Published in final edited form as:
Cognit Ther Res. 2009 ; 33(4): 406–415. doi:10.1007/s10608-009-9235-0.

Interpretation in Social Anxiety: When Meaning Precedes Ambiguity

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Abstract

Cognitive models of anxiety posit that negative beliefs influence socially anxious individuals' interpretation of ambiguous social cues. However, paradigms used to assess interpretation bias in social anxiety have not addressed such beliefs. Furthermore, studies have assessed interpretation with either self-report or reaction time paradigms, rather than using both methods. In the current study, socially anxious and non-anxious participants completed the Word Sentence Association Paradigm (WSAP). In the WSAP, participants decide whether or not a word (implying a threat or benign interpretation) is related to an ambiguous sentence. Threat or benign meanings preceded the ambiguity in order to examine the influence of positive and negative beliefs on interpretation of ambiguous information. The WSAP results in two types of interpretation indices: (1) response latency to make relatedness decisions for threat and benign interpretations, and (2) endorsement rates of the relatedness of threat and benign interpretations to ambiguous sentences. Results revealed a threat interpretation bias and a lack of a benign interpretation bias in both reaction time and self-report data. Threat and benign biases were not strongly correlated. These findings support the distinction between threat and benign interpretation biases.

Keywords

Interpretation bias; Social anxiety; Information processing

Introduction

Cognitive models of social anxiety posit that the interpretation of ambiguous information as threatening maintains anxiety (e.g., Clark & Wells 1995; Rapee & Heimberg, 1997). An interpretation bias for ambiguous information may be especially harmful to 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). The cognitive models suggest that socially anxious (SA) individuals rely on pre-existing negative beliefs to resolve ambiguous social cues. For example, a SA individual may enter a party with the negative belief (e.g., “I am boring”). That individual is then primed to interpret the yawn of a conversation partner as indicative of him or her as being boring, rather than the partner's exhaustion.

Given the proposed influence of negative beliefs on interpretation, it is surprising that most studies examining interpretation have not directly addressed them. Most interpretation paradigms present ambiguous stimuli (e.g., scenarios) followed by possible interpretations. Participants then respond to the provided interpretations in various ways (e.g., rank order, lexical decisions). This order of presentation does not control for the influence of participants' beliefs on their subsequent interpretation. However, presenting threat (e.g., boring) and benign (e.g., interesting) primes before the ambiguous stimuli may better imitate the priming effects of pre-existing beliefs on interpretative processes.

To our knowledge, only two studies have examined the effect of priming cues on the interpretation of ambiguity. Amir et al. (2005b) modified Simpson and Kang's (1994) homograph paradigm to examine learning on multiple encounters with social ambiguity. In that study, the authorspresented word pairs to prime threat meanings of homographs (e.g., chicken-wimp), benign meanings homographs (e.g., chicken-fried), or unrelated meanings (e.g., chickendesk).[1] These researchers then examined the effect of this priming on a second encounter with the same homograph paired with either threat or benign target words. Nonanxious controls (NAC) showed the expected pattern of learning. Specifically, they showed faster response latencies naming a target primed by a homograph with the same meaning (i.e., both threat or both benign) activated in two successive trials than naming the same target primed by an unrelated word. Furthermore, non-anxious participants showed slower response latencies naming a target when a different meaning of the homograph prime was activated in successive trials than naming a target primed by an unrelated word. Participants with social phobia did not show this pattern in learning a benign meaning of a homograph. The authors suggested that these results support the hypothesis that SA individuals rely on threat cues, but not benign cues, to interpret sources of social ambiguity.

Hazlett-Stevens and Borkovec (2004) modified a different homograph paradigm developed by Richards and French (1992) to examine whether individuals with generalized anxiety disorder (GAD) use cues to resolve ambiguity. Participants saw four antecedent words, followed by a homograph (e.g., growth), followed by a target word that reflected either the benign (e.g., height) or threat (e.g., cancer) meaning of the homograph. On some trials the antecedent words matched the meaning of the target word (threat or benign), and on other trials the antecedent words were unrelated to the target word. Interpretation of the ambiguous homographs was inferred from participants' reaction time to make lexical decisions about the target words. Results revealed that individuals with GAD relied on antecedent information to interpret the homographs, but only when the antecedent words were threatening. Conversely, non-anxious individuals relied on antecedent information only when the words were benign.

