

## Implicit Associations for Fear-Relevant Stimuli Among Individuals With Snake and Spider Fears

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This study investigated an implicit measure of cognitive processing, the Implicit Association Test (IAT; A. G. Greenwald, D. E. McGhee, & J. L. K. Schwartz, 1998), as a measure of fear-related automatic associations. Sixty-seven students with snake or spider fears completed 4 IAT tasks in which they classified pictures of snakes and spiders along with descriptive words indicating valence, fear, danger, or disgust. Results indicated that all 4 tasks discriminated between fear groups in terms of their implicit associations, and fear-specific effects were significant even after controlling for the impact of valence evaluation. Findings are discussed in terms of applications of the IAT methodology to examine cognitive processing and schemata in anxiety and potential uses for assessing anxiety disorders.

With the expanding popularity of cognitive theories of emotional disorders, investigators have tried to determine how cognitive processes are implicated in the onset and maintenance of emotional dysregulation. In particular, researchers over the last two decades have increasingly focused on information-processing differences among individuals suffering from anxiety. The general cognitive model of anxiety posits that maladaptive schemata influence information processing to make the individual more attentive to potentially threatening cues, more likely to interpret ambiguous cues as threatening, and more likely to recall cues relevant to the fear schema (e.g., Beck, 1976; Beck & Emery with Greenberg, 1985). Although researchers have made substantial progress in clarifying the nature of some cognitive processes, such as attentional and encoding biases, there remains great difficulty in characterizing other processes, such as memory effects. These complexities have made it difficult to form a coherent picture of the cognitive functioning of anxious persons.

In one review of the literature on memory biases, MacLeod and Rutherford (1998) concluded that anxiety is frequently associated with implicit bias (i.e., emotional influences on memory in the absence of conscious or explicit recall of the precipitating information), but they found little compelling evidence for anxiety-related explicit bias, which involves a conscious effort to remember information. Other reviewers have disagreed, arguing that the

findings are simply too confusing to draw any conclusions (e.g., Dalgleish & Watts, 1990) or even that “there is actually very little evidence to support the presence of an implicit memory bias among either high trait anxiety individuals or clinically anxious individuals” (Russo, Fox, & Bowles, 1999, p. 439).

The incongruent results found for memory biases are problematic given that the cognitive model is centered on the organizing influences of basic cognitive structures in memory (i.e., schemata). Further, without a clear understanding of memory effects, it is difficult to interpret the more consistently observed biases in attention and judgment. Most tests of memory bias have used paradigms that examine bias in recall or recognition of fear-relevant items. Although this represents one important aspect of biased information processing in memory, these paradigms are not able to evaluate more basic, underlying biases in memory structure (such as automatic associations in memory) that more closely reflect anxious schemata. Recall that schemata, which lie at the heart of the cognitive model, are generally conceived of as mental templates or cognitive structures in memory that automatically guide the way we perceive and interpret our experience (e.g., Fiske & Taylor, 1991; Myers, 1994). Thus, investigating memory biases that seem to occur at this very basic, structural level in memory (akin to schematic processing) may help to clarify the nature of fearful associations and enable more comprehensive evaluation of the cognitive model of anxiety.

The information-processing work testing for biases among spider phobia has tended to focus on attentional biases, using the modified Stroop task. There have been some interesting applications of other cognitive methodologies, such as writing of situation-specific scripts (Wenzel & Holt, 2000), abstract anticipatory memory for threatening imagery scripts (Kindt, Brosschot, & Boiten, 1999), and thought-suppression studies (Muris, Merckelbach, Horselenberg, Sijsenaar, & Leeuw, 1997; Zeitlin, Netten, & Hodder, 1995), but a coherent picture of phobia-specific processing has not yet emerged from these efforts.

The Stroop research has produced somewhat more consistent results, although the parameters of the interference effect are unclear. In one study, Watts and colleagues (Watts, McKenna, Sharrock, & Trezise, 1986) found that individuals with spider

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This research was partially funded by a fellowship from the Natural Sciences and Engineering Research Council of Canada. We thank members of the Yale University anxiety disorders research group for their assistance in the planning and coordination of this study and, in particular, Robin Carter for her extensive help in both recruiting and running participants. In addition, we are grateful to Brian Nosek and Mahzarin Banaji for their advice and to members of Eli Lab for providing access to lab space and computer facilities.

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phobia were significantly slower at color-naming of words associated with spiders compared with control participants, but there were no differences on naming of general threat words. Similarly, in an unmasked version of the Stroop task, spider phobics showed retarded color-naming of spider words, relative to either neutral or emotional words (Thorpe & Salkovskis, 1997). However, Thorpe and Salkovskis (1997) did not find evidence of a preattentive bias toward threat. Thus, it remains unclear whether the cognitive biases in specific phobia occur automatically, or only following strategic processing, and it is uncertain whether long-term memory biases are implicated in the distorted processing of specific phobias. The current study expands research in this field by extending the information-processing anxiety research, and specific phobia work in particular, to these new domains.

A new paradigm has been developed that may be useful for examining memory structures related to fear. The Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) is a measure that has been used to reflect automatic or unconscious attitudes primarily related to social prejudice, such as gender stereotypes (Rudman, Greenwald, & McGhee, 1996) and racial evaluations (Dasgupta, McGhee, Greenwald, & Banaji, 2000; McGhee, Greenwald, & Banaji, 1996; Ottaway, Hayden, & Oakes, in press; Rudman, Greenwald, Mellott, & Schwartz, 1999). It has adequate test-retest reliability (e.g., Bosson, Swann, & Pennebaker, 2000), shows expected differences across groups (e.g., Greenwald et al., 1998), and relates to other forms of implicit (e.g., Cunningham, Preacher, & Banaji, in press) and explicit (e.g., Nosek, Banaji, & Greenwald, in press) bias.

