Chapter 16

Cognitive Biases in Social Anxiety Disorder

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INTRODUCTION

Psychopathologists have been greatly influenced by information-processing models of emotional disorders that suggest preferential processing of threat-relevant information (i.e., information-processing biases) underlie these disorders (Beck, Emery & Greenberg, 1985; Williams Watts, MacLeod, & Mathews, 1988, 1997). Meta-analyses now show that information-processing biases do characterize anxious individuals (e.g., Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). More specifically, anxious individuals preferentially attend to threat-relevant information and interpret ambiguous information as threatening. There is also some evidence that there is preferential memory for social information in socially anxious individuals. By far the majority of this research has examined the correlational nature of these cognitive biases and anxiety. However, since the second edition of this book, accumulating evidence suggests that such biases may play a causal role in the development and maintenance of social anxiety disorders. In previous editions, we introduced the concept of experimental approaches to modifying information-processing biases and presented preliminary evidence suggesting the utility of these interventions. Since the last edition of this chapter, the field has witnessed a surge of interest in the modification of cognitive biases in social anxiety. Largely this research has focused on attentional bias modification (ABM), although research is beginning to accumulate examining the efficacy of interpretation bias modification (IBM) in reducing social anxiety symptoms. Together these studies suggest that information-processing biases may be causally implicated in social anxiety. Relative to attention and interpretation, research on memory biases in social anxiety lags behind.

In this chapter we summarize the evidence for information-processing biases that may characterize socially anxious individuals (SAIs). For each domain, we will provide a review of the literature and suggest areas of future research.

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ATTENTION

Evidence for Attentional Biases for Threat Relevant Information in Social Anxiety Disorder

The limited capacity of the human attentional system dictates that some information in the environment will be attended to while other information will be ignored. This suggests that incoming information must be prioritized. A bias in this prioritization can lead to increased availability of threat, causing anxiety.

To examine attentional bias for threat-relevant information in individuals with social anxiety disorder (SAD), researchers began by using the emotional Stroop task (Williams, Mathews, & MacLeod, 1996). In this task, participants are asked to name the color in which emotional words are written while ignoring the meaning of these words. SAIs are slower at color-naming socially relevant threat words than color-naming neutral words, whereas non-anxious controls are not (Amir, Freshman, & Foa, 2002; Amir, McNally et al., 1996; Mattia, Heimberg, & Hope, 1993; Spector, Pecknold, & Libman, 2003). This finding suggests that the activation of threat meaning of the words may interfere with the color-naming task in SAI*s* to a greater extent than it does in controls. However, the Stroop task is considered an impure measure of attention because some versions of the paradigm, i.e., presenting a block of words on one card may involve post-attentional processing of the stimuli (Fox, 1994), and because attention is measured while responding to threat material. Therefore, delayed response latencies for threat words in the Stroop paradigm may involve both initial biased attention to threat and later avoidance of cognitively processing the meaning of the emotional word, thus delaying response (de Ruiter & Brosschot, 1994).

Partly in response to the above criticism, researchers have used more direct measures of attentional bias (MacLeod, Mathews, & Tata, 1986). For example, in the probe detection task, subjects are presented with a threat and a non-threat stimulus (e.g., words, pictures) simultaneously, one on top of the other. The stimuli then disappear, and subjects see a probe that is located in place of either the top or bottom stimulus and are instructed to identify the location of the probe by pressing one of two buttons. Attentional bias in this task is revealed by shorter response latency in detecting the probe, when it replaces the previously presented threat stimulus, than the response latency when the probe replaced the previously presented neutral stimulus. In the first application of this paradigm to social anxiety, Asmundson and Stein (1994) found that SAIs were faster to respond to probes that replaced a social threat word. Musa, Lepine, Clark, Mansell, & Ehlers (2003) replicated this finding of attentional bias toward threat words in patients with social phobia.

Other studies have used the dot-probe detection paradigm using neutral and negative facial expressions rather than words. A number of studies using facial expressions have yielded similar findings as those that use words, namely, that individuals with social anxiety preferentially attend *toward* threat faces (Mogg & Bradley, 2002; Mogg, Philippot, & Bradley, 2004; Pishyar, Harris,

& Menzies, 2004; Sposari & Rapee, 2007). However, a number of studies have found opposite results, with SAIs demonstrating an attentional bias *away* from threat (Chen, Ehlers, Clark, & Mansell, 2002; Mansell, Clark, Ehlers, & Chen, 1999; Yuen, 1994). Moreover, Sposari, & Rapee (2007) found that patients with SAD preferentially attended to faces, regardless of expression, relative to household objects. Overall however, when two faces are shown in each trial of the paradigm (versus one face and one household item) and the stimulus presentation is brief (i.e., 500 milliseconds) there is consistent evidence for attentional bias for emotional faces (Bögels & Mansell, 2004).

Despite significant advantages of the dot-probe over the emotional Stroop task in separating attentional processes, the dot-probe paradigm does not clearly differentiate between enhanced alerting (facilitatory) effects of threat stimuli and difficulties disengaging from threat (Amir, Elias, Klumpp, & Przeworksi, 2003; Yiend & Mathews, 2001). That is, faster response latencies when the probe replaces the threat stimulus, relative to response latencies when the probe replaces the neutral stimulus, may be due to early and automatic attentional capture by the threat stimulus, difficulty disengaging attention from the threat stimulus and shifting attention to neutral stimuli, or both (Koster et al., 2004). Conversely, spatial cueing paradigms are better able to differentiate these components of attention. In typical spatial cueing paradigms, a single cue (e.g., threat or neutral word or picture) appears in a specific spatial location (e.g., right or left side of computer screen) and is then replaced by a target in the same or opposite location as the cue. Research using the spatial cueing paradigms suggests that SAD may be the result of difficulty disengaging attention from threat-relevant stimuli (i.e., longer response latencies for invalidly cued trials; Amir, Eilas, et al., 2003). However, not all research using the spatial cueing paradigm has found this effect (Rossignol, Philippt, Bissot, Rigoulot, & Campanella, 2012) and methodological differences across studies render comparisons difficult.

