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# Implicit and explicit measures of spider fear and avoidance behavior: Examination of the moderating role of working memory capacity



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## ABSTRACT

**Background and objectives:** Avoidance behavior is central to several anxiety disorders. The current study tested whether avoidance behavior for spiders depends on a dynamic interplay between implicit and explicit processes, moderated by the availability to exert control through working memory capacity (WMC).

**Methods:** A total of 63 participants completed an approach-avoidance task, an implicit association test, a spider fear questionnaire and a behavioral avoidance test that included an assessment of approach distance as well as approach speed. WMC was measured by a complex operation span task. It was hypothesized that in individuals with low WMC, implicit avoidance tendencies and implicit negative associations predict avoidance behavior for a spider better than the explicit measure, whereas in high WMC individuals, the explicit measure should better predict avoidance behavior than the implicit measures.

**Results:** Results revealed that WMC moderated the influence of implicit negative associations, but not implicit avoidance tendencies, on spider approach distance but not the speed of approaching. Although explicit spider fear directly influenced avoidance behavior, its impact was not modulated by WMC.

**Limitations:** Participants in our study were from a non-clinical sample, which limits the generalizability of our findings.

**Conclusions:** These findings suggest that implicit processes might become more pertinent for fear behavior as the ability to control such processes wanes, which may be particularly relevant for anxiety disorders given their association with lowered executive control functioning. As such, training procedures that specifically target implicit processes or control abilities might improve treatment outcomes for anxiety disorders.

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## 1. Introduction

While Tina is taking her bike from the shed, she notices a big, hairy spider. She jumps back and runs outside, leaving the bike behind. The inability to control such automatic impulses may eventually give rise to excessive, pathological forms of behavioral avoidance (Barlow, 2002; Beckers, Krypotos, Boddez, Effting, &

Kindt, 2013). Given that avoidance behavior is critical to several anxiety disorders (American Psychiatric Association, 2013), it is of theoretical and clinical importance to understand the factors that determine behavioral avoidance. The present study specifically examines the role of automatic processes, controlled processes, and executive control in the emergence of avoidance behavior in spider fear.

Dual-process models (e.g., Beavers, 2005; Wiers et al., 2007) state that psychopathological behavior is jointly determined by two systems of information processing. Automatic action impulses derive from a fast, implicit system in which affectively laden associations in memory are automatically activated upon perceiving an object and predispose individuals to either approach or avoid

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(i.e., action tendency). By contrast, long-term goals and expectancies reside in a slower, explicit system in which reasoning and decision-making processes activate controlled, goal-directed behavior. The relative influence of both processes on behavior is assumed to critically depend on the availability of executive control functions such as working memory capacity (WMC; Hofmann, Gschwendner, Friese, Wiers, & Schmitt, 2008), which determines the capability for shielding explicit from implicit processes (Barrett, Tugade, & Engle, 2004). Individuals dispositionally differ in WMC and these individual differences are presumed to moderate the expression of the two information-processing systems. Under conditions of low WMC, there is limited cognitive capacity for explicit processes to override the influence of implicit processes, resulting in implicit processes gaining stronger control over behavior as a result (Hofmann et al., 2008). Accordingly, dual-process models predict that implicit processes have a stronger influence on behavior in individuals relatively low in WMC, whereas explicit processes have a stronger influence on behavior in individuals relatively high in WMC.

There is accumulating evidence supporting the moderating role of executive control functioning in approach behaviors such as food consumption, sexual interest (Hofmann et al., 2008), aggressive behavior (Hofmann et al., 2008; Wiers, Beckers, Houben, & Hofmann, 2009), smoking (Grenard et al., 2008), and alcohol use (Grenard et al., 2008; Houben & Wiers, 2009; Peeters et al., 2012; Thush et al., 2008). For instance, several studies showed that implicit alcohol associations predict drinking behavior more strongly in individuals with low compared to high levels of executive control (e.g., Grenard et al., 2008; Thush et al., 2008). The reversed pattern has been observed for explicit alcohol associations, such that these associations predict alcohol use better in individuals with high compared to low levels of executive control (Thush et al., 2008). Recently, Peeters et al. (2012) reported similar results regarding the impact of action tendencies on drinking behavior: Alcohol approach tendencies had a stronger impact on alcohol use for individuals low in executive control compared with those high in executive control. These findings collectively provide empirical support for executive control moderating the impact of different types of implicit processes (e.g., implicit associations and action tendencies) and explicit processes on approach behavior. While it has been argued that such principles may also apply to avoidance behavior (Strack & Deutsch, 2004), research in this area is remarkably scarce.

