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Depth of processing and recall of threat material in fearful and nonfearful individuals

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Abstract
Although many studies have examined the nature of memory distortions in anxious individuals, few have considered biases in specific memory processes, such as encoding or retrieval. To investigate whether the presentation of threat material facilitates encoding biases, spider fearful ($n=63$), blood fearful ($n=73$), and nonfearful ($n=75$) participants encoded spider related, blood related, and neutral words as a function of three levels of processing (i.e., structural, semantic, and self-referent). Participants subsequently completed either a free recall or a recognition task. All participants demonstrated a partial depth of processing effect, such that they recalled more words encoded in the self-referent condition than in the other two conditions, but groups did not differ in their recall of stimuli as a function of word type. Relative to participants in the other groups, spider fearful participants had fewer spider related intrusions in the recall condition, and they made fewer errors in responding to structural and semantic encoding questions when spider related words were presented. These results contribute to an increasingly large body of literature suggesting that anxious individuals are not characterized by a memory bias toward threat, and they raise the possibility that individuals with spider fears process threat-relevant information differently than individuals with blood fears.

Keywords: *Depth of processing, memory bias, cognition, fear, spider, blood*

Cognitive theories of anxiety suggest that anxious individuals should demonstrate enhanced recall for threat-relevant information, such that they should recall more threat-relevant materials than neutral material and that they should recall more threat-relevant materials than nonanxious individuals (e.g., Beck & Clark, 1997; Beck & Emery, 1985). In fact, these theories indicate that distorted threat-related memories contribute to the development of maladaptive "danger" schemas that in turn cause biased processing of threat-relevant information. Despite the strong theoretical underpinnings supporting the existence of memory biases in anxious individuals, empirical studies have yielded mixed results. In general, research demonstrates that individuals with panic disorder and those with posttraumatic stress disorder indeed exhibit enhanced recall of threat-relevant material (e.g., McNally, Foa, & Donnell, 1989; Vrana, Roodman, & Beckham, 1995), but that individuals with generalized anxiety disorder and those with social phobia do not exhibit such a bias (e.g., Mogg, Mathews, & Weinman, 1987; Rapee, McCallum, Melville,

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Ravenscroft, & Rodney, 1994). However, it is difficult to draw definitive conclusions because of differences among studies in the nature of particular memory tests used (e.g., free recall, recognition), particular stimuli used (e.g., single words, pictures), and memory processes studied (i.e., explicit memory, implicit memory). Moreover, most anxiety disorders are characterized by substantial comorbidity (Brown, Campbell, Lehman, Grisham, & Mancill, 2001), making it unclear whether results can be attributed to the anxiety disorder itself or, more generally, to elevated levels of emotional distress.

Specific phobias are perhaps the ideal anxiety disorder to examine anxiety-relevant cognitive processes, as they are associated with less comorbidity than the other anxiety disorders (Brown et al., 2001), raising the possibility that processes relevant to relatively "pure" anxiety can be illustrated in phobic samples. Unfortunately, research examining memory biases in individuals with specific fears and phobias is perhaps the most difficult to interpret of all of the anxiety disorders. Much of this research uses samples of individuals with spider phobia and examines biases in explicit memory, or the "conscious attempt to retrieve memories of past events" (Roediger & Amir, 2005; p. 122). Results from some of these studies suggest that spider phobic individuals are characterized by a memory bias toward enhanced recall of spider related information (e.g., Kindt & Brosschot, 1998; Kindt, Brosschot, & Boiten, 1999; Rusted & Dighton, 1991; Watts & Coyle, 1992). All of these studies used free recall tasks and either single-word or prose passage stimuli. In contrast, results from other studies indicate that spider phobic individuals have poorer memory for spider related information, at least in some circumstances (e.g., Watts & Coyle, 1993; Watts & Dalgleish, 1991; Watts, Trezise, & Sharrock, 1986). Stimuli in these studies included actual spiders and single words, and memory tasks were of both free recall and recognition. Thorpe and Salkovskis (2000) showed spider phobic, other phobic, and nonphobic participants video clips depicting spiders and found that all three groups recalled a similar amount of video details and recognized a similar amount of spider stimuli. In all, no one methodological variable is able to explain these discrepant findings, and the investigation of memory bias in spider phobia has largely been abandoned.

Only a few studies have examined memory biases in individuals with fears of stimuli other than spiders. Sawchuk, Lohr, Lee, and Tolin (1999) found that individuals with blood/injury/injection (BII) fears were more likely than nonfearful individuals to complete threat-relevant word stems with words previously presented on an emotional Stroop task. That is, they demonstrated an implicit memory bias, as BII fearful participants' word-stem completion performance was influenced by the stimuli they had seen on the Stroop task when they were not specifically instructed to complete the stems using those stimuli (cf. Roediger & Amir, 2005). Wenzel, Jackson, Brendle, and Pinna (2003) assessed autobiographical memory biases in spider fearful, blood fearful, and nonfearful individuals and reported that both groups of fearful participants retrieved memories characterized by a more negative valence than nonfearful individuals. These studies raise the possibility that individuals with specific fears and phobias indeed exhibit a memory bias under some circumstances, but that such biases are not well detected unless tasks are designed to tap into specific memory processes.