Limitations of Current Methods of Assessing Attentional Bias

Despite some inconsistency in this body of literature, recent reviews suggest that across paradigms individuals with social anxiety demonstrate an attentional bias towards threat-related information (Bar-Haim et al., 2007). However, significant variability in the procedures used across studies complicates interpretation of findings. Therefore, a major limitation of the field is the lack of standardized assessment procedures for measuring attentional bias and the limited data on the psychometric properties of these measures. The assessment of attentional bias varies by paradigm, type of stimuli used (faces versus words), comparison stimuli (e.g., neutral faces or household items), stimulus presentation interval, etc. Moreover, the use of response latencies to measure attentional bias, in contrast to the relatively face-valid self-report or clinician-rated measures of social anxiety when measuring symptoms, brings into question the upper limit that can be placed on psychometric properties of attentional bias measures.

For example, response latencies are subject to computer speed, arbitrary decisions about cutoff scores and outliers, as well as variation in the precision of the program used to measure them. Little research has systematically examined the impact of these various factors in clinical settings. For example, some evidence suggests that the dot-probe paradigm may only possess low to moderate reliability in clinical settings (Price et al., under review; Schmukle, 2005). Furthermore, although research suggests that attentional bias may be present in SAD, the clinical utility of these biases depend on efforts to establish the psychometric properties of these measures. As researchers begin to investigate the use of these biases as tools to predict treatment outcome based on individual differences (Amir, Taylor, & Donohue, 2011; Kuckertz et al., 2014; Legerstee et al., 2009; Price, Tone, & Anderson, 2011; Waters, Mogg, & Bradley, 2012), not surprisingly, these early investigations have yielded conflicting findings. While these investigations represent an exciting avenue for future research, the widespread use of attentional bias measures as a clinical tool may be premature until a better understanding of these measures has been established.

Furthermore, although the reliability of the dot-probe has been low and nonsignificant in limited extant reports, reliability may vary as a function of, firstly, sample characteristics (e.g., clinical versus healthy populations, age group) and, secondly, specific task design and analysis decisions made by the experimenter. In spite of the task's popularity, researchers have not examined the impact of these study parameters in order to provide an empirical basis for improving reliability of the task. The impact of these decisions may be magnified in the context of clinical research, where inherent difficulties with recruitment and clinical assessment often limit the sample sizes that are feasible, further reducing power to detect effects of interest. These limitations in clinical research contexts may also limit the applicability of more complex methods of response latency modeling and analysis drawn from the cognitive psychology literature (e.g., diffusion models; Ratcliff & McKoon, 2008, Ratcliff, 2013). For example, the diffusion model extracts theoretically relevant components of processing from the accuracy and RT data providing a qualitatively and quantitatively accurate account of data, with the parameters of the model representing components of processing with improved reliability and validity. However, these modeling procedures are not easily available to clinical researchers and may have assumptions that may not be met when small numbers of participants and/or task trials are available.

To complement response latency-based measures of bias, researchers have also turned to alternative methods of assessing attentional bias. For example, psychophysiological measures such as eye tracking tasks may represent a useful method of assessing attentional bias (Armstrong & Olatunji, 2012). In general, eye tracking studies support the conclusion that social anxiety is characterized by aberrant attentional processing of social-relevant stimuli (Buckner, DeWall, Schmidt, & Maner, 2010; Buckner, Maner, & Schmidt, 2010; Chen, Clarke, MacLeod, & Guastella, 2012; Horley, Williams, Gonsalvez, & Gordon, 2003;

Mühlberger, Wieser, & Pauli, 2008), although evidence to date is mixed regarding the specific nature of these processing differences (i.e., problems with hypervigilance towards, difficulties disengaging from, or attentional avoidance of emotional stimuli). Other researchers have used event-related potentials (ERPs) obtained from electroencephalogram (EEG) recording to measure attentional biases in anxiety. For example, Mueller and colleagues (2009) found that when using both response latencies and ERP data, SAIs demonstrated an attentional bias toward threat-relevant information when compared to non-anxious controls. Specifically, SAIs showed larger amplitudes in the P1 component of attention (reflecting initial orienting) for angry-neutral face pairs relative to happy-neutral face pairs. Similar results have been obtained for the P2 component of attention; specifically, SAIs show larger P2 amplitudes in a modified emotional Stroop task for angry as compared to happy and neutral faces (van Peer, Sphinhoven, & Roelofs, 2010). SAIs may also experience larger N170 amplitudes over the right hemisphere when identifying angry emotional expressions (Kolassa & Miltner, 2006). Other research has found a more general association between social anxiety and enhanced P1 and P2 amplitudes for facial stimuli, regardless of valence. While findings in this emerging field are to date mixed, this area of research holds promise in better characterization of the nature of attentional biases in social anxiety. Moreover, psychophysiological measures such as EEG can be easily paired with more classic measures of attentional bias (i.e., response latency), offering comparability with previous research.

Causal Role of Attentional Biases and their Modification

Although the above studies indicate that social anxiety is associated with biased attention, they do not speak to the issue of causality. Indirect evidence for the causal role of attentional bias to threat in social phobia has been evaluated in the context of treatment outcome studies. That is, if attentional bias to threat is a necessary condition for social phobia, then amelioration of the disorder should be associated with a reduction of attentional bias to threat. Empirical investigations of this question have generally supported this hypothesis in socially anxious individuals using both the emotional Stroop paradigm (Lundh & Öst, 2001; Mattia et al., 1993) and the dot-probe paradigm (Pishyar, Harris, & Menzies, 2008). Thus, there is evidence that successful treatment for social phobia is associated with a normalization of attentional bias for threat. However, such results do not rule out the possibility that attentional bias is simply a correlate of anxiety, rather than being a cause of anxiety.

