Implicit and Explicit Memory Bias Among Adolescents with Symptoms of Anxiety

Kirsten Wilkerson

Madison County Region II Special Education Cooperative

Jeff Laurent

Tri-County Special Education Association

Salvatore J. Catanzaro

Illinois State University

Dawn M. McBride

Illinois State University

Poster presented at the 37th Annual Convention of the

National Association of School Psychologists

Atlanta, GA

March 29 – April 2, 2005

Abstract

The purpose of this study was to investigate memory of threatening and non-threatening information among adolescents. Specifically, the study tested the prediction of cognitive theories of anxiety that anxious and non-anxious individuals process threatening information differently. High school students (*N* = 187) from a moderately sized Midwestern city were screened for anxiety using self-report measures. Students (*n* = 18) who obtained scores above a designated cut-off, and a contrast group matched on gender and grade (*n* = 18), completed implicit and explicit memory tasks along with a second administration of the self-report measures. Subsequently, adolescents were divided into anxious (*n* = 8) and mixed (anxiety and depression; *n* = 10) groups. These groups produced more threat-related words on a word-stem completion task than the contrast group. However, their ability to reproduce the primed (i.e., previously studied) threat words did not differ from the contrast group. The mixed group identified more threat words on a word recognition task than either the anxious or contrast groups. When recognition was adjusted for guessing, no group differences existed. Results did not support the hypothesized implicit memory bias for threatening material among students experiencing symptoms of anxiety. However, consistent with predictions, no or explicit memory bias was found. Implications of memory methodologies in the study of anxiety are discussed. (Contains 72 references and 4 tables)

Numerous research findings indicate a link between cognition and anxiety (see Daleiden & Vasey, 1997, for a review). Cognitive theories of anxiety predict that anxious and non-anxious individuals process threatening information in different ways (e.g., Williams, Watts, MacLeod, & Mathews, 1988). One approach that researchers have used to investigate this link is to compare memory for threatening information in both anxious and non-anxious individuals (Mathews, Mogg, May, & Eysenck, 1989*)*. This research has shown mixed results among adults (MacLeod & MacLaughlin, 1995). As anxiety is particularly problematic for children (Bernstein & Borchardt, 1991), an investigation of cognition in anxious children is particularly warranted. The current study investigated memory of threatening and non-threatening information among adolescents in order to extend the cognitive-anxiety link to youth. The research further tests the prediction of cognitive theories of anxiety that anxious and non-anxious individuals process threatening information differently.

Cognitive Theories of Anxiety

Cognitive theories attempt to explain how the underlying mechanisms of anxiety result in anxious behavior. Several of these theories focus on the concept of threat and the role it plays in the processing of environmental information. In fact, interpreting the environment as threatening is the hallmark characteristic of anxiety in Beck's (1976) cognitive theory of emotional disorders. According to Beck (1971, 1976; Beck & Emery, 1985), the processing of threatening information determines the affect, behavior, and physiological responses that individuals have to anxiety. Beck and Emery (1985) outline the cognitive structures that are associated with anxiety and the role they play in the maintenance of anxiety. These cognitive structures can affect the speed with which each new situation may be analyzed as threatening or non-threatening. According to Beck and Emery, an anxious person has an active danger or threat schema making them more likely to perceive incoming information as dangerous or threatening. Threat continues to occupy a central role in modifications to Beck's original work that are schema-based and rely on the processing of information in the environment (e.g., Beck & Clark, 1997; Ingram & Kendall, 1987; Kendall & Ingram, 1987). According to Beck, when the danger or threat schema is activated, an anxious person will give precedence to incoming information that is congruent with this schema (i.e., an individual perceives external threat cues as the most important information in the environment).

Consistent with Beck's (Beck & Clark, 1997) schema theory of anxiety, Williams et al. (1988) suggest that anxious individuals have a bias towards processing threatening information, but that they are automatically drawn towards the threatening information without attentional demands. Further, threatening information is processed in a way that does not entail elaborative processing. Instead, anxious individuals automatically encode threatening information, but do not engage in further conscious processing of the information. Different experimental methods have been used to investigate this proposition including dichotomous listening tasks (Mathews & MacLeod, 1986), emotional or modified Stroop color-naming tasks (Mathews & MacLeod, 1985; Mogg, Mathews, & Weinman, 1989), and reaction time tasks (MacLeod & Mathews, 1991). For example, Mathews and MacLeod (1985) demonstrated Stroop task interference when anxious subjects were asked to state the color of words presented in different colors. Anxious subjects took longer to name the color for threatening words than for non-threatening words, indicating that they processed the meaning of threat words even when this hindered task performance. Non-anxious subjects showed no differential interference as a function of threat content of the words. These results supported the Williams et al. theory that anxious individuals automatically process threatening information.

Based on this encoding difference for high and low anxious individuals, Williams et al. (1988) also predicted differences in memory processing. For example, explicit memory tasks (e.g., recall or recognition) require conscious retrieval of a past episode. Explicit memory is enhanced by encoding that makes use of elaborative processing or attentional resources (Jacoby, Toth, & Yonelinas, 1993; Toth, Reingold, & Jacoby, 1994). Therefore, if anxious subjects encode threatening items automatically and without attentional demands, they should not show an explicit memory bias for threatening information as compared to neutral or positive information. Conversely, performance on implicit memory tasks does not require conscious encoding of items (Jacoby et al., 1993; Toth et al., 1994). Instead, implicit tasks are influenced by previous episodes without conscious recollection of the episode. In other words, implicit retrieval is automatic and unintentional. Information encoded without attention can be retrieved on implicit tasks (Jacoby et al., 1993). Examples of tasks that measure implicit memory include word identification, word stem or fragment completion, and lexical decision tasks. In each of these tasks, individuals are asked to identify or complete a word without reference to the previous exposure to the word (Roediger, 1990; Schacter, 1987). Memory is shown by an advantage for items previously studied as compared to new (unstudied) items. Williams et al. predict that individuals experiencing feelings of anxiety will exhibit a positive bias for threat-related information on implicit tasks as compared to neutral (or positive) information due to the automatic encoding bias for this information, but no such difference is predicted for explicit memory tasks.

Overall, attempts to support this prediction with adult studies examining the role of attentional bias in implicit and explicit memory for individuals who suffer from symptoms of anxiety have provided mixed results. In one such study, Mathews et al. (1989) tested explicit and implicit memory bias using participants who were diagnosed as anxious, recovering from anxiety, and normal controls. Across the three groups of participants, a measure of explicit memory (stem cued recall) did not produce a positive memory bias for threatening words as compared to neutral items. However, when an implicit measure of memory was used (word stem completion), the clinically anxious group showed a trend toward a bias for threatening words. Furthermore, a positive memory bias for non-threatening information was found in the control group. These results suggest a tendency for anxious individuals to implicitly remember threatening information, while non-anxious individuals implicitly remember non-threatening information. Participants in the recovered anxious group presented an implicit memory bias that was similar to participants in the control group.

These findings have been replicated and extended in work by MacLeod and MacLaughlin (1995) examining patients diagnosed with generalized anxiety disorder. MacLeod and

MacLaughlin compared implicit and explicit memory performance for threatening and non-threatening words using a recognition task (explicit) and a tachistoscopic word identification task (implicit). Clinically anxious and control subjects studied words in a Stroop color naming task. Each participant then performed the two tasks with task order counterbalanced across participants. For the recognition task, participants were presented with a set of words containing items that were studied in the Stroop task and new items. Participants were asked to circle items they recognized from the color-naming task. Mean number of items recognized was similar for threat and non-threat words for both participant groups. For the word identification task, words were briefly flashed on a computer screen and participants had to name the word they saw. All participants were more likely to accurately name words they had seen in the Stroop task than new words, but the participant groups differed in word type performance. Identification performance, corrected for studied/unstudied differences, was higher for threat than non-threat words for anxious individuals, but lower for threat than non-threat words for controls.

Despite the supportive evidence provided by Mathews et al. (1989) and MacLeod and McLaughlin (1995), other studies have failed to confirm the finding of an implicit memory bias for threat information in non-clinical adult samples (e.g., Bradley, Mogg, & Williams, 1993; Eysenck & Byrne, 1994; McCabe, 1999; Nugent & Mineka, 1994). Further, Mathews (1994) failed to confirm his own findings in a similar study with generalized anxiety disorder patients. The mixed results may be explained, in part, by the samples used (e.g., clinical vs. non-clinical) or methods employed (e.g., inconsistent study tasks or implicit tasks that may involve conscious retrieval); however, it is unclear why these variables modify the effect. Further studies are needed to investigate these differences and to attempt to generalize Williams et al.'s (1988) theory of attentional processing in anxious individuals.

