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From Fear to Love: Individual Differences in Implicit Spider Associations

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The Implicit Association Test (IAT) was used to investigate automatic fear associations in fear of spiders. Fear associations toward spiders were measured among spider fearful and nonfearful participants (Experiment 1) as well as among nonfearfuls and spider enthusiasts (Experiment 2). It was shown that the IAT is sensitive to personal automatic fear associations and therefore distinguishes between high-fearful, nonfearful, and enthusiastic participants. Moreover, implicit spider associations measured by the IAT predicted avoidance behavior beyond self-reports. The results of Experiment 2 provide additional support for the argument that implicit spider associations are different from general stereotypes or knowledge about spiders.

Keywords: Implicit Association Test, IAT, fear, attitude, interindividual differences

Cognitive models of anxiety disorders (Barlow, 1988; Beck, Emery & Greenberg, 1985; Eysenck, 1992; Foa & Kozak, 1986) postulate an important influence of cognitive processes on the etiology and maintenance of anxiety. However, in assessing how specific anxiety disorders affect information processing (e.g., interpretation, judgment, memory) traditional cognitive paradigms offer little information about the structure of fear networks and schemata. Moreover, self-reports and other introspective methods are very limited alternatives (e.g., de Jong, Pasman, Kindt, & van den Hout, 2001; Dovidio & Fazio, 1992) because relevant cognitions may be unavailable to introspection and verbal descriptions, and they may be subject to self-presentational forces.

An alternative approach to the study of anxiety disorders would be to assess specific fear associations indirectly by measuring performance in seemingly unrelated tasks. Recently, a large number of such indirect measures have been proposed, the most prominent of them being the Implicit Association Test (IAT), introduced by Greenwald, McGhee, and Schwartz (1998). The IAT measures the strength of associations between an attribute dimension (e.g., pleasant vs. unpleasant) and targets (e.g., spiders vs. butterflies). In this reaction-time-based categorization task, participants have to press one of two response keys in reaction to a presented attribute or target stimulus. If strongly associated concepts share the same response in one of the two critical blocks (e.g., spiders and unpleasant words require pressing one key, butterflies and pleasant words the other key), responses in this so called *compatible block* should be faster than in the *incompatible block* with the opposite assignment (e.g., spiders and pleasant words mapped onto one key, butterflies and unpleasant words on the other). The difference in average response time between the compatible and the incompatible block indicates the strength of the associations between the paired categories.

The IAT has been developed to assess implicit attitudes by measuring the underlying automatic evaluation (Greenwald et al., 1998) and has been applied primarily in social cognition research (for reviews, see Greenwald & Nosek, 2001; Fazio & Olson, 2003). There are also promising applications of the IAT in clinical research, investigating implicit associations in depression (Gemar, Segal, Sagrati, & Kennedy, 2001) and anxiety disorders (de Jong, 2002; de Jong et al., 2001; de Jong, van den Hout, Rietbroek, & Huijding, 2003; Teachman, Gregg, & Woody, 2001; Teachman & Woody, 2003).

Teachman et al. (2001) investigated fear-related automatic associations among individuals with snake or spider fear and found the IAT to discriminate between the two groups. Teachman et al. used pictures of spiders and snakes as targets and paired them in four separate IATs with attribute concepts of "bad versus good," "afraid versus unafraid," "danger versus safety," and "disgusting versus appealing." Results indicated that individuals with spider or snake fear show automatic associations with pictorial stimuli of the feared animal but not with the nonfeared animal. These associations were robust across multiple semantic categorizations (valence evaluation, fear, danger, and disgust).

Using the same paradigm, Teachman and Woody (2003) examined spider phobic individuals before and after a group-based exposure treatment and compared the results with those of a group of nonphobic individuals. Before treatment, spider phobics showed stronger fear-related implicit associations toward spiders than did the nonphobic controls. Over the course of treatment, these associations changed significantly in the phobic group, such that after therapy they did not differ from the untreated control group anymore. These results support the clinical relevance of implicit fear

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associations, including prediction of phobic avoidance and treatment sensitivity of fear- and disgust-specific automatic associations.

de Jong et al. (2003) also explored the presence of implicit fear-related associations in participants who did or did not fear spiders. In contrast to the picture stimuli (spiders vs. snakes) used by Teachman and colleagues (2001, 2003), de Jong et al. (2003) used verbal spider cues versus neutral words as target stimuli and fear-related versus positive words as attributes. As expected, the groups differed on the explicit level, with more negative attitudes toward spider words in fearful participants. Surprisingly, both groups showed similar negative associations to spiders at the implicit level. de Jong et al. (2003) assumed that individuals may be similar with respect to a general implicit affective evaluation of spiders, whether they are explicitly spider fearful or not.

A comparison of the conflicting IAT results of Teachman et al. (2001) with de Jong et al. (2003) shows that it is unclear whether there is a real discrepancy between the results of the two studies or whether it is simply methodological differences that led to the inconsistent findings (for a detailed discussion of the methodological differences, see below). Some empirical evidence from studies of social phobia supports the results by Teachman and her colleagues, revealing differences in implicit fear associations between high- and low-fearful individuals (e.g., de Jong et al., 2001). But the evidence shown for social phobia does not rule out the possibility that some feared stimuli (e.g., spiders) are generally represented with negative implicit associations. When even explicitly nonfearful individuals have negative implicit associations toward spiders, it becomes doubtful whether negative implicit cognitions play a critical role in spider phobia (de Jong et al., 2003). Therefore, one goal of the present study was to address some of the open questions and unsolved problems regarding automatic fear associations in psychopathology: We wanted to clarify whether implicit fear-related associations toward spiders reflect individual associations or a cultural stereotype. Using the IAT, we investigated the differences between high- and low-fearful individuals regarding their implicit associations, and we assessed the predictive power of this measure beyond self-reports.