There is, however, extensive research suggesting that implicit and explicit processes each play a unique role in a variety of fear-related behaviors. Several studies have demonstrated that implicit and explicit processes have incremental predictive validity for fear-related behavior (e.g., Egloff & Schmukle, 2002; Klein et al., 2012; Rinck & Becker, 2007). Rinck and Becker (2007), for example, showed that avoidance tendencies explained additional variance in overt avoidance behavior for spiders in children beyond self-reported spider fear. There is also emerging evidence that implicit and explicit indices of spider fear are differentially related to components of fear-related behavior (e.g., Asendorpf, Banse, & Mücke, 2002; Huijding & de Jong, 2006; Van Bockstaele et al., 2011). Finally, implicit and explicit indicators of anxiety-relevant associations appear to explain unique variance in the onset and course of anxiety disorders (Glashouwer, de Jong, & Penninx, 2011, 2012). Whereas these studies examined the link between information processes and aspects of anxiety-related behavior, the role of executive control as a moderator is largely unknown.

In the field of anxiety, executive control has been examined as a moderator mainly with respect to cognitive processing biases (instead of behavior) (Derryberry & Reed, 2002; Lonigan & Vasey, 2009; Salemink, Friese, Drake, Mackintosh, & Hoppitt, 2013;

Salemink & Wiers, 2012). In line with dual-process models of anxiety (Mathews & Mackintosh, 1998) stating that processing biases can be considered as the joint outcome of information processes and executive functioning, Salemink et al. (2013) provided evidence for a moderating role of executive control regarding threat-related interpretive bias: Individual differences in executive control moderated the relationship between indicators of implicit and explicit social anxiety and interpretive bias. Given the crucial role of avoidance behavior in anxiety, the current study examined whether avoidance behavior for spiders depends on a similar dynamic interplay between implicit and explicit processing on the one hand and executive functioning on the other hand. To our knowledge, only one study exists that has applied a similar perspective to social anxiety (Gorlin & Teachman, 2015). A moderating role of executive functioning was found for the relationship between implicit processes and several anxiety indices but, unexpectedly, not for avoidance behavior.

In the present study, we tested whether executive control functioning (as indicated by WMC) moderates the relative influence of implicit and explicit processing on avoidance behavior for spiders. Specifically, we hypothesized that indicators of implicit spider fear (i.e., negative associations and avoidance tendencies) impact stronger on avoidance behavior in individuals relatively low in executive control, given their greater difficulty in overriding implicit processes. Conversely, we hypothesized that indicators of explicit spider fear would impact stronger on avoidance behavior in individuals relatively high in executive control, given their greater capability to shield the influence of implicit processes.

## 2. Methods

### 2.1. Participants

Participants were selected from a larger sample ( $N = 1037$ ) of students at the University of Amsterdam who completed a spider fear questionnaire (Spider Phobia Questionnaire, SPQ, range: 0–31; Klorman, Weerts, Hastings, Melamed, & Lang, 1974).

To get a broad range of spider fear, we randomly invited students who scored in the lower quartile ( $SPQ < 3$ ; 69 students), in the interquartile ( $SPQ 3$  to 11; 150 students), and in the upper quartile ( $SPQ > 11$ ; 188 students) of whom 27 students finally agreed to participate (3 low, 14 middle, 10 high). Additionally, we recruited individuals via advertisements on the university website. This resulted in a sample of 63 participants of who received either course credits or €11 for participation. As we excluded one participant due to procedural errors, the final sample consisted of 62 participants with a mean age of 21 years ( $SD = 2.3$ ; 47 females).

### 2.2. Measures<sup>1</sup>

#### 2.2.1. Depression anxiety stress scales (DASS)

The short version of the DASS (DASS-21; Lovibond & Lovibond, 1995) was used to assess levels of depression, anxiety, and stress. Participants rated the extent to which each of 21 items applied to them for the past week on a 4-point Likert scale ranging from 0 (did not apply to me at all) to 3 (applied to me very much). Cronbach's alpha's for the subscales indicate adequate internal consistency (range: .82–.90 in a non-clinical population; Henry & Crawford, 2005). Alpha coefficients in the present study ranged from .68 to .83.

<sup>1</sup> Only those measures relevant for the current hypotheses are presented here. Participants also completed a questionnaire regarding the AAT and IAT stimuli and two non-validated questionnaires concerning their general rating of spiders and butterflies and their attempts to control feelings of anxiety.

### 2.2.2. Fear of spiders questionnaire (FSQ)

The Dutch version of the FSQ was used to assess self-reported spider fear (Muris & Merckelbach, 1996; Szymanski & O'Donohue, 1995). It consists of 18 items that are rated on 7-point Likert scales ranging from 1 (completely disagree) to 7 (completely agree). The FSQ has good internal consistency in spider phobics and people with non-clinical levels of spider fear (Cronbach's alpha's ranging from .88 to .97; Muris & Merckelbach, 1996). In the present study the alpha coefficient was .95.