Although implicit attitude is a well-established construct in social cognition research, the IAT has yet to be applied to psychopathology research. Clinical researchers (particularly those from a cognitive tradition) would be more likely to think of the same construct as automatic associations in memory. Specifically, the IAT uses reaction time tasks to measure automatic memory-based associations without requiring conscious introspection. Processing speed is assumed to be an indirect measure of the individual's degree of association between two concepts. The speed with which an individual can link two concepts purportedly reflects how strongly associated those concepts are in memory. Implicit attitudes are generally considered to be a construct related to, but distinguishable from, explicit attitudes (Blair, in press; Greenwald et al., 1998). As evident from the many applications of the IAT in social cognition work, in some cases, implicit and self-report measures are related to one another, but in other cases they do not converge. The idea is not that implicit and explicit attitudes are orthogonal; rather, they reflect different levels of analysis that permit a unique view of cognitive processing.

The basic task of the IAT involves participants classifying words or pictures into superordinate categories (categories that are at a more general level). For example, participants would choose whether photographs of petunias, pansies, flies, and mosquitoes belong to the superordinate category "flowers" or the superordinate category "insects." However, the categories of "flowers" and "insects" are simultaneously paired with descriptive categories, such as "good" and "bad." Participants generally categorize the stimuli faster when the paired categories are matched (matched in the sense that they are congruent with the way they associate or evaluate those categories in memory) than when they are mismatched. The dependent variable in the IAT is the difference in

average response time between matched and mismatched classifications, which is interpreted as the degree of automatic association between the paired categories. To continue our example, when the category "flower" is paired with the category "good," and the category "insect" is paired with the category "bad," participants are expected to classify photographs of pansies and mosquitoes more quickly than during those trials when "flower" is paired with "bad," and "insect" with "good." In both cases, pansies and mosquitoes are the stimuli being classified, but the superordinate categories involve category pairings that match common societal evaluations of flowers as good and insects as bad versus mismatched category pairings. More details of the IAT design and the measurement of speed of association are described below.

Implicit associations are thought to represent automatic structures in memory and thus appear to share many of the qualities ascribed to schemata. The current study presents an attempt to evaluate whether fearful individuals will show implicit fear associations consistent with a schema perspective on fear. Specifically, this study was designed to determine whether self-reported fears of specific animals would be related to implicit memory associations for these feared animals, as measured by the IAT. In this initial evaluation of the IAT's utility in psychopathology research, we used participants who were extremely afraid of either snakes or spiders (but unafraid of the other animal). These groups effectively served as controls for one another, given that spiders and snakes both represent evolutionarily "prepared" fears (Seligman, 1971) and share a comparably negative evaluation. The need for a comparable fear control group is based on the relative nature of the IAT; latency (reaction time) to classify stimuli with one set of category associations is always compared with latency to classify stimuli with another set of category associations. Thus, the most appropriate comparison group within the IAT for a specific animal fear is a category that is seen as comparably negative and threatening within the general population.

Following from debate in the literature regarding the content specificity of biases in anxious responding (e.g., see Lavy, van Oppen, & van den Hout, 1994; Lundh, Czyzykow, & Öst, 1997), several categories of fear judgments were used in this exploration of the generality of fear-related implicit associations. Participants were asked to categorize pictures of snakes and spiders into their superordinate animal categories in conjunction with words relevant to the following four sets of opposing descriptive categories: bad-good, afraid-unafraid, danger-safety, and disgusting-appealing. The bad-good comparison was included to assess the influence of valence evaluation on the other fear-relevant memory associations. The afraid-unafraid and danger-safety comparisons were included to assess automatic subjective fear and threat associations, and the disgusting-appealing comparison was included because of recent debate concerning the role of disgust in snake and spider fears (Sawchuk, Lohr, Lee, & Tolin, 1999; Thorpe & Salkovskis, 1998; Woody & Teachman, 2000).

Our central question concerned whether the IAT measures of automatic associations would show significantly different reaction times as a function of fear group. We hypothesized that the snake-spider IAT tasks would effectively discriminate between individuals who were afraid of snakes as opposed to spiders. We expected that both fear groups would show evidence of automatic fear-relevant associations but that the pattern of associations would be opposite for the two groups, because the associations in mem-

ory should be opposing. Specifically, spider-fearful individuals would more quickly associate spiders with negative descriptors, whereas snake-fearful individuals would more quickly associate snakes with negative concepts. We included four different IAT tasks (valence evaluation, fear, danger, and disgust) to determine which evaluative or semantic qualities related to the fear response would be evident at the level of basic associations. Moreover, in order to test whether the IAT could capture automatic associations related specifically to fearful responding, we assessed whether the fear, danger, and disgust IAT tasks would continue to discriminate the fear groups after controlling for the effects of valence evaluation.