The IAT is a performance-related task that does not ask directly for a verbal report about the construct of interest. It seems reasonable to call the IAT an "indirect" measure (Fazio & Olson, 2003) based on automatic expressions of the constructs being tested (e.g., Dasgupta, McGhee, Greenwald, & Banaji, 2000). For the IAT, the emphasis is on controllability, because IAT responses are expressed without intention or control (Dasgupta et al., 2000). If the IAT reflects automatic and uncontrollable expressions of individual fear associations, the paradigm should be sensitive to individual differences between high- and low-fearful participants. However, Karpinski and Hilton (2001) as well as Olson and Fazio (2004) argued that IAT effects do not reflect individual associations but a cultural stereotype or "extrapersonal association" (p. 316). They argued that the IAT's focus is on the evaluative associations to the general category and not on the exemplar of the category and its associations (see also De Houwer, 2001). Regarding spider fear, one could assume that even nonfearful participants possess a strong association between the category "spider" and fear because they know that spiders are considered to be frightening animals to some people. This general knowledge or cultural stereotype is shared by all the participants and easily comes to mind when the category "spider" is presented in the IAT. If the IAT merely reflects general knowledge about the category "spider," one would expect rather small or even no differences between fearful and nonfearful participants.

Support for the claims by Karpinski and Hilton (2001) and Olson and Fazio (2004) comes from results by de Jong et al. (2003) who found negative associations toward spider-related words in both high and low fearful participants. In contrast, evidence in support of the IAT's sensitivity to personal associations comes from the experiments reported by Teachman and her colleagues (2001, 2003) who employed spider pictures in their experiments. Their reports of IAT group differences between high and low fearful participants and the changeability of individual fear associations are arguments against the assumption that cultural influences and knowledge about the category explain the IAT effects.

One reason for the opposing results of prior research may lie in methodological differences between the studies. de Jong et al. (2003) used spider-related words as targets (e.g., "web," "hairy"), whereas Teachman and her colleagues (2001, 2003) presented pictures of spiders and snakes. Compared to words, pictures may easily activate the concept of a spider and related fear associations in an experimental setting, leading to larger IAT effects in fearful participants. Spider-related words, in contrast, are not automatically associated with fear, whereas pictures easily activated a spider concept, as Ellwart, Becker, and Rinck (2005) showed. However, the results of Teachman et al. do not allow the conclusion that fearful and nonfearful groups indeed vary in the absolute direction of automatic fear associations. This would only be the case if one group would show nonfearful or even positive associations toward spiders. Because Teachman and colleagues (2001, 2003) presented snakes as a second target, automatic evaluations of spiders are always relative to the commonly aversive snake category, providing no estimate whether spiders might be evaluated in a neutral or even positive manner. Using a neutral target category relative to spiders, de Jong et al. (2003) claimed to provide an estimate relative to a "neutral baseline." However, their interpretation of the IAT effects is still problematic because there is converging evidence suggesting that affectively valenced stimuli (positive and negative) are generally processed more easily and more quickly than neutral stimuli (see Ferre, 2003) which may produce unwanted effects in the IAT categorization task. In this study, we chose butterflies as a second target, because butterflies are commonly perceived as positive. By using butterflies and spiders as targets in an IAT setting, there is the possibility that the automatic evaluation of spiders could actually approach a state of positive evaluation. Such evidence would support the claim that implicit associations as measured by the IAT are indeed individual associations and do not reflect a commonly shared negative stereotype.

In the present study, we argue that the IAT is able to assess personal automatic fear associations and clearly distinguishes between high and low fearful participants. In Experiment 1, we compared highly spider fearful to nonfearful participants regarding IAT performance. We assumed that spider fearful participants would show strong negative associations toward spiders, as revealed by large IAT effects. We further hypothesized that IAT effects of nonfearful controls would be significantly weaker than those of fearful individuals. However, even nonfearful individuals' associations should be more negative toward spiders than to butterflies, yielding weaker, but significant IAT effects in this group.

To provide additional support for the argument that automatic fear associations assessed by the IAT reflect individual effects, we conducted a second experiment, introducing spider enthusiasts as an experimental group. Spider enthusiasts should not differ from extremely nonfearful controls in direct measures such as fear questionnaires or clinical diagnoses. They do differ in behavior, however, by keeping spiders as domestic animals, and we also expected them not to show fear associations toward spiders. Therefore, spider enthusiasts served as a critical experimental population in Experiment 2. Assuming that neither spiders nor butterflies are associated with negativity in spider enthusiasts, advantages for either one of the combined blocks should be reduced significantly. Positive automatic evaluations of spiders by individuals such as the spider enthusiasts would demonstrate the ability of the IAT to assess personal associations, independently of the negative spider stereotype that exists in our culture. From a clinical perspective, it would also be interesting to test whether automatic evaluations of spiders can actually approach a state of positive evaluation.