### 2.2.3. Approach avoidance task (AAT)

A manikin version of the AAT (De Houwer, Crombez, Baeyens, & Hermans, 2001) assessed avoidance tendencies for spiders. In this task, participants moved a manikin either towards or away from pictures presented on a computer screen. The pictures included a set of 10 spider pictures and 10 butterfly pictures. The AAT comprised two blocks of 8 practice trials and 64 test trials each. On each trial, a white manikin appeared, centered, at the top or bottom half of a black screen. After 750 ms, a picture appeared centered in the opposite half of the screen. In each block, half of the pictures were horizontal (200 × 270 pixels) whereas the other were vertical (270 × 200 pixels). Participants were instructed to respond to the orientation of pictures. In one block, participants moved the manikin towards horizontal pictures and away from vertical pictures. In the other block, the instructions were reversed with the order of blocks counterbalanced across participants. Participants could move the manikin upwards and downwards by pressing the 'Y' and 'B' key respectively. Upon a key press, the manikin either moved in the indicated direction for 1500 ms (correct trials) or was replaced by a 1500-ms red cross (incorrect trials). The intertrial-interval was 2000 ms. Participants were instructed to respond as fast and accurately as possible. The latency between picture onset and a response was recorded.

During practice trials, two spider pictures and two butterfly pictures were presented two times each. During test trials, another eight spider pictures and eight butterfly pictures were presented four times each. Each picture type was displayed above the manikin on half of the trials and below the manikin on the other half. Pictures appeared in randomized order with no more than two consecutive pictures being of the same type. The spider AAT shows strong split-half reliability ( $r = .78$ ) (Krieglmeyer & Deutsch, 2010).

### 2.2.4. Implicit association test (IAT)

An IAT (Greenwald, McGhee, & Schwartz, 1998) assessed negative associations for spiders. Participants were asked to classify stimuli in four categories using two response keys. Stimuli consisted of a new set of eight spider pictures and eight butterfly pictures (targets; 6.8 cm high × 9.0 cm width) and eight positive words (holiday, summer, present, party, happy, friendly, healthy, cheerful) and eight negative words (death, pain, hate, liar, mean, aggressive, cruel, nasty) (attributes; green lower case letters). Labels were 'spider' and 'butterfly' (white lower case letters) for the target categories and 'positive' and 'negative' (green lower case letters) for the attribute categories. Throughout the task, stimuli appeared in the middle of the screen, while category labels were continuously shown in the upper left and right corners. Participants categorized stimuli by pressing the 'E' or 'I' key.

The IAT consisted of seven blocks. In the first block (32 trials), each word was presented twice to practice attribute categorization. Assignment of response keys to 'positive' and 'negative' was counterbalanced across participants. In the second block (32 trials), target categorization was practised while pictures were presented two times each. The spider category was assigned to the same key as the negative category in the first block, whereas the butterfly category was assigned to the other key. In the third block (32 trials),

participants practised the combined categorizing of words and pictures by compatible response mapping (spider-negative; butterfly-positive). Each stimulus was presented once. The fourth block (64 trials) comprised the test for combined compatible categorization and contained two presentations of each stimulus. In the fifth block (32 trials), target pictures categorization was practised while the labels for the target categories were switched, resulting in reversed response key assignments. Pictures were presented two times each. In the sixth block (32 trials), each stimulus was presented once to practise combined categorization of words and pictures with reversed target labels, such that response mapping was incompatible (spider-positive; butterfly-negative). The seventh block (64 trials) was the test for combined incompatible categorization and comprised two presentations of each stimulus. Because we were interested in individual differences, all participants completed the IAT in the same order (Egloff & Schmukle, 2002).

Instructions before each block explained the labels for categorization and stressed to respond as fast and accurately as possible. On each trial, the stimulus remained on the screen until correct responding. After incorrect responses, a red cross appeared below the stimulus for 200 ms until correct categorization. The intertrial-interval was 250 ms. The latency between stimulus onset and correct responding was recorded. Previous research revealed adequate split-half reliability for a similar spider IAT ( $r = .73$ ) (Van Bockstaele et al., 2011).