## Method

### Participants

Approximately 1,000 Yale University undergraduates were prescreened on the 9-item animal subscale of the Fear Survey Schedule—III (Wolpe & Lang, 1964), which requires participants to rate their level of fear toward particular animals on a 5-point Likert-type scale. The goal was to select participants who were highly fearful of snakes but reported low fear of spiders, or who were highly fearful of spiders but reported low fear of snakes. Students who differed in their reported fear of snakes and spiders by at least three points (e.g., fear level of 4 for one animal and 1 for the other) were contacted and invited to participate in the study. Compensation involved either money (\$7) or partial course credit. Sixty-seven college-aged participants (30 snake-fearful, 7 men; 37 spider-fearful, 12 men) were included in the final analyses. The gender ratio in this study approximates the prevalence rates found for specific phobias in the general population.

To reduce the possibility of response bias on self-report measures, participants were not informed as to why they were selected (i.e., their particular snake-spider fear pattern). They were simply invited to participate in a study of information processing and animal fears. In addition, the prescreening measure asked students to rate their fear level toward a variety of animals (not only snakes and spiders), and there was a delay of several weeks between completion of the prescreening measure and the initial phone contact from an experimenter.

### Materials

**Questionnaires.** Participants completed two established measures of specific animal fears. The Snake Questionnaire (SNAQ; Klorman, Weerts, Hastings, Melamed, & Lang, 1974) is a 30-item, true-false measure in which participants rate their feelings toward snakes and their avoidance and escape behaviors. Similarly, the Fear of Spiders Questionnaire (FSQ; Szymanski & O'Donohue, 1995) is an 18-item Likert-type measure (on a 7-point scale) that asks questions about participants' avoidance and fear of harm from spiders.

**IATs.** The IAT is a task in which individuals classify words or pictures into superordinate categories. Two sets of category pairs are presented simultaneously; one pair represents the target categories of interest (in this case, spiders and snakes), and a second represents descriptive categories (such as good and bad). During the test, participants see four category labels on the screen simultaneously: a target and descriptor category paired on one side of the screen (e.g., spiders and bad), and the opposite target and descriptor category paired on the other side of the screen (e.g., snakes and good). Stimuli representing any of these four categories can appear in the center of the screen on a classification trial, and the task is for participants to indicate on which side of the screen each stimulus belongs (i.e., what category it fits into). Thus, participants classify stimuli from the four concepts using just two responses (right or left side of screen), with each side assigned to two of the four concepts. Word stimuli are used for the

descriptor categories, and pictorial stimuli of snakes and spiders are used for the target categories (selection of stimuli is discussed below). Equal numbers of stimuli from each of the four categories appear during each IAT task, so that participants classify both words and pictures in all four of the snake-spider IAT tasks.

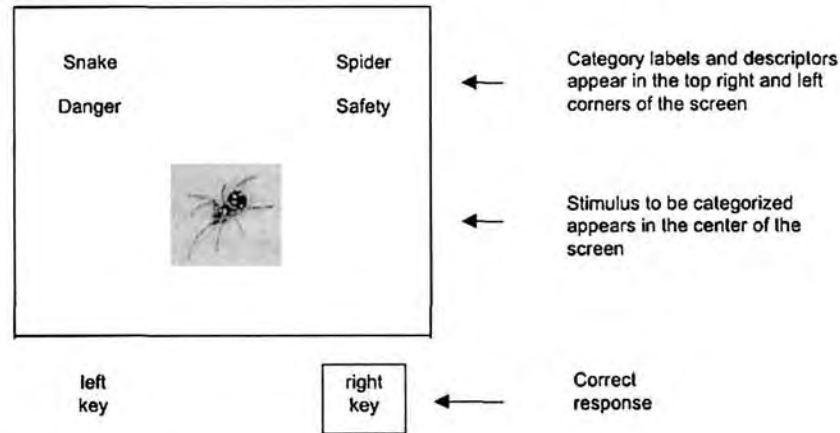
Stimuli are expected to be classified more quickly when the target and descriptor category pairings match the individual's automatic associations with the target (snake-spider) categories versus when the target and descriptor category pairings are mismatched. For example, the present study focused on individuals' fearful associations for snakes and spiders. A person who has negative automatic associations for snakes is expected to classify a picture of a snake relatively quickly when the target category "snake" appears on the screen alongside a negative descriptor category, such as "danger," because of the match to this person's automatic associations. However, this same antisnake person should classify a picture of a snake relatively slowly when the category "snake" appears on the screen paired with the descriptor "safety," because this is incongruent with the person's automatic negative associations with snakes. In each case, the person's implicit associations to one target category are assessed relative to his or her associations to the other target category; in essence, the IAT measures the relative strength of the paired associations. So, in the present study, automatic associations with snakes were measured relative to automatic associations with spiders.

Figure 1 illustrates how a computer screen might appear during a critical classification trial. In this pairing, the target category "snake" and the descriptor category "danger" have been paired on the left side, and "spider" and "safety" categories have been paired on the right. In the example presented in Figure 1, the correct response is to classify the stimulus into the spider category on the right side of the screen using the right-sided key. An incorrect response would be followed by feedback that the classification was inaccurate, before immediately proceeding to the next classification trial.

In a subsequent set of classifications, snake would be paired with safety, and spider would be paired with danger. Thus, participants classify the pictorial and word stimuli when the target animal categories are paired with associatively matched descriptor categories and again when the categories are paired with mismatched descriptor categories. The measure of interest is the difference between latency of responding when matching categories (e.g., snake-danger) are paired versus response latency when mismatching categories (e.g., snake-safety) are paired. The hypothetical trial shown in Figure 1 should match the automatic associations for snake-fearful participants because, for these participants, the association of snakes with danger and spiders with safety is a better match than the association of snakes with safety and spiders with danger. In contrast, the trial should be a mismatched association for spider-fearful participants because the opposite pattern of associations reflects their automatic negative associations with spiders. Thus, snake-fearful participants would be expected to complete the hypothetical classification trial in Figure 1 faster than spider-fearful participants because the category pairings more closely match the negative snake associations.