Experiment 1

Method

Participants and questionnaires. About 750 undergraduate students of Dresden University of Technology were prescreened through the use of a short screening questionnaire (Spider Anxiety Screening [SAS]; Rinck et al., 2002) that assesses fear and avoidance of spiders as well as possible distress. Two groups of students were selected consisting of 24 individuals with high fear of spiders and 24 individuals with very little fear. Among the spider fearful group, 6 participants fulfilled all *DSM–IV* criteria (American Psychiatric Association, 1994) for specific phobia (animal type/spiders), the remaining 18 spider fearfuls met all criteria except Criterion E (spider interferes significantly with person's daily routine, occupational functioning, or social life, or the person is markedly distressed about having the phobia). Because spiders can be easily avoided in Europe, relevant restrictions and strain are very rare in fear of spiders. For this reason, Criterion E did not have to be fulfilled. To diagnose spider fear and possible other disorders, a trained clinical psychologist interviewed participants using the Mini-Dips (Margraf, 1994). It is a short form of the Diagnostic Interview for Mental Disorders (DIMD; Margraf, Schneider, & Ehlers, 1991), a German adaptation of the Anxiety Disorders Interview Schedule—Revised (ADIS–R; DiNardo, Brown, & Barlow, 1994). The Mini-Dips allows for the diagnosis of anxiety disorders, affective disorders, substance-related disorders, somatoform disorders, and eating disorders, and a screening of psychotic disorders (Margraf, 1994). To assess the degree of spider fear, we required all participants to complete the Spider Fear Questionnaire (FAS, Rinck et al., 2002), a German version of the Fear of Spiders Questionnaire (Szymanski & O'Donohue, 1995), as well as the SAS (Rinck et al., 2002). In addition, we used a similar screening questionnaire, the Butterfly Anxiety Screening (BAS), to assess possible fear of butterflies. All participants were paid a modest fee for their participation.

Word materials. A list of unpleasant German words (all of these words were clearly anxiety-related), and a list of positive words were created.[1] First, a large pool of words specifically related to anxiety was created by a literature search and by contributions of clinical experts. To the resulting words, relevant synonyms were added, taken from Mueller (1972). Valence of the words (from very unpleasant to very pleasant) and relation to anxiety were determined in pretests. In addition, lists of pleasant words were created. These words referred to the topics of "vacation" and "relaxation." A total of 10 unpleasant–anxiety-related and 10 pleasant words were selected from these lists. The final 20 experimental words were unambiguously classifiable ("pleasant" vs. "unpleasant") by all members of the participant population. The two word types did not differ with regard to word frequency or word length. English translations of the words are given in the Appendix.

Picture materials. To draw conclusions about the valence of automatic associations in fearful and nonfearful participants, we chose butterflies as a positively evaluated target category in addition to spiders. In order to estimate and classify automatic fear associations toward spiders, butterflies are a useful alternative target category because they also represent a class of "insect-related" small animals, but with a generally positive evaluation across all participants. In pretests, butterflies were indeed evaluated as clearly positive, accompanied by very little variance between individuals. Therefore, butterfly pictures make it easier to attribute significantly different IAT effects between fearful and nonfearful individuals to different attitudes toward spiders. With butterflies as a second target category, the IAT still reflects associations toward spiders relative to butterflies. However, the absence of any IAT effects would indicate comparable positive automatic evaluations of spiders and butterflies. Twenty pictures of spiders and 20 pictures of butterflies were used in the IAT as target stimuli. As preselection, a pool of 56 spider and 54 butterfly pictures were gathered from different media and standardized as 16-bit color pictures in a 5 cm $\times$ 4 cm format. In pilot tests, only pictures that were easy to identify with similar valence ratings were selected. Participants of the pilot tests did not participate in the main experiment and were free of spider phobia. Finally, 10 spider pictures and 10 butterfly pictures were selected. Each of the resulting pictures was duplicated by creating its mirror image, yielding 20 experimental pictures in each category.

IAT. Each IAT consisted of a complete sequence of five blocks: (a) target discrimination, (b) attribute discrimination, (c) first combined block, (d) reversed target discrimination, and (e) reversed combined block. Each block started with instructions describing the category discrimination and the assignment of the response keys (left vs. right). The procedure started with the target discrimination block, in which participants had to categorize pictures of spiders and butterflies. The pictures were presented one after the other, and each one remained on the computer screen until participants pressed one of two possible response keys. Participants were asked to press one key (the letter *Y* on the keyboard) in response to one type of animal and another key (the hyphen key) in response to the other type of animal. The second block was the attribute dimension, in which participants had to categorize single words according to emotional valence (unpleasant vs. pleasant). The same two keys as in the preceding target discrimination block were used; however, the left key was assigned to one word type and the right key to the other word type. Each of these practice blocks consisted of 80 trials (each of the 40 pictures appeared two times, each of the 20 words appeared four times).

The next block, the first combined block, was a combination of target and attribute discrimination in which targets and attributes appeared in random order on alternating trials. The upper part of Figure 1 shows a sample trial from this block: A spider picture is shown in the center of the screen, and the correct response is to press the left key. The labels at the top of the screen indicate that the same response is correct for unpleasant words, whereas butterflies and pleasant words require pressing the right key. During the reversed target discrimination block that followed, participants learned a reversal of the response assignment for targets (spiders and butterflies), consisting of 120 trials (each of the pictures appeared three

[1] All of the unpleasant words were clearly anxiety related, consisting of symptoms, cognitions, and reactions that are typical in specific phobia. To ensure the comparability of this study with previous experiments, the category label of "unpleasant" vs. "pleasant" was chosen for the attribute dimension. de Jong et al. (2003) used the attribute dimension "negative" vs. "positive," whereas Teachman et al. (2001, 2003) applied various specific labels (e.g., "afraid" vs. "unafraid") as well as an unspecific dimension ("bad" vs. "good"). With rather general attribute labels but specific fear-related items, we considered the features of both studies.

