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The Effect of Single-Session Interpretation Modification on Attention Bias in Socially Anxious Individuals

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Abstract

Research suggests that individuals with social anxiety interpret ambiguous social information negatively (e.g., Amir, Foa, & Coles, 1998) and that much negative interpretation bias may share a common mechanism with other information processing biases (e.g., Mathews, Mackintosh, & Fulcher, 1997). In the current study, we examined effectiveness of an interpretation modification program in changing attention biases in socially anxious individuals. Participants were randomly assigned to either an Interpretation Modification Program (IMP) that guided them to make benign interpretations of ambiguous social scenarios or an Interpretation Control Condition (ICC) that did not guide participants' interpretation in either direction. Results revealed that individuals in the IMP group demonstrated greater ability to disengage attention from threat stimuli after completing the program, while individuals in the ICC did not. These results are consistent with the hypothesis that information processing biases in anxious individuals may share a common mechanism that may contribute to the maintenance of anxiety.

Keywords

social anxiety; interpretation bias; information processing; Posner; training

According to cognitive models of social phobia (SP), socially anxious individuals are characterized by biases in information processing. These biases maintain anxiety in social situations in part by influencing judgments about environmental cues (Clark & Wells, 1995; Rapee & Heimberg, 1997). Indeed, research has demonstrated that individuals with social anxiety demonstrate biases in interpretation, attention, and imagery when compared to non-anxious individuals (Hirsch & Clark, 2004 for a review). From a theoretical perspective, the different types of information processing biases in anxiety may share a common mechanism (Williams, Watts, MacLeod, & Mathews, 1997). For example, anxiety may prime individuals toward threatening perceptual representations that increase both attentional activation for threatening stimuli as well as negative evaluation of an ambiguous situation (Mathews, Mackintosh, & Fulcher, 1997). Moreover, different forms of information processing biases may work reciprocally or additively to maintain anxiety (Hirsch, Clark, & Mathews, 2006). Despite potential for a common underlying mechanism of information processing biases in SP, few studies have examined causal relationships between various types of biases. To examine

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causality, it is necessary to manipulate one form of information processing, and subsequently examine the effect on a separate information processing domain.

Prior research has demonstrated that interpretation bias is one form of information processing that is malleable (Grey & Mathews, 2000; Mathews & Mackintosh, 2000). Procedures designed to manipulate interpretations usually introduce contingencies between ambiguous stimuli and the valence of a target word that resolves the ambiguity of the information, encouraging participants to think of the ambiguous information in either a negative or positive way. Several studies have demonstrated that these types of cognitive bias modification programs effectively induce interpretation biases in non-anxious individuals (Grey & Mathews, 2000; Mathews, & Mackintosh, 2000), and that the effects of such modification are resilient across time (24 hours), as well as novel settings, experimenters, and training formats (Mackintosh, Mathews, Yiend, Ridgway, & Cook, 2006; Yiend, Mackintosh, & Mathews, 2005). In addition, changing interpretations has been shown to transfer to other forms of information processing in an unselected sample (i.e., mental imagery; Hirsch, Mathews, & Clark, 2006).

Interpretation modification programs also appear to be effective in changing this bias in individuals with social anxiety (Beard & Amir, 2008; Murphy, Hirsch, Mathews, Smith, & Clark, 2007). For example, Beard and Amir (2008) demonstrated that a computer-based Interpretation Modification Program (IMP), delivered twice a week for four weeks, can be used to facilitate benign interpretations in individuals with high levels of social anxiety (see Methods section for details of this paradigm). Before and after the IMP, participants completed a Word Sentence Association Paradigm (WSAP) to assess interpretation change with novel stimuli (Beard & Amir, 2009). Results indicated that the IMP modified interpretation bias, such that participants endorsed more benign and fewer threat interpretations after the program relative to individuals in the control group. Thus, interpretation modification procedures appear capable of influencing interpretation bias in socially anxious populations. However, thus far no published studies have examined the effects of such interpretation modification paradigms on other forms of information processing associated with anxiety and anxiety vulnerability in socially anxious individuals.