Figure 1 illustrates a trial in which participants are asked to categorize a spider picture. The process would be identical if a word had appeared in the center of the screen to be classified. For example, imagine that the photograph in Figure 1 was replaced by the word "lethal." Participants would categorize this stimulus into the category "danger" using the same method used for the photographs. Before the target and descriptor categories are paired (as shown in Figure 1), participants practiced categorizing photographs into the "spider" and "snake" categories and words into the opposing descriptor categories (e.g., danger-safety) in separate practice trials.

All participants completed four snake-spider IAT tasks, each lasting approximately 3–4 min. There were two critical trial blocks in each IAT task—one block of trials where the sets of target and descriptor categories were matched (e.g., snake plus disgusting and spider plus appealing for a snake-fearful participant) and one block in which the sets of target and



*Figure 1.* Schematic depiction of the Implicit Association Test procedure. Participants classify the stimulus using either the right or left key. The correct classification of the spider picture is on the right key in this example. This classification trial would represent an associatively matched pairing for a snake-fearful individual (because snakes are associated with danger) and an associatively mismatched pairing for a spider-fearful individual (because these individuals do not associate spiders with safety).

descriptor categories were mismatched (e.g., snake plus appealing and spider plus disgusting for the same snake-fearful participant). As the above example demonstrates, whether target plus descriptor category pairs were congruent (matched) or incongruent (mismatched) depended on whether the participant was snake- or spider-fearful. Each critical block consisted of 48 classification trials. Of these, the first 12 were practice trials, and the remaining 36 constituted the experimental data.

**IAT stimuli.** The investigators generated a large selection of words to serve as potential stimuli for each of the following descriptive constructs: danger, safety, disgusting, appealing, afraid, unafraid, bad, and good. These stimuli were approximately matched for length and then pre-rated on 7-point Likert-type scales by a group of students ( $N = 21$ ) for ease of categorization. Ease of categorization was selected, rather than word familiarity, because researchers have established that the implicit attitudes demonstrated with the IAT cannot be explained by differential familiarity with the word stimuli used to represent the target categories (Dasgupta et al., 2000; Ottaway et al., in press). The best three items for each descriptor category were chosen. Table 1 displays the final selection of descriptors with their associated stimuli.

Snakes and spiders were selected for the relative target categories because they can be effectively compared as both are common specific animal fears. In our pilot work, we established that the stimuli used to represent the snake and spider categories were evaluated equally negatively and were matched for level of fearfulness and disgust. In this way, we could be confident that the snake and spider categories were generally

comparable to one another in terms of their negative valence and fear-evoking appearance. The purpose of this pretesting was to minimize alternative explanations for differential responding to the animal categories due to potential differences in their perceived likeability. To generate stimuli, photographs of snakes and spiders were downloaded from various websites. A broad range of animal photos were downloaded to reflect the variety of different species within an animal group (e.g., spiders of different colors and degree of hairiness). The same group of 21 students who pre-rated the word stimuli rated each photograph on 7-point Likert-type scales for ease of categorization, as well as for the degree of fear, disgust, and pleasantness evoked. For the snake and spider categories, the three items that were best matched on all of the above characteristics were selected. This insured that differences in IAT reaction times between the fear groups could not be attributed to difficulties in classifying the stimuli or to differentially threatening or negative items. All photos used in the IAT tasks were standardized to a height of 10 cm, with the width varying between 8 and 16 cm (to maximize clarity of the object). All were high resolution and in full color. Thus, for each descriptor category, three words were used as stimuli, and for each target category (snake or spider), three pictures were used as stimuli. Pictorial stimuli are available from Bethany A. Teachman on request.

There were a number of reasons why we chose to use pictorial rather than text-based representations of animals. First, there has been disagreement in the literature about the importance of physical versus semantic content of threatening stimuli (MacLeod & McLaughlin, 1995; McNally, 1995). Some researchers have found an equal bias toward pictures and words of phobic stimuli (Kindt & Brosschot, 1997), whereas others have found no effect for words and question the external validity of written stimuli (Rapee, McCallum, Melville, Ravenscroft, & Rodney, 1994). Second, Marks (1987) noted that whereas fear responses are frequently elicited by pictorial phobic stimuli, a fear reaction to phobia-relevant words alone is rare. Third, our pilot work suggested that pictures might yield more robust results. Therefore, based on their more reliable provocation of anxiety, pictorial animal stimuli were used as target stimuli for all tasks.

### Apparatus

The experiment was conducted on IBM-matched desktop computers and programmed using Inquisit (Draine, 1999) running in either Windows 95 or Windows NT. Participants sat approximately 24 inches from a 17-inch

**Table 1**  
*Descriptor Categories and Associated Subordinate Stimuli for Implicit Association Test (IAT) Tasks*

Descriptor category label	Stimuli to be classified			
Danger	Threatened	Harm	Lethal	
Safety	Protected	Secure	Home	
Disgusting	Gross	Repulsive	Sickening	
Appealing	Tasty	Attractive	Tempting	
Afraid	Scared	Frightened	Alarmed	
Unafraid	Calm	Relaxed	Tranquil	
Bad	Awful	Terrible	Evil	
Good	Great	Wonderful	Nice	

high-resolution monitor and gave responses for the left-side categories by pushing the "A" key with their left forefinger and responses for the right-side categories by pushing the "S" key (on the numeric keypad) with their right forefinger.

