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Coherence and Specificity of Information-Processing Biases in Depression and Social Phobia

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Research has not resolved whether depression is associated with a distinct information-processing bias, whether the content of the information-processing bias in depression is specific to themes of loss and sadness, or whether biases are consistent across the tasks most commonly used to assess attention and memory processing. In the present study, participants diagnosed with major depression, social phobia, or no Axis I disorder, completed several information-processing tasks assessing attention and memory for sad, socially threatening, physically threatening, and positive stimuli. As predicted, depressed participants exhibited specific biases for stimuli connoting sadness; social phobic participants did not evidence such specificity for threat stimuli. It is important to note that the different measures of bias in memory and attention were not systematically intercorrelated. Implications for the study of cognitive bias in depression, and for cognitive theory more broadly, are discussed.

Cognitive models of depression (Abramson, Seligman, & Teasdale, 1978; Beck, 1967, 1976; Bower, 1981; Teasdale & Dent, 1987) have given rise to a large body of empirical research examining cognitive characteristics and structures that are posited to cause, maintain, and characterize depression. According to Beck's (1967, 1976) schema theory of depression, negative schemas, when activated through negative life events, affect thoughts and judgments about the self, the world, and the future. People who are depressed are hypothesized to attend to and remember information that is relevant to, and congruent with, their negative cognitive schemas. Beck's theory also suggests that these cognitive biases should manifest themselves across a range of tasks assessing perception, attention, and memory.

Beck (1967, 1976) postulated that the schemas of depressed people include themes of loss, separation, disappointment, and rejection, and similarly, that the schemas of persons diagnosed with anxiety disorders involve threats of physical harm, illness, anticipated loss (financial, medical, personal, etc.), or psychosocial problems (i.e., anticipation of social rejection). This content-specificity perspective has provided the impetus for numerous studies attempting to match the content of self-reported cognitions with the individuals' disorders. R. Beck and Perkins (2001) conducted a meta-analysis of this research and concluded that, although empirical findings generally do not support the content-specificity hypothesis, there is evidence of specificity in some areas.

Investigators examining biases in information processing have focused primarily on functioning of attention and memory in depression and anxiety. In this context, both depressed and anxious individuals are hypothesized to attend selectively to, and have better memory for, schema-congruent than schema-incongruent information. Thus, whereas depressed individuals are posited to be biased toward information concerned with sadness and loss, anxious individuals are expected to demonstrate biases for concepts of threat or danger on tasks assessing attention and memory.

Although investigators have used a variety of tasks in attempts to elucidate the nature of information-processing biases in depression, the results of these studies have been equivocal. The majority of these tasks assess one of three primary aspects of information processing: attention interference, selective attention, and recall bias. Attention-interference tasks, such as the emotional Stroop color-naming task, evaluate the extent to which negative information, extraneous to the primary cognitive task to be performed, intrudes on participants' ability to complete the task. Selective-attention tasks, such as word- or face-dot-probe tasks, assess the degree to which an individual preferentially attends to negative stimuli over simultaneously presented neutral or positive stimuli. Finally, recall bias is typically assessed using incidental-recall tasks, which examine the extent to which individuals remember recently presented negative stimuli better than they do neutral or positive stimuli.

Studies examining attention interference have generally used the emotional Stroop task, in which participants are asked to read the color in which emotional stimulus words are printed. Gotlib and

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Cane (1987) found that hospitalized depressed patients took longer to name the colors of depressed-content words than nondepressed-content words. Similarly, Gotlib and McCann (1984) and Williams and Nulty (1987) found that higher scores on a depression inventory were associated with greater interference to negative emotion words on this task. In contrast, however, Hill and Knowles (1991) found that scores on a depression inventory were not associated with reaction times on the emotional Stroop task. Gilboa and Gotlib (1997) reported that formerly depressed and never depressed participants did not demonstrate significantly different response latencies to negative stimuli after undergoing a negative mood induction procedure (see also Hedlund & Rude, 1995). Similarly, Mogg, Bradley, Williams, and Matthews (1993) also failed to find differential emotional Stroop reaction times in a sample of depressed participants, but did find that anxious participants demonstrated longer reaction times to negative words compared with positive words. On the basis of these results, Mogg et al. (1993) suggested that anxiety, but not depression, is associated with a bias on the Stroop task. In sum, whereas biases toward threat words in Stroop tasks are reasonably well documented for participants with anxiety disorders (Williams, Mathews, & MacLeod, 1996), results of studies using the Stroop task in depression research are less consistent. Mogg et al. (1993) have suggested that positive results on the Stroop task in depression may reflect the influence of comorbid anxiety, but few studies have included both depressed and anxious participants.

There have been fewer studies of *selective attention* (i.e., the deployment of attention toward negative stimuli and away from neutral or positive stimuli). Studies using the dot-probe paradigm, in which participants are asked to respond as quickly as possible concerning the location of a small dot probe that follows the simultaneous presentation of two words, one emotional and one neutral, have consistently reported attentional biases in anxious individuals (e.g., Mogg et al., 1995). Early investigations examining performance on this task in samples of depressed participants, however, did not obtain evidence of an attentional bias for negative words (e.g., Hill & Dutton, 1989; MacLeod, Mathews, & Tata, 1986). Importantly, subsequent studies that have used the dot-probe task with longer stimulus exposures (1,000 ms) have demonstrated an attentional bias for negative words among both dysphoric (Bradley, Mogg, & Lee, 1997) and depressed (Mogg et al., 1995) individuals.

More recently, researchers have developed selective attention tasks using faces instead of words (e.g., Bradley, Mogg, Millar, et al., 1997; Gotlib, Krasnoperova, Neubauer, & Joormann, 2004). Studies using the faces dot-probe task with 500-ms stimulus exposures have found evidence of decreased attention to happy faces among dysphoric individuals (Bradley, Mogg, Falla, & Hamilton, 1998; Bradley, Mogg, & Millar, 2000). In contrast, Mogg, Millar, and Bradley (2000) found that clinically depressed and anxious (generalized anxiety disorder; GAD) participants did not differ in their response latencies on a dot-probe task with sad, happy, threatening, and neutral faces presented for 1,000 ms. These null findings may not be unexpected however, in that 13 of the 15 depressed participants in this study had an additional diagnosis of GAD. Few studies have examined clinically depressed participants who did not also have comborbid anxiety disorders. Importantly, in one of the few investigations to separate depression from anxiety, Gotlib et al. (2004) found that individuals diagnosed with major depressive disorder (MDD), but not with GAD, were characterized by selective attention to sad faces that were presented for 1,000 ms. In general, therefore, whereas anxiety appears to be associated with a bias in early orienting components of attention, evidence for selective attention in depression is found more consistently with a longer stimulus duration of 1,000 ms. This pattern suggests that the attentional bias in depression functions to maintain, rather than to orient, attention (Bradley, Mogg, & Lee, 1997).

Findings of studies examining memory bias in depression have been more consistent. In a meta-analysis of studies in this area, Matt, Vazquez, and Campbell (1992) concluded that whereas nondepressed individuals tend to recall more positive than negative stimuli, people who are experiencing clinically significant depression show the opposite pattern, recalling more negative than positive stimuli. In addition, there is evidence that preferential recall of negative information among depressed individuals may be stronger if the material that is recalled is self-relevant (e.g., Baños, Medina, & Pascual, 2001). Finally, following a mood induction, individuals with a history of depression have been found to exhibit better recall of negative words than do those with no history of depression (Gilboa & Gotlib, 1997), suggesting that this negative memory bias can extend beyond the depressive episode itself.