Researchers have also examined the causal relationship between attentional bias toward threat and social anxiety using experimental methods that manipulate attention to examine the effect on anxiety. For example, Amir and colleagues (2009) administered an attentional training program to individuals diagnosed with SAD. The authors modified the dot-probe procedures used by Mathews and MacLeod (2002) to encourage SAIs to disengage their attention

from threat stimuli. Specifically, the paradigm created a contingency between the location of the non-threat stimuli (i.e., neutral face) and the probe in one group (attentional bias modification, or ABM) but not in the other (attention control condition, or ACC). Anxiety and attentional bias were assessed before and after training. Results revealed that the procedure effectively modified attentional disengagement. After eight sessions, the ABM group experienced significantly greater reductions in social anxiety symptoms compared to the control group. Moreover, 50% of the active condition, compared to 14% of the control condition, lost their diagnosis of SAD.

Schmidt et al. (2009) reported similar results with an identical protocol, finding that 72% of participants in the active condition, compared to 11% of participants in the control condition, did not meet diagnostic criteria for SAD after eight sessions of attentional training. Heeren et al. (2012) extended the examination of ABM beyond SAD symptoms, and also examined social anxiety-related behavior and physiological response to a social stressor. These investigators found that after four sessions of attentional training, both the ABM and the ACC groups displayed significant reductions in social anxiety symptoms from pre- to post-treatment. However, these results were only maintained at follow-up for the ABM group. Moreover, the ABM group, but not ACC group, demonstrated behavioral improvements in social anxiety symptoms and reduced physiological response associated with a speech performance task. These studies indicate that attention modification procedures may have clinical utility.

Several meta-analyses now support the efficacy of ABM as an effective intervention for anxiety (Beard, Sawyer, & Hofmann, 2012; Hakamata et al., 2010; Hallion & Ruscio, 2011). However despite these initial promising results several recent attempts at replicating these findings in SAD have failed to find expected group differences between the ABM and the ACC groups (Boettcher, Berger, & Renneberg, 2012; Carlbring et al., 2012; Neubauer et al., 2012), thus calling into question the efficacy of ABM (Emmelkamp, 2012).

While a number of factors could account for these discrepant results, one explanation may be that in these latter studies, the active dose of the mechanism of change for attentional training (i.e., attentional disengagement from threat) was delivered equally to both groups. At a fundamental level ABM is predicated on the idea that attentional bias is a malleable construct and that change in attentional bias is causally related to change in anxiety. Surprisingly in their enthusiasm to develop and deliver effective treatments, many of these basic questions have not been addressed in many of the extant studies. To formally test the relationship between change in attentional bias and change in anxiety, Amir and colleagues (2009) conducted formal mediational analyses showing that change in attentional bias mediated the relationship between treatment condition (ABM versus ACC) and reduction in social anxiety. Similarly, Heeren et al. (2012) found that change in attentional bias mediated the relationship between treatment condition and change in physiological reactivity from pre- to post-treatment, as well as fear of negative evaluation from post-treatment to follow-up. Thus,

change in attentional bias appears to be an essential ingredient of ABM, and as such, studies that fail to demonstrate this change in bias would not be expected to find changes in symptoms (Clarke, Notebaert, & MacLeod, 2014). Consistent with this hypothesis, the studies that failed to find significant group effects of ABM on symptoms also failed to show an effect of training on attentional bias (Boettcher et al., 2012; Carlbring et al., 2012; Neubauer et al., 2013).

To address some of these inconsistencies, Kuckertz et al. (2014) compared two groups of participants completing ABM. One group of participants completed traditional ABM via the internet. The second ABM condition was identical with the addition that participants were asked to activate their social anxiety fears immediately prior to each session. The first groups did not demonstrate a decrease in attentional bias, and did not experience a decrease in symptoms (data from Carlbring et al., 2012). In the second group there was both a decrease in attentional bias as well as significantly reduced symptoms. Moreover, Kuckertz et al. showed that change in attentional bias mediated the difference between these two active ABM groups and decrease in social anxiety symptoms, suggesting that specific protocol manipulations may be critical to optimizing the active ingredient hypothesized to underlie ABM treatments.

Attentional Biases for Threat or Attentional Control?

While a large body of research has accumulated suggesting the presence of an attentional bias towards threat (Bar-Haim et al., 2007), others have suggested that changes in anxiety following ABM may not result from modification of automatic attentional capture by threat per se, but rather, from the strengthening of more general attentional control that is otherwise deficient in anxious individuals (Bar-Haim, 2010; Derryberry, & Reed, 2002; Eysenck, Derkshan, Santos, & Calvo, 2007). That is, anxious individuals may experience difficulty with voluntary control of attention, regardless of stimulus valence. However, evidence for attentional control deficits in social anxiety has been mixed. In a study conducted by Wieser, Pauli, and Mühlberger (2009), participants performed an antisaccade task in which they were instructed for each trial to direct their attention either towards or away from an emotional or neutral expression presented on the screen. SAIs, compared to controls, exhibited more difficulty shifting their attention away from facial expressions, regardless of valence type, thus supporting attentional control theory. Conversely, using a modified version of the probe detection task, Moriya and Tanno (2011) found that SAIs demonstrated a threat-specific attentional bias, but found no evidence for impaired control of attention more generally.

Similarly, data have been mixed in studies of ABM, designed specifically to enhance attentional control rather than direct attention from threat specifically. Klumpp and Amir (2010) hypothesized that if SAIs experienced deficits in attentional control rather than specifically threat-attention bias, then ABM that is designed to train attention towards either threat or neutral facial expressions

should produce equivalent results. They found that a single session of attention training condition (regardless of valence training type) resulted in reduced anxiety in response to an impromptu speech task, compared to individuals in a no-training condition in SAIs. However, in a similar, multi-session study conducted by Heeren and colleagues (2012), an attend threat condition did not produce positive results in SAIs when compared to either an attend-positive condition or a control condition. Given the mixed state of the literature and the importance of this issue in terms of cognitive theories of social anxiety, continued research in this area is needed to further delineate the relative roles of attentional biases for threat versus deficits in attentional control in SAIs.