### Procedure

The order of tasks was randomized in each set of IAT tasks. Additionally, within each IAT task, the order in which the associatively matched versus mismatched blocks appeared was counterbalanced. Furthermore, we counterbalanced the order in which the IAT tasks versus the explicit questionnaires were completed, the order that the explicit snake and spider fear questionnaires were completed, and the order in which participants completed the sets of IAT tasks. To minimize the effects of fatigue, there was a 5-min break between the sets of IAT tasks during which participants had an opportunity to rest and read magazines.

Given the novelty of the task, all participants initially completed an unrelated practice IAT task (categorizing green vs. white objects) to familiarize them with the procedure. Participants were told that they would be completing a series of classification tasks during which they were to place words and pictures into categories that appeared on different sides of the screen. They were further instructed that the classification was completed by pressing one of two computer keys (and the experimenter demonstrated the process), and they were told that this was a response time task so they should try to proceed as quickly and as accurately as possible. To encourage accurate responding, error messages were flashed on the screen following incorrect classifications. In addition, error rate and average response times were displayed at the end of each task. The purpose of providing error feedback was to maintain motivation throughout the task. Because participants were instructed to classify the stimuli as quickly and as accurately as possible, the error feedback helped to sustain this goal. Further, given that the dependent measure involved comparison of response times for the matched and mismatched conditions, it was desirable to make the speed and accuracy goals salient across both conditions.

## Results

### Data Reduction

Prior to conducting the planned analyses, distributions of the IAT latency data were examined to check for outliers. Unusually slow responding on a trial (i.e., slow classification of the stimulus) typically indicates momentary inattention, whereas abnormally fast responding generally reflects anticipatory responding (in advance of actual perception of the stimulus). Accordingly, response latencies less than 300 ms or greater than 3,000 ms were counted as errors and recoded as 300 or 3,000 ms. These values reflect the standard cutoff times established by Greenwald et al. (1998) and are designed to be inclusive of individual trial data, so that variability in response time can be accommodated without including data that likely reflect inadequate performance on the task. In addition, participants' data were deleted if the error rates (i.e., % of stimuli classified incorrectly) on the critical IAT blocks were greater than 20%. As a result of these checks, data from 4 participants were omitted. The remaining trial latency data were reciprocally transformed (1,000/latency in ms) before being averaged over each block. Analyses were conducted using these transformed data (which can be interpreted as number of items per second) because this conversion stabilizes latency variance and normalizes the distribution. Given that the pattern of results is the same for both the untransformed and transformed data, we report only the

transformed data here. Further details on this transformation are provided in Greenwald et al. (1998).

### Questionnaires

Comparisons between our sample and those of previously published studies provide assurance that the fearful groups were strongly (and comparably) fearful, even though they were not formally diagnosed as phobic. Specifically, on the SNAQ, the snake-fearful group scored approximately two standard deviations above the normal college student sample described by Klorman et al. (1974; our means were  $15.7 \pm 5.9$  and  $5.6 \pm 3.9$ , respectively, for the snake and spider fearful groups), and around the 95th percentile of samples reported by both Klieger (1987) and Klorman et al. (1974). In a Swedish sample of snake and spider phobics (using a translation of the SNAQ), the mean score on the SNAQ for their snake phobic sample was  $24.44 \pm 2.95$ , and for the spider phobic group, the mean was  $8.06 \pm 6.07$  (Fredrikson, 1983). Our snake phobic group mean is at a lower level than their phobic group, but this may be a consequence of using the translated version of the SNAQ, because our means are comparable to English samples. The finding that our spider fear group performs at an equivalent level on the SNAQ as was found in the Swedish sample suggests that similar relative fear differences exist in the two samples.

On the FSQ, the spider-fearful group scored approximately one standard deviation below the mean of spider phobics in the Muris and Merckelbach (1996) study. Specifically, our sample means were  $68.3 \pm 23.7$  (spider-fearful) and  $31.9 \pm 14.3$  (snake-fearful), whereas their mean for spider phobics was  $89.1 \pm 19.6$ . Although it is not possible to directly evaluate magnitude of fear across our spider- and snake-fearful groups, the comparable findings across studies using the same questionnaires indicate that they are similar high-fear groups. In addition, SNAQ scores were significantly higher for the snake-fearful group than for the spider-fearful group,  $t(66) = 8.46$ ,  $p < .0001$ ,  $d = 2.08$ ,<sup>1</sup> and the reverse pattern was found for the FSQ,  $t(66) = -7.39$ ,  $p < .0001$ ,  $d = 1.81$ .

Given the importance of determining that our participants were appropriately classified in their respective animal fear groups, we also conducted the analyses reported below after removing 2 participants whose SNAQ and FSQ profiles did not match their prescreening profile (i.e., they were not clearly in the snake- or spider-fear cluster). The results were not different in any way, so we report results for the full sample here.

### IAT Effects: Snake-Spider Tasks

To determine whether the IAT measures of automatic associations would capture differences in responding to specific-fear stimuli, repeated-measures analyses of variance (ANOVAs) were conducted for each of the four snake-spider IAT tasks. The IAT critical blocks (average transformed response latencies for matched vs. mismatched blocks) served as a within-subjects factor,

<sup>1</sup> The effect size  $d$  is described in Rosenthal and Rosnow (1991) and is commonly used for  $t$  tests to index the magnitude of an effect independent of sample size. As recommended by Cohen (1988), a magnitude of  $d$  between 0.2 and 0.5 reflects a small effect, 0.5 to 0.8 reflects a medium effect, and above 0.8 reflects a large effect.

