence limits for the indirect effect: program PRODCLIN. Behavior Research Methods. 2007; 39:384–389. [PubMed: 17958149]

MacKinnon DP, Lockwood CM, Hoffmann JM, West SG, Sheets V. A comparison of methods to test mediation and other intervening variable effects. Psychological Methods. 2002; 7:83–104. [PubMed: 11928892]

Macleod C, Rutherford W, Campbell L, Ebsworthy G, Holker L. Selective attention and emotional vulnerability: assessing the causal basis of their association through the experimental manipulation of attentional bias. Journal of Abnormal Psychology. 2002; 111:107–123. [PubMed: 11866165]

Mathews A, Macintosh B. Induced emotional interpretation bias and anxiety. Journal of Abnormal Psychology. 2000; 109:602–615. [PubMed: 11195984]

Mathews A, Ridgeway V, Cook E, Yiend J. Inducing a benign interpretational bias reduces trait anxiety. Journal of Behavior Therapy and Experimental Psychiatry. 2007; 38(2):225–236. [PubMed: 17141179]

Murphy R, Hirsch CR, Mathews A, Smith K, Clark DM. Facilitating a benign interpretation bias in a high socially anxious population. Behavior Research and Therapy. 2007; 45:1517–1529.

Rapee R, Heimberg R. A cognitive-behavioral model of anxiety in social phobia. Behavior Research and Therapy. 1997; 35:741–756.

Roth D, Antony M, Swinson R. Interpretations for anxiety symptoms in social phobia. Behavior Research and Therapy. 2001; 39:129–138.

Salemink E, van den Hout M, Kindt M. Trained interpretive bias: validity and effects on anxiety. Journal of Behavior Therapy and Experimental Psychiatry. 2007a; 38:212–224. [PubMed: 17141735]

Salemink E, van den Hout M, Kindt M. Trained interpretive bias and anxiety. Behavior Research and Therapy. 2007b; 45:329–340.

Sobel, ME. Asymptotic confidence intervals for indirect effects in structural equation models. In: Leinhart, S., editor. Sociological methodology. Washington, DC: American Sociological Association; 1982. p. 290-312.

Spielberger, CD.; Gorsuch, RL.; Lushene, R. Manual for the state-trait anxiety inventory. Palo Alto, CA: Consulting Psychologist Press; 1970.

Stopa L, Clark D. Social phobia and interpretation of social events. Behavior Research and Therapy. 2000; 38:273–283.

Turner SM, Beidel DC, Dancu CV, Stanley MA. An empirically derived inventory to measure social fears and anxiety: the social phobia and anxiety inventory. Psychological Assessment. 1989; 1:35–40.

Turner SM, Stanley MA, Beidel DC, Bond L. The social phobia and anxiety inventory: construct validity. Journal of Psychopathology and Behavioral Assessment. 1989; 33:448–457.

Voncken MJ, Bögels SM, de Vries K. Interpretation and judgemental biases in social phobia. Behavior Research and Therapy. 2003; 41:1481–1488.

Wilson E, MacLeod C, Mathews A, Rutherford E. The causal role of interpretive bias in anxiety reactivity. Journal of Abnormal Psychology. 2006; 115:103–111. [PubMed: 16492101]

Yiend J, Mackintosh B, Mathews A. The enduring consequences of experimentally induced biases in interpretation. Behavior Research and Therapy. 2005; 43:779–797.

## Appendix

### Example materials

| Threat word | Non-threat word | Ambiguous sentence |
|---|---|---|
| Criticize | Praise | Your boss wants to meet with you. |
| Embarrassing | Funny | People laugh after something you said. |
| Mad | Distracted | A friend does not respond when you wave hello. |
| Ugly | Attractive | An old friend comments on how you look different now. |