INTERPRETATION

Studies of interpretation bias in social anxiety are informative because social interactions are often ambiguous. Thus, to the extent that socially anxious individuals interpret ambiguous social events as threatening, they would be more likely to experience social interactions as negative. The inherent ambiguity of social feedback dictates that one needs to judge the adequacy of one's own performance and judge others approval or disapproval. This judgment is often based on limited and incomplete information. A stern look from a friend, an unenthusiastic response to our greeting, or a temporary disagreement with a friend can all be interpreted in a neutral or negative (i.e., critical or sarcastic) way. Given identical ambiguous cues in a scripted social encounter, such as an interview for a job, socially anxious individuals habitually make more negative inferences about their performance than do non-anxious individuals (Hirsch & Mathews, 1997).

In the following review of interpretation biases in social anxiety, we focus primarily on interpretation biases in response to ambiguous social information. However, it should be noted that research suggests that SAIs also interpret non-ambiguous negative information as more strongly negative and more meaningful than non-anxious individuals. For example, Foa, Franklin, Perry, and Herbert (1996) found that SAIs estimated both the probability and cost of negative social events to be greater than did non-anxious controls (NACs). Similarly, Stopa and Clark (2000) found that SAIs rated mildly negative sentences as more negative than did low socially anxious individuals. The authors conclude that social anxiety may be associated with a tendency to catastrophize negative events.

Interpretation of Ambiguous Events

Researchers have used a number of paradigms to examine interpretation bias in anxiety using semantic (i.e., verbal) stimuli related to ambiguous social information. These methods include the interpretation of ambiguous scenarios (e.g., Amir, Foa, & Coles, 1998a; Stopa & Clark, 2000) or interpretation of homographs

(i.e., words with similar spelling but different meaning, Amir, Foa, & Coles, 1998b). In general, these studies suggest that SAIs are characterized by a bias towards negative interpretations, as well as a lack of benign and positive interpretations. In one of the first studies of interpretation of ambiguous social situations in SAD, Amir and colleagues (1998a) had participants rank the likelihood of three possible interpretations (either positive, negative, or neutral) of ambiguous scenarios using methodology adapted from Eysenck, Mogg, May, Richards, & Mathews (1991). SAIs rated the negative interpretations as more likely to come to their mind compared to both non-anxious individuals as well as individuals with obsessive-compulsive disorder, suggesting that this bias is specific to social anxiety rather than anxiety in general. There were no differences between groups when participants were asked to rank the interpretations in terms of how likely they would be to come to a typical person's mind. Thus, interpretation bias for threat in SAD appears restricted to self-relevant social scenarios rather than to social situations broadly. The finding that SAIs display negative interpretation biases when asked to rate experimenter-provided interpretations has been replicated in other studies (e.g., Voncken, Bögels, & Peeters, 2007; Wilson & Rapee, 2005). Moreover, Huppert, Foa, Furr, Filip, and Mathews (2003) demonstrated that negative interpretations of social situations were positively associated with social anxiety, while presence of a positive social interpretation bias was negatively related to social anxiety (as well as general negative affect). Positive and negative interpretation bias were only moderately correlated in this study, suggesting they may lie on two separate continuums, rather than being at opposite ends of a single dimension. However, both forms of bias may be associated with social anxiety. In a second study, Huppert, Pasupuleti, Foa, and Mathews (2007) provided participants with ambiguous social sentences and asked them, firstly, to generate multiple responses to complete the sentence, and, secondly, to indicate which of these responses best completed the sentence. SAIs generated and endorsed more negative or anxious responses and fewer positive and neutral responses than individuals low in social anxiety. These studies suggest that in addition to generating more negative interpretations than NACs, SAIs also appear to lack a positive bias characteristic of NACs.

More ecologically valid ambiguous stimuli have also been used to evaluate interpretation bias in SAIs. For example, Amir, Beard and Bower (2005) assessed interpretation bias using ambiguous videos rather than sentences. In each video, an actor or actress approached the viewer and made a comment (either ambiguous, positive, or negative) about the viewer. Participants rated the emotional valance of each video as to how they would feel in that situation. Results from this study revealed that SAIs rated ambiguous social interactions more negatively than did non-anxious individuals, high trait anxious individuals, and dysphoric individuals. Similarly, studies using face stimuli also indicate that SAIs may be more sensitive to detecting negative face cues in ambiguous pictures, relative to non-anxious individuals. For example, Richards et al. (2002)

presented SAIs and individuals low in social anxiety with pictures of faces containing two emotional expressions (happiness, surprise, anger, fear, disgust, and sadness) blended at varying gradations using digital facial morphing software. Thus, each participant was shown five faces representing different proportions of an angry face and a happy face (i.e., 90/10, 70/30, 50/50, 30/70, 10/90). Participants were then asked to classify the emotion. Results from this study indicated that SAIs categorized significantly more faces as expressing fear, thus suggesting a tendency to be sensitive to the presence of fear-relevant cues in ambiguous faces relative to controls.

However, not all studies find interpretation bias in SAIs using negative face stimuli. For example, at least two studies using face morphing paradigms similar to the Richards et al. (2002) study did not find group differences in SAIs and non-anxious individuals (Philippot & Douilliez, 2005; Schofield, Coles, & Gibb, 2007). Methodological differences may explain these discrepant findings. For example, Philippot and Douilliez (2005) blended negative emotional prototypes with neutral faces, rather than blending two valenced emotions (e.g., anger and happiness). Schofield et al. (2007) did combine two types of valenced face stimuli, but did not include fearful faces. Thus, interpretive biases demonstrated by SAIs may be detected specifically when the ambiguity in a facial expression is a combination of fear and another valenced expression (e.g., happy).

Although most studies have examined the relationship between social anxiety and interpretations or judgments about ambiguous or negative information, other studies suggest that SAIs may possess an interpretation bias in relation to *positive* information as well. Relative to non-anxious individuals, SAIs tend to interpret positive social situations negatively (Alden, Taylor, Mellings, & Laposa, 2008; Vassilopoulos, 2006) and to interpret positive facial expressions as less approachable (Campbell et al., 2009). Moreover, research has also demonstrated that SAIs experience fear surrounding *positive* evaluation, as well as negative (e.g., Weeks, Heimberg, Rodebaugh, & Norton, 2008).