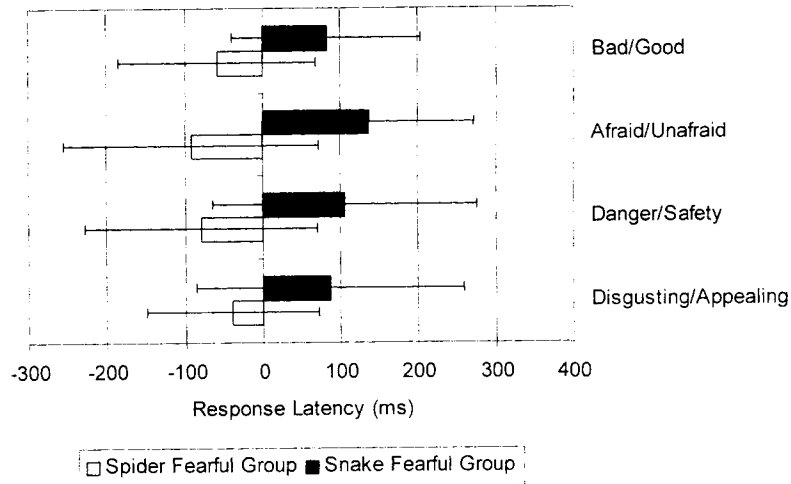


Figure 2. Relative attitude index: Mean latency and standard error for Snake-Spider IAT tasks by fear group. Response latencies are calculated by subtracting the mean reaction time on associatively matched trials from the mean reaction time on mismatched trials. Positive response latencies reflect more negative associations with snakes, indicating that the snake-fearful group responded more quickly when snake stimuli were paired with negative descriptors (relative to spider stimuli). In contrast, negative response latencies reflect relatively more negative associations with spiders, indicating that the spider-fearful group responded more quickly when spider stimuli were paired with negative descriptors (relative to snake stimuli).

and fear group (snake-fearful vs. spider-fearful) served as a between-subjects factor. A significant interaction term indicates that snake- versus spider-fearful groups showed differentially prolonged response latencies in a given categorization task. A crossover interaction was predicted because a matched trial for a snake-fearful participant was a mismatched trial for a spider-fearful participant, and vice-versa.

As expected, there were no significant main effects (all  $p$ s > .05, because the fear groups showed opposing response patterns), but each of the IAT tasks showed a significant interaction: bad-good,  $F(1, 65) = 26.64$ ,  $p < .0001$ ,  $f = 0.64^2$ ; afraid-unafraid,  $F(1, 64) = 43.15$ ,  $p < .0001$ ,  $f = 0.82$ ; danger-safety,  $F(1, 65) = 29.70$ ,  $p < .0001$ ,  $f = 0.67$ ; and disgusting-appealing,  $F(1, 64) = 13.80$ ,  $p = .0004$ ,  $f = 0.46$ . These results clearly indicate that response latencies, reflecting automatic associations, effectively discriminate among individuals with specific animal fears when using the double-dissociation design of the IAT (with snake- and spider-fearful participants serving as controls for one another).

For easier visual inspection, the response latencies in ms (i.e., untransformed data) and standard error bars are shown in Figure 2. Because difference scores were used, positive latencies reflect more negative associations for snakes, and negative latencies reflect relatively more negative associations for spiders. As indicated on the graph, all four IAT tasks resulted in the predicted reverse pattern of responding, whereby the snake-fearful group responded more quickly when snake stimuli were paired with negative descriptors (relative to spider stimuli), and the spider-fearful group responded more quickly when spider stimuli were paired with negative descriptors (relative to snake stimuli). In addition, the raw means and standard deviations of IAT latencies for each IAT set of category pairings (i.e., before the difference score was calculated) by fear group are included in Table 2.

### Effect of Valence Evaluation

Valence-based associations are of theoretical significance in many domains of study, but we were primarily interested in fear-specific implicit associations. Although our findings clearly demonstrate that the different fear groups had different automatic associations for snakes and spiders, we conducted further analyses to control for the degree to which the bad-good judgment might more parsimoniously account for the other categorical judgments. Separate analyses of covariance for each of the fear-specific IAT tasks were conducted to determine if the bad-good IAT would account for the remaining IAT effects. As expected, the two fear-related IAT tasks continued to show a significant interaction even after valence was accounted for: afraid-unafraid,  $F(1, 63) = 29.89$ ,  $p < .0001$ ,  $f = .69$ , and danger-safety,  $F(1, 64) = 10.86$ ,  $p = .002$ ,  $f = .41$ . However, the strength of the disgusting-appealing effect weakened somewhat in this analysis,  $F(1, 63) = 3.59$ ,  $p = .06$ ,  $f = .25$ . These results demonstrate that the semantic, fear-emotive associations capture individual differences above and beyond the simple effects of negative evaluation.

### Prediction of Fear Group Membership

To further evaluate the degree to which automatic fear-related associations would distinguish membership in the fear groups, logistic regressions were calculated for each of the four snake-

<sup>2</sup> The effect size  $f$  is described in Rosenthal and Rosnow (1991) and is commonly used for ANOVA to index the magnitude of an effect independent of sample size. As recommended by Cohen (1988), a magnitude of  $f$  between 0.10 and 0.25 reflects a small effect, 0.25 to 0.40 reflects a medium effect, and above 0.40 reflects a large effect.