These findings support the influence of threat primes on interpretation in anxiety. However, most studies of social anxiety have not specifically examined the role of priming in the interpretation of ambiguous information. Amir et al. (2005b) broached this issue in social anxiety; however, that paradigm specifically informed participants of the meaning of ambiguous homographs before assessing their interpretation of the same homograph on a subsequent encounter. As a result, that study did not assess the influence of threat/benign primes on the initial encounter with ambiguity. Thus, the first aim of the current study was to examine whether SA individuals would show a threat bias or lack a benign interpretation bias when exposed to different primes.

The second aim of the current study was to develop a paradigm to comprehensively assess interpretation bias. To date, studies have examined interpretation with either selfreport or

[1]Studies differ in their terms to describe types of interpretations (e.g., positive, negative, benign, non-threat, threat). To remain consistent, we will refer mostly to benign (includes neutral and positive) and threat interpretations from this point.

reaction time methods. Thus, it is not clear how biases obtained via self-report methods relate to biases inferred from reaction time data. Compared to NACs, most reaction time studies have revealed only a lack of benign bias in social anxiety (e.g., Hirsch and Mathews 1997, 2000), and most self-report studies have revealed only a threat bias in social anxiety (e.g., Amir et al. 1998, 2005a; Stopa and Clark 2000; Voncken et al. 2003, 2007; Huppert et al. 2007; Yoon and Zinbarg 2007). However, other selfreport paradigms have revealed a lack of benign bias (e.g., Constans et al. 1999), and some have supported both a threat bias and a lack of benign bias (e.g., Huppert et al. 2003, 2007; Vassilopoulos 2006). Furthermore, as mentioned above, reaction time studies that have controlled for different primes suggest that anxious individuals use threat primes, but not benign primes, to interpret ambiguity (e.g., Amir et al. 2005b; Hazlett-Stevens and Borkovec 2004). In sum, the relationship between interpretation biases measured via reaction time and self-report methods is in need of further empirical study. The differentiation of types of interpretation bias is important for advancing cognitive theories of social anxiety. Previous studies have differentiated threat bias and lack of benign bias as separate constructs (e.g., Huppert et al. 2003). However, to our knowledge no study has examined the relationship between interpretation biases inferred from self-report versus reaction time measures. Developing a paradigm that yields both self-report and reaction time data may provide a more comprehensive assessment of interpretation.

In the current study, we assessed interpretation bias in social anxiety using a novel paradigm called the Word Sentence Association Paradigm (WSAP). In the WSAP, participants decide whether or not a word (e.g., embarrassing) is related to an ambiguous sentence (e.g., people laugh after something you said). The WSAP differs from previous interpretation paradigms in social anxiety in two ways. First, it presents either a threat or benign prime before an ambiguous sentence. As mentioned before, this order of presentation was intended to activate beliefs proposed to influence interpretation during social interactions.

Second, the WSAP assesses interpretation bias using both self-report and reaction time measures. The self-report measure does not require participants to choose one interpretation over another, and it does not explicitly ask participants how they would interpret a situation. The reaction time measure reflects the amount of time participants take to determine the relatedness of the word and sentence. This type of reaction time data differs from previous studies that measured the amount of time to make a grammatical or lexical decision while reading text. Rather than providing an “on-line” measure of participants' initial interpretation as they read, the WSAP reaction time measure provides an index of how quickly (or easily) an individual accepts and rejects different interpretations.

We hypothesized that SA individuals would be (a) faster to endorse threat interpretations and faster to reject benign interpretations and that SA individuals would (b) endorse more threat interpretations and fewer benign interpretations than non-anxious individuals. Since this is the first study to measure both self-report and reaction time indices simultaneously, we also explored the relationship between these indices.

Methods

Participants

Participants comprised 52 undergraduate students (81% female) representing low (NACs) or high (SA) levels of social anxiety. Participants scoring 83 or above (70th percentile in community sample; Gillis et al. 1995) on the Social Phobia and Anxiety Inventory-Social Phobia Subscale (SPAI-SP) were selected for the SA group. Participants scoring 46 or below (30th percentile in community sample) were selected as NACs. Participants volunteered for the study to fulfill a course research requirement. Groups did not differ on age, gender, ethnicity, or education level (Ps[.2). Demographic information is presented in Table 1.