In their review of memory biases in the anxiety disorders, Coles and Heimberg (2002) concluded that memory biases toward threat-relevant stimuli are most likely to emerge when participants engage in elaborate, or "deep" encoding of the presented material. They also noted that most researchers do not report the specific instructions they give to participants during the presentation of stimuli and that it is quite possible that participants, even within the same study, encode stimuli to varying degrees. Thus, according to these researchers, depth of processing is a critical variable that could explain the confusing pattern of results in this literature, and elaborate processing of presented material is likely necessary for anxious individuals to exhibit a memory bias for threat-relevant stimuli. However, to date, the effect of varying levels of encoding upon recall of threat-relevant information in individuals with specific fears and phobias has not been examined.

Although there is a long tradition of examining various levels of processing in the cognitive psychology literature (e.g., Craik & Lockhart, 1972; Craik & Tulving, 1975), only a handful of studies have manipulated depth of processing in samples of individuals with clinically relevant concerns. The majority of these studies have attempted to contrast memory performance as a function of two encoding conditions — one designed to promote relatively *shallow* encoding (e.g., recording the number of letters in the word, simply reading the word, recording the number of syllables of the word, recording whether the number has been printed in capital letters) and the other designed to promote relatively *deep* encoding (e.g., rating the pleasantness of the word, generating the word in response to a cue, recording whether the word is a noun; Eysenck & Byrne, 1994; Pauli, Dengler, & Wiedemann, 2005; Ruiz-Caballero & Gonzales, 1997; Russo, Fox, Bellinger, & Nguyen-Van-Tam, 2001). For example, Ruiz-Caballero and Gonzales (1997) presented depressed and nondepressed individuals with positive and negative trait adjectives in shallow and deep processing conditions and compared their performance on word-stem completion and free-recall tasks. Groups did not differ in their performance on the word-stem completion or free recall of words presented in the shallow encoding condition, but significant group differences were detected in the free recall of trait adjectives in the deep encoding condition, such that depressed individuals recalled more negative than positive adjectives, whereas nondepressed individuals exhibited the opposite pattern. Eysenck and Byrne (1994) presented threat and nonthreat words to high, medium, and low trait anxious individuals in shallow and deep encoding conditions and examined free recall, cued recall, and word-stem completion performance. Their results indicated that high trait anxious participants demonstrated threat-relevant memory biases in the free recall and cued recall tasks when words were presented the deep encoding condition and in the word-stem completion task when words were presented in both encoding conditions. In contrast, Russo et al. (2001) reported that trait anxious individuals recalled more threat-relevant words in their shallow encoding condition, rather than their deep encoding condition. Moreover, Pauli et al.'s (2005) study with panic disorder patients found that depth of encoding made no impact on the recognition of threat-relevant stimuli.

Thus, results from studies examining two broad levels of processing — shallow and deep — have yielded mixed results with clinically relevant samples. However, it could be argued that the deep encoding condition in these studies did not truly promote elaborate processing, as participants generally were required to consider the meaning of stimuli only long enough to make a simple rating. There are some studies that have incorporated a level of processing that is presumed to facilitate even more elaborate processing than that which can be attained by consideration of the word's meaning – consideration of the word in relation to the self, called a *self-referent* condition. Ingram, Smith, and Brehm (1983), for example, instructed mildly depressed and nondepressed undergraduates to encode trait adjectives in one of four conditions: (1) structural (e.g., "Was the word read by a male or female voice?"); (2) phonemic (e.g., "Does the word rhyme with ____?"); (3) semantic (e.g., "Does the word mean the same as _____?"); or (4) self-referent (e.g., "Does the word describe you?"). Nondepressed participants who were led to believe that they had achieved success on a previous task recalled more positive than negative words only when they were encoded in the self-referent condition, but depressed participants did not show this effect. Using a similar task, Smith, Ingram, and Brehm (1983) reported that socially anxious undergraduates who were told that they were going to speak in front of others recalled more trait adjectives encoded in a public self-referent condition (e.g., "Would someone who knows you say that the word describes you?") than nonanxious individuals. Subsequently, Richards and French (1991) found that trait anxious individuals demonstrated threat-relevant memory biases when they imagined themselves in a scene with the stimuli (i.e., self-referent imagery), but not when they simply read the stimuli. Only Banos, Madina, and Pascual (2001) failed to find statistically significant differences between clinical (i.e., panic, depressed) and normal control groups in a self-referent encoding condition. However, it is likely that this finding occurred because of lack of statistical power (ns $=20$ per group), as the direction of the means suggested that when words were encoded with self-referent imagery, panic patients demonstrated biased retrieval of panic-related words, and depressed patients demonstrated biased retrieval of depression-related words.