Table 2  
Means and Standard Deviations of IAT Latencies for Implicit Association  
Test (IAT) Category Pairings

IAT category pairing			Spider-fearful group		Snake-fearful group	
			<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Danger + spider	and	Safety + snake	641.21	133.05	707.24	203.34
Danger + snake	and	Safety + spider	718.74	156.55	601.33	106.15
Disgusting + spider	and	Appealing + snake	651.48	158.24	681.41	204.91
Disgusting + snake	and	Appealing + spider	690.51	136.82	594.17	109.26
Afraid + spider	and	Unafraid + snake	646.19	144.23	723.85	174.81
Afraid + snake	and	Unafraid + spider	735.68	193.46	587.87	98.32
Bad + spider	and	Good + snake	613.49	129.64	632.37	147.09
Bad + snake	and	Good + spider	671.04	145.22	550.19	88.24

spider IAT tasks with fear group membership as the dichotomous dependent variable. Results indicated that all four IATs effectively explained fear group membership. The bad-good IAT task produced 82% concordant fear group classifications, Wald's  $\chi^2(1, N = 67) = 14.18, p = .0002, b = -5.40$ , odds ratio = .005,  $CI_{.95} = b \pm 2.35$ ; afraid-unafraid resulted in 88%, Wald's  $\chi^2(1, N = 66) = 16.55, p < .0001, b = -6.71$ , odds ratio = .001,  $CI_{.95} = b \pm 2.71$ ; danger-safety correctly classified 84%, Wald's  $\chi^2(1, N = 67) = 15.37, p < .0001, b = -5.19$ , odds ratio = .006,  $CI_{.95} = b \pm 2.17$ ; and the disgusting-appealing task produced 73% concordant classifications, Wald's  $\chi^2(1, N = 66) = 9.89, p = .002, b = -3.80$ , odds ratio = .022,  $CI_{.95} = b \pm 1.99$ . Most impressive was that when the four IAT tasks were averaged together and that combined variable was entered into a logistic regression, 92% of participants were correctly classified as either snake- or spider-fearful, Wald's  $\chi^2(1, N = 67) = 17.17, p < .0001, b = -12.24$ , odds ratio < .001,  $CI_{.95} = b \pm 4.85$ .

#### Convergent Validity: Relation to Self-Report Measures

We were interested in determining how the explicit and implicit measures of specific animal fears would relate to one another, so we examined correlations between each of the IAT tasks and the animal fear questionnaires. To make the questionnaire measures comparable to the implicit measures, which are relative (i.e., associations for snakes relative to associations for spiders), a relative self-report index was formed by calculating the difference between standardized scores on the SNAQ and the FSQ. The results indicate moderate to strong positive correlations between not only each of the separate IAT tasks but also between the explicit measure and each implicit task (see Table 3). As would be expected for different modalities of fear responding, these data suggest that self-report and implicit measures of specific animal fears are meaningfully related, but not entirely overlapping, providing preliminary support for the convergent validity of the IAT.

#### Discussion

The present study was designed to examine the presence of implicit fear associations among snake- and spider-fearful individuals using the IAT, which has previously been used to examine unconscious social attitudes and beliefs. Results convincingly indicate that individuals with specific animal fears show automatic

associations with pictorial stimuli of feared animals that are consistent with a schema-based conceptualization of anxiety disorders. Furthermore, these implicit associations were robust across multiple semantic categorizations (valence evaluation, fear, danger, and disgust), and the fear-specific effects remained strong even when the impact of valence was controlled. Logistic regression further established that implicit association tests were highly predictive of fear group membership, and moderate relations between the IAT and self-report measures of specific animal fears demonstrated convergent validity. These findings suggest that assessing automatic associations can potentially elucidate implicit cognitive processing among anxious individuals and, more broadly, can increase our understanding of how information processing is involved in emotional dysregulation.

As predicted by the cognitive theory of anxiety, associations related to fear-provoking stimuli appear to be represented at an automatic level, and those representations relate to self-reported fear. Although these results need to be replicated, the results support the notion that fear processing is instantiated in basic cognitive structures in memory, thus showing that the IAT may be a useful tool for investigating broader questions about schema theory in anxiety disorders. To the extent that measuring implicit

Table 3  
Correlations Between Implicit Snake-Spider Implicit Association  
Test (IAT) Tasks and Self-Report Fear Measures

Measure	Bad vs. good IAT	Afraid vs. unafraid IAT	Danger vs. safety IAT	Disgusting vs. appealing IAT
Fear questionnaires	.58***	.67***	.66***	.50***
Bad vs. good IAT	—	.41**	.58***	.46***
Afraid vs. unafraid IAT		—	.59***	.47***
Danger vs. safety IAT			—	.54***

Note. *N* ranges from 65 to 67 due to missing data for particular correlations. The fear questionnaires variable is the difference score between the standardized snake fear questionnaire and spider fear questionnaire. The use of a difference score renders the explicit variable comparable to the implicit measures that are relative in nature (i.e., attitudes toward snakes relative to spiders).

\*\**p* < .01. \*\*\**p* < .001.

fearful associations in memory approximates anxious schemata, more direct tests of cognitive theories of anxiety may be feasible, addressing some of the gaps in this literature.