<u>Anxiety and Memory in Adolescents</u>

One possible generalization of the Williams et al. (1988) theory is to anxiety in youth. Anxiety disorders have been identified as the most prevalent of the psychiatric disorders experienced by children and adolescents (Bernstein & Borchardt, 1991). Despite this, little research has examined the effect of anxiety on memory performance in children. In one of the few studies done, Vandermaas, Hess, and Baker-Ward (1993) examined explicit memory using free recall for an anxiety-producing event – a dental visit. They found that memory performance was poor for older children who experienced high levels of anxiety; whereas, younger children exhibited higher memory for the events when they experienced high levels of anxiety. These memory results for older children are inconsistent with some findings in the adult literature (e.g., Mathews et al., 1989). No comparison was made between threatening and non-threatening memories.

Other studies have investigated implicit/explicit memory differences for neutral (non-threatening) information in non-anxious children. In general, children show improvements in explicit memory abilities with increases in age, but implicit memory for children as young as 3 years of age is comparable to adult levels (see Naito & Komatsu, 1993, for a review). Therefore, children at the youngest ages tested can retrieve information unintentionally, but are unable to intentionally retrieve previous episodes. Despite these consistent findings, there is a paucity of research investigating implicit/explicit differences in children as compared to the abundant number of studies examining such differences in adults. In addition, research with children has primarily been concerned with elementary-age children. Adolescents have rarely been participants in implicit memory studies. Further, implicit memory studies with children have not compared children with different levels of anxiety.

Anxiety and Depression

Another possible reason for the mixed support for the theory of a processing bias for threatening information (Williams et al., 1988) involves the co-occurrence of symptoms of depression. MacLeod and McLaughlin (1995) point out that in addition to higher levels of anxiety, their participants reported higher levels of depression than controls. They suggest that symptoms of depression may serve to moderate the threat bias in implicit memory tasks, because, according to Williams et al., depressive individuals should engage in elaborative and conscious processing during encoding of threatening information. This type of encoding would serve to elevate explicit memory for threat information, but would not benefit implicit memory for threatening items.

In fact, research has shown that there is a considerable overlap between anxiety and depression, especially in children (for reviews, see Brady & Kendall, 1992; D. B. Clark, Smith, Neighbors, Skerlec, & Randall, 1994). Therefore, it is important to use a classification model that can differentiate anxiety from depression. One such model is the tripartite model of anxiety and depression proposed by L. A. Clark and Watson (1991). In this model, negative affect (NA), a general factor of subjective distress (e.g., fear, guilt), is common to both depression and anxiety. Depression is differentiated from anxiety on the basis of positive affect (PA) or pleasurable engagement with the environment; individuals suffering from depression are low on PA, while those who are anxious have “average” levels of PA. Physiological hyperarousal (PH), or the subjective awareness of bodily manifestations of autonomic arousal, differentiates anxiety from depression; those who are anxious are high on PH, but this is not true of persons who are only depressed. There is support for the utility of the tripartite model in both the adult (e.g., D. B. Clark et al. 1994; Watson et al., 1995) and child (e.g., Joiner, Catanzaro, & Laurent, 1996) literature. Findings concerning anxiety-related memory bias reported in the adult literature may be clouded by the absence of control for the comorbidity of reported anxiety and depression symptoms. Few studies examining memory have attempted to differentiate anxiety from depression in a way that would allow them to know whether their findings were the result of anxiety versus depression. This may account for some of the ambiguous findings obtained when examining the effects of anxiety on memory.

The Current Study

The current study extended Williams et al.’s (1988) theory of an encoding bias for anxious individuals to younger subjects by examining implicit and explicit memory bias in adolescents while considering symptoms of both anxiety and depression. Adolescents were chosen as the participants in the current study due to the relative absence of memory studies for this age group. Participants performed a Stroop color-naming task for the study episode. This task has been used in similar studies (Mathews & MacLeod, 1985; Mogg et al., 1989) and is recommended by MacLeod and McLaughlin (1995) as an appropriate encoding task. A recognition task served as the explicit memory task, while implicit memory was tested with a word stem completion task. Word stem completion was the task used in the original Mathews et al. (1989) study and was chosen in the current study in an attempt to generalize their findings to anxious adolescents.

Consistent with Williams et al.'s (1988) theory, we hypothesized that an implicit memory advantage for threat-related words compared to neutral (non-threatening) words would exist for adolescents reporting symptoms of anxiety. Non-anxious controls were expected to show either no implicit memory difference between the two word types or to have an implicit memory bias for neutral words. Both results have been found in previous studies. Mathews et al. (1989) found a neutral bias on word stem completion for non-anxious control subjects, as did MacLeod and McLaughlin (1995) on a word identification task. However, McCabe (1999) found no advantage with low-anxiety-sensitive subjects[1] for either word type on a stem completion task. Additionally, we hypothesized no difference in explicit memory bias for threatening information in both adolescents reporting symptoms of anxiety and those without symptoms. This hypothesis is based on the assumption that anxious individuals encode threatening information without attentional demands or elaborative processing (Williams et al., 1988), which is required for explicit retrieval of information (Jacoby et al., 1993; Toth et al., 1994).

The current study also examined the comorbidity of anxiety and depression in adolescent participants by classifying the anxious participants into anxious only and mixed anxiety and depression groups. Implicit and explicit memory were compared for these groups to determine the role of comorbidity in the memory bias for threatening stimuli.

Method

Participants

Participants were recruited from adolescents attending Grades 9 - 12 at a Midwestern high school. The sample consisted of 18 students who obtained a score that met or exceeded a pre-determined cut-off on an anxiety measure using a multiple gate screening technique described below. An additional 18 students were selected to act as a contrast group. Those in the contrast group were required to have scores on the screening measure that fell within the normal range.

The students who comprised the contrast group were matched on grade and sex; we were not able to obtain exact matches for each participant on ethnic background. Both groups had an equal number of females (n = 9) and males (n = 9). Each group contained 8 ninth graders, 4 tenth graders, 4 eleventh graders, and 2 twelfth graders. Of the students who were selected based on their scores on the anxiety measure, 94% were Caucasian and 6% were Asian. Of the students identified for the control group, 88% were Caucasian, 6% were African American and 6% listed "other" as their ethnic background.

Mood Measures

Children's Depression Inventory (CDI; Kovacs, 1992). The CDI is a self-rated symptom-oriented measure of depression designed for use with children and adolescents. The CDI consists of 27-items, each with three choices, scored 0, 1, or 2. Higher scores on individual items indicate increasing severity. Children are instructed to answer each item in relation to how they have felt during the past two weeks.

The CDI is the most widely used measure of childhood depression (Kazdin, 1990). Reliability for the CDI is good; reliability coefficients range from .71 to .89 (Kovacs, 1992). Additionally, information concerning the validity of the CDI is acceptable. Numerous research studies have been conducted using the CDI in clinical and experimental populations, and its utility has been demonstrated in the identification of depressive symptoms in children (Kovacs, 1992).

Revised Children's Manifest Anxiety Scale (RCMAS; C. R. Reynolds & Richmond, 1985). The RCMAS is a self-rated symptom-oriented measure of trait anxiety designed for use with children and adolescents age 6 to 19 years. The RCMAS consists of 37-items, 28 of which comprise the Total Anxiety score; the other 9 items comprise a Lie subscale. The 28-items that form the Total Anxiety score are divided into three anxiety subscales: Physiological Anxiety, Worry/Oversensitivity, and Social Concerns/Concentration. Children and adolescents are asked to respond *yes* or *no* to the presence of anxiety symptoms; *yes* scores are summed to obtain the raw score for each subscale and the Total Anxiety scale. The Total Anxiety score of the RCMAS is based on a T-score with a mean of 50 and a standard deviation of 10, while subscale scores are based on a scaled score with a mean of 10 and a standard deviation of 3.