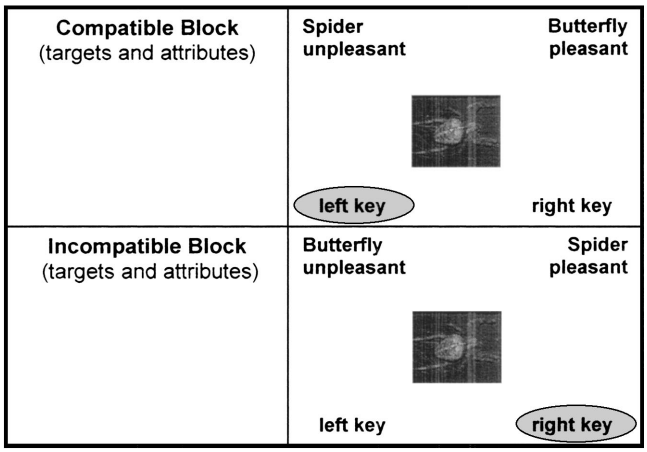

Figure 1. Depiction of a sample trial in the compatible block (upper part) and the incompatible block of the IAT.

times). The final reversed combined block combined the attribute discrimination (not changed in its assignment) with the reversed target discrimination. This is illustrated by the sample trial in the lower part of Figure 1: Again, a spider picture is shown in the center of the screen, and now the correct response is to press the right key. The same is true for pleasant words, whereas butterflies and unpleasant words require pressing the left key. Analogous to the first combined block, 240 items were presented (each of the 40 pictures appeared three times, each of the 20 words appeared six times). In general performance in a combined block should be faster, if a target concept (e.g., spiders) is highly associated with an attribute concept (e.g., unpleasant), and both require responding with the same key (called the *compatible block*). Performance should slow down in the combined block (called the *incompatible block*), when unassociated targets (e.g., spider) and attributes (e.g., pleasantness) require the same response.

All stimuli (black lettered words and colored pictures) were presented vertically and horizontally centered against a light gray background. During each trial, reminder labels (appropriate category names positioned in the top left and top right corner of the screen) remained visible. Stimuli appeared in the same fixed random order for each participant. Each stimulus was preceded by a fixation cross presented for 500 ms. The stimulus was shown until a response was made. After an incorrect response, a black "X" appeared in the center of the screen for one second. The experiment was programmed in RSVP (Williams & Tarr, 1998) and implemented on a Macintosh Performa 5100.

Behavioral Avoidance Test (BAT). To measure fear and avoidance of spiders, we asked participants to take a behavioral test. In front of a closed, separate room the participants were asked to open the door and approach a spider as quickly and closely as possible. The spider was a harmless 7-cm tarantula (*Aphonopelma Pallidum*) positioned about 5 m away from the door in a closed terrarium. When participants indicated that they wanted to stop the approach, we registered the remaining distance between the participant and the spider as well as the duration of the approach attempt. Because participants could avoid the spider either by approaching slowly (affecting time) or by refraining from approaching (affecting distance), we calculated the approach speed, taking both time and distance into account.

Procedure. Participants were tested individually and were informed that they would be completing a classification task including words and pictures. Before the experiment, participants completed the FAS, the SAS, and the BAS, followed by a diagnostic interview. Afterward, participants completed the IAT. To control for possible block order effects, the sequence of the combined discrimination blocks (first combined block and reversed combined block) was counterbalanced across participants, such that half of each group started with the compatible block and the others started with the incompatible block (*block sequence*). Participants were instructed to respond as quickly and accurately as possible during the task. The experimental session closed with the behavioral avoidance test and a valence rating of all presented word stimuli.

Design. The main dependent variable (i.e., the IAT effect) was calculated for each participant as the average latency of the incompatible block minus the average latency of the compatible block divided by the standard deviation of all the latencies in the two test blocks (transformed IAT effects are called *D scores*, according to the scoring algorithm suggested by Greenwald, Nosek, & Banaji, 2003). Positive IAT effects occur when mean reaction times are larger in the incompatible condition (when spiders are paired with positive attributes) than in the compatible condition (spiders paired with anxiety-related attributes). IAT effects were analyzed with an analysis of variance (ANOVA), including the between-subjects variables group (spider fearfuls vs. nonfearfuls) and block sequence (compatible block before incompatible or vice versa). Effect sizes are reported as Cohen's *d* value (Cohen, 1988).

Results

Participant characteristics. As Table 1 indicates, spider fearful participants and nonfearful controls differed markedly on direct measures of spider fear (FAS, SAS). The spider fearful group scored significantly higher on the FAS, $t(46) = 19.1$, $p < .001$, and on the SAS, $t(46) = 24.7$, $p < .001$. Neither the fearful group nor the controls reported fear, avoidance, or distress regarding butterflies, and their BAS scores did not differ from each other, $t(46) < 1$.