Measures

Participants completed the Social Phobia and Anxiety Inventory (SPAI; Turner et al. 1989). We calculated the Social Phobia subscale (SPAI-SP) and used this score for all analyses because the agoraphobia subscale has been found to be unrelated to other measures of social anxiety (Herbert et al. 1991). The SPAI-SP has demonstrated good test–retest reliability (r = . 86) and internal consistency (a = .96) in previous studies (Turner et al. 1989). Participants also completed the State Trait Anxiety Inventory (STAI; Spielberger et al. 1970) and the Beck DepressionInventory (BDI; Beck and Steer 1987). Means and standard deviations are presented in Table 1.

Materials

Word Sentence Association Paradigm—We created 76 ambiguous sentences that described social situations (e.g., “People laugh after something you said”) and 34 sentences that described non-social situations (e.g., “Part of the building is blown up”).[2] We selected two words for each ambiguous sentence: one that corresponded to a threat interpretation (e.g., “embarrassing” or “terrorist”) and one that corresponded to a benign interpretation (e.g., “funny” or “construction,” see “Appendix” for more examples). We then divided the word sentence pairs (220 total) into two sets of materials (A and B) to create two versions of the task. Sets were matched with respect to the types of situations depicted in the sentences (e.g., dating, work, performance). Within each set participants saw 55 ambiguous sentences: once paired with the threat interpretation prime (55 trials) and once with the benign interpretation prime (55 trials) for a total of 110 trials. No word–sentence pairs were repeated across sets, and the word–sentence pairs were presented in a different random order to each participant. We randomly assigned participants to each set (Set A: n = 31; Set B: n = 21).

Procedure—Participants were assessed individually. They read and signed a consent form, provided basic demographic information, and completed the self-report measures (i.e., SPAI, STAI, BDI). Participants then completed the WSAP on a computer.

Word Sentence Association Paradigm—Each WSAP trial comprised four steps. 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 prime 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 (see Fig. 1). Participants then pressed the space bar, and the next trial began. All text appeared in black, 12 point font against a gray background.

Results

Set Effects and Questionnaires

We compared participants in each set (A or B) on demographic characteristics, group assignment, social anxiety, depression, state anxiety, trait anxiety, and the WSAP social sentence indices (% threat endorsement, % benign endorsement, and reaction times). There were no significant set differences for any of these variables (*Ps* > .1). Thus, we continued our analyses collapsing across sets. The SA group was significantly more SA, t(50) = 17.90, *p*<.

[2]More examples of the materials are available from the first author upon request.

001, depressed, t(50) = 5.40, p<.001, state anxious, t(50) = 6.54, p<.001, and trait anxious, t (50) = 8.53, p<.001, than the NAC group. We also compared participants in each set on the nonsocial sentence indices. Sets differed on benign endorsement (p<.03), but not on threat endorsement or reaction times (*Ps*>.6). Thus, we included set (A or B) as a covariate on any analyses involving non-social sentence benign endorsement.

Reaction Time Data

We measured participants' reaction time to decide the relatedness of threat and benign interpretations to the ambiguous sentences (see Table 2 for means and standard deviations). Thus, the WSAP results in four types of reaction times: (1) endorsement of threat interpretations, (2) rejection of threat interpretations, (3) endorsement of benign interpretations, and (4) rejection of benigninterpretations.[3] In order to eliminate outliers, we excluded data from trials with reaction times shorter than 50 ms or longer than 2,000 ms. This resulted in the elimination of 3% of trials.

We conducted mixed ANOVAs with Group (SA, NAC) as the between-group factor and Valence (threat, benign), Response type (endorsement, rejection), and Sentence type (social, non-social) as within-group repeated factors. This analysis revealed main effects of group, F (1,47) = 10.07, P\.005, and Valence, F(1,47) = 5.24, P\.03, that were modified by a Group 9 Valence 9 Response type 9 Sentence type interaction, F(1,47) = 8.99, P\.005. The other main effects or interactions were not significant (Ps[.05).

We explored this four-way interaction further by conducting ANOVAs separately for social and non-social sentences. For non-social sentences, the ANOVA revealed main effects of Group, F(1,47) = 9.26, p <.005, and Response type, F(1,57) = 6.61, p <.02. None of the other effects were significant (*Ps*>.1). For social sentences, there was no main effect of Valence, F (1,50) = 3.28, p>.05, or response type, F(1,50) = .13, p>.05. There was a main effect of Group, F(1,50) = 6.02, p = .01, that was qualified by a Group X Valence X Response type interaction, F(1,50) =14.66, p <.001.