In sum, whereas relatively consistent support has been obtained for the operation of negative biases in recall, particularly when self-relevant stimuli are used, evidence for attentional biases has been mixed. This pattern of results has led Williams, Watts, MacLeod, and Mathews (1997) to posit that anxiety and depression differ not only in the content of cognitive biases, but in the processes as well. In contrast to theories that predict biases in all aspects of information processing in depression and anxiety (e.g., Beck, 1976; Bower, 1981), Williams et al. suggested that these two disorders are characterized by different cognitive biases. More specifically, Williams et al. proposed that whereas anxiety is characterized by a bias toward threatening stimuli in early automatic stages of information processing and away from threatening stimuli in later stages of processing, depression is characterized by a negative bias in the strategic elaboration of information. Consistent with this formulation, Williams et al. hypothesized that depressive biases would be evident in tasks assessing recall, but not in tasks assessing selective attention. Interestingly, recent findings now suggest that depression may indeed be associated with attentional biases if the tasks involve longer durations of stimulus exposure (Bradley, Mogg, & Lee, 1997; Gotlib et al., 2004; Mogg et al., 1995).

It is important to recognize that Williams et al.'s (1997) model is based primarily on comparisons of results across different studies using different tasks; only rarely have investigators administered two or more tasks to the same participants to assess the coherence of biases in information processing across different measures. Interestingly, the results of three recent studies suggest that different measures of information processing administered to the same sample of participants will yield different results. Mogg et al. (2000) administered the Stroop color-naming task and the dot-probe task to a nonclinical sample of anxious individuals, and found no significant relations between the measures of cognitive bias from these two tasks. In the second study, Dalgleish et al. (2003) administered the Stroop and dot-probe tasks to clinically depressed and clinically anxious children and adolescents and also found that cognitive bias scores for threat-related stimuli were uncorrelated on these two tasks. Because almost all studies of attentional biases in depression have relied on performance on a single task, it is difficult to determine whether the inconsistent results are related to a particular measure, to the study design, or to the sample being assessed. It is critical that biases in information processing be assessed on different tasks with the same participants.

In addition to the discrepancies that may be a function of the different tasks, it is also likely that the comorbidity of anxiety and depression affect the results of studies of information processing. For example, as we noted above, Mogg et al. (1993) have suggested that findings of attentional biases in depression may be a result of the presence of symptoms of comorbid anxiety. Because most studies of information processing in depression have not excluded individuals with comorbid anxiety disorders, it has not been possible to examine this issue of specificity. Furthermore, in studies in which individuals with "pure" depression (i.e., without any comorbid disorders) are compared with individuals diagnosed with anxiety disorders, the samples of anxious individuals are typically heterogeneous, including within a single sample individuals with panic disorder, social phobia, GAD, and posttraumatic stress disorder (e.g., Dozois & Dobson, 2001; Greenberg & Beck, 1989). Given Beck's (1976) formulation concerning the content specificity of biases in information processing, it is important to assess information-processing biases in a more homogeneous sample of anxious individuals.

The present study was designed to address two specific questions. First, do clinically anxious and clinically depressed individuals exhibit specific (and different) schema-congruent patterns of bias in information processing? And second, do information-processing biases cohere across different tasks assessing attention and memory functioning? Whereas Beck's (1976) model would predict a consistent pattern of bias in attention and memory for both depressed and anxious participants, Williams and his colleagues (1997) have posited that whereas anxiety is associated with negative biases in attention, depression is associated with biases in memory. To address these questions, we assessed three distinct groups of participants: participants diagnosed with MDD, participants diagnosed with generalized social phobia (GSP)/nonpsychiatric, and never-disordered control participants (NC).

We selected GSP as our anxiety psychiatric control group both because of the high rates of comorbidity between MDD and GSP (e.g., Kessler et al., 1994; Stein, McQuaid, Laffaye, & McCahill, 1999), and because of results of studies indicating that GSP may also be characterized by biases in information processing. A number of investigators, for example, have found that individuals diagnosed with social phobia exhibit longer latencies in naming the colors of social threat words on the emotional Stroop task than do NC participants (e.g., Maidenberg, Chen, Craske, Bohn, & Bystritsky, 1996; Mattia, Heimberg, & Hope, 1993). Similarly, Asmundson and Stein (1994) and Musa, Lepine, Clark, Mansell, and Ehlers (2003) found that individuals with social phobia demonstrate selective attention to social-threat stimuli on a dot-probe task. Importantly, however, other researchers have either reported evidence of an attentional bias away from threat stimuli (e.g., Chen, Ehlers, Clark, & Mansell, 1999; Mansell, Clark, Ehlers, & Chen, 1999), or failed to find information-processing biases in individuals with social phobia (e.g., Horenstein & Segui, 1997; Mansell, Ehlers, Clark, & Chen, 2002). To examine this issue more systematically, we administered tasks to all participants that assessed attention interference, selective attention, and memory functioning, and that incorporated stimuli with socially threatening, physically threatening, depressotypic, and positively valenced content.

Consistent with Beck's (1976) cognitive formulation, we generated three hypotheses in this study. First, we predicted that the MDD, GSP, and NC participants would differ with respect to biases in their processing of emotional stimuli. More specifically, we expected that, compared with the NC participants, both the MDD and the GSP participants would exhibit a negative bias on all tasks. Second, we predicted that we would find evidence of stimulus specificity, such that the MDD and GSP participants would demonstrate differential responses to the different categories of stimuli, with the GSP participants exhibiting stronger biases for socially threatening content stimuli and the MDD participants demonstrating stronger biases for sad-content stimuli.[1] Finally, we predicted that the different tasks administered in this study would cohere as measures of the broad construct of information-processing bias.

Method

Participants

Participants were 178 English-speaking adults between the ages of 18 and 60 years: 88 had been diagnosed with MDD, 35 had been diagnosed with GSP, and 55 were NC participants. Participants were recruited through advertisements and flyers, and through referrals from two outpatient psychiatry clinics at Stanford University. Approximately half of the MDD and GSP participants were recruited from the outpatient psychiatry clinics; the remaining participants were self-referred from the community. Participants had no reported history of brain injury and no mental retardation. All participants were interviewed with the Structured Clinical Interview for *DSM–IV* (SCID; First, Spitzer, Gibbon, & Williams, 1996), which was used to assess the following inclusion and exclusion criteria:

1. To be classified as depressed, participants must have met *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM–IV*; American Psychiatric Association, 1994) criteria for current MDD; to be classified as having social phobia, participants must have met *DSM–IV* criteria for current GSP; to be classified as NC, participants must have reported no lifetime history of Axis-I disorder.

2. The depressed participants had no current comorbid panic disorder or social phobia, and the participants with social phobia had no current major depression or panic disorder.

3. All participants had no lifetime history of mania, hypomania, or primary psychotic symptoms, and had no history of alcohol or psychoactive substance abuse or dependence in the past 6 months.

All participants were initially screened by telephone. Those who were considered likely to be eligible for participation in the study (approximately 35% of those screened) were invited to come in for an interview and to complete some self-report questionnaires. Those who remained eligible for the study (approximately 65% of those screened) were asked to return

[1] Although anxiety has been hypothesized to relate broadly to both physical and social threat, GSP has been conceptualized as a disorder that involves vulnerability, more specifically, to cues of social threat. To examine this formulation, we included both physical- and social-threat stimuli.

to the laboratory approximately 1 week later to complete additional questionnaires and to participate in a series of information-processing tasks. All participants were paid $25 per hour.

Diagnostic Evaluation

All participants were interviewed using the SCID. Interviewers were advanced psychology graduate students and postbaccalaureate research assistants, all of whom were trained in the use of the SCID. To assess interrater reliability, an independent trained rater who was blind to group membership evaluated 15 randomly selected audiotapes of SCID interviews with MDD participants, GSP participants, NC participants, and nonparticipants who met diagnostic criteria for disorders other than depression and social phobia (e.g., panic disorder). In all 15 cases, diagnoses of MDD, GSP, and NC matched the diagnoses made by the original interviewer ($\kappa = 1.00$). This indicates excellent interrater reliability, although we should note that the interviewers used the "skip out" strategy of the SCID, which may have reduced opportunities for the independent rater to disagree with the diagnoses.