In addition to classifying interpretation biases based on reactions to positive, negative, or ambiguous information, interpretation biases may be further characterized in terms of level of automaticity. That is, interpretation biases may be either online (fast or automatic) or offline (slow or effortful; Hirsch & Clark, 2004). This distinction may have theoretical importance in the maintenance of anxiety-related behaviors. For example, online interpretation biases may affect immediate processing and reactions while an individual is immersed in a social situation, whereas offline biases may affect post-event processing and decisions regarding whether to enter future social situations (Clark & Wells, 1995). Offline biases are typically measured in terms of endorsement rates for specific types of situations, whereas online biases may be assessed using speeded or reaction time measures. The studies presented thus far have primarily used self-report of semantic interpretations or face judgments. In these studies, SAIs have time to deliberate between possible interpretations, thus assessing their offline interpretation biases.

However, a number of studies reported interpretation using online measures, such as the time taken to read a word or sentence consistent with a negative or positive interpretation (e.g., Richards, Reynolds, & French, 1993). Other studies evaluating interpretation bias using reaction time measures have used paradigms such as a modified emotional card-sorting task (Mohlman, Carmin, & Price, 2007), an incidental learning paradigm (Yoon & Zinbarg, 2008), homograph decision tasks (Amir, Beard, & Przeworksi, 2005; Amir et al., 1998b), and an emotional priming paradigm (Yoon & Zinbarg, 2007). In general, findings suggest that SAIs are more likely than non-anxious individuals to interpret ambiguous information negatively in online situations. For example, Hirsch and Mathews (1997) asked SAIs and controls to read a realistically ambiguous description of themselves being interviewed for a job, presented line by line on a computer. At unpredictable intervals, they had to make a speeded decision about a probe word that matched possible negative or positive inferences. For example, immediately after reading the (incomplete) sentence, "As the interviewer asks you the first question, you realize that all your preparation has been ...," one of two probe words could be presented. In this example, the probe word could be "forgotten" (matching a negative inference) or "useful" (matching a positive inference). Speed of deciding whether the probe word could logically complete the sentence was used to operationalize the extent to which these different inferences had been made by the individual. SAIs were relatively faster to endorse threatening probes, whereas controls were faster to endorse the words matching positive or non-threatening inferences. Thus, controls demonstrated a positive online interpretative bias, likely to protect their self-image, whereas those fearing interviews demonstrated a negative online bias. Hirsch and Mathews (1997) suggested that such a reversal of a normally protective bias leaves SAIs more vulnerable to anxiety disorders. Similar results were obtained by Amir, Prouvost, and Kuckertz (2012). These researchers found that individuals diagnosed with SAD were significantly slower to endorse benign (including neutral and positive) interpretations of ambiguous sentences compared to non-anxious controls, thus suggesting that SAD is characterized by difficulty in making benign interpretations in an online context. That is, it may take longer for individuals with SAD to recognize social situations as benign. Amir and colleagues suggested that this reduced online benign bias may limit positive reinforcement in social situations, thus rendering social interactions less enjoyable for SAIs.

In summary, results have shown that SAIs are characterized by a tendency to more often interpret ambiguous information negatively and less often interpret ambiguous situations as positive or neutral. Such biases may be present at an effortful (offline) as well as automatic (online) level. Moreover, SAIs have more negative interpretations of mildly negative information, and also tend to interpret positive information in a more negative way, relative to non-anxious individuals. These types of biases appear to be present in processing of both semantic and facial expression stimuli, although results from studies using facial expressions are somewhat mixed. Future research in this area is needed to

delineate the parameters of interpretation bias for face and other ecologically valid stimuli.

Similar to the body of research on attention, recent empirical work suggests that interpretive biases in social anxiety may be malleable (e.g., Beard & Amir, 2008; Hirsch, Mathews, & Clark, 2007; Murphy, Hirsch, Mathews, Smith, & Clark, 2007; Voncken & Bögels, 2006). In these studies, interpretation biases are modified by requiring participants to repeatedly access benign meanings of ambiguous events. Several studies have shown that interpretation training may result in anxiety reductions (Beard & Amir, 2008) or decreased expectations of anxiety for an upcoming social situation (Murphy et al., 2007) in subclinically socially anxious individuals. Emerging research also suggests that interpretation training may be useful as a treatment for individuals diagnosed with SAD. Using previous methodology (Amir, Bomyea, & Beard, 2010; Beard & Amir, 2008), Amir and Taylor (2012) examined the efficacy of a 12-session interpretation modification program (IMP) in individuals with a diagnosis of SAD. In this program, participants viewed either a benign or negative word, followed by an ambiguous sentence. Participants were asked to decide whether or not the word and sentence are related. To modify interpretations, participants were given feedback about their relatedness judgments. Participants in the training group were given positive feedback (i.e., "You are correct!") for endorsing a benign interpretation or rejecting a threat interpretation, and negative feedback (i.e., "You are incorrect") for rejecting a benign interpretation or endorsing a threat interpretation. Feedback for participants in the control condition was not contingent upon response type. At post-treatment, the IMP group displayed greater reductions in anxiety and higher rates of diagnostic remission (65% lost diagnosis) compared to the placebo group (13% lost diagnosis). Thus, these studies support the causal relationship between interpretation bias and social anxiety outlined in theories of the disorder.

While the majority of interpretation-training research has focused on self-conducted, computerized programs, it may be possible to derive benefits from interpretation training conducted in a more naturalistic setting while still maintaining little to no therapist contact. Lau, Pettit, and Creswell (2013) modified social fears and negative social interpretations in children through parent-administered interpretation-training conducted over three consecutive days. Parents read a series of stories related to ambiguous social situations, presented a negative and a benign potential explanation, and asked their child to choose an explanation. Similar to previous methodology (Amir & Taylor, 2012; Beard & Amir, 2008), parents provided feedback that was consistent with reinforcing the benign interpretations and correcting the negative interpretations. Thus, parents served as "interpretation coaches" for their children. Children in the interpretation-training condition experienced greater changes in interpretation bias and reductions in social anxiety symptoms, relative to a no-treatment group.