### 2.2.5. Complex operation span task (OSPAN)

An automated version of the OSPAN (Unsworth, Heitz, Schrock, & Engle, 2005) assessed individual differences in WMC. In this task participants received sets of math equation-letter trials. Participants first saw a math equation consisting of one multiplication or division and one addition or subtraction (e.g.,  $(1*2) + 1 = ?$ ). After solving it, a digit (e.g., 4) was presented and participants indicated whether the presented outcome was true or false. Then, a letter appeared for 1000 ms followed by the next equation. Participants were instructed to solve the equations as quickly as possible while remembering the letters in serial order. At recall, participants were asked to identify the letters of a current set in correct order. Feedback was given on the number of letters recalled in the correct position and the percentage of correctly solved equations. A math accuracy rate of 85% was required to ensure that participants were not trading off between solving equations and remembering letters. The task started with three practise phases including letter recall, solving math equations, and their combination respectively. During the test phase, participants received sets of different sizes, with the number of trials in each set ranging between three to seven. Each set size was presented three times with the order of set sizes varying randomly between participants. A WMC index was calculated by summing up set sizes of perfectly recalled sets (maximum score of 75). Research indicates for this index both good internal consistency (alpha = .78) and test-retest reliability ( $r = .83$ ), and correlations with other WMC measures (range: .38–.45) (Unsworth et al., 2005).

### 2.2.6. Behavioral avoidance test (BAT)

A BAT was used to measure overt avoidance behavior. Participants were asked to approach a tarantula in an uncovered terrarium as fast and closely as possible until they wanted to stop. The tarantula was 7.5 cm long (with a 5-cm body) and its terrarium was positioned on a table in the corner of an empty room 496 cm away from a mark on the floor. During oral instructions, participants were standing on the mark behind a room screen, unable to view the terrarium. Participants were asked not to cross a line taped on the floor while approaching in order to keep in a straight line.

When participants stopped approaching, the remaining distance to the spider was measured by a measuring-tape that was fixed under the terrarium. Each test was videotaped and approach duration was afterwards assessed on a computer allowing for timing at one hundredth of a second. Time recording started after instructions and ended when the participant indicated to stop or when the participant stopped approaching. Two indices of behavioral avoidance were computed. For approach distance (cm), we subtracted the remaining distance from the initial distance. For approach speed (cm/s), we divided the approach distance by the approach duration. For both indices, lower scores reflected stronger avoidance behavior.

### 2.2.7. Subjective units of distress (SUD) ratings

At the moment of approach termination, participants rated their levels of fear and disgust using two 11-point SUD scales ranging from 0 (not at all) to 10 (very much).

### 2.3. Procedure

Upon arrival, participants were informed about the experiment and signed informed consent. The experiment started with the AAT and the IAT followed by filling out questionnaires in a fixed order (FSQ, DASS-21) in order to minimize between-subjects noise due to order effects (Egloff & Schmukle, 2002). Then, participants conducted the BAT including SUD ratings in another room. After returning, participants received a 5-min break before completing the OSPAN to minimize interference effects. The OSPAN, a relatively demanding task, was assessed after the BAT to prevent depletion of executive control resources during approach behavior.

## 3. Results

### 3.1. Outliers

Data of two participants were excluded from analysis because of high error rates (more than 3 SDs above group mean) on the AAT or the OSPAN. Another participant was not taken into account because of a high rate of slow responses (more than 3 SDs above group mean) on the AAT. Therefore, the analytic sample was 59.

### 3.2. Data reduction and preliminary analyses

For the AAT, practice trials were excluded from the analysis. Trials with incorrect responses (3.43%) and responses with latencies above 1500 ms (2.73%) were also discarded. An AAT index was calculated by subtracting the mean latency for incompatible trials from the mean latency for compatible trials. Negative values reflect an avoidance tendency for spiders relative to butterflies, while positive scores reflect an avoidance tendency for butterflies relative to spiders.

For the IAT, an index score ( $D$ ) was computed following Greenwald, Nosek, and Banaji (2003). Trials from all combination blocks were included (blocks 3, 4, 6, 7) as well as trials with and without errors. An IAT effect was calculated by subtracting the mean latency of the incompatible blocks from the mean latency of the compatible blocks divided by the pooled standard deviation for all four blocks. Negative scores reflect more negative associations for spiders relative to butterflies, while positive scores reflect more negative associations for butterflies relative to spiders.

For means and standard deviations of all measures, see Table 1. To evaluate avoidance tendencies and negative associations in our sample, one-sample  $t$ -tests were performed to test whether implicit measure scores deviated significantly from zero. While the AAT scores showed no significance,  $t(58) = -1.55$ ,  $p = .13$ ,  $d = .20$ ,

the IAT scores did,  $t(58) = -22.19$ ,  $p < .001$ ,  $d = .89$ , indicating more negative associations for spiders compared to butterflies. Additionally, we examined the reliability of the implicit measures on raw latencies. For each measure, we calculated a difference score between each  $n$ th congruent trial (avoid spider/approach butterfly) and each  $n$ th incongruent trial (approach spider/avoid butterfly) (Kersbergen, Woud, & Field, 2015). This resulted in 64 (AAT) and 96 (IAT), respectively, difference scores for each participant. We then computed Cronbach's alpha for each task. The AAT had poor reliability ( $\alpha = .24$ ), but reliability was good for the IAT ( $\alpha = .83$ ).