In the present study we examined the hypothesis that a computerized Interpretation Modification Program (IMP) can be used to modify attention bias in individuals high in social anxiety, relative to an Interpretation Control Condition (ICC). To this end, we manipulated interpretations in a group of high socially anxious individuals, and measured attention bias before and after the modification procedure. To measure attention, we selected an attention disengagement task. Cognitive psychologists have suggested that visual spatial attention is comprised of multiple sub-components, including facilitation and inhibition of attention to different locations (Posner, 1980). When attention is captured by a place in the visual field (i.e., facilitation), other mechanisms act to inhibit attention from areas outside the particular attended place. Posner has theorized that the process of shifting attention is a multi-step process, involving : 1) interruption of ongoing activity, 2) disengaging attention from the present stimuli, 3) moving attention to the new location, and 4) reengaging attention to the new stimulus. A number of studies have indicated that anxious individuals may experience particular difficulty disengaging attention from threatening information (e.g., Amir, Elias, Klumpp, & Przworski, 2003; Fox, Russo, Bowles, & Dutton, 2001, Yiend & Mathews, 2001). Given that difficulty with attention disengagement from threat appears to be one form of information processing bias characteristic of social anxiety (Amir et al., 2003), we hypothesized that this bias might be effected a modification program designed to change another form of cognitive bias, namely interpretations. Thus, to assess attention bias, we utilized a modified Posner task previously utilized in studies of attention disengagement in social anxiety (Amir, et al., 2003; Amir, Weber, Beard, Bomyea, & Taylor, 2008, Posner, 1980).

In the current study, we hypothesized that participants in the IMP would demonstrate a transfer of interpretation modification to attention processes. Specifically, we hypothesized that individuals in the IMP would demonstrate less difficulty disengaging their attention from threat-related information after modification relative to the ICC group.

Method

Participants

Participants comprised 57 (IMP = 29; ICC = 28) individuals recruited with an advertisement for “individuals with difficulty giving speeches.” Participants were further screened based on their self-report Liebowitz Social Anxiety Scale-Self Report score (LSAS-SR; Liebowitz, 1987) and invited to participate if they scored greater than 25 on this measure (Amir et al., 2008). This resulted in a mean LSAS-SR score of 48.2 ($SD = 20.2$) for our participants, placing their mean score approximately four standard deviations above the mean for individuals with no Axis-I diagnosis ($M = 10.2$, $SD = 9.3$; Fresco et al., 2001; Rinck & Becker, 2005) and approximately one standard deviation below the mean for individuals with a diagnosis of Generalized Social Phobia ($M = 73.37$, $SD = 23.23$; Fresco et al., 2001).

Design

The study was a 2 (Group: IMP, ICC) $\times$ 2 (Time: pre IMP/ICC, post IMP/ICC) design with repeated measurement on the second factor.

Measures

All participants completed the Spielberger State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), LSAS-SR, Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996), and Interpretation Questionnaire (Amir, Foa, & Coles, 1998). The Interpretation Questionnaire asks participants to read ambiguous scenarios and three experimenter-provided explanations of the scenario (one negative, one positive, and one neutral). Participants are asked to rank order the three according to which explanation would come to their mind first, second, and third. As in previous studies, we calculated the mean rankings for negative interpretations of social situations. Lower numbers indicate that negative interpretations are more likely to come to mind first.

Procedure

Participants completed two phases in the experimental protocol. In the first phase, they completed the self-report questionnaires described above. In addition, to examine the influence of change in interpretation bias on change in attention bias, participants completed a modified Posner procedure as described in Amir et al. (2003). In this task a cue word appears in one of two locations on the computer screen, either to the left or the right of a central fixation cross. After the cue word disappears, participants attempt to detect a probe (“*”) that appears in one of two locations. Cue words can be either valid (i.e., the probe appears in the same location as the cue word) or invalid (i.e., the probe appears in a location opposite the cue word). The participant then indicates which side of the screen the probe appears on by clicking a corresponding mouse button. Reaction time to identify the probe location on invalid trials following a threat word are a measure of attention disengagement from threat (Amir et al., 2003).