In the above study it is possible to argue that the interpretation-training program represented a distilled form of cognitive restructuring. However,

interpretation-training protocols such as that utilized by Lau and colleagues (2013) offer the advantage of being highly structured with easily followed directions, thus representing a more easily disseminable approach than traditional cognitive restructuring, which is typically conducted by highly trained cognitive behavioral therapists. However, whether this approach can be transferred to other age groups using family members or significant others as "coaches" is not clear. An additional advantage of interpretation-training programs over current attention training programs is that they may offer greater face validity (Beard, Weisberg, & Primack, 2012). Future research should examine to what extent the type of training plays a role in treatment outcomes and dissemination.

SAIs may be characterized by both the presence of a threat interpretation bias as well as the lack of a benign interpretation bias that is otherwise present in non-anxious individuals. Thus, interpretation training may exert its effects on social anxiety through correction of threat biases, strengthening of benign biases, or both. Formal mediation analyses may be informative in answering questions of mechanism. Amir and Taylor (2012) found that decrease in threat interpretations was a stronger mediator of change than was increase in benign interpretations when examining social anxiety symptoms. Conversely, Beard and Amir (2008) found that in undiagnosed, yet highly socially anxious individuals, change in benign interpretation bias was a stronger mediator. It may be the case that the training exerts its effects differently as a function of social anxiety severity. However, the relative importance of reduced benign interpretations versus increased threat interpretations in social anxiety remains an open question.

MEMORY

Compared to studies of attentional bias and interpretation bias, studies of memory bias in social anxiety are less conclusive. While some studies have found enhanced memory for threat-relevant information in SAI (e.g., Foa, Gilboa-Schechtman, Amir, & Freshman, 2000), at least one study has found decreased memory for threat-relevant information (Wenzel & Holt, 2002), and others have found no memory biases (e.g., Rapee, McCallum, Melville, Ravenscroft & Rodney, 1994; Rinck & Becker, 2005; Wenzel, Jackson, & Holt, 2002).

These divergent results may be in part due to different memory processes examined in different studies. Cognitive psychologists distinguish between explicit and implicit memory (Roediger, 1990; Schacter, 1987, 1992). According to Schacter (1987), "Implicit memory is revealed when previous experiences facilitate performance on a task that does not require conscious or intentional recollection of those experiences; explicit memory is revealed when performance on a task requires conscious recollection of previous experiences (p. 501)." Implicit memory is measured by tasks such as stem-completion and perceptual identification that reveal the effects of prior exposure to information without requiring that subjects consciously remember this information. Explicit memory

tasks involve subjects retrieving previously presented information. Although discrepancies exist even when examining explicit and implicit memory biases separately, the literature as reviewed below suggests that overall, participants with social anxiety are more likely to exhibit an implicit rather than an explicit memory bias.

Although research suggests that anxious patients may be characterized by aberrant implicit (unconscious, capacity-free, automatic) memory for threat-related information, more so than explicit (conscious, effortful, strategic) memory, studies of implicit and explicit memory bias in social anxiety have produced inconsistent results. These results may be explained by differences in tasks used to assess memory. Perhaps the most commonly used paradigm across memory bias experiments is the stem completion task. In the classic version of this task, subjects are first presented with a list of words for encoding (e.g., honey). Memory is then measured by presenting subjects with a set of word stems (e.g., h o n _ _). Explicit memory is measured by asking subjects to complete the stems with the words they had seen earlier in the experiment. Implicit memory, on the other hand, is measured by asking subjects to complete the stems with the first word that comes to mind. Although instructions to subjects differ, the subjects' tasks are identical.

Researchers have used the stem completion task to study memory processes in SAD. Rapee and colleagues (1994) were the first to examine whether biased memory-processing exists in SAD. Using the stem completion task, these authors asked individuals with SAD and NACs to complete words presented with a three-letter stem that were previously presented to participants from a list of neutral and social threat words (explicit memory). In another condition, participants were presented with identical stems but asked to fill in the first word that came to mind (implicit memory). The authors did not find any evidence for biases in either explicit or implicit memory in SAD. Lundh and Öst (1997) conducted a similar study with the stem completion task, again finding no evidence for explicit or implicit memory biases in SAD. The authors did, however, find evidence for an implicit social threat memory bias when examining a subgroup of participants with non-generalized SAD.

The studies discussed above have relied on stem-completion as the measure of implicit memory. However, stem-completion, the most commonly used measure of implicit memory, has at least two limitations. Firstly, it is strongly influenced by orthographic, perceptual aspects of the material rather than by their conceptual, semantic aspects (e.g., Roediger, 1990; Schacter, 1992). For example, if subjects are first exposed to words written in upper case letters during the study phase and later shown stems in lower case letters during the test phase, priming effects diminish (Roediger & Blaxton, 1987). Because of their relative insensitivity to semantics, word-stem procedures have limited relevance for the study of automatic access to meaningful emotional memories (McNally, 1994, p. 132). Secondly, performance on the stem-completion task may be contaminated by explicit memory processes because subjects may use

their explicit memory of the previously seen items to complete the task (Nugent & Mineka, 1994). However, a number of other paradigms have subsequently been used in memory research with SAIs and may be more sensitive in detecting implicit memory biases.

One implicit memory paradigm that addresses the above concerns is the noise judgment paradigm (Jacoby, Allan, Collins, & Larwill, 1988). In this paradigm, participants first hear a set of sentences and repeat them aloud. Next, participants hear these "old" sentences intermixed with a new set of sentences against a background of noise. Participants are asked to repeat the sentences and to rate the volume of the background noise. Jacoby et al. found that noise accompanying "old" sentences was rated as less loud than noise accompanying "new" sentences. This differential noise rating for the "old" and "new" sentences was interpreted as reflecting implicit memory for the former. Interestingly, priming effects in the noise judgment paradigm seem to persist even when participants are fully informed about how the paradigm works and are instructed to resist its effects (Jacoby, Roth, Lindsay, & Debner, 1992).