One tentative hypothesis about the meaning of the IAT results is that associatively matched pairings are more quickly categorized because they involve concepts that are strongly elaborated or accessible within the same schema. Because these concepts are closely linked in memory and associations between them have been repeatedly reinforced, it is easy for the individual to access this connected information and process congruent stimuli. In contrast, associatively mismatched pairings take longer to categorize because they require the individual to override these highly connected associations to perform the categorization task. From this standpoint, mismatched pairings are difficult to access not only because they are not part of the same organized set of information but also because they actively contradict the established automatic associations. This hypothesis follows from the assumption that reaction time can be used to assess ease of cognitive processing, which in this case reflects the extent that a concept or association is accessible in memory. Reaction time is commonly used to index accessibility in social cognition research (e.g., Fazio, Sanbonmatsu, Powell, & Kardes, 1986), and this approach maps nicely onto the clinical domain to reflect accessibility of schematic fear associations.

The IAT is a relatively new tool, which carries with it a number of clear advantages for use in anxiety research but also a number of unresolved questions. A primary advantage of the IAT in assessing implicit associations related to threat cues is its within-subject design. This essentially controls for the influence of state anxiety by presenting the feared stimulus in both of the conditions being compared—the mismatched category pairings where slower responding is expected and the matched category pairings where faster responding is anticipated. The reason state anxiety is an issue is that many information-processing tasks are potentially affected by state anxiety. Specifically, many of the paradigms used to evaluate cognitive biases involve stimuli that are designed to be threatening or anxiety-provoking for fearful participants. Consequently, it has been difficult to tease apart whether performance differences on these tasks result from cognitive processing differences or simply from the influence of anxious arousal. Although the effects of state anxiety are interesting, the cognitive model is more ambitious, attempting to explain the genesis of states of anxiety rather than to simply describe the effects of those states.

An additional methodological advantage is that even though IAT participants can easily identify the stimuli being classified as well as the purpose of the task, this awareness does not seem to enable participants to control their responses on the measure (Greenwald et al., 1998). Thus, this procedure appears to dramatically reduce the impact of self-presentation concerns. This feature of the IAT is particularly valuable because admitting to fear is perceived as undesirable in some subcultures. In addition, the elegance of the within-subject IAT design means that attentional biases to, and cognitive avoidance of, threat-relevant information is controlled across the two conditions being compared. As a result of this design, many of the confounds frequently cited against cognitive measures of fear (the influence of state anxiety in particular) are controlled because the potentially confounding factors exert identical effects in both the associatively matched and mis-

matched category pairings (because the same threat-relevant stimuli appear in both).

One of the unresolved questions about the IAT relates to the constraints on the relative categories being compared. Because the IAT effects reflect difference scores (the mismatched category pairings minus the matched category pairings), evaluating automatic associations with one category (e.g., snakes) cannot be understood independently of the participants' associations with the comparison category (e.g., spiders). It is for this reason that it was important to compare snake- and spider-fearful participants in this first application of the IAT to fear research. As a next step, it will be interesting for future research to examine how nonfearful participants perform on these tasks, as we expect them to show no strong preference for either snakes or spiders (given that both animals are typically disliked in the general population). It will be interesting to test this empirically and also to extend the findings from the present study that uses an analogue high-fear sample to a clinical sample with specific phobias. Ongoing research in our lab is addressing these questions. In addition, social psychologists are currently working on more sophisticated variations on the IAT that do not have the same stringent requirements for a contrary, relative category, so the task may become more flexible with these developments (Blair, Ma, & Lenton, in press; Nosek & Banaji, 2000).

The flexibility of the IAT may permit investigation into the question of the generality of the processing biases associated with anxious schemata. Whereas the present study examined constructs related to fear, disgust, and danger, it may be possible in future work to tap even more specific concepts related to an individual's fear representation, including one's self-concept as fearful or one's view of the stimulus as unpredictable. These questions may shed some light on the prominent sex differences in some types of phobia. Evaluation at this level of specificity has proven difficult in the past (e.g., see Lundh et al., 1997), but may be possible with the IAT given its relatively large effect sizes, which may permit more sensitive assessment of individual differences. Although more work is needed to determine whether various fear-relevant constructs are meaningfully distinct from one another, the results from the present study suggest that automatic associations show some generalization, corresponding not only to fear, but also to related constructs, such as danger and disgust.

Examining the effects of schema in anxiety disorders is not only interesting from a theoretical perspective. There are also potential implications for identifying cognitive vulnerability factors, assessing outcome, and predicting relapse. One implication of the imperfect correspondence between self-report measures and implicit fear-related associations in this study is that implicit fear responding may provide an indication of schematic associations in memory that the individual cannot consciously access. Particularly as they relate to disorders more serious than specific phobia, measurement of such schematic associations may provide clinicians with another tool for examining the degree to which a client's underlying structures in memory may place them at risk for developing a problem such as panic disorder or experiencing relapse following treatment.

The confusing literature on information processing in anxiety disorders, particularly related to memory biases, cannot be settled with a single study. We still have far more questions than answers about the implications of implicit fear-related associations. None-

theless, this initial application of the IAT to address questions related to psychopathology suggests that automatic associations to threat-relevant stimuli can reliably discriminate between fear groups. Furthermore, the evaluation of cognitive structures in memory that are consistent with a schema perspective on fear may help to more closely align cognitive theories of anxiety with basic research in other areas of psychology, broadening our understanding of information processing in psychopathology.

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Received November 15, 1999  
Revision received July 11, 2000  
Accepted January 8, 2001 ■



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