In all, the depth of processing paradigm has achieved only modest success in characterizing memory biases as a function of clinically relevant individual differences, but there is preliminary evidence that inclusion of a self-referent condition might be necessary to promote deep levels of encoding that would in turn facilitate memory biases. The present study was designed to clarify the manner in which depth of encoding affects threat-relevant memory biases in individuals with specific fears. To achieve this aim, individuals with self-reported spider fears, individuals with self-reported blood fears, and nonfearful individuals were presented with spider relevant, blood relevant, and neutral single words in the context of three levels of encoding: structural, semantic, and self-referent. Subsequently, they completed either a free recall or a recognition task. It was predicted that fearful individuals would recall or recognize more words associated with their primary domain of fear than individuals in the other two groups only when they encoded material in the self-referent condition.

Method

Participants

Three samples were used in the present study: 63 individuals with self-reported spider fears, 73 with self-reported blood fears, and 75 with neither self-reported spider nor self-reported blood fears. They were recruited from undergraduate psychology classes and completed the study for course or extra credit. Participants had a mean age of 20.0 years, and 93% were Caucasian. These demographic variables did not differ among groups. However, groups differed significantly on gender, $\chi^2(2) = 39.41$, $p < .001$. Approximately 95% of the spider fearful, 63% of the blood fearful, and 50% of the nonfearful individuals were female.

Participants were identified and recruited through an elaborate screening process. In group testing sessions, students ($n = 3778$) completed the Spider Phobia Questionnaire-Avoidance Scale (SPQ-AV; Watts & Sharrock, 1984) and the Fear Questionnaire-Blood/Injury Scale (FQ-B/I; Marks & Mathews, 1979), both of which have excellent psychometric properties.[1] Individuals scoring one standard deviation above the mean on the SPQ-AV and below the mean on the FQ-B/I (SPQ-AV ≥ 6; FQ-B/I ≤ 8) were identified for the spider fearful group, and individuals scoring one standard deviation above the mean on the FQ-B/I and below the mean on the SPQ-AV (SPQ-AV ≤ 3; FQ-B/I ≥ 16) were identified for the blood fearful group. Individuals scoring one standard deviation above the mean on both inventories were excluded from the study in order to separate samples of relatively pure spider fearful individuals and relatively pure blood fearful individuals. Individuals scoring one standard deviation below the mean on both the SPQ-AV and FQ-B/I (SPQ-AV ≤ 1; FQ-B/I ≤ 1) were identified for the nonfearful group. Three hundred and sixteen individuals (8.4% of the total sample; mean SPQ-AV = 7.3; mean FQ-B/I = 4.5) met the criteria to be contacted for participation in the spider fearful group, 329 individuals (8.7% of the total sample; mean SPQ-AV = 1.6; mean FQ-B/I = 21.3) met the criteria for the blood fearful group, and 152 individuals (4.0% of the total sample; mean SPQ-AV = 0.7; mean FQ-B/I = 0.2) met the criteria to be contacted for participation in the nonfearful group.

Eligible participants were contacted by telephone to inquire about their interest in participating in the study. Reasons for eligible research participants declining participation included having already completed their course requirement, scheduling difficulties, having dropped the introductory psychology class, no interest, and failing to report for an experimental session. At the time of the experimental session, all participants again completed the SPQ-AV and the FQ-B/I to assess the degree to which scores on the fear scales regressed to the mean. Data from fearful individuals were excluded from analyses if their score on the scale associated with their primary domain of fear dropped below the mean obtained on the screening sample or if their score on the scale associated with the other domain of fear increased to that which was one standard deviation above the mean obtained on the screening sample. Data from nonfearful individuals were excluded from analyses if their scores on either fear scale rose above the mean obtained on the screening sample. In all, data from 30 spider fearful individuals, 17 blood fearful individuals, and six nonfearful individuals were excluded from analyses for these reasons. Of the spider fearful individuals whose data were omitted from analyses, six were omitted due to scoring below the mean on the SPQ-AV, 22 were omitted due to scoring above the mean on the FQ-B/I, and two were omitted due to scoring below the mean on the SPQ-AV and above the mean on the FQ-B/I. Of the blood fearful individuals whose data were omitted from analyses, six were omitted due to scoring below the mean on the FQ, nine were omitted due to scoring above the mean on the SPQ-AV, and two were omitted due to scoring below the mean on the FQ-B/I and above the mean on the SPQ-AV. Of the nonfearful individuals whose data were omitted from analyses, two were omitted due to scoring above the mean on the SPQ-AV and four were omitted due to scoring above the mean on the FQ-B/I.