Self-Report Measures

In addition to the SCID, participants completed the Hamilton Depression Inventory (HDI; Reynolds & Kobak, 1995) and the Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988). The HDI is a self-report version of the interview-based Hamilton Rating Scale for Depression (HRSD; Hamilton, 1960) that has been shown to correlate highly with the clinical interview and has demonstrated high reliability and validity (Kasch, Rottenberg, Arnow, & Gotlib, 2002; Kobak & Reynolds, 2000; Reynolds & Kobak, 1995). The questions on the inventory are virtually identical to the suggested interview questions in the HRSD. In this study, we used the 17-item version. The internal consistency of the HDI was .94 for the present sample. The BAI is a 21-item self-report measure of anxiety symptoms. This measure has been demonstrated to have good reliability and validity (see Steer & Beck, 1997, for a review) and has been widely used in studies of depression and anxiety (Roemer, 2001). The internal consistency of the BAI was .90 in our sample. In this sample, the BAI and the HDI were highly correlated ($r = .73$, $N = 181$, $p < .01$), which limits our ability to examine separately the effects of the symptom severity of depression and anxiety.

Finally, all participants completed the Shipley Institute of Living Scale (Shipley, 1940), a simple, self-administered, vocabulary test that provides a robust estimate of verbal intelligence (Weiss & Schell, 1991). The Shipley test is frequently used in studies of cognitive ability, biases, or neurometabolic activity to ensure that observed differences between groups on cognitive tasks are not due to differences in verbal ability (e.g., Nixon, Parsons, Schaeffer, & Hale, 1995).

Stimuli for Information-Processing Tasks

Self-referential encoding and incidental recall task (SRET). We developed a set of 116 adjectives from 4 different categories for use as stimuli in the incidental recall task: 22 depressotypic, 22 socially threatening, 22 physically threatening, and 50 positive adjectives. The stimulus words were selected from a variety of sources. Some words were selected from previous studies of information processing in depression (e.g., Gotlib & Cane, 1987; Gotlib & McCann, 1984; McCabe & Gotlib, 1993). Additional anxiety- and depression-relevant words were drawn from those used by Mogg et al. (1993), who had judges rate each word with respect to relevance to depression and anxiety. All stimulus words were rated by five senior psychology graduate students with respect to their relevance to depression, physical threat or danger, social threat, and positive emotions; only words for which there was unanimous agreement were used. The groups had equivalent average emotionality, range of emotionality, length, and frequency of the words. Neutral words were chosen from specific categories because several recent studies have shown that the use of uncategorized neutral words can lead to misleading comparisons to the emotion words, which tend to be semantically interrelated (e.g., Mogg et al., 1993).

Emotion face dot-probe task. The emotion face dot-probe task differs from the other tasks in the use of pictorial stimuli. This version of the task was developed to provide greater ecological validity compared with the use of word stimuli (Bradley et al., 1998). Previous research has documented that attentional biases for threatening faces can be documented using visual probe tasks among people with anxiety disorders (Bradley et al., 1998; Mogg & Bradley, 1999). Given that interpersonal triggers for depression have been well documented (Gotlib & Hammen, 1992, 2002), such stimuli, which are more closely related to naturalistic social feedback cues, would seem to have an advantage.

A set of over 1,600 photographs of faces of people posing different emotions was assembled from a number of sources, including photograph collections of other researchers, standardized sets of emotional faces developed by Ekman and his colleagues (Matsumoto & Ekman, 1988; Ekman & Friesen, 1976), and sets of photographs developed by Lang and his colleagues (e.g., Lang, Bradley, & Cuthbert, 1997). In addition, photographs were taken of 27 undergraduate, graduate, and postdoctoral student volunteers posing different emotions. All of the images were digitized and edited to be monochromatic and of approximately the same size (260 pixels $\times$ 300 pixels, or approximately 9 cm $\times$ 10 cm). All images were then rated by graduate and undergraduate students on 7-point scales of expressed intensity of sad, angry, happy, and neutral emotions. The decision to include angry faces was based on previous research by Gilboa-Schectman, Foa, and Amir (1999), who found that participants diagnosed with social phobia demonstrated a greater attentional bias for angry than for disgust faces. Photographs were classified as expressing sadness, anger, or happiness if they had a mean rating of 5 or more on the relevant scale and mean ratings of 2 or less on the other two scales; photographs were classified as neutral if they had mean ratings of 2 or less on all three emotion scales. On the basis of these ratings, 60 pairs of images were chosen. Each pair depicted a unique poser with two different facial expressions: 20 pairs had angry and neutral facial expressions, 20 pairs had sad and neutral expressions, and 20 pairs had happy and neutral expressions. The pictures were matched across these three categories with respect to the gender of the poser and the intensity of the dominant emotion displayed in the picture. An additional 12 neutral–neutral face pairs of the same poser (i.e., two identical neutral faces) were used for practice trials.

Emotional Stroop task. We developed a set of 120 emotion and neutral words for use as stimuli in the emotional Stroop task. Potential stimuli were selected from previous studies examining cognitive functioning and the relation between cognition and emotion (e.g., Bradley & Mathews, 1983; Gotlib & McCann, 1984; Mathews, Mogg, May, & Eysenck, 1989; Richards & French, 1991; Teasdale & Russell, 1983). Stimuli from these sources were selected for inclusion in this study on the basis of independent ratings provided by three clinical psychologists who have extensive experience in the treatment of anxiety and depression. These psychologists rated on 5-point scales how relevant each word was to depression, social threat, physical threat, and happiness. Words were selected if all three judges rated them as 3 or more for relevance to one category and less than 3 for relevance to the other categories. Words were selected as neutral if all three judges gave ratings of less than 2 for relevance to any of these emotion categories. Thus, there were four categories of emotion words (depressotypic, socially threatening, physically threatening, and positive) and a set of neutral words. Each category contained 24 words. Words were presented in one of four colors: blue, green, yellow, or red. Each word was rated for content by at least four independent raters so that categories did not overlap in emotion content. Each set of words had equal average word length and frequency.

Procedure

Participants completed the clinical interview and questionnaires in the first session. In a separate second session, scheduled approximately 3–7 days later ($M = 6.72$ days, range $= 0$–36 days), the participants completed the battery of information-processing tasks. The equipment used to present the tasks included an IBM-compatible computer and a Dell 15-in. (38.1 cm) color monitor. Micro Experimental Laboratory software and response box with microphone (MEL 2.0; Schneider, 1995) were used to control stimulus presentation and record response accuracy and latency. Each participant completed the tasks in the same fixed order: SRET, emotion face dot-probe task, and emotional Stroop task. This order ensured that verbal and nonverbal tasks were alternated and that no retroactive interference would occur on the incidental recall task.

Self-referential encoding and incidental recall task. Participants were tested individually. They were seated in front of the computer, with the index finger of their right hand on a key labeled *yes* and the third finger of their right hand on a key labeled *no.* Participants were instructed to focus on a cross in the middle of the screen, and then to indicate whether the word that followed on the screen described them. For each trial, the words *Describes me?* appeared in the center of the screen for 500 ms, followed by a 250-ms pause. Then, one of the stimulus words was presented in capital letters. Participants indicated whether the displayed word described them by pressing the appropriate key. Following the participants' response, the word disappeared. The computer recorded the latency and response for each trial. The intertrial interval was 1,000 ms. The words were presented in random order. Once the practice trials were complete, the experimenter waited outside the room until the participants were finished. The participants were then asked to work on the digit-symbol copying task of the Wechsler Adult Intelligence Scale—Revised (WAIS–R; Wechsler, 1981) for 3 min as a distracter task. The experimenter left the room during this time, then returned with a sheet of paper asking the participants to recall as many words as possible from the previous self-referential encoding task, regardless of whether they endorsed the words as self-descriptive. The experimenter left the room for 3 min, then returned and told the participants to stop trying to remember words.