Reliability coefficients for the Total Anxiety score range from .79 to .85 based on age (C. R. Reynolds & Paget, 1983). Additionally, information concerning the validity of the RCMAS is acceptable (C. R. Reynolds & Paget, 1983).

Positive and Negative Affect Scale for Children (PANAS-C; Laurent et al., 1999). The PANAS-C is a 27-item measure developed using the PANAS-X (Watson & Clark, 1991). The Negative Affect (NA) scale consists of 15 items and the Positive Affect (PA) scale contains 12 items. Individuals are asked to indicate to what extent they have felt different feelings and emotions within the past few weeks. An individual's responses are based on a 5-point Likert-type scale with options ranging from *very slightly or not at all* to *extremely*.

The psychometric properties of the PANAS-C scales are very similar to those of its adult namesake. Internal consistency reliabilities on the PA scale and NA scale ranged from .87 to .89 and .92 to .94, respectively (Laurent et al., 1999). In addition, the PANAS-C demonstrated good convergent and discriminant validity with existing self-report measures of anxiety and depression in samples of unselected students and in a psychiatric inpatient sample.

Physiological Hyperarousal Scale for Children (PH-C; Laurent, Catanzaro, & Joiner, 1998). The PH-C is an 18-item self-report scale that is used to measure physiological hyperarousal based on the tripartite model of anxiety and depression (L. A. Clark & Watson, 1991). Items were selected using the DSM-IV criteria for anxiety disorders and existing self-report measures of anxiety and include items that specifically refer to physiological aspects of anxiety (e.g., sweaty palms, dry mouth, pounding heart). Individuals are asked to indicate to what degree they have experienced the symptoms listed on a 1 to 5 response scale ranging in severity from *very slightly or not at all* to *extremely*.

Preliminary analyses of the psychometric properties of the PH-C reveal that it is internally consistent; alpha = .87. Also, the scale acted in ways predicted by the tripartite model in a factor analysis with the PANAS-C and correlational comparisons with measures of NA, PA, and PH, suggesting promising validity (Laurent et al., 1998). PANAS-C and PH-C scores were used for classification according to the tripartite model of anxiety and depression (see discussion below).

Memory Tasks

Stroop Study Task. Participants studied target words during a modified emotional Stroop color-naming task. The modified Stroop color-naming task has been used in previous studies examining attention and memory biases (MacLeod & McLaughlin, 1995; Mathews & MacLeod, 1985; Mogg et al., 1989). Threatening and non-threatening words were printed in different colors (e.g., red, blue, green, purple). A list of 110 total words (44 threatening, 44 non-threatening, and 22 practice words) was developed for use in the current study. The words categorized as threatening were taken from Vasey, Daleiden, Williams, and Brown (1995). The same practice words used by Vasey et al. were also included in the current study. Non-threat target words were chosen based on their length as well as the frequency of occurrence in the English language (Kucera & Francis, 1967) such that they were comparable to the threat words chosen from Vasey et al. In addition, the non-threat words were at or below the 6th grade reading level (Carroll, Davies, & Richman, 1971) suggesting that the high school students in the study would be familiar with the words. The 88 target words (threat and non-threat) were divided into two lists, List A (22 threatening, 22 non-threatening) and List B (22 threatening, 22 non-threatening).

Implicit Memory Task: Word-Stem Completion. For the stem completion task, students were given a sheet of paper containing 44 three-letter word-stems (e.g., elb__) and were asked to complete the stem with the first word that came to mind (e.g., elbow). Twenty-two of the word-stems were derived from target words classified as threatening words; 11 of these had been presented during the Stroop task and 11 had not been previously seen (unstudied). The remaining 22 word-stems were derived from non-threatening target words that had either been presented during the Stroop task (11 word stems) or had not previously been seen by the participant (11 word stems). Implicit memory was measured as the difference in target word completion rates between studied and unstudied target words. All word stems presented on the stem completion task were unique to one another and to all words used in the experiment. Each of the 110 target words had a unique three-etter stem. Each stem had at least one other possible completion word besides the target word.

Explicit Memory Task: Word Recognition. For the recognition task, students were given a sheet of paper containing 44 words (threatening and non-threatening) and were asked to circle those words that they remembered from the previous Stroop task. Twenty-two were threatening words; 11 had been presented during the Stroop task while the other words had not previously been seen. The remaining 22 words were taken from non-threatening words that had either been presented during the Stroop task (11 words) or had not previously been seen by the participant (11 words). Explicit memory was measured by the difference between correctly recognized studied words (hits) and false recognition of unstudied words (false alarms).

Procedure

A letter was sent to parents explaining the purpose and procedures involved in order to obtain consent for their teenager to participate in the study. Consent was obtained for 187 students (*M* age = 16.09 years, *SD* = 1.18). The breakdown by grade was as follows: 79 ninth graders, 43 tenth graders, 36 eleventh graders, and 29 twelfth graders. Males composed 49% of the sample; females made up 51% of the sample. The majority of the sample (87%) were Caucasian, 3% were African American, 3% were of Asian descent, 3% were inter-racial, and the remaining 4% identified other ethnic backgrounds (e.g., Hispanic, Middle Eastern). Seventy percent of the sample lived with both biological parents, 13% lived with only their mother, 1% lived with only their father, 6% lived with their mother and stepfather, 5% lived with their father and stepmother, and the remaining 5% reported other living arrangements (e.g., adoptive parents, aunts and uncles).

All 187 students assented to participate in the initial assessment where they completed the CDI, RCMAS, PANAS-C, and PH-C. Screenings took place with groups of 5 - 15, and measures were administered by grade level whenever possible.

Participants completed mood measures for group classification. Primary classification into anxious and mixed groups was determined by a multiple screening technique. At the beginning of the experimental procedure, participants completed the RCMAS. Participants who received a $T \geq 60$ on the total RCMAS or a scaled score ≥ 13 on the Worry subscale of the RCMAS were preliminarily placed in the anxiety group ($n = 34$).[2] The *T*-score cut-off has been used in previous studies to identify students with elevated symptoms of anxiety (e.g., Laurent, Hadler, & Stark, 1994). The Worry scaled score cut-off was used because it measures a key symptom in identifying children and adolescents who suffer from anxiety (Laurent, Landau, & Stark, 1993; Silverman, 1987; Vasey, Crnic, & Carter, 1994). Participants completed the RCMAS a second time after the experimental procedure. Any participants from the anxiety group who also met these criteria on the second administration remained in the anxiety group ($n = 20$).

During the second stage of the study, each continuing student was tested individually in a quiet room seated at a desk across from the experimenter. Each session began with 22 practice trials on the Stroop task using the neutral practice words to ensure that participants understood the task. Students were given a book of 22 practice words, each word presented separately on an individual page, and were asked to read the color of the word and then read the actual word. Participants in this study, similar to the participants in the study conducted by MacLeod and McLaughlin (1995), were asked to say the word after naming the color in order to ensure encoding of the stimulus words.

Next, students were given a book of 44 target words (22 threatening and 22 non-threatening) and were asked to perform the same task of color naming and reading the test word. Each subject received target words from either List A or List B. Half of the students were exposed to words from List A, while half of the students were exposed to words from List B. Participants in the anxious and mixed groups were randomly assigned to receive either List A or B during the Stroop study task. The matched subjects in the control group received the same list as their anxious or mixed partner. All participants received the same 22 practice words before presentation of the 44 target words from List A or B.

Once the students had completed the encoding task (i.e., identifying words by their color and reading the word aloud), they were given a series of nonverbal problem solving tasks to complete in a period of 5 min; participants were not aware of the time limit. The problem solving tasks served as a filler task between the encoding task and the memory task. The problem solving tasks were nonverbal in nature; therefore, interference with studied words was minimal.

After a period of 5 min, the implicit and explicit memory tasks were administered. Each participant received the implicit memory measure first and the explicit memory measure second. This order of presentation was used in an attempt to hide the nature of the implicit task and prevent subjects from intentionally retrieving words from the Stroop task to complete the stems. Due to the nature of the implicit memory task (i.e., memory without conscious retrieval) participants might have been able to determine the nature of the task if they had been given the explicit measure first. The implicit memory task (stem completion) contained word stems to elicit 11 studied threat words (presented during the Stroop encoding task), and 11 studied non-threat words. The other 22 stems on this task elicited words the subject had not studied and were from target words on the study list that the subject had not seen during the encoding task (either A or B). On the explicit memory task (recognition), 11 of the 22 threat words were old (studied); the same was true of the non-threat words. The recognition task also included 22 words the subjects had not seen (also from the list the subject did not study, A or B).