IAT effects. Data for each block included response latencies (in ms) and error rates. Prior to the planned analyses, distributions of error rates were examined. Error rates were uniformly low, averaging just under 5% on critical IAT blocks. Thus, only analyses of latencies are reported below. Table 2 displays IAT effects (*D* scores) for both groups (fearfuls and controls) separately for attributes and targets (including effect sizes). Generally, a significant IAT effect indicates faster processing of the compatible block (reflecting associations between spiders and anxiety-related words vs. butterflies and positive words) compared with the incompatible block (reflecting associations between butterflies and anxiety-related words vs. spiders and positive words). An overall ANOVA with the between-subjects variables group and block sequence indicated no influence of block sequence on IAT performance and no Group × Block Sequence interaction on IAT performance (both $F[1, 44] < 1$). However, there was a marginally significant main effect of Group, $F(1, 44) = 3.35$, $p < .07$, $d = .55$, indicating larger IAT effects for fearful participants than for nonfearful controls. Moreover, both spider fearful participants and nonfearful controls showed IAT effects that were significantly larger than zero (fearful group: $M = .47$, $SD = .24$, $t[23] = 9.70$, $p < .001$; controls: $M = .34$, $SD = .29$, $t[23] = 5.62$, $p < .001$). Finally, the split-half reliability of the IAT for all stimuli ($r = .85$) and separately for attributes ($r = .84$) and targets ($r = .82$), suggested good psychometric properties compared with other reaction time measures.

Behavioral Avoidance Test (BAT) and relations among fear measures. As expected, the two groups' behavior differed significantly in the BAT for mean approximation time, distance, and speed (see Table 3). Compared with nonfearful controls, spider fearfuls were significantly slower in approaching the spider (speed: $t[46] = 10.3$, $p < .001$; time: $t[46] = 6.57$, $p < .001$), and

Table 1
Participant Characteristics, Mean Valence Ratings, and Standard Deviations of Word Materials in Experiments 1 and 2

	Experiment 1				Experiment 2			
	Spider fearful		Control		Spider Enthusiasts		Control	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Participants								
n	24		24		9		9	
Gender ratio (F/M)	22/02		20/04		04/05		04/05	
Age	23.38	2.36	23.21	2.73	25.78	6.57	27.11	4.88
FAS	62.42	15.47	1.38	2.16	.00	.00	.44	.73
SAS Spider	19.21	2.87	1.71	1.94	.00	.00	3.67	2.06
BAS Butterfly	.67	1.31	.46	1.06	.00	.00	.22	.44
Ratings of word stimuli[a]								
Pleasant words	1.61	.24	1.53	.28	1.52	.36	1.58	.41
Unpleasant words	−1.67	.24	−1.65	.26	−1.52	.12	−1.40	.01

Note. FAS = Spider Fear Questionnaire; SAS Spider = Spider Fear Screening; BAS Butterfly = Butterfly Fear Screening.
[a] Range of scale: −2 = *very unpleasant,* −1 = *unpleasant,* 0 = *neutral,* 1 = *pleasant,* 2 = *very pleasant.*

they avoided standing close to the animal, $t(46) = 3.1$, $p < .01$. Table 4 displays relations between these behavioral fear measures, IAT scores, and questionnaire scores. The overall pattern indicates moderate correlations of the main IAT score with behavioral measures of fear (approach speed, approach time). Correlations with self-reported fear scores were only marginally significant for the SAS ($p < .07$) and were not significant for the FAS ($p < .14$). The preselection of fearful and nonfearful participants may lead to an overestimation of the relation between implicit associations, questionnaires, and behavior. Indeed, separate correlations within the extreme groups yielded a lower degree of the relationships of IAT effects with questionnaires (fearful group: $r = .10$; nonfearful group: $r = .05$) and behavior (fearful group: $r = -.12$; nonfearful group: $r = -.36$). All within-group correlations indicated the same direction as the correlations collapsed across the groups. Because of the reduced range and the limited number of individuals in these groups, however, the correlations did not approach significance.

To explain whether direct and indirect measures explain unique variance in phobic behavior, we computed a hierarchical regression. Approach speed was the criterion variable during the BAT. The direct measure (FAS) was entered as the first predictor in the model, followed by the indirect measure (IAT effect). As expected, the fear questionnaire significantly predicted avoidance behavior in the first step of the analysis (model: $F(1, 46) = 89.7$, $p < .001$, $R^2 = .66$; fear questionnaire: $B = -.88$, $\beta = -.81$, $p < .001$). When both predictors were included, the overall model was significant, $F(2, 45) = 51.0$, $p < .001$, $R^2 = .69$, and both the questionnaire and the IAT predicted avoidance behavior (fear questionnaire: $B = -.85$, $\beta = -.77$, $p < .001$; the IAT: $B = -23.8$, $\beta = -.18$, $p < .05$). These results indicate that IAT scores predict unique aspects of avoidance behavior beyond fear questionnaires.

Discussion

The results of Experiment 1 indicate that this modified version of the IAT is a useful method to assess implicit expressions of fear associations, providing predictive information in addition to traditional direct questionnaire measures. Participants with high scores of spider fear showed marginally stronger fear-related associations to spiders than nonfearful participants. Moreover, implicit associations correlated with behavior during confrontation with the feared object. The predictive potential of the IAT is underlined by the result that the indirect IAT measure uniquely predicted avoidance of spiders, even beyond standard fear questionnaires.