The Posner task comprised eight social threat and eight neutral word cues. Words were presented in lowercase (3-5 mm) against a black background in the center of the computer monitor. Words remained on the screen for 600ms and the probe remained on the screen until the participant had responded. The inter-trial interval was 1650 ms. Participants saw 192

experimental trials total in random order; 2/3 (128) were valid trials, 1/6 (32) were invalid trials, and 1/6 (32) were un-cued trials.

In the second phase of the study, participants were randomly assigned to one of two computer tasks, either the Interpretation Modification Program (IMP) or the Interpretation Control Condition (ICC). During each trial the participant saw a word representing either a social threat (e.g., “embarrassing”) or benign (e.g., “funny”) interpretation of an ambiguous sentence that followed (e.g., “People laugh after something you said.”). They were then asked to decide whether the word was related to the sentence or not. The IMP reinforced participants for endorsing a benign interpretation of the ambiguous sentence. That is, participants received positive feedback (i.e., “You are correct!”) when they endorsed a benign interpretation *or* rejected a threat interpretation of an ambiguous sentence. Participants received negative feedback (i.e., “You are incorrect.”) when they endorsed a threat interpretation *or* rejected a benign interpretation of an ambiguous sentence. The ICC was identical to the IMP procedure except that feedback contingency was changed to 50% toward threat and 50% toward benign interpretations. Thus, this group was reinforced equally for making threat and benign interpretations so that interpretations would not be significantly modified in either direction. Participants were seated approximately 30 cm from the computer screen. All words were presented in the center of the computer screen using lower case letters (3-5mm). The program that presented the stimuli was written in Delphi (Borland, Inc, 2005) for this experiment. Each participant saw 110 word-sentence pairs during the course of the IMP/ICC program. To control for any order effect, sentences were presented in a different random order to each participant.

After completing the computer tasks, participants completed the second STAI-S in order to examine any mood effects as a result of the IMP/ICC tasks. They also completed the Interpretation Questionnaire as a manipulation check, to ensure that IMP effectively modified participants' interpretations. In addition to the self-report measures, participants completed the Posner task a second time so that we could examine the effect of IMP on attention bias to threat.

Results

Overview of data analysis

The current study tested the hypothesis that individuals in the IMP will demonstrate faster attention disengagement from threat-relevant information after the program, relative to the ICC group. In order to test this hypothesis, we first conducted an overall 2 (Group: IMP, ICC) $\times$ 2 (Trial type: Valid, Invalid) $\times$ 2 (Time: pre IMP/ICC, post IMP/ICC) $\times$ 2 (Valence Type: Social threat, Neutral) analysis of variance on reaction time data from the Posner paradigm. The specific analysis of interest was for social threat invalid trials (i.e., trials measuring attention disengagement from threat). Thus, the critical analysis was a follow-up 2 (Group: IMP, ICC) $\times$ 2 (Trial type: Valid, Invalid) $\times$ 2 (Time: pre IMP/ICC, post IMP/ICC) ANOVA for social threat-relevant trials.

Preliminary analyses

Groups did not differ on demographics or questionnaire measures of social anxiety, state or trait anxiety, or depression at baseline ($ps > .2$). Groups also did not differ on state anxiety post modification, $t(55) = .3, p > .8$. To determine whether the IMP was effective in modifying interpretation, we submitted responses on the negative social interpretation items on the Interpretation Questionnaire to a 2 (Group: IMP, ICC) $\times$ 2 (Time: pre IMP/ICC, post IMP/ICC) ANOVA with repeated measurement on the last factor. This analysis revealed an interaction of Group by Time, $F(1, 55) = 6.3, p < .05, \eta^2 = .10$. Follow-up tests indicated that, compared to pre-modification, individuals in the IMP became less likely to endorse negative social situations as coming to mind after the IMP modification, $t(28) = -2.4, p < .03, d = .91$.

Individuals in the ICC did not show this pattern of results, $t(27) = 1.5, p = .09$ (See Figure 1). Table 1 summarizes demographic and clinical characteristics of the IMP and ICC groups.