Students were then asked to again complete the CDI, RCMAS, PANAS-C, and PH-C. Once students had completed the self-report questionnaires, they were debriefed concerning the purpose of the study and were allowed to ask questions. As part of the debriefing, students were asked to explain what they perceived to be the purpose of each task that they were asked to complete during the experiment. Students who recognized that the implicit memory task was a memory task were removed from the study, because this awareness may have caused the subjects to retrieve items explicitly during the implicit task.

The 20 students who obtained a *T*-score $\geq$ 60 or a Worry subscale score $\geq$ 13 on the RCMAS during both the first and second stages of the study constituted the anxious group; however, two students who identified the implicit memory task as a memory task were removed, leaving *n* = 18 in the anxious group. As participants in the anxious group were identified, members of the contrast group were selected who matched their anxious group counterpart on grade and gender, but who obtained a *T*-score between 40 - 50 and a scaled score < 13 on the Worry subscale of the RCMAS during the initial screening. Students in the contrast group underwent the same procedures as their matched counterparts in the anxious group. To be retained in the contrast group, students' *T*-scores on the RCMAS had to remain between 40 - 50 and their score on the Worry subscale had to be < 13 at the second administration of the measures.

Because of the extensive literature on the comorbidity of anxiety and depression in youth (e.g., Brady & Kendall, 1992; King, Ollendick, & Gullone, 1991; Seligman & Ollendick, 1998), we were particularly sensitive to scores not only on the RCMAS, but also the CDI. It is not clear that previous adult and child research on attention and memory biases has always dealt with the comorbidity issue, which may explain inconsistent findings. Scores for the total RCMAS, the Worry subscale, and the total CDI for the 36 participants in the study at the initial and subsequent screenings were reviewed. Initial assignment to the anxious group required that students met the RCMAS criteria described above. However, an examination of the CDI scores suggested that the students in the anxious group should be divided into two subgroups: anxious (*n* = 8) and mixed (*n* = 10). The mixed group consisted of students who met the RCMAS criteria at both screenings and obtained a CDI score $\geq$ 19 during at least one screening; members of this group actually obtained CDI scores $\geq$ 15 at both screenings.[3] The members of the anxious group had CDI scores < 15 at both screenings. The scores of the members of the contrast group were consistent across screenings and did not meet the selection criteria for either the anxious or mixed groups.

Inter-rater reliabilities for reproduced words on the implicit memory task and identified words on the explicit memory task were computed using kappa (Cohen, 1960). The kappa statistic was chosen to control for chance agreement when measuring inter-rater reliability. Ten cases were randomly selected from the sample of 36 students to check reliability. Raters were the first and second authors. The kappa for reproduced words on the implicit memory task was .90. The kappa for identified words on the explicit memory task was 1.00.

Results

Descriptive statistics for the anxious, mixed, and contrast groups on each of the self-report measures are presented in Table 1. A repeated measures multivariate analysis of variance (MANOVA) was conducted with Group as a between-subject variable and Time as a within-subject variable using scores from the CDI, RCMAS Total scale, RCMAS Worry subscale, PA and NA scales of the PANAS-C, and PH-C. Results of the MANOVA revealed a significant main effect for the Group variable, Pillai's criterion = 1.41, $F(12, 54) = 10.87$, $p < .001$.[4] The findings of univariate ANOVAs for the measures are reported in Table 1, along with results from post hoc *t*-tests. Because they were used as selection criteria, group differences on the CDI and RCMAS were not unexpected. Results concerning the PANAS-C and PH-C scales were consistent with expectations based on theory. Although the results of the *t*-test analysis of the anxious and control groups' scores on the PH-C at Time 2 indicated that they were statistically similar, the difference approached significance ($p = .06$). No main effect was found for the within-subject variable, Time, Pillai's criterion = 0.08, $F(12, 54) = 0.39$, $p = .88$. The Group x Time interaction also was not significant, Pillai's criterion = 0.35, $F(12, 54) = 0.96$, $p = .50$. An examination of the means reported in Table 1 reveals that scores on each measure remained relatively consistent for each group across time.

Implicit Memory Task Performance

An ANOVA was conducted to examine general completion rates among subject groups (see Table 2). This ANOVA revealed a significant difference in the number of threat-related words produced by the groups, $F(2, 33) = 5.70$, $p < .01$. Specifically, the mixed group produced significantly more threat words than the contrast group, $t(33) = 3.26$, $p < .01$, but did not differ from the anxious group, $t(33) = 1.02$, $p = .32$. Participants in the anxious group produced more threat words than the contrast group. Although the difference in the number of threat-related words produced by the anxious versus contrast groups approached significance, it fell short,

$t(33) = 1.89$, $p = .07$.

To determine whether participants displayed differences in implicit memory, we counted the number of threat-related words that were exactly reproduced or very similar to the stimulus words presented (e.g., worry for worried). This is a common practice when scoring this type of task (e.g., Cloitre, Cancienne, Heimberg, Holt, & Liebowitz, 1995). Memory scores were calculated for each subject by dividing the number of studied target word completions by the total number of threat words. Initial analyses indicated no significant differences between the anxious and mixed groups; therefore, these groups were combined to add power to the main analysis of memory performance. The mean target word completion rates for threat and non-threat words are presented in Table 3.

An ANOVA on the memory scores revealed no significant difference in implicit memory for threat and non-threat target words, $F(1, 34) = 0.35$, $p = .67$, $\eta^2 = .006$. There was also no significant main effect of group (anxious or contrast), $F(1,34) = .40$, $p = .53$, $\eta^2 = .012$, and no significant word type by group interaction, $F(1,34) = .76$, $p = .43$, $\eta^2 = .002$. Therefore, none of the groups exhibited higher memory performance for threat or non-threat target words. However, subjects showed implicit memory for both word types. Studied target word completion was higher than unstudied target word completion for both threat target words, $t(35) = 2.15$, $p = .04$, and non-threat target words, $t(35) = 2.45$, $p = .02$.

Together, these findings suggest that those students in the mixed and anxious groups generally had a propensity for completing word stems with threatening words compared to the contrast group. However, there was no difference in any groups' ability to reproduce the threat words to which they had been previously exposed. The implicit memory bias that was expected was not found, but a bias toward producing threat-related words was revealed.

Explicit Memory Task Performance

We examined the total number of threat words that students circled on the word recognition task to determine whether differences existed between the groups (see Table 2). This was done by summing the studied and unstudied words. The ANOVA conducted using the total threat words circled revealed differences between the groups, $F(2, 33) = 5.31$, $p = .01$. The mixed group circled more threat words than either the anxious or contrast groups, $t(33) = 2.69$, $p = .01$ and $t(33) = 2.99$, $p < .01$, respectively. The anxious and contrast groups did not differ in terms of the number of threat words circled, $t(33) = 0.23$, $p = .82$.

A memory index was calculated by subtracting "false alarms" (circled unstudied words) from "hits" (circled studied words). Consistent with the implicit memory task data, no differences were found between the anxious and mixed groups in initial analyses; therefore, data for these groups were combined to add power to the main analysis conducted. The means for number of words circled for each group are presented in Table 3.

An ANOVA was conducted using the explicit memory index scores to determine whether differences existed between the two groups. No significant main effects were found for either word type, $F(1,34) = .09$, $p = .76$, $\eta^2 = .003$, or group, $F(1,34) = .16$, $p = .70$, $\eta^2 = .005$. Further, no interaction between word type and group was evident, $F(1,34) = .57$, $p = .45$, $\eta^2 = .017$. As with the stem completion task, no memory bias for threat-related words was demonstrated for the recognition task. However, subjects did display explicit memory for both word types. A comparison of the hits and false alarms was significant for both threat target words, $t(35) = 8.50$, $p < .001$, and non-threat words, $t(35) = 7.61$, $p < .001$.

These findings suggest that the anxious group (especially the mixed group) may be predisposed to respond to threat words, reporting that they recognized words that they had not previously seen. The results also demonstrate the importance of subtracting false alarms to establish a baseline for determining the actual influence of memory. As noted above, these differences are not found when a correction is made for the higher number of unstudied words that the anxious or mixed groups circled.