### 3.3. Bivariate analyses

Since only the FSQ, OSPAN, and approach speed were normally distributed, Spearman's correlations are reported. As shown in Table 1, FSQ scores were significantly correlated with approach distance as well as with fear and disgust ratings during behavioral assessment. In line with our predictions, more self-reported spider fear was associated with a less close approach (i.e., stronger behavioral avoidance) and more feelings of fear and disgust while approaching the spider. Unexpectedly, self-reported spider fear did not significantly correlate with approach speed. None of the implicit measures correlated significantly with the behavioral measures. However, the AAT, but not the IAT, correlated significantly with disgust ratings, such that stronger avoidance tendencies for spiders were associated with more disgust feelings while approaching. Remarkably, subjective ratings were unrelated to approach speed, but significantly correlated with approach distance, indicating that participants who reported less fear and disgust feelings approached the spider more closely. Finally, approach speed and approach distance were positively associated as were fear and disgust ratings.

### 3.4. Multiple regression analyses

To test whether WMC moderates the impact of implicit and explicit measures on avoidance behavior, we evaluated two regression models. One model included approach speed as dependent variable (Rinck & Becker, 2007) while the other model comprised approach distance as dependent variable (Van Bockstaele et al., 2011). Because distance scores were not normally distributed (i.e., many participants approached the spider closely), these scores were transformed into a binary variable based on the median (478 cm). This new variable differentiated between participants who did not approach the spider closely ( $n = 29$ ) and those who did approach the spider closely ( $n = 30$ ). Although the use of the median for discrimination may be somewhat arbitrary, it closely matched discriminating participants' approach behavior (i.e., closely or not) based on video scoring by a rater blind to FSQ scores (93% agreement). Covered distance to the spider was significantly larger for the closely approach group ( $M = 487.41$ ,  $SD = 5.43$ ) than for the not-closely approach group ( $M = 447.32$ ,  $SD = 44.12$ ),  $t(28.82) = -4.86$ ,  $p < .001$ ,  $d = 1.29$ .

For both regression models, we entered explicit spider fear (FSQ), implicit spider fear (AAT, IAT), WMC, and the interactions between explicit spider fear and WMC (FSQ  $\times$  WMC) and implicit spider fear and WMC (AAT  $\times$  WMC, IAT  $\times$  WMC) as predictors. To reduce multicollinearity and to arrive at the correct beta weights, continuous variables were first  $z$ -standardized (Aiken & West, 1991). As multivariate outliers may vary as a function of analysis (Cousineau & Chartier, 2010), they are reported for each analysis separately.

#### 3.4.1. Predicting approach speed

Preliminary analyses for approach speed revealed five

**Table 1**  
Descriptives and Spearman's correlations between central variables (N = 59).

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. DASS-A	–								
2. FSQ	.17	–							
3. AAT	.09	–.13	–						
4. IAT	.18	.09	.11	–					
5. WMC (OSPAN)	–.14	–.10	–.09	–.23	–				
6. BAT-distance (cm)	–.02	–.58**	.12	.11	.12	–			
7. BAT-speed (cm/s)	–.24	–.22	–.08	.09	.04	.29*	–		
8. SUD-anxiety	–.09	.63**	–.23	–.04	.06	–.65**	–.19	–	
9. SUD-disgust	.00	.53**	–.28*	–.13	.00	–.69**	–.19	.62**	–
Range	0–12	18–101	–19.80–99.15	–1.17–.07	3–68	264–496	14.36–100.88	0–9	0–8
M	2.63	41.66	–8.35	–.69	37.98	467.70	64.11	2.88	2.85
SD	2.72	19.04	41.40	.24	14.60	36.91	21.32	2.64	2.66

\* $p < .05$ , \*\* $p < .01$ .

multivariate outliers (Studentized deleted residuals more than  $\pm 3$ , Mahalanobis distance more than 20, Cooks distance more than 1), and hence, these datapoints were excluded. A moderated linear regression analysis revealed that the full model was not significant,  $F(7, 46) = .55$ ,  $p = .79$ ,  $f^2 = .08$ . In line with the correlational analyses, neither explicit (FSQ) nor implicit measures (IAT, AAT) of spider fear predicted approach speed (see Table 2). Moreover, we found no evidence that working memory interacted with explicit and implicit measures of spider fear in the prediction of approach speed.