Transfer of Interpretation Modification to Attention Disengagement from Threat

We hypothesized that individuals in the IMP group would become better able to disengage from threat after the modification (i.e., faster reaction times on invalid social threat trials), relative to the ICC. Figure 1 presents participants' performance on the Posner task before and after the IMP and ICC procedures. We submitted participants' mean response latencies for correct responses on the Posner task for neutral and social threat words to a 2 (Group) $\times$ 2 (Trial type: Valid, Invalid) $\times$ 2 (Time: pre IMP/ICC, post IMP/ICC) $\times$ 2 (Valence Type: Social threat, Neutral) ANOVA with repeated measurement on the last three factors.

This analysis revealed main effects of Time, $F(1, 55) = 55.3, p < .001, \eta^2 = .50$, and Trial Type, $F(1, 55) = 131.9, p < .001, \eta^2 = .71$, that were modified by an interaction of Trial Type by Time, $F(1, 55) = 75.2, p < .001, \eta^2 = .58$, and a significant interaction of Group by Trial Type by Time by Valence Type $F(1, 55) = 3.9, p = .05, \eta^2 = .07$. None of other effects were significant ($ps > .09$).

We then conducted separate 2 (Group) $\times$ 2 (Trial type: Valid, Invalid) $\times$ 2 (Time: pre IMP/ICC, post IMP/ICC) ANOVA analyses for neutral and social threat words separately. For neutral words this analysis revealed main effects of Trial Type, $F(1, 55) = 116.4, p < .001, \eta^2 = .68$, and Time, $F(1, 55) = 36.7, p < .001, \eta^2 = .40$, that were modified by an interaction of Trial Type $\times$ Time, $F(1, 55) = 41.0, p < .001, \eta^2 = .43$. None of other effects were significant ($ps > .3$).

For social threat words this analysis revealed main effects of Trial Type, $F(1, 55) = 130.8, p < .001, \eta^2 = .70$, and Time, $F(1, 55) = 62.1, p < .001, \eta^2 = .53$, that were modified by an interaction of Trial type by Time, $F(1, 55) = 50.3, p < .001, \eta^2 = .48$, and Group by Trial type by Time, $F(1, 55) = 5.7, p = .02, \eta^2 = .09$. To explore this 3-way interaction further, we conducted separate 2 (Group) $\times$ 2 (Time) ANOVAs for valid and invalid trials.

For valid threat word trials this analysis revealed a main effect of Time, $F(1, 55) = 129.4, p < .001, \eta^2 = .70$. None of the other effects were significant ($ps > .09$). For invalid threat word trials this analysis revealed an interaction of Group by Time, $F(1, 55) = 5.1, p = .03, \eta^2 = .09$. None of the other effects were significant ($ps > .08$). Follow-up t-tests revealed that participants in the IMP and ICC did not respond differently to invalid threat words before the modification program, $t(55) = 1.1, p = .27$. Afterward, however, participants in the IMP group were faster to respond to invalid threat words than were individuals in the ICC group, $t(55) = 2.3, p < .03, d = .62$. Paired t-tests revealed that participants in the IMP group became faster at responding to invalid threat words after the modification when compared to their baseline response latencies, $t(28) = 3.30, p < .01, d = 1.25$. Participants in the ICC did not show a change in response to invalid threat words before and after the program, $t(27) = -.34, p = .74$. Thus, individuals in the IMP became faster to disengage their attention from threat words after the interpretation modification program.

Discussion

The current study tested the hypothesis that modifying interpretation bias would generalize to changes in attention bias. Results from the Interpretation Questionnaire indicated that individuals in the IMP group became less likely to rank negative interpretations of ambiguous social scenarios as coming to mind first. As expected, our results suggest that the IMP modified participants' interpretations, and more importantly that effects of the IMP generalized to attention bias as assessed by the Posner paradigm. Specifically, groups did not differ on

attentional bias for validly cued words or invalidly cued neutral words. However, the IMP group became faster in responding to invalidly cued social threat words while the ICC group did not. This suggests that the IMP program designed to facilitate more benign interpretations of ambiguous social scenarios also facilitated attention disengagement from social threat cues. Because anxiety did not change differentially between groups, these results cannot be attributed to mood effects induced by modification. In sum, these results indicate that changes in interpretation bias can influence other measures of information processing bias, in particular the attention disengagement bias that has been demonstrated in socially anxious individuals (Amir et al., 2003). To our knowledge this is the first study to demonstrate a transfer of information processing bias modification from interpretation bias to a form of attention bias in socially anxious individuals.