Depth of Processing Task

Depth of processing questions. A series of single-word stimuli were read by a male voice on a recorded audiotape and were presented at 9-second intervals (cf. Ingram et al., 1983; Smith et al., 1983). After hearing each word, participants responded with a "yes" or "no" to a question about that word. The questions corresponded to one of three levels of processing: (1) *structural* (e.g., "Was the word made up of five letters?"); (2) *semantic* (e.g., "Does the word fit into this sentence?"); or (3) *self-referent* (e.g., "Does the word reflect a situation that you have experienced?"). For structural items, questions corresponding to "yes" responses indicated the correct number of letters comprising the word, and questions corresponding to "no" responses indicated a number that was either one higher or one lower than the correct number of letters. For semantic items, questions corresponding to "yes" responses described a sentence into which the presented word clearly fit, and questions corresponding to "no" responses described a sentence in which the presented word clearly did not fit. Thus, the number of correct and incorrect responses to the structural and semantic questions could be tabulated. In contrast, self-referent questions were constructed to correspond roughly to the same distribution of "yes" or "no" responses, although this distribution could not be ensured, and correct responses could not be verified. Specifically, self-referent questions pertaining to instances occurring in one's lifetime were regarded as being equivalent to "yes" responses because it was likely that participants would have had at least some exposure to the words on the list, all of which were common. Self-referent questions pertaining to instances occurring in the past week were regarded as being "no" responses because it was less likely that they would have a specific experience with most of the stimuli in that time frame.

Word list. The list comprised 60 single words. The middle 48 words included 12 related to the word *spider*, 12 related to the word *blood*, 12 related to the word *chair*, and 12 related to the word *window*. Stimuli relating to spider, blood, chair, and window were the target words (i.e., blood, chair, window) and their 11 strongest associations, which were borrowed from Palermo and Jenkins (1965; cf. Roediger & McDermott, 1995). Because associations to the word spider were not published, they were identified though the same procedure described by Palermo and Jenkins (1965), such that undergraduate students listed the ten associations that entered into their mind when cued with that word. The 12 words from each of the four categories were randomly distributed across the list with the exception that no more than two words from a particular category fell in contiguous order, and then the list was divided into six groups of eight words each. Using a Latin-Square counterbalancing scheme, these six chunks were arranged into six orders of stimuli. In addition, six related words were placed at the beginning to control for primacy effects, and six related words were placed at the end to control for recency effects (cf. Reber, Perrig, Flammer, & Walther, 1994). These 12 "buffer" words comprised three associations to each target word that were weaker than those included in the counterbalanced lists. All lists had the same six beginning words and the same six ending words, as memory performance for these stimuli were not of interest in analyses.

Alignment of depth of processing questions and words. Stimuli were aligned with the depth of processing questions as follows. Four words from each category were assigned to each of the three levels of processing: structural, semantic, and self-referent. Care was taken to ensure that the varying degrees of association strength were equally represented in the three levels of processing. In addition, two items from each level of processing pertaining to each word category corresponded to "yes" responses, and two corresponded to "no" responses. Each stimulus, level of processing, and "yes" vs. "no" response was distributed equally across the six different list orders.

Procedure

Participants were randomly assigned to one of six pre-recorded orders of stimuli. After presentation of the word list was complete and participants had responded to each of the levels of processing questions, they completed the *Beck Depression Inventory* (BDI; Beck, Ward, Mendelsohn, Mock, & Erbaugh, 1961) and the *State-Trait Anxiety Inventory-Trait Version* (STAI-T; Spielberger, Gorsuch, & Lushene, 1970). The time allotted for the completion of these inventories was 7 minutes, which was determined through pilot testing as the amount of time it takes most psychology undergraduates to complete these measures. These measures were given at this time to focus participants' attention on material of roughly equal emotional intensity that was unrelated to the contents of the memory task in order to keep their arousal at a similar level that it was during the encoding task, so that level of arousal at the time of encoding would be similar to the level of arousal at the time of retrieval. Immediately following the completion of the inventories, half of the participants were asked to complete a recall task, and half were asked to complete a recognition task. No mention of this memory component of the task was made previously. In the recall condition, participants wrote down all of the stimuli they could remember in any order in a 5-minute period of time. The recognition task consisted of 24 already presented words (six from each of the four word categories) and 24 words that were new but still related to the word categories (six related to each of the four word categories), and participants were instructed to record whether each word was new or had been presented previously. After the conclusion of memory task, participants completed the FQ-B/I and the SPQ and provided demographic information.

Results

Self-Report Inventories

A series of one-way ANOVAs were conducted to examine differences among groups on self-report inventory scores, as summarized in Table I. There were significant differences among groups on the SPQ-Total Score ($F(2, 261) = 114.70$, $p < .001$), as well as on its three main components, the Vigilance scale ($F(2, 261) = 61.96$, $p < .001$), the Avoidance scale ($F(2, 261) = 154.79$, $p < .001$), and the Preoccupation scale ($F(2, 261) = 13.26$, $p < .001$). Follow-up tests of simple effects revealed a consistent pattern of results, such that the spider fearful participants reported more severe levels of spider fearfulness than both the blood fearful and nonfearful participants. Blood fearful participants reported equal levels of spider fearfulness as the nonfearful participants. There were also significant differences among groups on the FQ-BI ($F(2, 261) = 170.38$, $p < .001$), such that blood fearful participants scored higher than spider fearful participants, who in turn scored higher than the nonfearful participants. In addition, there were significant differences among groups on the STAI-T ($F(2, 261) = 9.80$, $p < .001$), such that participants in both fearful groups scored higher than nonfearful participants. There were no group differences in BDI scores.