#### 3.4.2. Predicting approach distance

Preliminary analyses for approach distance yielded four multivariate outliers (Standardized residuals more than  $\pm 3$  and Cook's distance more than 1), and hence, these datapoints were excluded. We performed a binary logistic regression analysis with the close encounter of the spider as the dependent variable (closely = 1, not closely = 0) (cf. Van Bockstaele et al., 2011). The regression analysis revealed significant main effects of FSQ, IAT, and WMC, and a significant interaction between IAT and WMC (see Table 3). Higher self-reported fear of spiders as well as more negative associations for spiders decreased the probability for approaching the spider closely relative to approaching not closely (i.e., more avoidance behavior). Higher levels of WMC, on the other hand, increased the probability for approaching the spider closely relative to not approaching closely. To examine the interaction between IAT and WMC, we probed the effects of negative associations for spiders within high and low WMC ( $\pm 1$  SD) (Hayes & Matthes, 2009). Fig. 1 depicts the results for the probing regression analyses at high and low WMC. As illuminated by Fig. 1, the analysis revealed no effect of IAT scores for participants high in WMC,  $B = .50$ ,  $SE = .56$ ,  $p = .38$ . For participants low in WMC, however, and in line with predictions, there was a significant effect of IAT scores on approach distance,  $B = 3.92$ ,  $SE = 1.44$ ,  $p = .01$ , such that participants were less likely to

approach the spider closely (i.e., they avoided the spider more) as negative associations for spiders became stronger.<sup>2</sup>

## 4. Discussion

In the present study, we examined whether individual differences in WMC moderate the influence of measures of both implicit and explicit spider fear on avoidance behavior. In line with dual-process models (e.g., Strack & Deutsch, 2004), it was shown that negative implicit spider associations influenced avoidance behavior (i.e., approach distance) in individuals low in WMC, but not in those high in WMC. More specifically, individuals with strong negative implicit spider associations, compared to those with weak implicit spider associations, were less likely to approach the spider closely (i.e., avoid the spider) when they were low in WMC. By contrast, for individuals high in WMC, approach distance was not affected by the strength of their implicit spider associations. No moderating role of WMC, however, was found for either the impact of implicit avoidance tendencies or self-reported spider fear on approach distance to the spider. Together, these results suggest that the availability of control resources determine only whether implicit memory associations predict avoidance behavior (i.e., approach distance).

Previous research provided support for working memory moderating the impact of implicit associations in the prediction of approach behaviors such as alcohol use and eating (e.g., Hofmann et al., 2008; Thush et al., 2008). Although it was proposed that similar principles may extend to avoidance behavior as well (Strack & Deutsch, 2004), this is the first empirical evidence for a moderator role of WMC in avoidance behavior. These findings suggest that not only approach behaviors but also avoidance behavior may be conceptualized as the result of a dynamic interplay between implicit and control processes. Moreover, the current findings are consistent with a recent study in the field of anxiety showing WMC to determine the influence of implicit associations on threat-related interpretive bias (Salemink et al., 2013). Together, these findings suggest that implicit processes become more pertinent for fear-related behavior as the ability to control such processes wanes, which is particularly relevant for anxiety disorders as anxiety is associated with lowered executive functioning (Ikeda, Iwanaga, & Seiwa, 1996).

While the expected moderator effects were clear-cut for implicit associations, they did not emerge for action tendencies. One explanation for this discrepancy is that working memory impacts differently on various aspects of implicit processing. A more

**Table 2**  
Linear regression analysis predicting avoidance behavior (approach speed) by z-transformed variables (N = 54).

Dependent variable	Predictor	B (SE)	$\beta$
BAT approach speed	FSQ	–.14 (.16)	–.14
	AAT	.02 (.15)	.02
	IAT	–.16 (.16)	–.16
	WMC	–.13 (.16)	–.13
	FSQ $\times$ WMC	.10 (.17)	.09
	AAT $\times$ WMC	.03 (.24)	.02
	IAT $\times$ WMC	.01 (.15)	.00

Note:  $R^2 = .08$ , B coefficients with stand errors (SE) and standardized  $\beta$  coefficients are reported.

<sup>2</sup> Given the rather low reliability of the AAT, we performed the same regression analyses on the same sample excluding the AAT. Both the analyses for approach speed and approach distance yielded similar results.

**Table 3**  
Logistic regression analysis predicting avoidance behavior (approach distance) by z-transformed variables (N = 55).

