

## Implicit Approach–Avoidance Associations Predict Leisure-Time Exercise Independently of Explicit Exercise Motivation

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Traditional models of exercise motivation presume that behavior is driven by rational decision-making processes. However, recent evidence suggests that automatic motivational processes also play a role in motivating exercise behavior. The current study examined whether regular exercise engagement is linked to implicit approach–avoidance memory associations, as well as explicit intentions and self-determined exercise motivation. A sample of 104 healthy adults completed self-reported measures of exercise intentions, self-determined exercise motivation, and levels of exercise engagement. Approach–avoidance associations were measured using a modified Re-coding-Free Implicit Association Test. Overall, participants associated exercise more strongly with approach than with avoidance attributes in memory, indicating an approach bias for exercise cues. In addition, individuals who reported engaging in higher levels of leisure-time exercise displayed a significantly stronger approach bias for exercise than less active individuals. Furthermore, approach–avoidance associations explained unique variance in exercise behavior after controlling for the effects of explicit exercise intentions and self-determined exercise motivation. These findings suggest that increased engagement in leisure-time exercise is associated with an implicit cognitive bias to approach exercise-related cues in the environment. Moreover, these findings support current theoretical models that suggest that exercise is at least partly motivated by implicit motivational processes.

*Keywords:* exercise, motivation, automatic processes, implicit

The benefits of engaging in regular exercise are well documented. Not only is exercise effective

for weight management (Jakicic, Marcus, Lang, & Janney, 2008), but it is also associated with a range of physical and psychological health benefits (Stanton & Reaburn, 2014; Warburton, Nicol, & Bredin, 2006). Despite this, global rates of insufficient exercise remain high (World Health Organization [WHO], 2014), and successfully maintaining long-term exercise behavior appears difficult for some people (Nam, Dobrosielski, & Stewart, 2012). As a result, identifying the factors that may influence an individual's decision to engage in regular exercise is a primary aim of current health-behavior research (Hofmann, Friese, & Wiers, 2008). In particular, increasing evidence now suggests that behavior can be motivated by a range of impulsive (i.e., automatic) motivational processes that operate outside of conscious awareness (Rothman, Sheeran, & Wood, 2009). Guided

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by the reflective-impulsive model (RIM; Strack & Deutsch, 2004), the purpose of the current study was to examine the strength of implicit approach-avoidance memory associations and investigate whether or not engagement in leisure-time exercise is linked to an implicit approach bias for exercise as well as explicit (i.e., self-reported) forms of exercise motivation.

According to RIM (Strack & Deutsch, 2004), behavior can be motivated by two separate but interacting cognitive processing systems: the reflective system and the impulsive system. The reflective system is responsible for controlled processes that motivate behavior in a relatively slow, careful, and deliberate way (Rothman et al., 2009). For instance, an individual may learn of the health benefits associated with regular exercise and consciously decide (i.e., form positive intentions) to incorporate this behavior into his or her daily routine (Ajzen, 2002). In contrast, the impulsive system is responsible for automatic processes that motivate behavior spontaneously through the activation of implicit memory associations which an individual acquires over time (Deutsch & Strack, 2006; Rebar et al., 2016). For example, a person who regularly enjoys exercise may form an associative network or cluster for “exercise” in which the mental representation of “exercise” is implicitly associated with the concepts “fun” or “enjoyment.” Once formed, these implicit associations can be easily triggered by environmental cues (e.g., workout gear, other people exercising, and thoughts about exercise) and impulsively motivate exercise behavior independently of controlled motivational processes (Brand & Ekkekakis, 2018; Cheval et al., 2018; Conroy & Berry, 2017; Schinkoeth & Antoniewicz, 2017).

In recent years, a growing body of research has investigated how automatic processes can bias information processing and behavior in the context of exercise engagement (Rebar, 2017). In particular, implicit attitudes (e.g., positive or negative associations with exercise) have been suggested to play an important role in the automatic regulation of exercise (Conroy & Berry, 2017). Indeed, it has been reported that the strength and direction of implicit attitudes toward exercise and physical activity are associated with both recent (Bluemke, Brand, Schweizer, & Kahlert, 2010; Calitri, Lowe, Eves, & Bennett, 2009; Padin, Emery, Vasey, &

Kiecolt-Glaser, 2017) and prospective exercise behavior (Chevance et al., 2018; Conroy, Hyde, Doerksen, & Ribeiro, 2010; Forrest, Smith, Fussner, Dodd, & Clerkin, 2016; Hyde, Elavsky, Doerksen, & Conroy, 2012). Moreover, Antoniewicz and Brand (2016b) demonstrated that strengthening positive implicit attitudes toward exercise via evaluative conditioning (Walsh & Kiviniemi, 2014) positively influenced exercise-related decision-making (e.g., chosen intensity on an exercise task). Research has also shown biased attentional processing of exercise-related stimuli. For example, Berry (2006) found that regular exercisers displayed an attentional bias for exercise cues, whereas nonexercisers displayed an attentional bias for sedentary cues. Similarly, Calitri et al. (2009) found that higher levels of exercise were associated with a stronger attentional bias for exercise cues, but that this relationship was strongest among individuals with positive explicit exercise attitudes.