Depth of Processing Effects

Preliminary analyses. Preliminary analyses were conducted to (1) determine whether the expected depth of processing effect was obtained, such that participants would remember

Table I. Scores on self-report inventories.

	Spider fearful group ($n = 63$)	Blood fearful group ($n = 73$)	Nonfearful group ($n = 75$)
Spider Phobia Questionnaire	14.87 (4.84)[b]	5.99 (4.33)[a]	4.49 (2.36)[a]
Vigilance scale	4.97 (2.50)[b]	2.27 (1.60)[a]	1.79 (1.11)[a]
Avoidance-Coping scale	6.77 (1.52)[b]	1.59 (1.19)[a]	1.04 (0.92)[a]
Preoccupation scale	3.13 (2.03)[b]	2.12 (2.99)[a]	1.67 (1.06)[a]
FQ-BI	3.95 (2.61)[b]	19.51 (7.42)[c]	1.84 (2.11)[a]
STAI-T	38.00 (9.48)[b]	39.58 (12.06)[b]	31.83 (9.96)[a]
BDI	7.43 (6.49)	7.94 (8.96)	4.54 (4.74)

Note. Values in parentheses are standard deviations. FQ-BI = Fear Questionnaire; STAI-T = State-Trait Anxiety Inventory-Trait Version; BDI = Beck Depression Inventory. Different superscripts represent significant differences between groups at $p < .05$.

more stimuli encoded in the self-referent condition than in the semantic condition, and in turn would remember more stimuli encoded in the semantic condition than in the structural condition; and (2) determine whether performance varied as a function of Yes–No responses to the depth of processing questions. A 3 (level) $\times 2$ (Yes–No response) repeated measures ANOVA was conducted for both recall and recognition data. For recall data, there was a main effect for level ($F(2, 210) = 31.91$, $p < .001$) that was qualified by a level by Yes–No response interaction ($F(2, 210) = 3.79$, $p = .024$). Follow-up analyses indicated that all participants recalled more stimuli that were encoded in the self-referent condition than in the other two conditions; however, there was no difference in recall performance between the structural and semantic conditions. Stimuli associated with questions in the structural condition that received a "Yes" response were recalled at a higher rate than those associated with questions in the structural condition that received a "No" response ($t(105) = 2.00$, $p = .049$). However, recall performance did not vary as a function of Yes–No response in the semantic and self-referent conditions.

For recognition data, the repeated measures ANOVA yielded main effects for level ($F(2, 206) = 13.87$, $p < .001$) and Yes–No response ($F(1, 206) = 4.55$, $p = .035$). Similar to the pattern described above, all participants recognized more stimuli that were encoded in the self-referent condition than in the other two conditions, and there was no difference in recognition performance between the structural and semantic conditions. Furthermore, all participants recognized more stimuli associated with "Yes" responses on the encoding task than with "No" responses, a well-documented phenomenon in the depth of processing literature (cf. Craik & Tulving, 1975).

These analyses confirm that the self-referent condition achieved its desired effect – memory performance was enhanced in this condition, presumably because it facilitated very elaborate processing. Unlike many previous studies, the semantic condition was not associated with better memory performance than then structural condition. Thus, a series of planned comparisons were conducted in the recall and recognition conditions for two dependent variables: (1) number of stimuli remembered that had been encoded in the self-referent condition; and (2) number of stimuli remembered that had been encoded in the structural+semantic conditions, divided in half so that values were comparable with those obtained in the self-referent condition. For each of these variables, two planned comparisons were conducted. One planned comparison involved groups' performance for spider stimuli, in which performance for spider fearful participants was assigned a coefficient of $+1$, whereas performances of blood fearful and nonfearful participants were each assigned coefficients of -0.5. The other planned comparison involved groups' performance for blood stimuli, in which performance for blood fearful participants was assigned a coefficient of $+1$, whereas performances of spider fearful and nonfearful participants were each assigned coefficients of -0.5.