Discussion

This study examined the relationship between symptoms of anxiety and implicit (unconscious) and explicit (conscious) memory in adolescents. Students were identified using scores from the RCMAS and CDI, and subsequently classified as anxious or mixed anxious and depressed. Students matched on gender and grade acted as a contrast group. We found that on the implicit memory task (i.e., word-stem completion) the mixed group produced significantly more threat-related words than the anxious or contrast groups. The anxious group produced more threat words than the contrast group, although the difference was not statistically significant. However, in terms of actually remembering previously seen or studied words and reproducing them, there were no statistical differences between the three groups. In other words, no group demonstrated a difference in implicit memory for threat words.

These results were not consistent with predictions based on theory. It was expected that those adolescents experiencing symptoms of anxiety would exhibit a positive bias for threat-related information, which in turn would magnify the priming of threat-related information, and result in an implicit memory for such information (Beck & Emery, 1985; Ingram & Kendall, 1986; Williams et al., 1988). However, there was no difference among the groups in their implicit memory for threatening information. All groups demonstrated similar abilities on the implicit memory task. There are adult studies that support an implicit memory bias in individuals who suffer from symptoms of anxiety (Amir, McNally, Riemann, & Clements, 1996; MacLeod & McLaughlin, 1995; Mathews et al., 1989). Studies that consistently find support for an implicit memory bias have used panic disordered and PTSD samples (Amir, McNally, & Wiegartz, 1996; Cloitre & Liebowitz, 1991; McNally, Foa, & Donnell, 1989; McNally, Hornig, Otto, & Pollack, 1997; Zeitlin & McNally, 1991). Other studies using samples experiencing other forms of anxiety either have not found an implicit memory bias for anxiety-congruent information or report inconclusive findings (Bradley, Mogg, & Williams,1993; Bradley, Mogg, & Williams, 1995; Cloitre et al., 1995; Dalgleish, 1994; Eysenck & Byrne, 1994; Foa, McNally, & Murdock, 1989; McCabe, 1999; Mogg, Mathews, & Weinman, 1987; Mogg et al., 1989; Nugent & Mineka, 1994). Our study is consistent with the latter group.

Participants were also compared on an explicit memory task involving word recognition. All groups recognized more words (threat and non-threat) that were presented during the memory task than words that were not previously viewed. We also found that all groups recognized previously viewed threat words more often than previously viewed non-threat words; this difference was statistically significant for the mixed and anxious groups. When considering the total number of threat words students indicated they recognized, whether they were accurate (i.e., hits) or not (i.e., false alarms), the mixed group had more words recognized than either the anxious or contrast groups; the latter two groups did not differ from one another. It is interesting that the mixed group, the only group that had an elevated level of depressive symptoms based on their CDI scores, indicated that they recognized more total threat words than the other groups. In other words, this group recognized or circled more threat words than they possibly could have given the memory task. Those who have found an explicit memory bias among adults who reported depression suggest that these individuals tend to use elaborative processes that lead them to dwell on threat or negative words (Watkins, Mathews, Williamson, & Fuller, 1992). We may have seen this process working to some extent in the mixed group. Nevertheless, the explicit memory index, which corrected for guessing, was not significantly different for any of the groups. The fact that we did not find a significant difference in explicit memory bias among our groups was expected based on previous research with adults that suggests that processing occurs outside of conscious awareness (e.g., MacLeod & MacLaughlin, 1995; Mathews et al., 1989). It is worth noting, however, that others have reported an explicit memory bias for adults with elevated anxiety sensitivity (McCabe, 1999).

When considering why we did not find the implicit memory bias for threat-related information that would be predicted based on cognitive theories of anxiety, our attention turned to how participants were identified. Common self-report measures of childhood anxiety and depression were used, and standard cut-off criteria were employed. Even using multiple screenings, the issue of lack of discriminative validity that has been raised concerning these measures continued to exist (e.g., Brady & Kendall, 1992; Wolfe et al., 1987). If the measures we used in constituting our groups were fallible, perhaps our anxious group was not anxious, and our inability to find support for an implicit memory bias represented inaccurate measurement rather than poor theory. Because we had measures consistent with the tripartite model we could examine, at least on a superficial level, what would happen if an alternative identification procedure had been used.

Remember, the differences on the PA and NA scales of the PANAS-C and the PH-C were largely consistent with predictions based on the tripartite model for our groups constituted using traditional self-report measures. However, we asked what would have happened had we used the tripartite model to identify groups? To examine this question, we determined the means and standard deviations for the tripartite-related scales using all 187 adolescents who completed these measures: PA scale $M = 42.08$ ($SD = 8.83$), NA scale $M = 27.66$ ($SD = 9.57$), PH-C $M = 29.14$ ($SD = 8.52$). We used the means and one standard deviation above (NA scale and PH-C) or below (PA scale) the mean in determining cut-offs. Based on these criteria, to be identified as anxious, a student would have to obtain a PA raw score > 33, a NA raw score $\geq$ 37, and a PH-C raw score $\geq$ 38. To be identified as depressed, a student would have to obtain a PA score $\leq$ 33, a NA score $\geq$ 37, and a PH-C score < 38. To be identified as experiencing both anxiety and depression (i.e., mixed), an adolescent would need to obtain a PA score $\leq$ 33, a NA score $\geq$ 37, and a PH-C score $\geq$ 38. To be considered absent of anxiety and depression, a participant would obtain a PA score > 33, a NA score < 37, and a PH-C score < 38. Table 4 presents changes in group membership that would occur if tripartite measures had been used for identification purposes.

Using a tripartite classification strategy, only 1 of the 8 students in the current anxious group would have been identified as anxious, and only half of the members of the current mixed group would have continued in that group. This raises an important question not only about the current study but about previous studies as well. Could the equivocal results in the literature be due to the way in which individuals were classified? It may be that studies that have used traditional paper-and-pencil self-report measures of anxiety and depression in identifying groups, such as our study, have not accurately identified or grouped individuals. Inaccurate identification makes it difficult, if not impossible, to fairly test hypotheses about memory bias.

One way around this issue would be to use structured diagnostic interviews. Although this may be desirable, it may also be impractical in non-clinical settings such as schools. A more promising solution may be to use tripartite-based measures that are more sensitive to the diagnostic issues surrounding anxiety and depression such as the PANAS (Watson, Clark, & Tellegen, 1988), Mood and Anxiety Symptom Questionnaire (MASQ; Watson et al., 1995), or their youth equivalents (e.g., PH-PANAS-C; Laurent et al., 1998, 1999).

Alternatively, a future study could use a clinical sample in examining memory bias among adolescents. It could be argued that because the adolescents with elevated symptoms of anxiety in this study were not recruited from a clinical population, they did not suffer severe enough symptoms of anxiety to produce an implicit memory bias for threat-related information. However, when a comparison was made between the participants in this study with those in adult studies who were clinically diagnosed with an anxiety disorder (e.g., MacLeod & McLaughlin, 1995; Mathews et al., 1989) there were little or no differences in the self-reported symptoms of anxiety or depression. Nevertheless, level of anxiety may be an important variable in finding the memory bias effects predicted by theory.

Another potential avenue for future study relates to the nature of the memory tasks. The work of Roediger (1990) and Schacter (1987) suggests that there are two types of information processing, perceptual and meaning-based, that are components of both implicit and explicit memory. Recall and recognition tasks are examples of explicit meaning-based memory measures, while word-stem completion tasks are implicit perceptual memory measures. Building on this view, Blaxton (1989) developed memory tasks that provided perceptual explicit information and meaning-based implicit information. The explicit perceptual task developed by Blaxton (1989) is a graphemic cued-recall test which asks participants to look at new words that are visually and phonetically similar to previously presented words and use this information to recall the previously presented words (e.g., sat as a cue for sad). The implicit meaning-based task is a general knowledge test that asks participants to answer general trivia-like questions in order to measure implicit memory for previously presented words (e.g., “What happened to the character Harry in the 1998 season finale of the television show Third Rock from the Sun?” as a conceptual priming question for the previously presented word “kidnapped”). The current study used a perceptual implicit memory task (word-stem completion) and a meaning-based explicit memory task (recognition). Roediger (1990) has suggested that the assessment of implicit memory as well as explicit memory will differ based on the type (perceptual vs. meaning-based) of memory task employed.