Emotion face dot-probe task. Participants were seated in front of the computer, with the index finger of their left hand on the *Z* key, which was labeled *L* for left, and the index finger of their right hand on the *M* key, which was labeled *R* for right. Participants were told that their goal in this task was to respond as quickly and as accurately as possible when they detected a small dot by pressing the key labeled *L* if the dot appeared on the left side of the screen, and the key labeled *R* if the dot appeared on the right side. Participants first completed four practice trials of a simplified dot-detection task, in which the dot followed a fixation cross in the absence of any intervening face stimuli. Participants were then given further instructions informing them that the task would now be made more difficult and more interesting. In addition to being presented with a cross and a dot, they were told that they would also be briefly shown a pair of photographs of a person's face in between the presentations of the cross and the dot. They were told that, as before, their task was to detect the dot as quickly and as accurately as possible. Participants completed 12 practice trials of the faces–dot task (with neutral–neutral face pairs) with the experimenter present in the room. When the participants felt comfortable with the procedure, the experimenter left the room and the participants completed 240 test trials of the task on their own. When projected on the screen, the size of each picture was approximately 9×10 cm. The pictures in each pair were approximately 13 cm apart (measured from their centers). Each of the 60 picture pairs was presented in each of four blocks, for a total of 240 trials, with a brief rest period between each block. The four presentations of each picture pair counterbalanced the side in which the emotion face was presented, and the side in which the dot was presented, such that, for each pair, one of each of the four possible iterations was presented in each block. The 60 trials within each block were presented in a new, randomized order for each participant.

Each trial began with the display of a white fixation cross in the middle of the screen for 500 ms, followed by the presentation of a face pair on the screen for 1,000 ms. Following the offset of the pictures, a small gray dot appeared in the center of the screen location where one of the pictures had been, and remained on the screen until the participant pressed a key on the keyboard. The computer recorded the accuracy and latency of each response and gave auditory feedback, a 500-ms beep, to incorrect responses. The intertrial interval was 1,000 ms. The emotional stimulus faces (angry, sad, or happy) appeared in the right and the left positions with equal probability, with the matched neutral face of each pair appearing in the other position. The dot probe was also presented in both positions with equal probability.

Emotional Stroop task. The words were presented in a random order and assigned randomly to appear in one of the four presentation colors—blue, green, yellow, or red—with the following limitations: The four colors were equally presented in each of the categories of words, and no color was presented more than twice consecutively. Participants were instructed to read the color in which each word was presented. Each trial began with a fixation cross for 500 ms, which was followed by a 500-ms pause, and then by the presentation of the stimulus word in the assigned color. The MEL voice-activated microphone and response box recorded the latency from stimulus presentation to the participant's color-naming vocal response, which activated the offset of the word. The intertrial interval was 1,000 ms. After the practice trials, the experimenter left the room while the participant finished the study trials.

Measures

Self-referential encoding and incidental recall task. Three ratios were calculated to assess endorsement, reaction time to endorsement, and incidental recall. Endorsement was operationalized as the number of words endorsed in a content category (e.g., sad, social threat, physical threat, positive) divided by the total number of words endorsed. As such, endorsement scores reflected self-perceptions, but they were not an index of information-processing bias. On this task, information-processing bias was assessed through reaction time and incidental recall. Consistent with previous studies, reaction time was calculated as the mean latency to make a decision (*yes* or *no*) for the words in each content category, that is, to make a self-referential judgment (Dozois & Dobson, 2001). Incidental recall scores were operationalized as the number of the originally endorsed and subsequently recalled words from each content category, divided by the total number of words that were endorsed and recalled. For example, a sad bias score of 0.25 indicated that 25% of the words the participant endorsed and subsequently recalled were depressotypic emotional content. This method of scoring ensures that memory bias is not confounded with possible group differences in endorsement or in overall memory performance.

Emotion face dot-probe task. Bias on this task was calculated using a reaction-time subtraction method. The dot-probe bias score was operationalized as the response latency to detect the dot probe when it appeared on the same side of the screen as the emotional face (happy, sad, or angry), subtracted from the latency to detect the dot probe when it appeared on the opposite side of the screen as the emotional face. Greater bias on this task, as indexed by a stronger tendency to look at the emotional faces than at the neutral faces, was reflected by shorter reaction times to detect the dot when the probe was on the same side of the screen as the face to which participants were attending, and longer reaction times when the dot probe and attended-to face were on opposite sides of the screen.

Emotional Stroop task. Bias scores on the emotional Stroop task were calculated on the basis of the mean reaction time for words in each emotional condition, minus the mean reaction time for words in the neutral condition. Higher scores on this task indicated greater interference and, therefore, greater bias; more specifically, longer reaction times in the emotional words conditions indicated greater interference.

Results

Demographic and Clinical Characteristics

Demographic and clinical characteristics for participants in the MDD, GSP, and NC groups are presented in Table 1. The three

Table 1
Demographic and Clinical Characteristics of the Sample

Variable	MDD		GSP		NC	
	M	*SD*	*M*	*SD*	*M*	*SD*
Gender (%)						
Female	70.7		65.8		75.0	
Male	29.3		34.2		25.0	
Age	34.5	11.0	33.2	9.2	33.6	11.4
Years of education[a]	6.6	1.5	6.3	1.6	6.5	1.5
Shipley score[b]	35.13	3.53	34.08	4.10	34.75	3.27
Annual income*[c]	3.22	1.60_a	3.41	1.43_{ab}	3.96	1.40_b
HDI score***	27.41	7.92_a	20.69	8.21_b	4.23	3.30_c
BAI score***	15.98	9.73_a	15.00	7.13_a	2.58	3.46_b

Note. Different subscripts indicate significant group differences within rows at $p < .05$ or better. MDD = major depressive disorder group; GSP = generalized social phobia group; NC = nonpsychiatric control group; HDI = Hamilton Depression Inventory (Reynolds & Kobak, 1995); BAI = Beck Anxiety Inventory (Beck et al., 1988).
[a] Education was assessed on an 8-point scale, with higher numbers representing more education—a score of 6 reflects some college education. [b] Shipley Institute of Living Scale score (Shipley, 1940). [c] Income was assessed on a 6-point scale, with higher numbers representing higher income—a score of 3 reflects an annual income of $25,000–$50,000.
* $p < .05$. *** $p < .001$.

groups did not differ with respect to age, $F(2, 187) < 1$; gender, $\chi^2(1, N = 190) < 1$; education level, $F(2, 185) < 1$; or scores on the Shipley test, $F(2, 179) < 1$ (all *p*s > .05). A one-way analysis of variance (ANOVA) yielded significant differences among the groups in income level, $F(2, 159) = 3.70$, $p < .05$. Fisher's least significant difference (LSD) tests indicated that the NC participants had higher incomes than did the MDD participants; the GSP participants did not differ from either of these groups. It is important to note, however, that income was not correlated significantly with bias scores on any of the information-processing tasks.

As expected, the three groups differed on the clinical variables. One-way ANOVAs yielded significant effects for group: HDI, $F(2, 179) = 256.22$; BAI, $F(2, 185) = 59.09$ (both *p*s < .001). Fisher LSD tests indicated that as expected, the MDD and GSP participants reported more disturbance on each of these measures than did the NC participants. The two clinical groups did not differ significantly from each other on the BAI, but the MDD participants reported greater symptom severity on the HDI than did the GSP participants.