Table II displays means for levels of processing effects for threat-relevant stimuli as a function of group and stimuli for recall and recognition performance. The planned comparisons for number of spider and blood words *recalled* in the self-referent condition were nonsignificant ($t(103) = -0.59$, $= .556$, Cohen's $d = -.159$; t(103) $= -1.07$, $p = .288$, Cohen's $d = -.183$, respectively). The planned comparisons for number of spider and blood words *recalled* in the structural and semantic conditions also were nonsignificant ($t(103) = -.71$, $p = .478$, Cohen's $d = -.282$; $t(103) = 1.57$, $p = .119$, Cohen's $d = .267$, respectively). Similarly, the planned comparisons for the number of spider and blood words *recognized* in the self-referent condition were nonsignificant ($t(101) = .96$, $p = .341$, Cohen's $d = .267$; $t(101) = .05$, $p = .964$, Cohen's $d = .063$, respectively). Finally, the planned

Table II. Memory performance for threat-relevant stimuli as a function of level of processing.

	Recall condition		
Encoding condition	Spider fearful group ($n = 33$)	Blood fearful group ($n = 35$)	Nonfearful group ($n = 38$)
Structural + semantic			
Spider words	0.89 (0.68)	0.96 (0.67)	1.03 (0.61)
Blood words	1.03 (0.78)	1.34 (0.72)	1.16 (0.80)
Self-referent			
Spider words	1.21 (0.82)	1.23 (0.97)	1.53 (1.87)
Blood words	2.00 (0.97)	1.60 (0.98)	1.66 (1.15)
	Recognition condition		
Encoding condition	Spider fearful group ($n = 30$)	Blood fearful group ($n = 38$)	Nonfearful group ($n = 36$)
Structural + semantic			
Spider words	1.58 (0.63)	1.42 (0.53)	1.35 (0.55)
Blood words	1.53 (0.47)	1.49 (0.58)	1.46 (0.50)
Self-referent			
Spider words	1.73 (0.83)	1.53 (0.76)	1.61 (0.79)
Blood words	1.67 (0.48)	1.66 (0.58)	1.64 (0.59)

Note. Values in parentheses are standard deviations. Values for the structural + semantic variables were divided by 2, so that they would be comparable with values for the self-referent condition; thus, all values ranged from 0 to 4.

comparisons for the number of spider and blood words *recognized* in the structural and semantic conditions were nonsignificant ($t(101) = 1.63$, $p = .106$, Cohen's $d = .322$; $t(101) = -.09$, $p = .932$, Cohen's $d = .023$, respectively).

Secondary Analyses

Intrusions. Intrusions are words that participants claimed to have remembered but that had not been previously presented and were coded as being related or not related to the target words "spider" and "blood." Table III displays the mean number of intrusions for threat-relevant stimuli as a function of group and stimuli for recall and recognition

Table III. Mean number of intrusions in recall and recognition conditions.

	Spider fearful group ($n = 33$)	Blood fearful group ($n = 35$)	Nonfearful group ($n = 38$)
Recall condition			
Spider words	0.00 (0.00)	0.09 (0.28)	0.07 (0.25)
Blood words	0.15 (0.36)	0.17 (0.51)	0.11 (0.31)
	Spider fearful group ($n = 30$)	Blood fearful group ($n = 38$)	Nonfearful group ($n = 36$)
Recognition condition			
Spider words	0.80 (1.61)	0.92 (1.94)	0.61 (1.50)
Blood words	1.03 (1.49)	0.79 (1.51)	1.17 (1.65)

Note. Values in parentheses are standard deviations. Values for the structural + semantic variables were divided by 2, so that they would be comparable with values for the self-referent condition.

performance. A similar analytic strategy was adopted as for the main depth of processing analyses, such that planned comparisons were conducted in the recall and recognition conditions for number of spider related and blood related intrusions. In the *recall* condition, analyses suggested that spider fearful participants made fewer spider related intrusions than participants in the other two groups ($t(103) = -2.74$, $p = .008$, Cohen's $d = -.245$) but that blood fearful participants did not differ from participants in the other two groups in their number of blood related intrusions ($t(103) = .449$, $p = .655$, Cohen's $d = .195$). In the *recognition* condition, there were no differences among groups in the number of spider related or blood related intrusions ($t(101) = .10$, $p = .921$, Cohen's $d = .036$; $t(101) = -1.0$, $p = .323$, Cohen's $d = -.267$, respectively).

Errors. We conceptualized errors as instances in which participants responded incorrectly to items on the depth of processing questionnaire. Table IV displays the mean number of errors as a function of group and stimuli in the structural and semantic conditions. Errors were not examined at the self-referent level because we could not verify that responses were correct, as these questions assessed personal experiences with presented stimuli. Planned comparisons, similar to those described above, were conducted to examine the number of errors committed on structural and semantic encoding questions as a function of presentation of spider related or blood related stimuli. Analyses were not separated by type of memory task (i.e., recall vs. recognition), as errors occurred before participants knew that their memory of presented stimuli would be tested. For *spider related* words, spider fearful participants made fewer errors than participants in the other groups on both structural ($t(207) = -2.16$, $p = .033$, Cohen's $d = .203$) and semantic (t $(207) = -2.24$, $p = .026$, Cohen's $d = .161$) questions. In contrast, for *blood related* words, blood fearful participants made a similar number of errors as participants in the other two groups for structural ($t(207) = -1.15$, $p = .252$, Cohen's $d = .155$) and semantic ($t(207) = -.42$, $p = .675$, Cohen's $d = -.158$) questions.