Dependent variable	Predictor	B (SE)	Exp(B)	95% CI for Exp(B)
BAT approach distance	FSQ	−3.78 (1.11)	.02**	.00–.20
	AAT	−1.33 (.79)	.27	.06–1.24
	IAT	2.21 (.82)	9.09**	1.82–45.48
	WMC	1.33 (.68)	3.79*	1.01–14.22
	FSQ × WMC	.23 (.83)	1.25	.24–6.43
	AAT × WMC	1.89 (1.14)	6.64	.71–62.45
	IAT × WMC	−1.71 (.73)	.18*	.04–.75

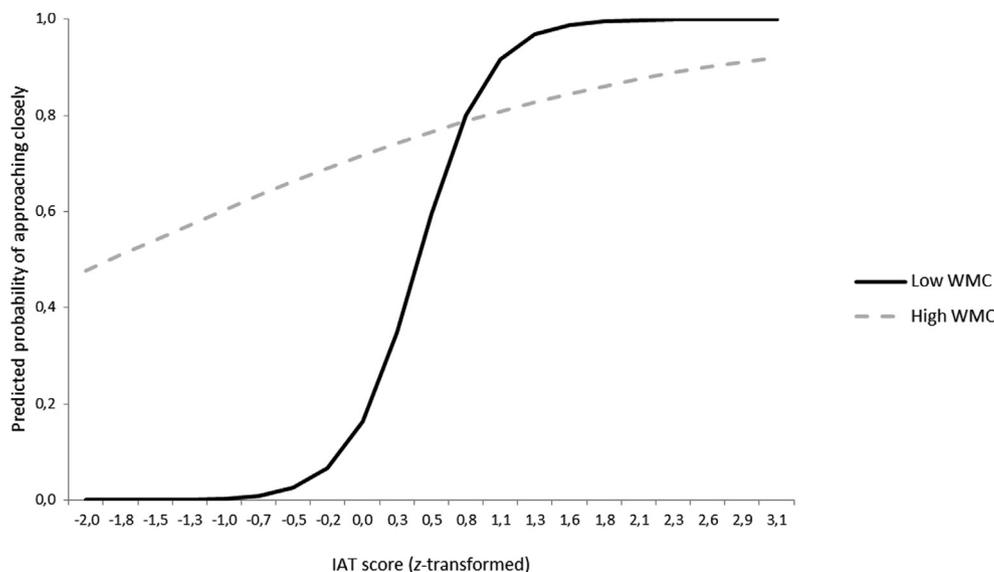
Note:  $R^2 = .53$  (Cox & Snell),  $.70$  (Nagelkerke). Model  $\chi^2(7) = 41.04$ ,  $p < .001$ ,  $p < .05$ ,  $**p < .01$ .

plausible explanation, however, is that the AAT was not valid and reliable. Regarding its validity, AAT scores were unrelated to individuals' levels of self-reported spider fear. Weak correlations between implicit and explicit measures, however, are not uncommon (e.g., Ellwart, Rinck, & Becker, 2006; Klein et al., 2012; Van Bockstaele et al., 2011; but see Rinck & Becker, 2007) and may merely indicate that they measure different processes (Roefs et al., 2011). Note that scores on the IAT were also uncorrelated to explicit spider fear, while, in contrast to the AAT, this task did show predictive capacity for the distance kept to the spider. Poor validity might also relate to the nature of the task, in which participants responded to the picture's orientation, not its content of interest. On the one hand, tasks in which the stimulus content of interest is task-irrelevant (as was the case here) are arguably better suited for capturing implicit processes than tasks in which the stimulus content of interest is task-relevant (Roefs et al., 2011), increasing the validity of the former. On the other hand, in content-irrelevant tasks the content of interest is possibly ignored, particularly in a non-phobic sample, which decreases the chance of affective stimulus information influencing responding, hence decreasing validity (Everaert, Spruyt, & De Houwer, 2013). Future studies on the AAT's predictive validity may therefore either use variants of the AAT in which stimulus content is task-relevant (Spruyt et al., 2013) or directly compare content-relevant variants with irrelevant ones. Moreover, the observed poor reliability of the AAT further precludes validity.

Predicted moderation effects of executive control were also absent for the impact of explicit processes on avoidance behavior.

This might be due to the fact that we used self-reported spider fear as an indicator of explicit processing. Dual-process accounts state that control processes specifically come to play a role in behavior determination when the implicit and the explicit system activate incompatible behavioral schemata accompanied by a feeling of conflict (e.g., Wiers et al., 2007). For example, regarding food consumption, a dieting person may be tempted to eat chocolate on a party, yielding a conflict between an implicit desire to eat and an explicit goal to abstain. However, in the case of spider fear, a self-report measure may not necessarily unveil a conflict between the explicit and the implicit system. Self-reported spider fear may activate behavioral schemata that are in the same direction as measured by indicators of implicit spider fear. For example, in spider anxious individuals, the sight of a spider may directly activate an avoidance tendency, while the explicit belief that spiders are terrifying may also lead to the behavioral decision to avoid rather than to approach the spider. Therefore, future research may use an explicit measure that can reveal a response conflict between the two systems (Sharbanee et al., 2013), such as a measure that captures participants' wish or motivation to overcome their spider fear for instance in treatment-seeking individuals.