How might the IMP program have modified attention biases? The IMP was intended to address socially anxious individuals' lack of a benign interpretation bias by reinforcing benign interpretations and extinguishing negative interpretations. Changes in interpretations of ambiguous situations during the IMP may have provided practice for participants in accessing more benign assumptions about social information. That is, the program provided participants with practice in inhibiting negative social information and inferences, while accessing more benign information. This may have led to greater ease of switching away from negative information, which generalized to the information in the Posner task, making disengagement from the negative stimuli in the attention paradigm easier.

The present findings support cognitive models of anxiety that hypothesize that multiple forms of information processing biases work conjointly to cause and maintain symptoms (Hirsch et al., 2006; Williams et al., 1997). They are also in line with models of social phobia emphasizing the role of attention and interpretation biases in the maintenance of social fear (Clark & Wells, 2005; Rapee & Heimberg, 1997). This study is the first to demonstrate that interpretation bias is causally implicated in the maintenance of other information processing biases, namely difficulty with attention disengagement from threat. Prior studies have indicated that changes in attention bias elicited over a single session of cognitive bias modification can have lasting effects. For example, Amir et al., (2009) demonstrated that improving attention disengagement from threat led to decreased anxiety and better observer-rated performance on a speech task in individuals with social anxiety. Moreover, although the effects may seem small, this type of modification may have clinical utility if administered over multiple sessions (e.g., Beard & Amir, 2008). Future studies might clarify how interpretation and attention interact to maintain anxiety, and also how combination procedures targeting both of these biases might be used for reducing anxiety symptoms.

Our study has limitations. For example, participants were not given a clinical interview to determine diagnostic status, and the mean level of social anxiety was in the moderate range. Therefore, we can not generalize these results to individuals with a diagnosis of social phobia. Furthermore, we did not collect follow-up data from our participants. Thus, we cannot speak to the longevity of the modification effects. In the present study, we limited our exploration to attention, as measured by the Posner task. Future studies might use other ways of measuring of these constructs (e.g., dot probe paradigm), and might also assess other forms of information processing biases, such a bias in image generation. In addition, future studies might examine different sequences of information processing bias modification, such as manipulating attention and observing effects on interpretation or imagery. The above limitations notwithstanding, the present study provides causal evidence that interpretation modification procedures have the potential to affect attention biases. Moreover, our findings suggest that such procedures may have clinical utility, in that strategic reinforcement of more benign interpretations (such as cognitive restructuring in CBT) may influence other mechanisms thought to maintain anxiety.

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Figure 1. Responses on the Interpretation Questionnaire in the IMP and ICC groups before and after the program

Figure 2. Change in response latency on valid and invalid trials of the Posner paradigm before and after training.

Table 1

Demographics and questionnaire data

	Group	
	IMP (n= 29)	ICC (n= 28)
% Female	45	61
Age	19 (1.2)	20 (1.9)
Education	14 (0.9)	14 (1.1)
BDI	8.5 (6.6)	7.7 (5.9)
LSAS	46.4 (18.8)	50.1 (21.7)
STAI-T	36.6 (8.8)	39.9 (10.3)
STAI-ST (pre)	36.9 (8.5)	46.6 (9.8)
STAI-ST (post)	38.9 (10.1)	38.1 (10.6)

BDI = Beck Depression Inventory, (Beck, Steer, & Brown, 1996); LSAS = Liebowitz Social Anxiety Scale-Self-report version (Liebowitz, 1987), STAI = Spielberger state trait anxiety inventory, (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983).