Discussion

The present study was designed to examine the degree to which recall of threat varied as a function of depth of processing in spider fearful and blood fearful individuals. Depth of processing is an important variable to manipulate systematically in this area of study, as Coles and Heimberg (2002) suggested that explicit memory biases toward threat in anxious and fearful individuals might only be observed when stimuli are encoded at an elaborate or "deep" level. Contrary to expectation, depth of processing did not affect the degree to which fearful participants recalled threat-relevant material, and all participants performed similarly on the memory tasks. Results from this study add to an increasingly large literature

Table IV. Mean number of errors in structural and semantic conditions.

	Spider fearful group ($n = 63$)	Blood fearful group ($n = 73$)	Nonfearful group ($n = 75$)
Structural condition			
Spider words	0.11 (0.36)	0.22 (0.45)	0.27 (0.56)
Blood words	0.08 (0.27)	0.18 (0.45)	0.15 (0.39)
Semantic condition			
Spider words	0.05 (0.21)	0.10 (0.41)	0.21 (0.47)
Blood words	0.06 (0.30)	0.05 (0.28)	0.08 0.27)

suggesting that some types of anxiety are not associated with enhanced memory of threat, which refutes tenets put forth in cognitive theories of anxiety (e.g., Beck & Clark, 1997; Beck & Emery, 1985).

It is incumbent upon cognitive psychopathologists to identify the reason why memory biases are *not* exhibited in fearful individuals, given that they clearly allocate their attention preferentially toward threat in early stages of information processing (e.g., Sawchuk et al., 1999; Watts, McKenna, Sharrock, & Trezise, 1986). Several explanations have been posited to explain this counterintuitive pattern of results. Mogg et al. (1987) proposed that anxious individuals are characterized by a vigilance-avoidance pattern, such that they avoid elaborate processing of threat-relevant material despite detecting it quickly in their environment. Although this explanation resonates with avoidance symptoms that are often observed in anxious individuals, it suggests that fearful participants in the present study should have recalled *fewer* threat-relevant stimuli than nonfearful participants. It is possible that this pattern of results did not occur because participants were forced to engage in deep processing in many trials. Recently, Wenzel, Pinna, and Rubin (2004) determined that some types of anxiety-related memories, such as those related to panic and traumatic stress experiences, are more detailed and vivid than other types of anxiety-related memories, such as those related to experiences associated with worry and social anxiety. According to these researchers, it is possible that the vivid nature of panic- and trauma-related memories interacts with aspects of panic and traumatic stress pathology to supercede the avoidance mechanism proposed by Mogg et al. (1987) and drive exaggerated memories for these threatening experiences. According to this account, memory biases toward threat in anxious individuals would only be observed when the types of memories to be retrieved are especially salient, a property that a memory of a single threat-relevant word is probably lacking. Finally, another explanation for the lack of observed memory bias is that fearful participants may elaborate on the implications of threat-relevant stimuli (e.g., pain from a needle, being bitten by a spider) rather than the stimulus itself (cf. Coles & Heimberg, 2002).

It also is important to acknowledge that data from our study only partially replicated the levels of processing effect. Although participants recalled more words encoded in the self-referent condition, memory performance was similar for words encoded in the structural condition and in the semantic condition. According to the depth of processing researchers (cf. Craik & Tulving, 1975), words encoded at a semantic level should be recalled more effectively than that at a structural level. However, Mueller's (1979) program of research with test anxious individuals suggests that the high arousal level experienced by anxious individuals leads them to focus on physical features of stimuli at the expense of semantic features. According to this account, one would expect that anxious individuals would encode words presented in a structural condition just as deeply, if not more deeply, than words presented in a semantic condition. We encourage future researchers to take on a careful analysis of the manner in which group membership (i.e., anxious vs. nonanxious), stimuli content (i.e., threat-relevant vs. neutral), and anxious arousal during the experimental session interact to affect encoding and subsequent retrieval.

Although hypotheses were not posited *a priori* for expected results associated with intrusions and errors, analyses of these variables yielded evidence that spider fearful participants processed threat-relevant information differently than blood fearful participants. Specifically, relative to participants in the other groups, spider fearful participants had fewer spider related intrusions in the recall condition, and they made fewer errors in responding to structural and semantic encoding questions when spider related words were presented. This pattern of results suggests that spider fearful participants were particularly vigilant toward spider related words, such that they attended more closely than participants in the other groups to these stimuli and subsequently performed particularly efficiently on the depth of processing questions and free recall test.