Following this line of reasoning, Daleiden (1998) examined the memory processes of children using both perceptual and meaning-based implicit and explicit measures. He found that memory for negative information on memory tasks (implicit vs. explicit) was dependent on the type of processing task required (perceptual vs. meaning-based). He also found no difference between low and high anxious children on perceptual memory tasks (implicit and explicit). Our findings were consistent with Daleiden’s in this respect; there was no significant difference between the anxious, mixed, and contrast participants’ memory for threatening information on an implicit perceptual memory task.

However, Daleiden did find a difference between low and high anxious children on meaning-based tasks. High anxious children exhibited a memory bias for negative information when meaning-based tasks (implicit and explicit) were used as measures of memory. Thus, children who suffered from symptoms of anxiety exhibited a memory bias for negative information on meaning-based tasks whether the task was measuring implicit or explicit memory. As with several previous studies (Bradley et al., 1993, 1995; Cloitre et al., 1995; Dalgleish, 1994; Eysenck & Byrne, 1994; Foa et al., 1989; Mogg et al., 1987, 1989; Nugent & Mineka, 1994), an implicit perceptual memory task was used in the current study to measure memory bias rather than an implicit meaning-based task. This difference in approaches to measuring implicit memory may explain, in part, why the current study and others found no implicit memory bias or inconclusive support for an implicit memory bias. Perhaps, an implicit memory bias for threatening information may only be measured by using an implicit meaning-based task, and not an implicit perceptual task.

Furthermore, Daleiden’s (1998) research suggests that the mode of processing information (perceptual vs. meaning-based) may be more important in the remembering of threatening information than the type of memory system (implicit vs. explicit). Thus, the ability to remember threatening information is related to the meaning an individual places on the information and how it is remembered, whether consciously or unconsciously.

Others also have highlighted important considerations when measuring implicit memory. For example, Jacoby and colleagues (Jacoby, 1991; Jacoby et al., 1993) have suggested that indirect methods of testing implicit memory, such as word-stem completion, often are not pure measures because they may involve both conscious and automatic processes. In other words, aspects of explicit memory may influence this implicit memory task. Future research should examine implicit and explicit memory tasks that are both perceptual and meaning-based. This would provide a clearer picture as to the way in which threatening information is processed and how individuals remember it. Clearly, it is important to carefully choose implicit and explicit memory tasks to optimize the ability to test theory-based hypotheses of memory bias.

The current study has several limitations that should be noted. For example, it is possible that the manner in which the information was presented had an impact on the results of this study. The participants were presented with words printed on sheets of paper where they had to read the color of the word and the word itself. Thus, the length of time the participants were exposed to each individual word was variable and dependent on the length of time it took them to read. Computer presentation of the words with fixed time exposure for each presented word would provide more control over the presentation of stimuli as well as the memory tasks given participants. Future research examining memory in children and adolescents may benefit from a more controlled presentation of stimuli such as that used in the research examining memory bias in adults (e.g., MacLeod & McLaughlin, 1995; Mathews et al., 1989).

In addition, we note that the number of participants in each group was relatively small. At the same time, we point out that these numbers were similar to other studies conducted in the adult and child literatures (e.g., Lang & Craske, 1997; Vasey et al.,1995; Vasey, El-Hag, & Daleiden, 1996). Also, the sample represented a fairly homogeneous population of adolescents. A larger, more diverse sample may have produced different results, as may a clinical (e.g., outpatient, inpatient) sample. In addition, future research with adolescents should investigate memory when different types of words are used. Although not a component of this study, some research has used separate physical threat and social threat words to measure a difference in memory based on the type of anxiety experienced by the individual. Also, positive words have been used as well as neutral and threat words to determine if memory is based on the emotionality of the word and not the content of the word. Finally, in addition to the use of different types of words, research examining memory bias for threatening information could use scenarios to examine memory for details and meaning-based information.

In summary, our findings add to the equivocal results others have reported concerning memory bias and anxiety. We found that students in our anxious and mixed groups produced or (inaccurately) identified more threat words than the contrast group, suggesting that adolescents experiencing elevated levels of anxiety may have a general tendency to view their environment as more threatening. However, we did not find the implicit memory bias predicted by theory. We did find a lack of explicit memory bias, consistent with theory and previous research with adults. Finally, we highlighted issues concerning samples and measuring memory that future investigators should consider. Until researchers address these issues, it will be difficult to provide a truly fair test of whether memory bias exists among adolescents with elevated levels of anxiety.

References

Amir, N., McNally, R. J., Riemann, B. C., & Clements, C. (1996). Implicit memory bias for threat in panic disorder: Application of the "white noise" paradigm. Behaviour Research and Therapy, 34, 157-162.

Amir, N., McNally, R. J., & Wiegartz, P. S. (1996). Implicit memory bias for threat in post-traumatic stress disorder. Cognitive Therapy and Research, 20, 625-635.

Beck, A. T. (1971). Cognition, affect, and psychopathology. Archives of General Psychiatry, 24, 495-500.

Beck, A. T. (1976). Cognitive therapy and the emotional disorders. Madison, CT: International Universities Press, Inc.

Beck, A. T., & Clark, D. A. (1997). An information processing model of anxiety: Automatic and strategic processes. Behaviour Research and Therapy, 35, 49-58.

Beck, A. T., & Emery, G. (1985). Anxiety disorders and phobias: A cognitive perspective. New York, NY: Basic Books, Inc.

Bernstein, G. A., & Borchardt, C. M. (1991). Anxiety disorders of childhood and adolescence: A critical review. Journal of the American Academy of Child and Adolescent Psychiatry, 30, 519-532.

Blaxton, T. A. (1989). Investigating dissociations among memory measures: Support for a transfer appropriate processing framework. Journal of Experimental Psychology: Learning, Memory and Cognition, 15, 657-668.

Bradley, B. P., Mogg, K., & Williams, R. (1993). Implicit and explicit memory for emotional information in non-clinical subjects. Behaviour Research and Therapy, 32, 65-78.

Bradley, B. P., Mogg, K., & Williams, R. (1995). Implicit and explicit memory for emotion-congruent information in clinical depression and anxiety. Behaviour Research and Therapy, 33, 755-770.

Brady, E. U., & Kendall, P. C. (1992). Comorbidity of anxiety and depression in children and adolescents. Psychological Bulletin, 11, 244-255.

Carroll, J. B., Davies, P., & Richman, B. (1971). Word frequency book. New York, NY: American Heritage.

Clark, D. B., Smith, M. G., Neighbors, B. D., Skerlec, L. M., & Randall, J. (1994). Anxiety disorders in adolescence: Characteristics, prevalence, and comorbidities. Clinical Psychology Review, 14, 113-137.

Clark, L. A., & Watson, D. (1991). Tripartite model of anxiety and depression: Psychometric evidence and taxonomic implications. Journal of Abnormal Psychology, 100, 316-336.

Cloitre, M., Cancienne, J., Heimberg, R. G., Holt, C. S., & Liebowitz, M. (1995). Memory bias does not generalize across anxiety disorders. Behaviour Research and Therapy, 33, 305-307.

Cloitre, M., & Liebowitz, M. R. (1991). Memory bias in panic disorder. Journal of Abnormal Psychology, 103, 396-399.

Cohen, J. (1960). A coefficient of agreement for nominal scales. Educational and Psychological Measurement, 20, 37-46.

Daleiden, E. L. (1998). Childhood anxiety and memory functioning: A comparison of systemic and processing accounts. Journal of Experimental Child Psychology, 68, 216-235.

Daleiden, E. L., & Vasey, M. W. (1997). An information-processing perspective on childhood anxiety. Clinical Psychology Review, 17, 407-429.

Dalgleish, T. (1994). The relationship between anxiety and memory biases for material that has been selectively processed in a prior task. Behaviour Research and Therapy, 32, 227-231.

Eysenck, M. W., & Byrne, A. (1994). Implicit memory bias, explicit memory bias, and anxiety. Cognition and Emotion, 8, 415-431.

Foa, E. B., McNally, R., & Murdock, T. B. (1989). Anxious mood and memory. Behaviour Research and Therapy, 27, 141-147.

Ingram, R. E., & Kendall, P. C. (1986). Information processing approaches to clinical psychology. Orlando, Florida: Academic Press.