Interestingly, we found evidence for a moderating role of WMC in one of the behavioral measures of spider fear only: that is, for approach distance, but not for approach speed. This may relate to a methodological issue of our BAT, in which we required participants to approach the spider as fast as possible. Although in line with other studies emphasizing speediness during such tasks (e.g., Rinck & Becker, 2007), approach speed may capture other concepts than



**Fig. 1.** Probability for approaching the spider closely as a function of working memory capacity (WMC: low, high) and standardized scores on the implicit association test (IAT). Negative IAT values reflect more negative associations for spiders relative to butterflies.

only spider fear. This is suggested by our finding that approach speed was negatively, though non-significantly, correlated with both levels of general anxiety and self-reported spider fear. By contrast, approach distance was associated with self-reported spider fear, but not with general anxiety. Moreover, only approach distance, but not approach speed, was correlated with reports of anxiety and disgust provided after the behavioral task. Together, this suggests that approach distance was conceptually more related to spider fear than approach speed (but see Ellwart et al., 2006).

Another important issue to consider is that WMC predicted approach distance directly. Not only the combination of low levels of WMC and implicit associations, but also low levels of WMC in general decreased the likelihood of approaching the spider closely relative to retaining distance (i.e., more avoidance behavior). Although main effects in a regression model should be interpreted with caution when they are conditional on interaction effects (Cohen, Cohen, West, & Aiken, 2003), there is evidence showing that low executive control in general is dysfunctional as it is associated with both internalizing and externalizing problems as well as psychopathological disorders (Caspi et al., 2014). The possible negative effects of low executive control (either trait or state) on behavioral avoidance could be an interesting target for future research.

Some limitations to the present study should be highlighted. First, the current conceptualization of a strict dissociation between implicit and explicit processes may not fully capture the complexity of human information processing. More recent approaches emphasize continuous interactions between the two processing systems, rather than separate systems that work in sequence (Cunningham, Zelazo, Packer, & Van Bavel, 2007). Second, our sample included unselected students, which limits the generalizability of our findings to clinical samples. Third, students may be characterized by relatively high levels of WMC (Unsworth et al., 2005), which might hinder the observation of moderation by WMC due to ceiling effects. Future research should therefore test the hypotheses in a clinical sample. A final limitation relates to the ordering of tasks. Participants completed the WMC task (OSPAN) after the behavioral task (BAT) to avoid interference of exhaustion by the WMC task on measuring avoidance behavior. However, we cannot exclude that this order influenced the results, despite the 5-min break between tasks. The behavioral task might have been fearful, especially for spider-anxious individuals. High state anxiety may temporarily reduce control resources (low state levels of WMC) and subsequently negatively affect the assessment of trait WMC (OSPAN). In that case, however, a significant negative correlation would have been expected between explicit spider fear and WMC, which was not the case.

The current study extends prior research by showing that individual differences in WMC not only moderate the impact of implicit associations on approach behavior, but also on avoidance behavior. Insights into factors that determine the relative strength of avoidance behavior may have clinical implications. In addition to traditional exposure techniques that reduce avoidance behavior, the current findings may give rise to training procedures that specifically target implicit processes or control abilities to improve treatment outcomes. For instance, it may be beneficial to weaken implicit associations or strengthen WMC to counteract the negative impact of implicit processes. Recent evidence suggests that implicit associations can change by cognitive modification training (Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011) or conditioning training procedures and that these changes are related to reductions in avoidance behavior (Clerkin & Teachman, 2010). Also, novel WM training procedures have shown to successfully enhance WMC with corresponding behavioral changes (e.g., Houben, Wiers, & Jansen, 2011; Owens, Koster, & Derakshan, 2013; Verbeken, Braet,

Goossens, & van der Oord, 2013; but see Shipstead, Redick, & Engle, 2012). The cross-sectional design of the current study, however, warrants future research to explore such causal links between implicit processes and WMC on the one hand and behavior on the other hand.

In conclusion, individual differences in WMC moderated the impact of implicit associations, but not implicit action tendencies, on the distance kept when approaching a spider. Although explicit spider associations directly influenced such avoidance behavior, their influence was not moderated by WMC. Those findings may help to illuminate the factors that determine whether individuals will face an inability to approach feared stimuli.

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