We explored the Group X Valence X Response type interaction further by conducting ANOVAs separately for threat and benign trials. For threat reaction times, this analysis revealed a main effect of Group, F(1,50) = 4.95, p <.04, that was modified by a Group 9 Response type interaction, F(1,50) = 8.89, p <.005. The main effect of Response type was not significant, F(1,50) = 1.54, p>.2. Simple effects of Group revealed that the SA group was significantly slower to reject threat interpretation than the NAC group, t(50) = 2.90, p = .006. Groups did not differ in their reaction time to endorse threat interpretations, t(50) = .97, p>.3. Followup paired sample t-tests revealed that the SA group was significantly faster to endorse than to reject threat interpretations, t(25) = -2.36, p <.03. The NAC group was marginally faster to reject than to endorse threat interpretations, t(25) = 1.95, p = .06.

For benign reaction times, the ANOVA revealed a main effect of Group, F(1,50) = 6.07, p <. 02, that was modified by a Group X Response interaction, F(1,50) = 6.96, p <.02. The main effect of Response type was not significant, F(1,50) = .46, p >.5. Simple effects of Group revealed that the SA group was significantly slower to endorse benign interpretations than the NAC group, t(50) = 3.33, p = .002. Groups did not differ on rejection of benign interpretations, t(50) = 1.18, p >.2. Follow-up paired sample t-tests revealed that the SA group was faster to reject than to endorse benign interpretations, t(25) = 2.25, p <.04. However, the NAC group

[3]Due to the nature of the WSAP paradigm, participants have varying numbers of reaction times for each trial type. The number of reaction times per trial type was the following: endorsement of threat (M = 10, SD = 6, range = 1–27), rejection of threat (M = 11, SD = 7, range = 5–34), endorsement of benign (M = 11, SD = 7, range = 6–35), and rejection of benign (M = 8, SD = 5, range = 1–27).

did not show any differences between endorsement and rejection of benign interpretations, t (25) = -1.45, p >.1.

In order to more easily compare the reaction time indices to the self-report indices, we calculated bias scores for the social sentences: threat bias = reaction times (reject threat - endorse threat) and benign bias = reaction times (endorse benign - reject benign). Thus, larger bias scores indicate more bias toward threat and away from benign interpretations. Independent samples t-tests revealed that the SA group had significantly larger threat bias scores, t(50) = 2.98, p <.005, and benign bias scores, t(50) = 2.64, p <.02, than the NAC group.

Endorsement Data

We calculated the percentage of threat and benign interpretations that each participant endorsed as being related to the sentence (see Table 2 for means and standard deviations). We conducted ANOVAs with Group (SA, NAC) as the between-group factor and Valence (threat, benign) and Sentence type (social, non-social) as within-group factors. This analysis revealed main effects of Valence, F(1,50) = 32.97, p <.001, and Sentence type, F(1,50) = 20.27, p <.001, that were modified by a Group X Valence interaction, F(1,50) = 36.73, p <.001, and a Group X Valence X Sentence type interaction, F(1,50) = 28.88, p <.001. None of the other effects were significant (*Ps* >.*2*).

We explored the Group X Valence X Sentence type interaction further by conducting analyses separately for social and non-social sentences. For social sentences, the main effect of group was not significant, F(1,50) = 2.14, p > .1. There was a main effect of Valence, F(1,50) = 27.34, p <.001, that was modified by a Group X Valence interaction, F(1,50) = 55.48, p <.001. Simple effects for group showed that the SA group endorsed more threat interpretations, F(1,50) = 34.26, p <.001, and fewer benign interpretations, F(1,50) = 16.64, p <.001, than the NAC group. Simple effects for Valence did not reveal significant differences in the SA group's endorsement of threat interpretations compared to benign interpretations, t(25) = 1.39, p = .16. However, the NAC group endorsed significantly more benign interpretations than threat interpretations, t(25) = -10.56, p <.001.

For non-social sentences, we submitted responses to an ANCOVA, controlling for set differences. This analysis revealed a Group X Valence interaction, F(1,49) = 10.59, p <.005. None of the main effects were significant (*Ps* >.7). Simple effects for group revealed that groups did not significantly differ in endorsement of threat interpretations, F(1,50) = 3.08, p >.08, or benign interpretations, F(1,50) = 3.37, p >.07. Simple effects for Valence did not reveal significant differences in the SA group's endorsement of threat interpretations compared to benign interpretations, t(25) = 1.37, p >.1. However, the NAC group endorsed significantly more benign interpretations than threat interpretations, t(25) = 5.45, p <.001.