Ingram, R. E., & Kendall, P. C. (1987). The cognitive side of anxiety. Cognitive Therapy and Research, 11, 523-536.

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic and intentional uses of memory. Journal of Memory and Language, 30, 513-541.

Jacoby, L. L., Toth, J. P., & Yonelinas, A. P. (1993). Separating conscious and unconscious influences of memory: Measuring recollection. Journal of Experimental Psychology: General, 122, 139-154.

Joiner, T. E., Jr., Catanzaro, S. J., & Laurent, J. (1996). The tripartite structure of positive and negative affect, depression, and anxiety in child and adolescent psychiatric inpatients. Journal of Abnormal Psychology, 105, 401-409.

Kazdin, A. E. (1990). Assessment of childhood depression. In A. M. LaGreca (Ed.), Through the eyes of the child: Obtaining self-reports from children and adolescents (pp. 189-233). Boston: Allyn and Bacon.

Kendall, P. C., & Ingram, R. E. (1987). The future for cognitive assessment of anxiety: Let's get specific. In L. Michelson & L. M. Ascher (Eds.), Anxiety and stress disorders: Cognitive-behavioral assessment and treatment (pp. 89-104). New York: Guilford Press.

King, N. J., Ollendick, T. H., & Gullone, E. (1991). Negative affectivity in children and adolescents: Relations between anxiety and depression. Clinical Psychology Review, 11, 441-459.

Kovacs, M. (1992). Children's Depression Inventory manual. New York: Multi-Health Systems, Inc.

Kucera, H., & Francis, W. N. (1967). Computational analysis of present-day American English. Providence, RI: Brown University Press.

Lang, A. J., & Craske, M. G. (1997). Information processing in anxiety and depression. Behaviour Research and Therapy, 35, 451-455.

Laurent, J., Catanzaro, S. J., & Joiner, T. E., Jr. (1998, April/May). A child measure of the tripartite model: Initial development and validation of the Physiological Hyperarousal-Positive and Negative Affect Scale for Children. In S.J. Catanzaro (Chair), The tripartite model of anxiety and depression: Current research and future prospects. Symposium conducted at the 70th Annual

Meeting of the Midwestern Psychological Association, Chicago, IL.

Laurent, J., Catanzaro, S. J., Joiner, T. E., Jr., Rudolph, K. D., Potter, K. I., Lambert, S., Osborne, L., & Gathright, T. (1999). A measure of positive and negative affect for children: Scale development and validation. Psychological Assessment, 11, 326-338.

Laurent, J., Hadler, J. R., & Stark, K. D. (1994). A multiple-stage screening procedure for the identification of childhood anxiety disorders. School Psychology Quarterly, 9, 239-255.

Laurent, J., Landau, S., & Stark, K.D. (1993). Conditional probabilities in the diagnosis of depressive and anxiety disorders in children. School Psychology Review, 22, 98-114.

MacLeod, C., & Mathews, A. (1991). Biased cognitive operations in anxiety: Accessibility of information or assignment of processing priorities. Behaviour Research & Therapy, 29, 599-610.

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. Journal of Abnormal Psychology, 95, 15-20.

MacLeod, C., & MacLaughlin, K. (1995). Implicit and explicit memory bias in anxiety: A conceptual replication. Behaviour Research and Therapy, 33, 1-14.

Mathews, A. (1994). Anxiety and the processing of emotional information. In L. Chapman & D. Fowles (Eds.) Progress in experimental personality and psychopathology research. New York: Springer.

Mathews, A., & MacLeod, C. (1985). Selective processing of threat cues in anxiety states. Behaviour Research and Therapy, 23, 563-569.

Mathews, A., & MacLeod, C. (1986). Discrimination of threat cues without awareness in anxiety states. Journal of Abnormal Psychology, 95, 131-138.

Mathews, A., Mogg, K., May, J, & Eysenck, M. (1989). Implicit and explicit memory bias in anxiety. Journal of Abnormal Psychology, 98, 236-240.

McCabe, R. E. (1999). Implicit and explicit memory for threat words in high- and low-anxiety-sensitive participants. Cognitive Therapy and Research, 23, 21-38.

McNally, R. J., Foa, E. B. & Donnell, C. D. (1989). Memory bias for anxiety information in patients with panic disorder. Cognition and Emotion, 3, 27-44.

McNally, R. J., Hornig, C. D., Otto, M. W., & Pollack, M. H. (1997). Selective encoding of threat in panic disorder: Application of a dual priming paradigm. Behaviour Research and Therapy, 35, 543-549.

Mogg, K., Mathews, A., & Weinman, J. (1987). Memory bias in clinical anxiety. Journal of Abnormal Psychology, 96, 94-98.

Mogg, K., Mathews, A., & Weinman, J. (1989). Selective processing of threat cues in anxiety states: A replication. Behaviour Research and Therapy, 27, 317-323.

Naito, M., Komatsu, S. (1993). Processes involved in childhood development of implicit memory. In P. Graf & M. E. J. Masson (Eds.) Implicit memory: New directions in cognition, development, and neuropsychology (pp. 231-260). NJ: Erlbaum.

Nugent, K., & Mineka, S. (1994). The effect of high and low trait anxiety on implicit and explicit memory tasks. Cognition and Emotion, 8, 147-163.

Peterson, R. A., & Reiss, S. (1992). Anxiety Sensitivity Index revised test manual (2nd ed.) Worthington, OH: IDS.

Reynolds, C. R., & Paget, K. D. (1983). National normative and reliability data for the Revised Children's Manifest Anxiety Scale. School Psychology Review, 12, 324-336.

Reynolds, C. R., & Richmond, B. O. (1985). Manual for the Revised Children's Manifest Anxiety Scale. Los Angeles: Western Psychological Services.

Reynolds, W. M. (1986). A model of screening and identification of depressed children and adolescents in school settings. Professional School Psychology, 1, 117-129.

Roediger, H. L. (1990). Implicit memory: Retention without remembering. American Psychologist, 45, 1043-1056.

Schacter, D. L. (1987). Implicit memory: History and current status. Journal of Experimental Psychology: Learning, Memory, and Cognition, 13, 501-518.

Seligman, L. D., & Ollendick, T. H. (1998). Comorbidity of anxiety and depression in children and adolescents: An integrative review. Clinical Child and Family Psychology Review, 1, 125-144.

Silverman, W.K. (1987). Childhood anxiety disorders: Diagnostic issues, empirical support, and future research. Journal of Child and Adolescent Psychotherapy, 4, 121-126.

Tabachnick, B. G., & Fidell, L. S. (1989). Using multivariate statistics (2nd ed.). New York: Harper Collins.

Toth, J. P., Reingold, E. M., & Jacoby, L. L. (1994). Toward a redefinition of implicit memory: Process dissociations following elaborative processing and self-generation. Journal of Experimental Psychology: Learning, Memory, and Cognition, 20, 290-303.

Vandermass, M. O., Hess, T. M., & Baker-Ward, L. (1993). Does anxiety affect children's reports of memory for a stressful event? Applied Cognitive Psychology, 7, 109-127.

Vasey, M. W., Crnic, K. A., & Carter, W. G. (1994). Worry in childhood: A developmental perspective. Cognitive Therapy and Research, 18, 529-549.

Vasey, M. W., Daleiden, E. L., Williams, L. L., & Brown, L. M. (1995). Biased attention in childhood anxiety disorders: A preliminary study. Journal of Abnormal Child Psychology, 23, 267-279.

Vasey, M. W., El-Hag, N., & Daleiden, E. L. (1996). Anxiety and the processing of emotionally threatening stimuli: Distinctive patterns of selective attention among high- and low-test-anxious children. Child Development, 67, 1173-1185.

Watkins, P. C., Mathews, A., Williamson, D. A., & Fuller, R. D. (1992). Mood-congruent memory in depression: Emotional priming or elaboration? Journal of Abnormal Psychology, 101, 581-586.

Watson, D., & Clark, L. A. (1991). The PANAS-X: Preliminary manual for the Positive and Negative Affect Schedule - Expanded Form. Unpublished manuscript, Southern Methodist University, Dallas, TX.

Watson, D., Clark, L. A. & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. Journal of Personality and Social Psychology, 54, 1063-1070.