Table 2
Mean Reaction Times (in Milliseconds) for Compatible and Incompatible Blocks and IAT Effects

	Experiment 1					Experiment 2				
	Spider fearful		Control			Spider enthusiasts		Control		
Block and effect	*M*	*SD*	*M*	*SD*	*d*	*M*	*SD*	*M*	*SD*	*d*
Compatible	600	55	627	80		917	286	697	140	
Incompatible	779	141	678	82		902	209	866	153	
IAT effect	.47**	.24	.34**	.29	.55	.00	.40	.57**	.35	1.63

Note. Implicit Association test (IAT) effects (*D* scores) are computed as the mean latency difference between the compatible and the incompatible block divided by the standard deviation of all the latencies in the two blocks. Effect sizes are reported as Cohen's *d.*
** $p < .01$.

Table 3
Behavior Assessment Tests (BAT) in Experiment 1

	Spider fearful		Control	
BAT	*M*	*SD*	*M*	*SD*
Distance (cm)	104.8**	148.0	11.3	4.5
Time (s)	23.6**	11.1	8.3	2.4
Speed (cm/s)	29.7**	14.1	88.9	24.2

Range of emotional rating scale: 1 ("not at all") to 5 ("extremely").
** $p < .01$.

Experiment 2

Experiment 2 was conducted to investigate the question whether spiders are generally evaluated in a negative manner. For this reason, spider enthusiasts were introduced as an experimental group. Moreover, if implicit associations assessed by the IAT effects do *not* reflect individual associations, but primarily reflect a cultural stereotype or extrapersonal association (see Karpinski & Hilton, 2001; Fazio & Olson, 2003; Olson & Fazio, 2004), spider enthusiasts should exhibit IAT effects that are comparable to those of nonfearful participants. Spider enthusiasts as well as nonfearful individuals know that spiders are considered to be frightening and aversive animals. Hence, one could assume that even nonfearful participants and spider enthusiasts may possess associations between the category "spider" and fear, even though fear is not automatically activated in response to a spider. On the other hand, positive automatic evaluation of spiders by spider enthusiasts would demonstrate the ability of the IAT to assess personal associations, independently from a negative spider stereotype in our culture or our knowledge.

Method

Participants and questionnaires. Spider enthusiasts and controls served as participants in this experiment, all of them without fear of spiders. Spider enthusiasts were recruited through newspaper and radio advertisements. Different from nonfearful control participants, spider enthusiasts had to own at least one spider as a domestic animal (most of them collected and/or bred spiders). Nine spider enthusiasts participated in Experiment 2. Matched in age, sex, and educational level, nine yoked control participants were also recruited and invited to the study. To diagnose spider fear or possible other disorders, a trained clinical psychologist interviewed participants using the Mini-Dips (Margraf, 1994). To assess the degree of spider fear, all participants completed the FAS, SAS, and BAS. To participate in this study, all participants had to be free of spider fear, of any other major mental illness (e.g., other anxiety disorders, depression), and of any associated disorder (drug abuse, alcoholism, personality disorder, mental deterioration). None of the participants reported increased fear of butterflies, and no one had participated in the previous experiments.

Short IAT, words, pictures, and design. The only difference to the IAT procedure of Experiment 1 was the reduction from five to two blocks: (a) first combined block followed by (b) reversed combined block (either "compatible" or "incompatible"). This was done for economic reasons, to avoid time consuming and exhaustive experimental sessions in the field. Results reported by Teachman et al. (2001, 2003) support the usefulness of this reduction to only two blocks. As before, in the compatible block, spiders and unpleasant words required the same response, as did butterflies and pleasant words. In the incompatible block, the allocation of pictures to response keys was switched, such that spiders and pleasant words now required the same response, as did butterflies and unpleasant words. For ease of comprehension, the labels "compatible block" and "incompatible block" are used in the same way as in Experiment 1. One should keep in mind, however, that these compatibility labels may correspond only to the associations of spider fearful participants and nonfearful controls, but not necessarily to the associations of spider enthusiasts. The experimental design mirrored that of Experiment 1. Each block consisted of 240 experimental trials (each of the 40 pictures appeared 3 times, each of the 20 words appeared 6 times). The words and pictures were identical to those of Experiment 1.

Procedure. All participants were tested individually. Before application of the IAT, a "warm-up" interview addressed the topic of spider enthusiasm as well as possible mental and medical illnesses. Then participants completed the FAS, SAS, BAS, and the IAT. Again, the sequence of the combined discrimination blocks was counterbalanced across participants. After completing the IAT, the word stimuli were rated regarding emotional valence.

Results

Participant characteristics. Spider enthusiasts and nonfearful controls did not differ from each other regarding education, gender distribution (4 women and 5 men in each group), or age (spider enthusiasts: mean 25.78, *SD* 6.57; controls: mean 27.11, *SD* 4.88; $t(16) = .49$, *ns*). In the FAS and the SAS, enthusiasts scored uniformly zero. Nonfearful controls did not differ from spider enthusiasts in the FAS, $t(16) = 1.84$, *ns*, whereas they had slightly

Table 4
Experiment 1: Correlations Between Fear Measures

Measure	1	2	3	4	5	6
IAT	.30*	−.05	−.35*	.22	.27	.09
BAT						
1. Time	—	.07	−.78**	.66**	.65**	.09
2. Distance		—	−.43**	.54**	.45**	−.07
3. Speed			—	−.81**	−.82**	.03
4. FAS				—	.96**	.10
5. SAS					—	.08
6. BAS						—

Note. Implicit Association Test (IAT; mean overall IAT effect); Behavior Assessment Test (BAT) time: (time to approach the spider); BAT distance: (final distance from spider); BAT speed: (speed approaching the spider); FAS = Spider Fear Questionnaire; SAS = Spider Fear Screening; BAS = Butterfly Fear Screening.
* $p < .05$. ** $p < .01$.

higher SAS scores, $t(16) = 5.34$, $p < .001$. This significant difference is without practical relevance, however, because the mean SAS score of 3.67 for the nonfearful controls indicates extremely low fear of spiders, similar to the scores of the nonfearful participants in Experiment 1. Again, the groups did not differ from each other in their BAS scores, $t(16) = 1.51$, *ns*. All participant characteristics are displayed in Table 1.