Correlational Data

To explore the relationship among the various interpretation indices, we conducted correlational analyses. The threat and benign reaction time biases were not significantly correlated, r(52) = .20, p = .16. Threat and benign endorsement rates were also not significantly correlated, r(52) = -.25, p = .07. Threat reaction time bias was correlated with threat endorsement, r(52) = .38, p = .006, but not with benign endorsement, r(52) = -.20, p = .15. Benign reaction time bias was correlated with benign endorsement, r(52) = -.41, p = .002, but not with threat endorsement, r(52) = .05, p = .70.

We also explored the correlation between each interpretation index and social anxiety level. Social anxiety was correlated with all of the indices: threat reaction time bias, q(52) = .35, p

<.02; benign reaction time bias, q(52) = .36, p <.01; threat endorsement, q(52) = .64, p <.001; benign endorsement, q(52) = -.57, p <.001.

Discussion

We examined interpretation bias using a novel paradigm that controlled for the influence of threat and benign primes on interpretation, as well as yielded self-report and reaction time data. The reaction time data supported the hypothesis that social anxiety is characterized by bias regarding both threat and benign interpretations. Specifically, the SA and NAC groups exhibited opposite patterns of reaction times for threat and benign interpretations. The SA group was significantly slower to reject threat interpretations and to endorse benign interpretations compared to the NAC group. The NAC group's reaction times did not differ for endorsing versus rejecting threat or benign interpretations. However, the SA group was significantly faster to endorse than to reject threat interpretations and faster to reject than to endorse benign interpretations. These differences in reaction time were specific to the social sentences as the patterns did not generalize to non-social sentences. These findings converge with a previous reaction time study that examined the effect of learning on interpretation (Amir et al. 2005b). Specifically, findings from both studies suggest that in social anxiety, threat interpretations are activated, which may make accepting benign interpretations difficult.

However, other reaction times studies (Hirsch and Mathews 1997, 2000) have found that SA individuals do not favor threat or benign interpretations, while non-anxious individuals respond more quickly to benign interpretations (Hirsch and Mathews 1997, 2000). It is difficult to directly compare the current results to previous studies because the reaction times were obtained through different tasks and reflect different processes. Thus, it is not surprising that the current results differ from previous studies, as they suggest that differences in response time regarding benign and threat interpretations are important in social anxiety.

Procedural differences may account for mixed reaction time findings. For example, in the current study we presented a threat or benign prime followed by an ambiguous sentence. This allowed us to test the hypothesis that the presentation of the prime activated cognitive processes involved in interpretation (e.g., negative beliefs) that then influenced the interpretation of an ambiguous sentence. If the threat words in fact primed participants' negative beliefs, then this may have made the WSAP more sensitive to reaction time differences in responding to threat interpretations. This finding converges with a reaction time study of individuals with GAD that also showed a threat bias when primed with threat cues (Hazlett-Stevens and Borkovec 2004). The current finding of bias related to both threat and benign interpretations suggests that future research examining the influence of primes on interpretation is warranted. For example, future studies might examine the effect of primes by comparing the current version of the WSAP to a version in which the ambiguous sentence precedes the valenced words.

The task instructions also differed between the current study and the Hirsch and Mathews studies. In Hirsch and Mathews (1997, 2000), participants made speeded grammatical and lexical decisions about words that resolved ambiguous statements. Thus, those tasks assessed “online” interpretations made when participants initially encountered ambiguity. However, our reaction time data reflects the ease with which individuals accept or reject interpretations. Thus, our reaction time data may assess a different type of interpretation bias than previous studies.

Because participants in the current study were allowed unlimited time to judge the relatedness of the words and sentences, one could argue that our reaction time data is an “off-line” measure of interpretation, similar to the endorsement rates. Because the reaction time data do not reflect participants' actual comprehension or interpretation of text, it is difficult to classify it as an “online” or “offline” measure. Instead, the reaction time data may reflect a different aspect of

bias that is neither on-line nor off-line. Off-line measures assess interpretation retrospectively using recall or question answering. The WSAP reaction time measures do not fit this definition well. First, reaction times from the current study were faster than previous online studies, which suggest that participants made speeded decisions, rather than slower, retrospective decisions. The fast reaction times were likely due to the speeded nature of the WSAP. Specifically, the threat/benign words were presented for 500 ms, and participants were encouraged to make decisions as quickly as possible. Second, the reaction time bias scores were not strongly correlated with selfreport endorsement rates, suggesting that they represent related, but distinct, measures.