It is intriguing that spiders and blood are two content areas that form the basis of the same type of pathology, specific phobia, but that high levels of fearfulness in these areas are associated with different patterns of cognition. A growing body of literature has produced similar results. For example, Wenzel (2005) found that spider fearful individuals' automatic thoughts about a common scenario involving a spider were characterized by elevated levels of worry, fear, and subjective distress, whereas blood fearful individuals' automatic thoughts about a common scenario involving blood were not. Several studies using spider phobic participants have found that these individuals demonstrate attentional biases toward threat, as measured by Stroop color-naming interference (e.g., Watts et al., 1986), but Sawchuk et al. (1999) failed to replicate this finding in a sample of blood phobic participants. One speculation to explain this pattern of results is that sympathetic activation, which characterizes spider fearfulness, is related more closely to biased cognition than is parasympathetic activation, which characterizes blood fearfulness (Page, 1994). Sympathetic activation narrows attention and heightens alertness, which creates a ripe context for the emergence of information processing biases, particularly those that involve enhanced vigilance and detection of threat. In contrast, parasympathetic activation is associated with fainting, which prevents individuals from allocating adequate cognitive resources toward processing information in their environment.

Although results from this study provide the basis for hypotheses to be tested in future research, several limitations also must be acknowledged. First, participants were undergraduate students who scored high on a self-report inventory of specific fears. Although an extensive screening procedure was utilized to ensure that fearful participants reported substantial and stable levels of specific fears (e.g., exclusion of participants from analyses if scores regressed to the mean), they were not experiencing levels of fearfulness of the same magnitude as a clinical population. Thus, it is possible that encoding biases would be detected in samples of fearful individuals who are diagnosed with specific phobia or who are seeking treatment for their concerns. Second, it was possible that null results were found because some of the threat-relevant stimuli were not sufficiently potent to activate relevant fear structures and bias information processing. Although the target word (i.e., spider, blood) and their 11 highest associations were included as stimuli, it remains likely that some threat words were more relevant to the primary concerns of fearful participants than others. This is a difficult limitation to overcome when using single words as stimuli to investigate cognitive biases in specific fears, and it implies that researchers in this area should strive to include more ecologically valid stimuli in their designs. On a related note, because three levels of processing were considered in the context of the 12 stimuli, there were only four observations per cell, which might have hindered reliability.

We also made some design choices that had the potential to influence obtained results. For example, the BDI and STAI-T were administered as a filler task, raising the possibility that this filler task could have served as a distress-relevant mood induction or cued participants to think about what makes them feel anxious. These measures were given at this time to maintain a consistent level of arousal, so that level of arousal at the time of encoding would be similar to the level of arousal at the time of retrieval, which should have optimized conditions for threat-relevant memory biases to emerge. Nevertheless, perhaps a different pattern of results would have been obtained if a neutral filler task had been utilized. In addition, the self-referent condition was different than many others used in studies referenced in this manuscript, as it required participants to indicate whether they had experience with the stimulus in a specified time frame rather than the more typical instructions of indicating whether the stimulus described them. We included these instructions because it was not logical that concrete nouns (e.g., spider, blood) would characterize participants in a descriptive sense. Nevertheless, it is possible that our self-referent condition was not as powerful in promoting deep encoding and that significant results would have been obtained if we had used phobia-relevant adjectives (e.g., frightened) as stimuli and, in the self-referent condition, asked participants to indicate whether the word characterized them. Moreover, stimuli were presented orally to be consistent with the "classic" depth of processing studies using clinically relevant samples (Ingram et al., 1983; Smith et al., 1983), but it is acknowledged that this procedure deviates from the more typical procedure of presenting stimuli to participants visually (e.g., Craik & Tulving, 1975). Perhaps, the oral presentation disrupted memory performance because stimuli were encoded in a different modality than they were retrieved. Finally, there was no actual encounter with threat worked into the experimental design, which was a feature of two studies examining self-referent encoding that did reveal individual differences in the recall of words as a function of depth of processing (i.e., Ingram et al., 1983; Smith et al., 1983).

In sum, the present study found no evidence to suggest that memory biases in fearful individuals are caused by a bias in encoding processes, nor did it confirm the suggestion put forth by Coles and Heimberg (2002) that memory biases toward threat are observed when threat-relevant material is elaborately encoded. These findings must be replicated in a sample of individuals who are diagnosed with specific phobia before a definitive conclusion can be drawn. Nevertheless, results from this study, in conjunction with many other studies in the literature finding no memory bias toward threat in anxiety, suggest that cognitive theories of anxiety should be modified. Moreover, our reported results support those described in other studies that contrast information processing associated with spider and blood fears, raising the possibility to be tested in future research that spider fearfulness is associated with a profile of information processing biases that are distinct from blood fearfulness.

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Note

1 Watts and Sharrock (1984) provided evidence of the SPQ's factor structure and excellent concurrent validity. Marks and Mathews (1979) reported a 1-week test–retest reliability of .96 for the blood/injury scale using a clinical sample with a variety of phobias. The coefficient alphas for these scales obtained on similar spider fearful, blood fearful, and nonfearful samples were .88 and .85, respectively (Wenzel et al., 2003).

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