IAT effects. Response latencies, error rates, and IAT effects (*D* scores) were computed and analyzed as before. The IAT effects and effect sizes observed in this experiment are displayed in Table 2. As in the first experiment, the 2 × 2 ANOVA with the between-subjects variables Group and Block Sequence did not yield a significant main effect of Block Sequence, $F(1, 14) < 1$. It is important to note that the IAT effect in the nonfearful group was significantly larger than the effect in the enthusiast group, $F(1, 14) = 9.44$, $p < .01$, $d = 1.63$. No other interaction or main effect approached significance. As expected, nonfearful controls showed IAT effects, $t(8) = 5.10$, $p < .001$, comparable to the effects observed in Experiment 1. These positive IAT effects reflect stronger associations between spiders and anxiety-related words compared to spiders and positive words. In contrast, spider enthusiasts did not show positive IAT effects. Instead, results indicate similar response times for the incompatible and the compatible block with no performance advantages for one of the two combinations. This suggests the same automatic (positive) associations for spiders and butterflies. Finally, the split-half reliability of the IAT was calculated for all stimuli ($r = .89$) and separately for attributes ($r = .81$) and targets ($r = .96$), suggesting good psychometric properties.

Relations between IAT and questionnaires. Because there was only minimal variance in direct measures of fear, there were no significant correlations of the IAT with the questionnaires (FAS: $r = .27$, *ns*; SAS: $r = .38$, *ns*; BAS: $r = .11$, *ns*).

Discussion

IAT effects of spider enthusiasts indicated similar reaction times for the compatible (spider-fear) and the incompatible (spider-pleasure) IAT block. With butterflies as the second target, there was no advantage for one of the combined blocks, suggesting that spiders and butterflies share similarly positive associations in the spider enthusiast group. Although one may be tempted to attribute the lack of an IAT effect in spider enthusiasts to lack of statistical power due to the small sample size, the highly significant difference between enthusiasts and nonfearfuls may not. The nonnegative automatic evaluations of spiders by spider enthusiasts support the hypothesis that personal associations assessed by the IAT are independent from the generally negative spider stereotype in our culture.

General Discussion

Experiment 1 was designed to investigate whether high and low spider-fearful participants differ in implicit fear-related associations, and whether the IAT is able to distinguish between these two groups. Previous experiments were not able to answer this question satisfactorily, since results by de Jong et al. (2003) yielded no group differences in IAT performance between high and low fearful individuals, in contrast to the experiment by Teachman and Woody (2003), who found significant IAT differences. In contrast to the study by de Jong et al. (2003), the experimental paradigm used in Experiment 1 was sensitive to interindividual differences in the strength of affective associations. Nonfearful and fearful participants exhibited marginally significant differences in their strength of negative implicit associations toward spiders, with more negative associations for spider fearful individuals (e.g., the results of Experiment 1 with Teachman et al., (2001), with de Jong et al., 2003). One reason could be that target stimuli used by de Jong et al. (2003) consisted of verbal spider cues like "web" and "hairy" versus neutral cues such as "door" and "key." In contrast, the present study as well as the studies by Teachman and her colleagues (2001, 2003) used ecologically more valid stimuli (pictures of spiders) to assess implicit associations between spiders and negative, anxiety-related attributes. Visual confrontation with phobia-related pictures may indeed lead to differential activation of spider-fear associations, other than words would do (Ellwart, Becker, & Rinck, 2005).

The study reported here revealed a dissociation between direct and indirect measures of spider fear: Nonfearful individuals' questionnaire scores suggested rather neutral evaluations of spiders, whereas their IAT scores revealed negative implicit associations. Moreover, correlations between IAT effects, questionnaire scores, and behavioral tests in Experiment 1 point to the usefulness of IAT data. Automatic associations explained fearful behavior even after controlling for the influence of questionnaire scores, supporting the claim that indirect measures such as the IAT are able to predict aspects of behavior beyond direct measures such as questionnaires.

Unfortunately, it is not possible to draw conclusions about the absolute associations toward spiders, because the associations tested by the IAT are always relative to another object. It is obvious that the second target puts strong restrictions onto the interpretation of IAT effects. For example, presenting snakes as a second target (see Teachman et al., 2001), automatic evaluations of spiders are always relative to the commonly aversive snake category, providing no estimate whether spiders might be evaluated in a neutral or even positive manner. On the other hand, using a neutral category relative to spiders as done by de Jong et al. (2003) would provide an estimate relative to a "neutral baseline." However, the interpretation of the IAT effects is still problematic because valenced stimuli (positive and negative) are generally processed more easily and more quickly than neutral stimuli (see Ferre, 2003) which may produce unwanted effects in the IAT categorization task. With butterflies as a second target, unpredictable effects of neutral stimuli are avoided. Moreover, relating IAT effects to a positive category offers the possibility to investigate whether automatic associations toward spiders are generally negative for fearful and nonfearful individuals, or whether even positive automatic evaluations exist.