Similar to the reaction time data, the self-report data (% endorsement of threat and benign interpretations) supported our hypothesis that social anxiety involves both a lack of benign bias and the presence of threat bias. Specifically, SA individuals endorsed more social threat interpretations and fewer social benign interpretations than the NACs. Significant group differences did not emerge for non-social sentences. Thus, when defining interpretation bias as a divergence from non-anxious individuals' interpretation patterns, the self-report data support both a threat bias and a lack of benign bias specific to social stimuli. This finding converges with other self-report studies that examined threat and benign interpretations as separate constructs (e.g., Huppert et al. 2003, 2007). Assuming that 50% represents a baseline endorsement level, the NAC group's threat endorsement was low (30%) and their benign endorsement was high (71%). The SA group's threat and benign endorsement levels were closer to baseline (59% and 52% respectively). Thus, in the current study, it may be more accurate to associate control status with a lack of a threat bias and the presence of a benign bias, rather than associating social anxiety with bias.

It is also important to examine interpretation bias defined by within group differences. We found that the NAC group endorsed more benign interpretations than threat interpretations, whereas the SA group's benign endorsement did not differ from threat endorsement. Thus, the NAC group favored benign interpretations, while the SAs did not favor either type of interpretation. This pattern of results is inconsistent with many self-report studies that found that SA individuals favor threat interpretations (e.g., Amir et al. 1998). However, these findings are consistent with reaction time studies and other self-report studies that examined threat and benign interpretations as separate constructs (e.g., Constans et al. 1999; Vassilopoulos 2006). The WSAP (as well as the Constans and Vassiopoulos paradigms) may have been more sensitive to an off-line lack of benign bias because it did not ask participants to choose one interpretation over another, which is required in rank ordering (although see Huppert et al. 2007 for an exception).

We designed the WSAP to comprehensively assessinterpretation bias so that we could examine the relationship among the observed biases. Correlational analyses revealed that threat and benign reaction time bias scores were not significantly related ($r = .20$). Similarly, threat and benign endorsement levels were not significantly correlated ($r = -.25$). These findings suggest that the lack of benign bias and presence of threat bias should be conceptualized as separate constructs. Huppert et al. (2003) also drew this conclusion based on a similar correlation between threat and positive bias scores ($r = -.28$). The current results extend this conclusion to reaction time bias scores.

The current results may have clinical implications. Recent studies suggest that cognitive behavioral treatment for social phobia positively affects interpretation bias (Franklin et al. 2005). Moreover, recent versions of cognitive treatment have specifically focused on changing interpretation bias (Voncken and Bögels 2006). The current findings suggest that treatments targeting both threat interpretation bias and the lack of benign interpretation bias may produce better results than treatments that target exclusively threat interpretations. For example, during

cognitive restructuring clients often learn that their probability estimates of threat interpretations are inflated. The current results suggest that it may be beneficial to not only help clients evaluate probability estimates of threat interpretations, but also help clients assess the probability of benign interpretations. SA clients might benefit from evaluating benign interpretations of a situation in a similar manner as they would evaluate their threat interpretations. This would ensure that clients spend an equivalent amount of time elaborating on benign interpretations as they do threat interpretations. Finally, the current results highlight the need for therapists to help clients identify their particular negative beliefs that may influence interpretation. Our findings suggest that treatments targeting interpretation biases using experimental, computer based procedures may be beneficial. Hirsch and Mathews (2000) reached a similar conclusion, and suggested the development of treatments to increase the accessibility of on-line, benign interpretations. Interpretation modification paradigms have shown positive effects on anticipated anxiety for a social interaction (Murphy et al. 2007) and social anxiety symptoms (Beard and Amir 2008) in SA individuals. The current findings suggest that programs that target both threat and benign interpretations (e.g., Beard and Amir 2008) may be superior to programs that only increase benign interpretations. Future studies should test this hypothesis to determine the optimal method of changing interpretation in social anxiety.

Our study has several limitations that could be addressed in future research. First, our sample comprised high SA individuals, rather than individuals with a social phobia diagnosis. Although the mean SPAI-SP score for the SA group was in the clinical range (e.g., Hofmann et al. 2004), we did not assess diagnosis and therefore cannot speak to the generalizability of the results to individuals with social phobia. The current study did not examine the specificity of the observed biases to social anxiety, rather than to depression or trait anxiety. Although controlling for depression is common, we chose not to apply this approach because current models of anxiety and depression suggest that these two constructs are conceptually related and co-occur for meaningful reasons. Separating them may result in spurious data (Miller and Chapman 2001). However, studies that included anxious or depressed control groups (e.g., Amir et al. 1998, 2005a; Voncken et al. 2007) suggest that interpretation biases for social information are specific to social anxiety.