Group Differences in Cognitive Functioning

Self-referential encoding and incidental recall task. We examined the self-referential encoding data to determine whether participants in the MDD, GSP, and NC groups differed in the proportion of words in different categories that they endorsed, independent of their recall. Group means and standard deviations for the proportion of words endorsed in each of the four categories are presented in Table 2. Because the four proportions necessarily sum to 1.0, all four emotion categories cannot be included in a single ANOVA. Therefore, we conducted two separate ANOVAs: one with the three categories of negative emotion words, the other with the positive words. The 3 (diagnostic group) × 3 (negative emotion category) repeated measures ANOVA yielded significant main effects for diagnosis, $F(2, 134) = 93.32$, and emotion category, $F(2, 139) = 70.14$ (both *p*s < .001). Post hoc tests of the group main effect indicated that the MDD participants endorsed more negative words than did the GSP participants, who in turn endorsed more negative words than did the NC participants. Post hoc tests of the main effect for emotion revealed that sad words were endorsed more frequently than were social threat words,

Table 2
Group Differences on the Self-Referential Encoding Task

Category	MDD		GSP		NC	
	M	*SD*	*M*	*SD*	*M*	*SD*
Proportion of words endorsed						
Sad	.22	$.07_a$	.15	$.09_b$	.02	$.04_c$
Social threat	.17	$.07_a$	.20	$.07_a$	.06	$.05_b$
Physical threat	.12	$.06_a$	.09	$.07_b$	.02	$.04_c$
Positive	.49	$.15_a$	.57	$.19_b$	.90	$.12_c$
Mean reaction time (in ms) to words						
Sad	1,999.83	648.49	1,930.09	756.02	1,484.03	623.95
Social threat	1,959.49	679.76	1,851.88	633.40	1,668.09	714.10
Physical threat	1,854.59	755.87	1,681.59	584.95	1,354.52	563.53
Positive	1,972.38	627.13	1,941.12	550.72	1,715.82	668.39
Proportion of endorsed and recalled words						
Sad	.26	$.13_a$	.17	$.14_b$	.03	$.06_c$
Social threat	.15	$.14_a$	.16	$.16_a$	.06	$.11_b$
Physical threat	.15	$.15_a$	.09	$.11_{ab}$	.05	$.16_b$
Positive	.44	$.20_a$	.57	$.26_b$	.86	$.22_c$

Note. Different subscripts indicate significant group differences within rows at $p < .05$ or better. MDD = major depressive disorder group; GSP = generalized social phobia group; NC = nonpsychiatric control group.

which were endorsed more frequently than physical threat words. These two main effects were qualified, however, by a significant interaction of diagnosis and emotion category, $F(4, 278) = 18.70$, $p < .01$. Follow-up tests indicated that whereas the MDD participants endorsed a significantly higher proportion of sad than social threat and physical threat words, both the GSP and the NC participants endorsed a significantly higher proportion of social threat than sad and physical threat words. The one-way ANOVA (by diagnostic group) conducted on endorsement of positive words yielded a significant main effect, $F(2, 140) = 93.32$, $p < .01$. Fisher LSD post hoc tests indicated all three groups differed significantly from each other (all ps $< .05$), with the MDD participants endorsing the lowest proportion of positive adjectives, followed by the GSP participants, and then the NC participants.

As described above, information-processing bias on this measure was reflected in two measures: reaction time to make self-referential decisions about words, and recall of endorsed words. A 3 (diagnostic group) $\times$ 4 (emotion category) repeated-measures ANOVA was conducted on latencies to make self-referential decisions for the words. Group means and standard deviations for participants' reaction times for words in each emotion category are presented in Table 2. The ANOVA yielded significant main effects for diagnostic group, $F(2, 139) = 6.00$, $p < .05$, and emotion category, $F(3, 137) = 10.02$, $p < .01$; the interaction of Group $\times$ Emotion Category was not significant, $F(6, 274) = 1.54$, $p > .05$. The main effect for group indicated that both the MDD and GSP participants were slower ($p < .05$) to make self-referential decisions than were the control participants, but did not differ significantly from each other. The main effect for emotion category reflected the fact that reaction times for the physical threat words were faster than was the case for the other emotion categories (all ps $< .05$).

Group means and standard deviations for the proportion of recalled and endorsed words in each category are also presented in Table 2. Again, because the scores from the four emotion categories sum to one, two separate analyses were conducted: a 3 (diagnostic group) $\times$ 3 (negative emotion category) repeated-measures ANOVA conducted on the proportion of endorsed and recalled negative words, and a one-way ANOVA (by diagnostic group) conducted on the proportion of endorsed and recalled positive words.

The two-way ANOVA conducted on the negative words yielded significant main effects for diagnostic group, $F(2, 140) = 49.40$, $p < .01$, and for emotion category, $F(2, 139) = 5.58$, $p < .05$. Post hoc tests of the group effect revealed that the MDD participants recalled a higher proportion of negative words that they endorsed than did the GSP participants, who themselves were higher on this measure than were the NC participants. Post hoc tests of the emotion effect indicated that a higher proportion of sad than physically threatening endorsed words were recalled; the proportion of social threat words recalled did not differ significantly from the proportion of sad or physically threatening words. These two main effects were qualified, however, by a significant interaction of group and emotion category, $F(4, 278) = 4.95$, $p < .05$. Post hoc tests revealed that whereas the MDD participants recalled a significantly higher proportion of sad words than of social threat and physical threat words that they endorsed, the GSP participants recalled a higher proportion of sad words and social threat words that they endorsed than of endorsed physical threat words, and the NC participants did not exhibit differential recall of the negative words that they endorsed. Moreover, as expected, the MDD participants recalled a greater proportion of sad words that they endorsed than did the GSP participants, but these two clinical groups did not differ with respect to recall of endorsed social threat or physical threat words. Finally, the univariate ANOVA conducted on the positive words yielded a significant effect for diagnostic group, $F(2, 140) = 49.40$, $p < .01$. The MDD participants recalled a significantly lower proportion of positive words than did participants in the GSP group, who recalled a significantly lower proportion of endorsed positive words than did the NC participants.[2]

Emotion face dot-probe task. To minimize the influence of outliers on this task, reaction times that were less than 100 ms were considered anticipation errors and were excluded from analyses. Similarly, reaction times that were greater than 2,000 ms were excluded because they were extremely infrequent and likely reflected lapses of concentration. Statistical tests were then conducted on both the remaining untransformed reaction time data, and on all of the data after an inverse transformation (cf. Ratcliff, 1993). The two sets of analyses produced the same pattern of results. Untransformed data are presented here for ease of comprehension.