Amir, Foa, and Coles (2000) examined both implicit and explicit memory bias for threat-relevant information in SAIs. They hypothesized that if SAIs are characterized by an implicit memory bias for social-threat information, they should rate the noise accompanying old social-threat sentences as less loud than the noise accompanying new social-threat sentences, whereas control subjects should not. If SAIs are characterized by an explicit memory bias for threat they should show better recognition of these sentences. Consistent with their prediction these authors found that individuals with SAD are characterized by an implicit, but not an explicit, memory bias of threat-relevant information.

The studies described above used words and sentences as stimuli for social threat. However, researchers have suggested that more ecologically valid stimuli, such as faces, may constitute more appropriate material for studying memory biases in social anxiety (Amir, Bower, Briks, & Freshman, 2003; Foa, Gilboa-Schechtman, Amir, & Freshman, 2000; Lundh and Öst, 1996). Accordingly, a number of studies have adapted implicit memory paradigms for use with non-verbal material. For example, Amir, Bower, et al. (2003) subsequently modified the noise judgment paradigm to make the stimuli more ecologically valid. Instead of rating clarity of auditory stimuli, participants were asked to provide a visual clarity rating with videos of positive or negative social scenarios. Results from this study revealed that this type of task effectively indexed implicit memory, and that SAIs demonstrated a larger implicit memory bias for negative scenarios, relative to non-anxious individuals and dysphoric individuals.

Similarly, explicit memory bias in SAIs has also been examined using face stimuli. In the aforementioned video clarity rating study (Amir, Bower, et al., 2003), the experimenters assessed explicit memory by asking participants to state whether or not they had previously seen the presented faces. Groups did not differ in explicit recognition of positive versus neutral faces. However, findings suggesting a lack of explicit memory bias for non-verbal stimuli are not

unequivocal. For example, Lundh and Öst (1996) assessed recognition memory for facial expressions by presenting 20 photographs to SAIs and to controls and asking them to rate whether the face was critical or accepting. Following a distracter task, participants were presented with 20 photographs of individuals encountered in the initial task, and 60 distracter photographs. Subjects were asked to identify the faces they had seen in the initial task. SAIs recognized more faces they had rated as "critical" than faces they had rated as "accepting," whereas controls exhibited the opposite pattern.

Despite the positive findings obtained by Lundh and Öst (1996) for an explicit memory bias for faces, the design of the study made it impossible to determine whether a response bias or a memory bias underlies SAIs' preference for critical faces. Foa and colleagues (2000) examined these questions in two experiments. In the first experiment, SAIs and NACs were presented with pictures of faces and instructed to memorize the name and emotional expression associated with each actor. When asked to recall the name and emotional expression for each picture, SAIs did not demonstrate a memory bias for threat faces. However, SAIs did demonstrate a bias for threat faces when the experimenter cued participants with the actors' names and asked them to name the corresponding emotional expression. As this study provided mixed evidence for the presence of an explicit memory bias for faces in SAD, the authors suggested that memory biases may have been attenuated in SAIs because the task involved remembering verbal information (i.e, names, labels for emotional expressions) in addition to non-verbal information (i.e., remembering the actual faces). To address this concern, Foa and colleages conducted a second experiment in which SAIs and NACs were asked to discriminate between previously presented pictures (old faces) and pictures of the same individual, but with different emotional expressions (new faces). Thus, this study was similar to the methodology employed by Lundh and Öst (1996) but corrected for the possibility of a response bias for threat faces in SAIs by including new faces in the recognition task. Foa and colleagues found that SAIs exhibited better discrimination between old and new threat faces relative to neutral and happy faces, but this pattern was not seen in NACs. Thus, results obtained by Foa and colleagues across both studies suggest the presence of an explicit memory bias for SAIs, and that this bias is particularly strong for exclusively non-verbal material (i.e., faces).

Taking an alternative approach to explaining discrepancies between studies of explicit memory biases in SAD, some researchers have examined the effect of encoding tasks that are personally relevant on subsequent memory performance. For example, Vassilopoulos (2012) asked high and low socially anxious children to rate a series of positive and negative social-related words in terms of how well the words described them personally, according to someone who knew the participant well (e.g., friend). In a later unexpected recall task, high socially anxious children were able to recall fewer positive social words compared to low socially anxious children. Similar findings were obtained based on an earlier study with an adult sample (Mansell & Clark, 1999).

Together, these studies suggest that explicit threat biases may be demonstrated more reliably under conditions of evaluative and personally-relevant encoding, prior to recall. Moreover, deficits in remembering positive information, rather than enhanced recall for negative information, may be related to social anxiety.

An alternative method of examining memory bias in SAIs is to evaluate memory functioning in the context of learning information. The retrieval-induced forgetting paradigm (Anderson & Spellman, 1995; Amir, Coles, Brigidi, & Foa, 2001) is one such method. In this task, individuals are shown category-plus-exemplar pairs (e.g., fruit—orange). They are then asked to practice remembering half of the exemplars from half of the categories. After a delay, a cued-recall test is used to examine how retrieval practice impacts memory. In general, results from these paradigms reveal that practicing half of the items within a category negatively impacts recall of the second half of unpracticed items within a category. Amir et al. (2001) modified this paradigm by creating four different categories for social (e.g., party, job, dating, conversation) and nonsocial (e.g., drinks, weapons, fish, fruits) words. The social words were further split into positive and negative social words, thus comprising three total word types: negative social, positive social, and nonsocial words. In this study, individuals with SAD showed the same memory patterns as NACs for practiced categories for positive social and nonsocial words. For negative social words, however, individuals with SAD benefited less from practice relative to the NACs. Their recall of unpracticed words from practiced categories (e.g., party-boring) was also decreased less from the effect of practicing competing negative social information within the same category (e.g., party-dull), relative to NACs. The authors conclude that the memory of social threat words for SAIs is more stable relative to NACs; that is, SAIs may be less affected by practice, and experience decreased memory inhibition for nonpracticed competing social threat words. The authors suggested that the effects of such memory processes on learning and habituation related to social information may play an important role in the maintenance of social anxiety.