The results of Experiment 1 and 2 also provide empirical support for the claim that IAT effects reflect individual fear related associations, different from general stereotypes and knowledge. According to arguments put forward by Karpinski and Hilton (2001), Fazio and Olson (2003), as well as Olson and Fazio (2004), cultural stereotypes or extrapersonal associations influence the IAT categorization task because the IAT's focus is on the evaluative associations to the general category and not to the exemplar of the category. Assuming that all participants either carry or know about negative and fear-related associations toward spiders (and

this easily comes to mind when the category "spider" is presented in an IAT) one would expect no differences between spider fearful, nonfearfuls, and enthusiasts. However, the observed group differences in Experiment 1 and 2, and the lack of negative associations in spider enthusiasts, provide empirical evidence that IAT effects do reflect individual fear related associations.

From a clinical perspective, the performance-based indirect approach of the IAT, based on automatic uncontrollable expressions of fear associations, offers a useful tool to assess specific cognitive aspects of fear processing. McNally (1995) suggested that cognitive biases in anxiety are automatic in the sense of being involuntary, whereas other aspects of automaticity (unconscious or capacity-free processes) do not apply to selective processing of threat associated with anxiety. In accordance with McNally (1995), we also argue that the IAT taps into involuntary automatic aspects of fear processing. For fearful participants, it seems impossible to suppress associations between spiders and negative fear-relevant attributes while performing the incongruent IAT block (spider and pleasant words are assigned to the same key), leading to longer reaction times and IAT effects. This suggestion is also consistent with results by Mayer, Merckelbach, and Muris (2000), who showed that phobic participants perceived their responses to spiders more often as automatic, and not under intentional control. However, looking at positive automatic spider associations, exhibited by spider enthusiasts, it is worthwhile to think about possible implications for therapy of spider phobia. Teachman and Woody (2003) were able to demonstrate changes of implicit fear associations in spider phobia with successful exposure therapy, down to the baseline level of control participants. The clearly positive automatic associations observed with spider enthusiasts suggest that it might even be possible to eliminate fear-related implicit associations altogether. If therapeutic techniques were able to change automatic spider associations in such fundamental ways, consequential risk of relapse after successful CBT might be greatly reduced.

Despite the promising results of IAT applications in psychopathological research, some problems and open questions require attention in future research. First, the relative nature of the IAT is one of its major limitations. In studies examining cognitive structures and schemata on anxiety disorders, the absolute degree of fear associations is certainly more important than the relative strength of alternative associations. Therefore, new methods, which are able to assess the strength of associations in more absolute terms, represent promising alternatives for future research, such as the "Extrinsic Affective Simon Task" (EAST) by De Houwer (2003), the Single Target IAT (STIAT) by Wigboldus, van Knippenberg, and Holland (2001), or the "Go/No-Go Association Task" by Nosek and Banaji (2001).

Second, despite the promising correlations of automatic fear-relevant associations with clinically relevant behavior, one should focus on aspects of fear-related behavior that are not easily predicted by questionnaires and interviews. In this study, the critical behavior was avoidance of spiders assessed by the time and spatial distance when approaching a spider. Although it is reasonable to validate IAT measures by observable behavior (which has not been done very often in previous IAT studies), there is theoretical and empirical evidence that it is useful to discriminate between spontaneous/automatic aspects and controlled aspects of behavior. As an example, the MODE model of attitude-behavior relations (Fazio, 1990; Fazio & Towles-Swenn, 1999) postulates that attitudes measured indirectly predict spontaneous or highly automatized behavior better than controlled behavior, whereas the reverse is true for attitudes measured directly (see also Asendorpf, Banse, & Muecke, 2002). Following these indications, future research should also focus on those kinds of spontaneous or automatic behavior (e.g., physiological arousal, uncontrollable stressful behavior) that are not predictable by self-reports.

Third, before indirect measures such as the IAT may be used as reliable instruments for individual diagnostics in psychopathology and other fields, more needs to be known about the nature of implicit associations assessed by these tasks. Therefore, it will be important to investigate whether dysfunctional implicit associations are relatively stable, or whether they are malleable, and what their malleability depends on. There is empirical evidence from social psychology research (e.g., Wittenbrink, Judd, & Park, 2001; Mitchell, Nosek, & Banaji, 2003) as well as from clinical psychology (e.g., Ellwart et al., 2005) that spontaneous evaluations tested through performance-based indirect measures are influenced by context. If implicit associations and their activation are easily affected by external context situations, retest reliability will suffer. Therefore, further research should determine whether the associations of interest represent a state or trait construct, and how qualities of these associations such as activation level may change during tests.

The results of this study lead to the conclusion that the performance-based methodology of the IAT is a useful and practical approach to implicit fear associations. Currently, the use of indirect measures in clinical psychology is still at its beginning, and it will require intensive methodological and theoretical efforts. In the long run, however, implicit aspects of fear associations may be useful for implications in psychopathology, such as the prediction of treatment outcome and the likelihood of relapse after therapy, or for the identification of cognitive factors of vulnerability.

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Appendix

English Translations of Attribute Words Used in Both Experiments

Pleasant words	Unpleasant, fear-related words
pleasure	panic
exaltation	fear
amusement	to torment
happy	shock
contentment	mortal fear
happiness	horrify
to recreate	panic attack
easygoing	threateningly
vacation	dangerously
exultation	cold sweat

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