The WSAP is a novel procedure and could benefit from several improvements. First, the WSAP did not result in equal numbers of reaction times for each trial type. Moreover, a minority of participants had extremely small numbers of reaction times for a particular trial type (e.g., one participant had only one reaction time for threat rejection trials). Thus, the advantage of having reaction time data related to participants' self-report responses was tempered by unequal and small numbers of reaction times. This problem arose in part because all of the prime words were in fact related to the ambiguous sentences. We cannot be certain about how unequal and small cell sizes may have affected the current results. However, a similar pattern of results emerged when we analyzed median reaction times rather than means. We would have observed a larger discrepancy if the reaction times overall were unstable. Second, we cannot be certain that participants were actually reading the words or the ambiguous sentences. For example, it is possible that participants were only responding to the words, rather than determining the relatedness of the word to the sentence. Anecdotally, experimenters in the room observed the participants spending the expected amount of time to read when the sentences were on the screen. Additionally, participants were not told the purpose of the WSAP task (i.e., to assess an individual's interpretation), but were only given instructions to determine the relatedness of a word and a sentence. In our experience, research pool participants have been compliant with experimenter provided instructions for computer tasks. However, since we cannot be certain that participants read the sentences, future studies that utilize the WSAP may benefit from including a comprehension question to assess whether participants actually read the ambiguous sentences. Future studies could also improve the WSAP by developing a separate set of

ambiguous sentences to which the threat and benign words are unrelated. Researchers could then compare endorsement rates for the same words in related and unrelated trials. This improvement would allow for the assessment of accuracy and enable researchers to rule out response bias as an explanation for the group differences observed in the current study. Finally, the current correlational design cannot address the causal direction of the relationship between interpretation bias and social anxiety. Only studies that directly modify interpretation and examine the effect on anxiety allow causal conclusions to be made (e.g., Wilson et al. 2006). The current findings highlight the need for further research to determine which types of interpretation bias are causally related to the maintenance of social anxiety.

In summary, the WSAP is a novel procedure for assessing interpretation biases in social anxiety. The current results extend previous studies and suggest that threat bias and the lack of a benign bias are evident using both self-report and reaction time indices. Moreover, threat and benign biases are not significantly correlated, and selfreport and reaction time biases are not strongly related. It may be beneficial to incorporate both types of interpretation (threat and benign) and both types of methodology (self-report and reaction time) in the assessment and treatment of social anxiety. Future research should also address the relationship between negative beliefs and interpretation of ambiguity in social anxiety.

Appendix. Example materials

Threat word	Benign 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
Bored	Busy	Your date has to leave early
Clumsy	Graceful	You carry a tray of food at a party