There were three emotion expression conditions for the emotion face dot-probe task: sad, happy, and angry. Group means and standard deviations for bias scores on the emotion face dot-probe task are presented in Table 3. We conducted a 3 (diagnostic group) $\times$ 3 (emotion category) repeated-measures ANOVA on the participants' reaction times. There were no main effects of either diagnostic group or emotion category, both $F(2, 162) < 1$ (both ps $> .05$). There was, however, a significant interaction of diagnostic group and emotion category, $F(4, 162) = 2.58$, $p < .05$. Follow-up Fisher LSD analyses indicated that the MDD participants had higher bias scores than did the NC participants in the sad face condition; there were no other differences among the diagnostic groups. In addition, a repeated-measures ANOVA conducted within the MDD group alone yielded a significant main effect of emotion category, $F(2, 78) = 3.18$, $p < .05$. Follow-up paired t tests indicated that the MDD participants were significantly faster to detect the dot probes behind the sad faces than they were for the happy or angry faces, which did not differ from each other. Similar ANOVAs yielded no such effect for either the GSP participants, $F(2, 30) < 1$, or the NC participants, $F(2, 53) = 1.38$ (both ps $> .05$). Thus, the depressed participants attended to the

[2] Parallel analyses were conducted on the proportion of words recalled, regardless of endorsement. A 3 (diagnostic group) $\times$ 4 (emotion category) repeated-measures ANOVA was conducted on the proportion of words from each category that were recalled. The ANOVA yielded a significant main effect for emotion category, $F(3, 162) = 11.16$, $p < .01$, reflecting that participants recalled more happy words than other words, and more sad words than social or physical threat words, which were comparable to each other. The main effect for diagnostic group was not significant, $F(2, 164) = 1.68$, $p > .05$, indicating that participants in the three groups remembered a comparable number of words. Finally, the ANOVA yielded a significant interaction of Group $\times$ Emotion Category, $F(6, 324) = 3.56$, $p < .05$. Post hoc tests indicated that the NC participants recalled a smaller proportion of sad words than did the MDD and GSP participants, who did not differ from each other. Participants in the three groups did not differ with respect to their recall of happy, physically threatening, or socially threatening words.

Table 3
Bias Scores on the Emotion Face Dot-Probe Task

	MDD[a]		GSP		NC	
Content	*M*	*SD*	*M*	*SD*	*M*	*SD*
Sad[a]	7.67	25.91_a	0.80	13.47	−0.86	16.53_b
Angry	2.25	25.20_b	4.60	11.24	2.48	13.92
Happy	−2.42	23.86_b	1.93	16.16	5.02	21.11

Note. Different subscripts indicate significant group differences within rows and within columns at $p < .05$. MDD = major depressive disorder groups; GSP = generalized social phobia groups; NC = nonpsychiatric control group.
[a] $p < .05$ or better within diagnostic group and within content category.

sad faces to a greater extent than they attended to the other faces, and to a greater extent than did the NC participants. GSP participants did not differ significantly in their bias scores from the NC or the MDD participants in any of the emotion categories on this task.

Emotional Stroop task. As with the dot-probe task, we minimized the influence of outliers on the emotional Stroop task by excluding from analyses reaction times that were less than 100 ms or greater than 2,000 ms. Because analyses of both the remaining untransformed reaction time data and all the data following an inverse transformation yielded the same pattern of results, the untransformed data are presented for ease of comprehension.

Group means and standard deviations for bias scores (reaction times to name the colors of the emotion words, minus reaction times to the neutral words) on the emotional Stroop task are presented in Table 4. A 3 (diagnostic group) × 4 (emotion category) repeated-measures ANOVA conducted on the bias scores yielded a significant main effect of emotion category, $F(3, 155) = 7.22$, $p < .05$, but no main effect of diagnostic group, $F(2, 157) < 1$, and no interaction of diagnostic group and emotion category, $F(6, 310) < 1$. Follow-up tests for the main effect of emotion category revealed that reaction times for the physical threat bias scores were significantly lower than were reaction times for the other categories.

Correlations of the information-processing tasks with depression and anxiety symptoms within the depressed group. Given the heterogeneity among individuals with depression, we also assessed whether bias scores on the information-processing tasks were associated with depressive and anxiety symptom severity within the depressed group. As shown in Table 5, bias scores for the happy faces on the emotion face dot-probe task were significantly correlated with severity of current depression: More severely depressed individuals demonstrated a greater bias away from happy faces. Contrary to expectations, physical threat bias scores from the SRET were also significantly correlated with the severity of current depression. None of the other bias scores were significantly correlated with severity of depressive symptoms within the group of participants diagnosed with MDD. Current symptoms of anxiety were also negatively correlated with happy bias scores from the emotion face dot-probe task, as well as with physical threat bias scores on the SRET. The similar pattern of correlations for the depression and anxiety severity measures may reflect the substantial correlation between the HDI and the BAI within this group ($r = .53$, $n = 87$, $p < .05$).

To examine the role of lifetime anxiety, we also computed Spearman correlation coefficients of lifetime anxiety disorders (presence or absence) with each bias score. Lifetime anxiety diagnoses were available for 64 of the participants with MDD. As shown in Table 5, the presence of a lifetime anxiety disorder did not appear to account for the pattern of bias. That is, lifetime anxiety disorders were unrelated to most bias scores, with the exception of less bias for sad faces on the dot-probe task ($r = -.33$, $n = 60$, $p < .05$). Thus, it does not appear that history of anxiety disorders can account for the pattern of findings within the depression group.

Associations among the information-processing tasks. Finally, we examined the associations among scores on the information-processing tasks (Stroop, emotion face dot-probe, and SRET recall). Because we were most interested in depressotypic biases, we focused specifically on bias scores involving the happy and sad stimuli on the three tasks. We correlated the bias scores separately within the groups of MDD, GSP, and NC participants, and these correlations are presented in Table 6.

In general, the pattern of results presented in Table 6 indicates that the bias scores do not cohere as measures of a unitary con-

Table 4
Bias Scores on the Emotional Stroop Task

	MDD		GSP		NC	
Content[a]	*M*	*SD*	*M*	*SD*	*M*	*SD*
Sad	4.63	30.20	6.23	33.93	7.54	31.81
Social threat	13.69	30.96	9.21	35.66	8.08	32.08
Physical threat	−1.40	27.83	2.68	28.02	−3.01	36.41
Positive	5.78	31.98	10.45	33.06	11.95	33.51

Note. MDD = major depressive disorder group; GSP = generalized social phobia group; NC = nonpsychiatric control group.
[a] For each content category, $p < .05$.

Table 5
Correlations Within the MDD Group of Depression Severity and Bias Scores

Task and stimulus	HDI	BAI	Lifetime diagnosis of anxiety disorder
Dot probe			
Sad	.16	.13	−.33*
Happy	−.36**	−.28	−.05
Angry	.22	.09	−.13
Stroop			
Sad	−.04	−.02	−.13
Happy	−.00	.14	.04
Social threat	.09	−.01	−.01
Physical threat	−.06	−.10	−.16
SRET			
Sad	.05	−.23	.10
Happy	−.19	.10	−.09
Social threat	−.03	−.12	−.08
Physical threat	.28*	.19	.13

Note. MDD = major depressive disorder group; HDI = Hamilton Depressive Inventory (Reynolds & Kobak, 1995); BAI = Beck Anxiety Inventory (Beck et al., 1988); SRET = Self-referential encoding and incidental recall task.
* $p < .05$. ** $p < .01$.

Table 6
Correlations Among Bias Scores Within Groups

Stimulus and task	1	2	3	4	5	6
			MDD			
1. Sad dot probe	—					
2. Happy dot probe	−.61**	—				
3. Sad Stroop	−.02	−.13	—			
4. Happy Stroop	.09	−.06	.42**	—		
5. Sad SRET	−.20	.09	.17	.07	—	
6. Happy SRET	.02	.06	−.07	−.20	−.48**	—
			GSP			
1. Sad dot probe	—					
2. Happy dot probe	.02	—				
3. Sad Stroop	−.10	−.35	—			
4. Happy Stroop	−.37*	−.09	.37*	—		
5. Sad SRET	−.20	−.19	.28	.30	—	
6. Happy SRET	−.04	.28	−.38	−.32	−.61**	—
			NC			
1. Sad dot probe	—					
2. Happy dot probe	−.45**	—				
3. Sad Stroop	.31*	.45**	—			
4. Happy Stroop	.14	.20	.58**	—		
5. Sad SRET	−.25	.16	−.27	−.23	—	
6. Happy SRET	−.02	.03	.36*	.23	−.49**	—