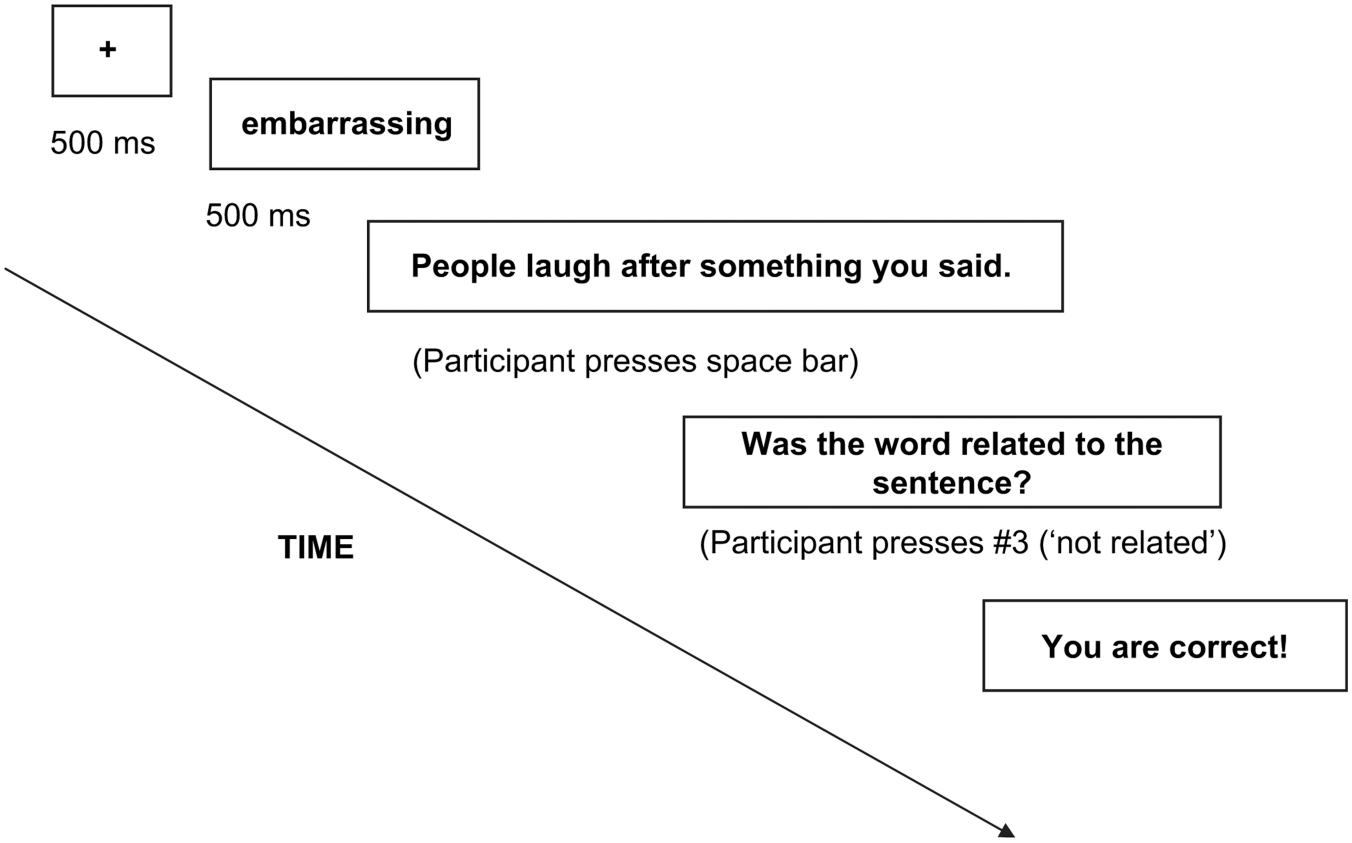


**Fig. 1.**
Example trial.

**Table 1**

Demographic information

| | **IMP (*n* = 13)** | **ICC (*n* = 14)** |
|---|---|---|
| Age (*M*, SD) | 19 (1.92) | 20 (2.88) |
| Education (years; *M*, SD) | 13 (0.65) | 14 (1.21) |
| Sex (% female) | 92% | 93% |
| *Ethnicity* | | |
| Caucasian | 84% | 70% |
| African American | 8% | 7% |
| Asian | 8% | 21% |

*Note*: IMP = interpretation modification program, ICC = interpretation control condition.

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**Table 2**

Self-report and WSAP measures

| **Self-report** | ***M* (SD)** | | | | ***F*(p)** | | |
|---|---|---|---|---|---|---|---|
| | **Pre** | | **Post** | | **Results** | | |
| | **IMP (*n* = 13)** | **ICC (*n* = 14)** | **IMP (*n* = 13)** | **ICC (*n* = 14)** | **Time** | **Group** | **Time × Group** |
| SPAI-SP | 125.69 (24.16) | 134.14 (24.00) | 88.00 (33.98) | 114.29 (26.62) | 46.66 (.00) | 3.32 (.09) | 4.48 (.04) |
| BDI-II | 20.54 (11.67) | 21.57 (15.70) | 11.08 (10.56) | 13.71 (12.21) | 20.64 (.00) | 0.17 (.69) | 0.18 (.68) |
| STAI-T | 53.85 (11.52) | 57.21 (9.54) | 42.54 (13.65) | 48.43 (10.39) | 35.88 (.00) | 1.42 (.25) | 0.41 (.53) |
| WSAP | (%, SD) | | | | | | |
| Threat endorsement | 60% (18) | 65% (19) | 9% (16) | 49% (22) | 61.24 (.00) | 14.02 (.00) | 17.04 (.00) |
| Non-threat endorsement | 44% (17) | 57% (19) | 90% (16) | 63% (16) | 60.82 (.00) | 1.45 (.24) | 33.90 (.00) |

*Note*. IMP = interpretation modification program, ICC = interpretation control condition, SPAI-SP = social phobia and anxiety inventory-social phobia subscale, BDI-II = Beck depression inventory, 2nd edition, STAI-T = Spielberger state-trait anxiety inventory-trait form.

Degrees of freedom for all effects: 1, 25.