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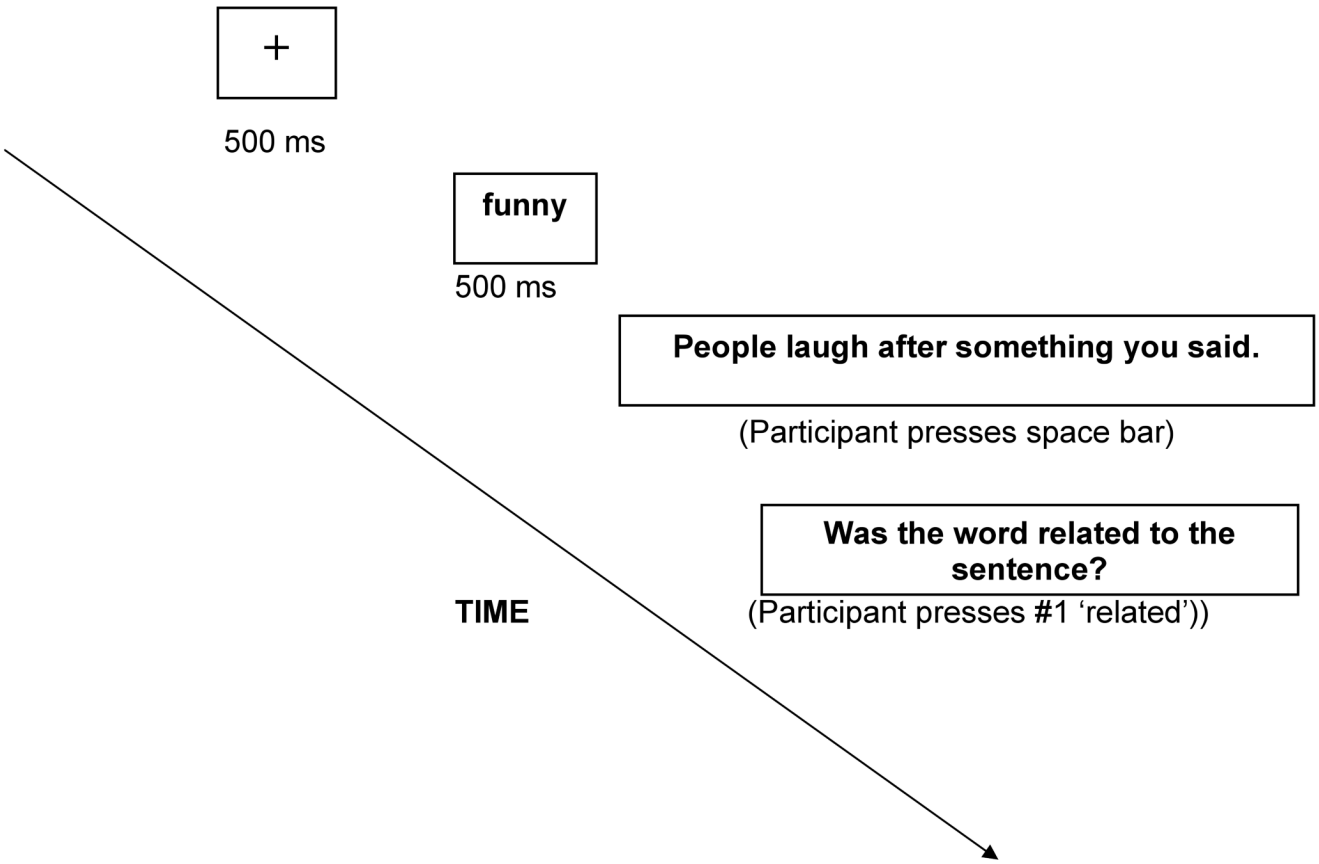

Figure 1.
Example Trial

Table 1

Demographic information and self-report measures

	Socially Anxious (n = 26) n (%)	**Non-anxious controls (n = 26) n (%)**
Sex (% female)	22 (88)	19 (73)
Ethnicity (%)		
Caucasian	19 (73)	19 (73)
African American	4 (15)	4 (15)
Asian	3 (12)	3 (12)
	M (SD)	M (SD)
Age	19 (1.29)	19 (1.12)
Education (in years)	14 (1.00)	14 (1.00)
Self-report measures		
SPAI-SP	123.00 (23.05)	29.00 (13.63)
BDI	19.42 (12.21)	4.92 (6.17)
STAI-S	44.92 (9.86)	29.08 (7.43)
STAI-T	52.65 (10.80)	30.65 (7.49)

Note. SPAI-SP Social Phobia and Anxiety Inventory-Social Phobia Subscale, BDI Beck Depression Inventory, STAI-S Spielberger State-Trait Anxiety Inventory-State Form, STAI-T Spielberger State-Trait Anxiety Inventory-Trait Form

Table 2

WSAP indices

	Socially anxious (n = 26)	Non-anxious controls (n = 26)
	M (SD)	M (SD)
Self-report indices (%)		
Social threat endorsement	59 (18)	30 (18)
Social benign endorsement	52 (19)	71 (14)
Non-social threat endorsement	59 (18)	49 (23)
Non-social benign endorsement	64 (15)	71 (18)
Reaction time indices (ms)		
Social sentences		
Endorsement of threat	532 (163)	485 (186)
Endorsement of benign	657 (226)	460 (199)
Rejection of threat	626 (267)	447 (169)
Rejection of benign	577 (200)	507 (228)
Benign bias score	80 (181)	-47 (166)
Threat bias score	94 (203)	-39 (101)
Non-social sentences		
Endorsement of threat	550 (183)	434 (121)
Endorsement of benign	538 (183)	477 (198)
Rejection of threat	571 (187)	470 (198)
Rejection of benign	662 (286)	513 (235)

Note: Threat bias = reaction time (reject threat - endorse threat); benign bias = reaction time (endorse benign – reject benign)