Note. MDD = major depressive disorder group; SRET = Self-referential encoding and incidental recall task; GSP = generalized social phobia group; NC = nonpsychiatric control group.
* $p < .05$. ** $p < .01$.

struct. Bias scores on the recall task were generally not correlated with the bias scores from either the Stroop or the face dot-probe tasks, suggesting more specifically that the attention and recall tasks do not cohere. Bias scores for happy stimuli were also not correlated across the three tasks. Contrary to expectations, within all three participant groups, bias scores on the Stroop task for happy and sad words were positively correlated. Within both the MDD and the GSP participant groups, the bias scores for sad stimuli were not significantly intercorrelated (all ps $> .05$). Indeed, only one of the intercorrelations of information-processing scores was significant in the expected direction: Within the group of NC participants, bias scores for sad stimuli on the Stroop task were positively correlated with bias scores for sad stimuli on the emotion face dot-probe task. In contrast, in the two clinical groups this correlation was nonsignificantly negative. Z transformations were computed to compare the magnitude of the correlations between the Stroop and the emotion face dot-probe bias scores for sad stimuli across the three diagnostic groups. The results of these analyses indicated that the correlation between the attentional bias scores for sad stimuli was significantly higher within the group of NC participants than it was within both the MDD participants ($z = 2.24$) and the GSP participants ($z = 2.68$; both ps $< .01$), who did not differ significantly from each other ($z < 1$).

Discussion

Cognitive biases have been studied extensively in the anxiety and depressive disorders (see Dalgleish & Watts, 1990, Williams et al., 1997, and Gotlib, Gilboa, & Sommerfeld, 2000, for reviews). Although findings have sometimes been contradictory, there are many published studies documenting the operation of negative cognitive biases in both anxious and depressed individuals. The present investigation examined the specific patterns of bias for sad, socially threatening, physically threatening, and positive stimuli in carefully diagnosed groups of MDD participants and GSP participants. Importantly, this is also one of the first investigations in which several types of bias were assessed simultaneously on different information-processing tasks in the same participants. According to some cognitive theories, attention and memory biases should coalesce as constructs, reflecting the operation of activated negative schemas. The results of the present study, however, paint a different picture. We first discuss the results of each task individually, and then turn to a discussion of the coherence of the various measures of information-processing biases.

As expected, the results from the endorsement analyses on the self-referential encoding task indicated that participants in both clinical groups perceive themselves in a more negative and less positive manner than do the NC participants. Moreover, the pattern of endorsement was particularly negative within the depressed group: Compared with the GSP participants, MDD participants endorsed as self-referential a higher proportion of sad and physical threat words, and a lower proportion of positive words. It is important to note that despite this depression-association pattern of negative endorsement, there was no evidence that the depressed or social phobic participants processed emotionally relevant words more quickly on the SRET than did nondepressed controls. Importantly, however, studies examining decision latencies on the SRET have yielded mixed results. Whereas MacDonald and Kuiper (1982) found dysphoric undergraduates to be slower than nondysphoric students to evaluate whether positive words were self-referential, and MacDonald and Kuiper (1985) found clinically depressed persons to evaluate negative words more quickly than nondepressed control participants, other investigators using clinically depressed samples have failed to replicate these effects (e.g., Bradley & Mathews, 1983; Dozois & Dobson, 2001).

The results of the incidental recall task did reflect the operation of a negative memory bias in both the MDD and the GSP participants: Compared with the NC participants, participants in both clinical groups recalled a lower proportion of positive words and a higher proportion of negative words that they had endorsed. There was also modest evidence for specificity on this task: Compared with the GSP participants, the MDD participants recalled a higher proportion of their endorsed sad words and a lower proportion of their endorsed positive words. Contrary to expectations, however, depression severity was significantly correlated with recall of endorsed physical threat words.

Data from the recall task are limited by the small number of negative words that were endorsed by the nonpsychiatric controls. In addition, it is possible that the nonpsychiatric controls endorsed the least emotional words from the negative word sets. To examine the possibility that differential endorsement influenced the results for the recall task, we also examined recall for all words, regardless of whether they were endorsed. These analyses yielded comparable results, in that the MDD and the GSP participants recalled more sad words than did the NC participants. Bias in the recall of positive words, though, was not found in these analyses. Thus, across analyses, there was consistent evidence that depression and social phobia were associated with a negative bias in recall.

We also found modest evidence of diagnostic specificity on the emotion face dot-probe task: Whereas the MDD participants demonstrated a stronger bias for sad than for angry or happy faces, neither the GSP nor the NC participants exhibited attentional biases for emotional faces. Moreover, within the MDD group, greater symptom severity was related to a stronger bias to direct attention away from happy faces. The pattern in the MDD group is consistent with findings of previous studies using dot-probe tasks, particularly with longer stimulus durations (e.g., Bradley, Mogg, & Lee, 1997; Mogg et al., 1995). The specificity of these results is limited by the absence of significant differences between the MDD and the GSP groups, and the finding that severity of anxiety symptoms as well as depressive symptoms was related to a bias to direct attention away from happy faces. Overall, however, the pattern of results obtained on the emotion face dot-probe and self-referent endorsement tasks indicates that depressed individuals are characterized by biases in attention and recall, biases that appear to be more pronounced for sad stimuli than for other negative stimuli, and more consistently observed for participants diagnosed with MDD than with GSP.

Given these results, combined with formulations derived from cognitive theory, we also expected to find a negative processing bias in the depressed participants on the emotional Stroop task. Contrary to our expectations, however, the three groups of participants did not differ on this task. These findings are congruent with previous research showing a lack of relation between depression and Stroop indices (e.g., Mogg et al., 1993). Moreover, although the results of previous studies have suggested that individuals with social phobia exhibit an attentional bias on the emotional Stroop task (e.g., Maidenberg et al., 1996; Mattia et al., 1993), we found no evidence of this in our sample of participants diagnosed with GSP. Interestingly, the results of other investigations suggest that attentional bias on the emotional Stroop task among individuals with social phobia is suppressed if the individuals are anxious at the time they participate in the task (Amir, Freshman, & Foa, 2002; Amir, McNally, Riemann, & Burns, 1996), or if the stimuli are presented in random order (as in the present study), rather than blocked order (Holle, Neely, & Heimberg, 1997). Moreover, Musa et al. (2003) found that whereas individuals with social phobia exhibited selective attention to social-threat words on a dot-probe task, individuals with comorbid social phobia and depression did not, suggesting that concurrent depression abolishes the attentional bias associated with social phobia. Although participants in the present study did not have comorbid depression and social phobia, it does now appear that attentional bias among individuals with social phobia is not as robust a phenomenon as was originally believed.

Beyond the lack of sensitivity to symptoms or disorder, positive and negative bias scores on the Stroop task in the present study were found to be positively correlated. Consistent with this finding, it is noteworthy that in previous studies investigators have found that positive words, like negative words, also interfere with color naming on the Stroop, likely through activation of negative antonyms of the positive words (see Ruiz-Caballero & Bermudez, 1997, for a review of these studies). Because the emotion face dot-probe task does not rely on semantic processing, it is less susceptible to the possibility of unintentional valenced activation and, consequently, may provide some advantages for studying reactions to specific emotionally relevant stimuli. Lending support to this formulation, the strongest depression-associated biases were obtained on this task, both in the present study and in previous research in our laboratory with an independent sample of depressed participants (Gotlib et al., 2004).