Watson, D., Weber, K., Assenheimer, J. S., Clark, L.A., Strauss, M. E., & McCormick, R. A. (1995). Testing a tripartite model: Evaluating the convergent and discriminant validity of anxiety and depression symptom scales. Journal of Abnormal Psychology, 104, 3-14.

Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathew, A. (1988) Cognitive psychology and emotional disorders. Chichester, England: John Wiley & Sons Ltd.

Wolfe, V. V., Finch Jr., A. J., Saylor, C. F., Blount, R. L, Pallmeyer, T. P. & Carek, D. J. (1987). Negative affectivity in children: A multitrait-multimethod investigation. Journal of Consulting and Clinical Psychology, 55, 245-250.

Zeitlin, S. B., & McNally, R. J. (1991). Implicit and explicit memory bias for threat in post-traumatic stress disorder. Behaviour Research and Therapy, 29, 451-457.

Footnotes

[1] In the McCabe (1999) study, anxiety classification was based on a low score on the Anxiety Sensitivity Index (Peterson & Reiss, 1992).

[2] Although not the focus of this study, students who only obtained a CDI raw score $\geq$ 19 were screened a second time per the suggestion of W. M. Reynolds (1986). Students who obtained a T-score $\geq$ 60 on the RCMAS Total scale or a scaled score $\geq$ 13 and a raw score $\geq$ 19 on the CDI (n = 5) continued in the study. The parents of those students who continued to obtain a score above the designated cut-offs at the second screening were notified and provided information regarding community agencies that they might contact for further evaluation of their teenager's emotional functioning.

[3] Kovacs (1992) provides an extensive discussion of the effects of using different raw score cut-offs on the CDI. Using a CDI raw score of 15 at both screenings may represent a more liberal approach to identifying students who may be depressed, but provided some assurance that the Anxious group was less influenced by depression.

[4] Pillai's criterion was used rather than Hotellings' statistic or Wilk's lambda because of its robustness. As Tabachnick and Fidell (1989) note, "as sample size decreases, unequal *n*'s appear, and the assumption of homogeneity of variance-covariance matrices is violated, the advantage of Pillai's criterion in terms of robustness is more important" (p. 399).

Table 1

Means and Standard Deviations for Self-Report Symptom Measures

	Anxious (n = 8)		Mixed (n = 10)		Contrast (n = 18)				
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*	*t*	Comparisons
Time 1									
RCMAS - Total	61.87	3.48	69.20	4.47	43.33	4.14	143.51	3.76***, 10.63***, 15.97***	M > A > C
RCMAS - Worry	13.88	1.55	14.70	1.34	7.33	2.28	60.56	0.91, 8.04***, 9.76***	A = M > C
CDI	11.00	2.00	20.00	6.39	6.17	3.67	32.50	4.36**, 2.62*, 8.06***	M > A > C
PA	38.13	3.91	32.00	5.52	42.61	7.10	9.01	2.05*, 1.72, 4.23***	M < A = C
NA	34.63	7.03	48.33	8.72	24.44	7.43	29.21	3.67***, 3.12**, 7.61***	M > A > C
PH	33.50	7.13	44.30	8.72	26.89	7.24	16.65	2.98**, 2.03*, 5.77***	M > A > C
Time 2									
RCMAS - Total	61.62	4.47	70.00	5.14	42.17	5.36	105.58	3.45**, 8.94***, 13.77***	M > A > C
RCMAS - Worry	14.00	1.41	15.00	2.05	7.44	1.89	67.43	1.14, 8.36***, 10.38***	A = M > C
CDI	9.25	2.82	22.80	5.59	6.56	4.22	45.32	6.49***, 1.44, 9.36***	M > A = C
PA	39.75	5.87	32.60	5.78	41.59	8.29	5.09	2.10*, 0.60, 3.15**	M > A = C

(table continues)

Table 1 (cont'd.)

	Anxious (*n* = 8)		Mixed (*n* = 10)		Contrast (*n* = 18)				
	M	*SD*	*SD*	*M*	*SD*	*M*	*F*	*t*	Comparisons
NA	32.25	7.92	49.70	7.38	21.76	3.87	67.27	6.09***, 4.05***, 11.60***	M > A > C
PH	31.38	9.58	44.00	11.21	25.00	3.65	19.17	3.42**, 1.93, 6.19***	M > A = C

Note. RCMAS - Total = Revised Children's Manifest Anxiety Scale Total scale *T* - score, RCMAS - Worry = Revised Children's Manifest Anxiety Scale Worry subscale scaled score, CDI = Children's Depression Inventory raw score, PA = Positive Affect scale of the PANAS-C, NA = Negative Affect scale of the PANAS-C, PH-C = Physiological Hyperarousal Scale for Children. All univariate *F*s have 2, 33 degrees of freedom and $p < .001$, except Time 2 PA where $p < .05$. The *t*-values have 33 degrees of freedom, are reported as absolute values, and are presented in the following order: Anxious - Mixed, Anxious - Contrast, Mixed - Contrast. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 2

Performance on Memory Tasks – 3 Groups

	Anxious (n = 8)		Mixed (n = 10)		Contrast (n = 18)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Implicit Memory Task (Word-Stem Completion)						
Total Threat Words	12.63	3.16	13.80	1.75	10.67	2.40
Studied Threat Words	5.75	1.83	5.20	1.03	5.11	1.57
Proportion Studied	0.45		0.38		0.48	
Explicit Memory Task (Word Recognition)						
Threat						
Studied Words	4.63	2.39	6.80	2.49	4.89	2.30
Unstudied Words	1.63	1.30	3.40	1.84	1.67	1.28
Memory Index	3.00		3.40		3.22	
Non-Threat						
Studied Words	2.88	2.85	4.10	2.02	4.61	2.57
Unstudied Words	0.88	1.46	0.60	0.70	1.22	1.86
Memory Index	2.00		3.50		3.39	

Note. Total Threat Words = all threat words produced on the implicit memory task; Proportion Studied = the proportion of threat words that were reproduced from original stimuli presented relative to all threat words produced. The explicit memory index is the difference between the previously seen words (studied) and words that participants said they recognized but were not previously seen (unstudied).

Table 3

Performance on Memory Tasks – 2 Groups

	Anxious (*n* = 18)		Contrast (*n* = 18)	
	M	*SD*	*M*	*SD*
Implicit Memory Task (Word-Stem Completion)				
Studied (Hits)				
Threat Words	5.44	1.42	5.11	1.57
Non-threat Words	3.39	1.61	2.78	1.66
Unstudied (False Alarms)				
Threat Words	5.06	1.21	3.89	1.53
Non-threat Words	2.33	1.50	1.78	1.17
Proportion Studied – Threat	.52		.57	
Proportion Studied – Non-Threat	.59		.61	
Explicit Memory Task (Word Recognition)				
Studied (Hits)				
Threat Words	5.83	2.62	4.89	2.30
Non-threat Words	3.56	2.43	4.61	2.57
Unstudied (False Alarms)				
Threat Words	2.61	1.82	1.67	1.28
Non-threat Words	.72	1.07	1.22	1.86
Memory Index – Threat	3.22		3.22	
Memory Index – Non-Threat	2.84		3.39	

Note. For the stem completion task, means are number of target words subjects used to complete the stems. For the recognition task, means are number of words circled.

Table 4

Reclassification of Group Membership Using the Tripartite Model Measures

	Tripartite Measures						
	Anxious	Depressed	Mixed	High NA	LowPA	High PH	Average
Traditional Measures							
Anxious (*n* = 8)	1			2	1		4
Mixed (*n* = 10)	1	1	5	3			
Contrast (*n* = 18)					2		16

Note. NA = Negative Affect, PA = Positive Affect, PH = Physiological Hyperarousal. Traditional measures are based on scores from the Revised Children's Manifest Anxiety Scale (RCMAS) and Children's Depression Inventory (CDI): Anxious = RCMAS Total $\geq$ 60 and/or Worry $\geq$ 13 and CDI < 15; Mixed = RCMAS Total $\geq$ 60 and/or Worry $\geq$ 13 and CDI $\geq$ 15; Tripartite measures are based on scores from the Positive and Negative Affect Scale for Children (PANAS-C) and the Physiological Hyperarousal Scale for Children (PH-C): Anxious = PA > 33, NA $\geq$ 37 and PH $\geq$ 38; Mixed = PA < 33, NA $\geq$ 37 and PH $\geq$ 38. Contrast and Average are used interchangeably.