Although Amir and colleagues (2001) specified learning and memory-related processes as the construct under examination, they noted that the observed effects may be explained at least in part by biased interpretations of poorly formed memories, and/or an attentional vigilance for threatening stimuli. That is, biased performance on memory tasks may not be indicative of an exclusively memory-related bias, but rather may also be closely associated with other forms of information-processing, such as interpretation or attentional biases. Indeed, more recent studies evaluating the presence of memory biases have begun to examine the interaction of memory and other forms of information-processing, including interpretation bias (Brendle & Wenzel, 2004; Hertel, Brozovich, Joorman, & Gotlib, 2008; Wenzel, Finstrom, Jordan, & Brendle, 2005), attentional bias (LeMoult & Joormann, 2012), post-event processing (Cody & Teachman, 2010; Mellings & Alden, 2000; Morgan & Banerjee, 2008), and imagery (Nilsson, Lundh, & Viborg, 2012; Stopa & Jenkins, 2007). In general,

these studies suggest that memory biases apparent in SAIs may be the product of multiple interactive information-processing biases that make threat-relevant information more salient at the time of information retrieval.

For example, Hertel et al. (2008) presented individuals with SAD and non-anxious individuals with ambiguous social and non-social scenarios and asked them to complete the scenario (experiment 1). After a brief distraction period, they asked participants to recall the content of the scenarios. Trained raters determined whether any memory errors were the product of intrusions of the participants' interpretations of the scenario. Results indicated that individuals with SAD reported a larger percentage of memory intrusions that were consistent with negative, but not neutral or positive, interpretations made about the ambiguous social scenarios relative to non-anxious individuals. Similarly, in experiment two of this study, the authors demonstrated that similar negative memory intrusions can also be induced in non-anxious individuals by providing instructions to imagine oneself in the given scenario and providing the negative resolutions of the scenarios. Thus, the authors conclude that errors in memory in SAD may be related to interpretation biases of social information. This is consistent with prior studies indicating that memory biases in SAIs may reflect biased interpretation, rather than inability to recall factual detail (Brendle & Wendle, 2004; Wenzel et al., 2005).

There is also an emerging interest in the role of working memory capacity in social anxiety (e.g., Amir & Bomyea, 2011; Moriya & Sugiura, 2012; Salemink, Friese, Drake, Mackintosh, & Hoppitt, 2013). While this represents an important area of study, differences in working memory capacity may be better classified within the realm of executive functioning rather than memory biases per se (Engle, 2002). Thus, a discussion of working memory deficits in SAD is outside the scope of this chapter.

In summary, studies using diverse methodologies have found intermittent support for the hypothesis that individuals with social anxiety are characterized by a memory bias for threat-relevant information. Moreover, because many of the studies that do demonstrate a memory bias or its absence have not been replicated, it is difficult to suggest a comprehensive role of memory bias for threat in social anxiety. At present, the role of memory bias for threat in social anxiety seems to be confined to certain memory systems and materials. Thus, the task for future researchers will be to delineate the role of various forms of memory bias in a comprehensive model of social anxiety, and to determine what types of negative emotional expressions elicit such biases (e.g., positive versus threat). Future research might also continue to examine how different types of cognitive biases, such as interpretation or attentional biases, might lead to memory biases in the disorder.

CONCLUSIONS

The research reviewed in this chapter suggests that biased information-processing towards threat relevant information may be causally involved in SAD. This is especially the case when examining attentional bias and interpretation biases. In

contrast to research on attention and interpretation, the role of memory biases in SAD is still not clearly understood. Although different experiments address one of these domains of information-processing (attention, interpretation, memory), these domains are clearly related, and increasingly theory and research has begun to examine the relationship between these domains. Such questions represent exciting new areas for future research. Moreover, new paradigms assessing other domains of cognitive functioning have not been characterized within the existing framework of cognitive biases in anxiety. For example, the Approach Avoidance Task (AAT) is a measure of automatic action tendencies. Researchers have used the AAT both as an assessment (Heuer, Rinck, & Becker, 2007; Lange, Keijsers, Becker, & Rinck, 2008; Roelofs et al., 2010) and bias modification (Asnaani, Rinck, Becker, & Hofmann, 2013; Rinck et al., 2013; Taylor & Amir, 2012) tool for individuals with social anxiety. As the name suggests, this paradigm measures and manipulates the automatic tendencies for individuals to approach or avoid emotional information. It is likely that performance on the AAT is influenced by attentional and interpretation processes, but to what extent these processes overlap is not clear.

An improved understanding of the interactions between forms of biased cognition will also inform future efforts within the field of CBM. For example, there is now evidence to suggest that both ABM and IBM may be useful in ameliorating symptoms of social anxiety. Some investigators (Beard, Weisberg, & Amir, 2011) have begun to examine the effects of combining these approaches in the hope of improving treatment response. Similarly, researchers are beginning to examine the extent to which CBM is comparable to, and compatible with, existing treatments for anxiety, such as CBT. Limited data suggests that ABM may be equally effective as CBT when treatments are delivered via the internet for individuals with SAD (Kuckertz et al., 2014). Emerging data has been mixed regarding the utility of combining CBM and CBT (e.g., Britton et al., 2013; Rapee et al., 2013; Riemann, Kuckertz, Rozenman, Weersing, & Amir, 2013).

The conviction that studies of information-processing are useful in explaining pathological anxiety is based on the notion that these biases are the most proximal level of analysis for the phenomenon of interest, i.e. the identification of psychological vulnerability in anxious individuals. As such, these biases may serve as a better indicator of the underlying construct than self-report measures. Studying such biases may allow us to relate symptoms to cognitive vulnerabilities, i.e. information-processing bias, and to use these measures of vulnerability to implement prevention, assess treatment efficacy, and predict relapse. Finally, we may be able to use these measures to pinpoint the specific mechanisms of successful treatment. However, while a large body of research now suggests that cognitive biases exist in SAIs, it remains less clear how such biases are reliably assessed and modified. Multiple methodologies have been used to assess cognitive biases in SAD. However the psychometric properties of each measure and its utility in changing cognitions is in need of further research. Future research

regarding the reliability of information-processing assessments and the mechanisms as well as moderators of CBM methodologies will address a number of questions in the field, and are of great importance in advancing the science of information-processing assessment and modification in SAD.

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