Overall, the group differences that were obtained in this study suggest that clinically depressed individuals are characterized by a negative bias in recall and by greater attention to sad than to neutral faces. Moreover, there was modest evidence to indicate that these biases may be specific to depression: Compared with GSP participants, MDD participants exhibited significantly stronger attention to sad (compared with neutral) faces and recalled more endorsed sad words and fewer endorsed happy words. Importantly, previous studies have found a cognitive negative bias in remitted depressives, suggesting that these negative biases may not be merely state-dependent artifacts (e.g., Gilboa & Gotlib, 1997). Conclusions regarding specificity, however, are limited in that whereas the GSP group could not be differentiated from the NC group on several dimensions, they also could not be differentiated from the MDD group.

According to Beck's (1976) and Bower's (1981) formulations, negative cognitive biases in the depressed participants should be consistent across tasks. In contrast, Williams et al. (1997) have posited that depression is associated with a bias in memory tasks but not in tasks assessing selective attention. In the present study, we assessed concordance across three different tasks measuring biases in attention and memory within the same participants, and we found a lack of coherence across tasks. Broadly considered, biases in attention and memory were not significantly intercorrelated.

What is more disturbing, however, is even the tasks in the present study assessing only attentional biases did not demonstrate the expected pattern of correlations. More specifically, bias scores for sad stimuli on the emotional Stroop task and the emotion face dot-probe task were significantly correlated only among the NC participants, and attentional bias scores for positive stimuli did not cohere within any of the three groups. Although this pattern of results is inconsistent with the predictions of Beck's (1976) model, it is consistent with findings from a small but growing literature directly comparing these two tasks. Dalgleish et al. (2003) and Mogg, Bradley, et al. (2000) all failed to find significant correlations between bias scores obtained on a dot-probe task and bias scores obtained on a Stoop task.

From a cognitive science perspective, one might not expect these tasks to cohere. Although both the emotion face dot-probe task and the emotional Stroop task essentially assess allocation of attention to competing stimuli, there are important differences in the cognitive demands of these two tasks. In addition to the obvious differences of the stimuli (faces vs. words) and required response (voice vs. keypress), it is possible, as Brosschot, de Ruiter, and Kindt (1999) have proposed, that these two tasks do not assess the same aspect of attentional processing. Whereas the Stroop task requires the active suppression of a prepotent response, this is not the case with the dot-probe task, which assesses the allocation of visual attention. As a related point, the Stroop task is differentiated from the face dot-probe task in that participants are instructed to ignore the emotion-relevant stimuli on the Stroop task, but are free to attend to them on the dot-probe task. Because these instructions for the Stroop task may invoke strategic processing, the dot-probe task might allow for a more "naturalistic" examination of the allocation of attentional resources. Indeed, LaBerge (1995) has suggested that selective attention is not a unitary concept but instead consists of multiple components. Whereas Stroop effects might primarily reflect the initial orienting toward stimuli and the interference caused by this initial orienting, dot-probe tasks, and in particular those tasks using long stimulus exposure durations, more likely reflect the maintenance component of selective attention.

As a related point, a number of investigators have raised the possibility that interference effects on the emotional Stroop task are due to processes that do not involve attention. For example, de Ruiter and Brosschot (1994) have implicated the construct of cognitive avoidance, as participants attempt to suppress the threatening meaning of the words, and Wells and Matthews (1994) have suggested that Stroop interference may be due to mental preoccupation and elaboration on the themes related to the emotional words. Other researchers have criticized the Stroop task as a measure of selective attention because its outcome measure of reaction time confounds stimulus factors with response factors (e.g., Gotlib, MacLachlan, & Katz, 1988; MacLeod et al., 1986). That is, it is difficult to determine whether group differences in Stroop interference are due to differences in input processes (i.e., encoding; Seymour, 1977), output processes (i.e., response production; Duncan-Johnson & Kopell, 1981), or both (e.g., Stirling, 1979). To the extent that group differences on the emotional Stroop task are due to biases in output rather than input, we would not obtain clear information concerning group differences in attentional processing, nor would we necessarily expect coherence with performance on the dot-probe task.

It is clear, therefore, that future research is required to systematically investigate how different task demands, type of stimuli, specific word sets, duration of stimuli, response modes, and even task order affect the operation of attentional biases among individuals diagnosed with anxiety and depression. Moreover, we did not include all of the information-processing tasks that have been used to study cognitive biases in depression and anxiety, and it is possible that bias scores on other tasks would have been more highly intercorrelated than were scores on the three tasks assessed in the present study.

Nevertheless, it is apparent from the present study that different measures of information-processing biases are not significantly intercorrelated and, furthermore, that they likely assess different constructs. The three tasks used in the present investigation are among the most commonly used measures of information-processing bias in depression and anxiety. The lack of coherence across these measures highlights a concern that is difficult to reconcile with early cognitive theory — there is little evidence for consistency of information-processing biases when they are assessed with different types of stimuli and with different experimental tasks. Although it is possible that the low correlations simply reflect the unique method variance associated with each task, the current results suggest that different forms of psychopathology are characterized by different types of biases. More specifically, the evidence for a general bias that operates across multiple measures of attention and recall is limited. Although Williams et al. (1997) have emphasized the importance of memory biases in depression, the current results, as well as recent neurobiological research suggesting that depressed individuals exhibit elevated limbic system activation in response to presentations of sad faces (e.g., Whalen, Shin, Somerville, McLean, & Kim, 2002) suggest that it would be premature to abandon the study of attentional processes in this disorder. The current results dovetail with Bradley, Mogg, and Lee's (1997) findings to suggest that depression might be associated with a bias not in initial orienting, but rather, in the maintenance of attention.

In understanding the results of this study, we should point out that there are a number of issues that we did not address. For example, we did not assess participants prior to the onset of, or following recovery from, their depression or anxiety. Consequently, it is unclear whether the depression-associated biases in information processing that we did find are due to state-dependent effects of the disorder, or are more stable characteristics of individuals who are vulnerable to this disorder. We also included only social phobia as our anxiety disorder, because of both its high comorbidity with depression and indications in other studies that it is characterized by information-processing biases. Our sole focus on social phobia, however, precludes our ability to make statements regarding other types of anxiety disorders, which may demonstrate different patterns of associations on information-processing tasks. Finally, although we took great care in diagnosing participants for this study and eliminating those with current comorbid depression and social phobia, it is possible that the lack of specificity of patterns of information processing in the GSP participants is a function of their relatively high rate of lifetime depression (76% had reported previous episodes of depression), or of the comparable levels of self-reported symptoms of anxiety among the GSP and MDD participants.

Despite these limitations, however, this study has several important strengths. We assessed carefully diagnosed samples of participants who did not have current comorbid anxiety and depression. Consequently, we were able to assess the differential relation of diagnoses of anxiety and depression to biases in information processing. This is particularly important in light of the formulation that attentional biases found in depressed individuals may be due to high levels of comorbid anxiety (cf. Williams et al., 1997). We were able to separate the contributions of these two disorders, at least for current symptoms, and it does not appear from the present results that a diagnosis of comorbid anxiety accounts for the attentional bias exhibited by individuals with MDD. As a related strength, in contrast to many studies that have used nonclinical samples split along a continuous self-report measure as either high or low in anxiety or depression, we used a reliably diagnosed clinical sample, with many of the participants being referred through a psychiatry outpatient department. This clinical relevance was further evident in the fact that most of our participants were moderately depressed or anxious, as indicated by both their SCID evaluations and their elevated scores on the HDI and BAI.

Future research might profitably continue to examine the issue of concordance of cognitive bias among various information-processing tasks. For example, high-risk studies of depression using priming procedures could be designed to assess whether consistent, negative biases in attention and memory are evident premorbidly, before the onset of the disorder. It is also important to compare the relative sensitivity of biases in attention and memory for identifying individuals at greatest risk for onset of depression, as well as the role of these biases in hindering recovery from this disorder. Finally, the results of the present study underscore the need for a stronger and more explicit conceptual and methodological focus on the similarities and differences among various measures of cognitive biases.

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