In addition, evidence suggests that exercise-related cues may elicit immediate impulses to approach or to avoid, known as approach and avoid biases, respectively (Cheval et al., 2018). One method of assessing approach-avoid biases is through the use of computerized procedures such as the manikin task (Krieglmeyer & Deutsch, 2010). During this task, participants are required to move a computerized manikin either toward or away from certain cues, depending on the task instruction. For instance, Cheval, Sarrazin, Isoard-Gautheur, Radel, and Friese (2015) asked participants to move the manikin toward and away from images depicting exercise (e.g., a person swimming) and sedentary behaviors (e.g., a person watching TV). Faster approach than avoid responses for each set of cues indicated a stronger approach than avoid bias for those cues. In that study, an approach bias for exercise cues positively predicted leisure-time exercise behavior, whereas an approach bias for sedentary cues negatively predicted the behavior. Using that same task, Cheval, Sarrazin, and Pelletier (2014) found that approach bias for exercise positively predicted performance on a nonvolitional physical activity task (i.e., exerted physical effort on a hand-grip task), even after controlling for the effects of explicit exercise intentions.

Alternatively, approach-avoid biases can be measured by assessing the strength of implicit

approach–avoidance memory associations, using tasks such as the Implicit Association Test (IAT; Greenwald, Nosek, & Banaji, 2003). The IAT is one of the most widely used implicit measures (Nosek, Hawkins, & Frazier, 2011). In this task, the strength of implicit memory associations is inferred from reaction times (RTs) to categorize different stimuli (Greenwald et al., 2003). For instance, Palfai and Ostafin (2003) used an approach–avoid IAT to explore alcohol-related behavioral associations in a sample of hazardous drinkers. Participants were required to use two response keys (e.g., left or right) to categorize stimuli as belonging to one of four concept categories. The authors found that hazardous drinkers were faster to respond to stimuli when the categories “alcohol” and “approach” were mapped onto the same response key and the categories “electricity” and “avoid” were mapped onto the same response key, than the reversed pairings. In other words, hazardous drinkers showed a cognitive bias to approach alcohol-related cues in their environment. Subsequent studies that have used this procedure have found similar results for alcohol (Cohn et al., 2012; Ostafin, Marlatt, & Greenwald, 2008), smoking-related (De Houwer, Custers, & De Clercq, 2006), and both healthy and unhealthy food cues (Kemps & Tiggemann, 2015; Kemps, Tiggemann, Martin, & Elliott, 2013; Kraus & Piqueras-Fiszman, 2016). However, to date, the assessment of such approach–avoidance associations in the context of exercise has not yet been investigated with the IAT. In the current study, we thus aimed to extend the findings of previous research (Cheval et al., 2014, 2015) by utilizing an IAT-based measure of approach bias to determine whether or not exercise engagement is linked to the strength of implicit approach–avoidance memory associations.

In addition, it is important to examine whether approach–avoidance associations are linked to exercise independently of explicit exercise motivation. One model of human motivation that is often applied in the exercise domain is self-determination theory (Deci & Ryan, 2000). According to this theory, motivation can be distinguished along a continuum of autonomy (i.e., self-determination) that reflects the person’s self-endorsement of a specific behavior. In particular, behaviors that are self-determined are performed for reasons that em-

anate from within the self, such as exercising because a person genuinely enjoys exercise or personally values its outcomes. In contrast, behaviors that are not self-determined are more likely to be performed in response to external cues or pressures, such as exercising to gain social approval or to avoid punishment. Although previous research has found automatic processes to predict behavior independently of behavioral intention (Cheval et al., 2014; Conroy et al., 2010), few studies have taken into account whether the behavior is performed for self-determined or non-self-determined reasons (Keatley, Clarke, & Hagger, 2012). The current study thus controlled for levels of self-determined exercise motivation alongside exercise intention, given that the effects of both constructs on exercise behavior have been well established (Dimmock & Banting, 2009; Hagger & Chatzisarantis, 2009).

### The Current Study

The goal of the current study was to examine the relationship between implicit approach–avoidance associations and leisure-time exercise engagement, using an approach–avoid variant of the IAT. Similar to previous research (Kraus & Piqueras-Fiszman, 2016), approach–avoidance associations were assessed using a recoding-free IAT (IAT-RF; Rothermund, Teige-Mocigemba, Gast, & Wentura, 2009). The IAT-RF differs from the original IAT in that congruent trials (i.e., trials in which exercise cues are paired with approach and nonexercise cues are paired with avoid) and incongruent trials (i.e., trials in which nonexercise cues are paired with approach and exercise cues are paired with avoid) are presented within the same, rather than in separate, blocks of trials. Adopting this procedure can help to minimize strategic recoding practices (i.e., the categorization of stimuli based on features other than category membership; Rothermund et al., 2009). Faster response times on congruent versus incongruent trials are indicative of stronger implicit exercise–approach associations and an approach bias for exercise cues (Kemps & Tiggemann, 2015).

We examined the utility of the IAT-RF in assessing approach bias for exercise cues in a number of ways. First, we examined whether or not an IAT-based measure of approach bias

could discriminate between individuals who perform high levels of exercise (i.e., more than the recommended amount of 2.5 hr of exercise per week; WHO, 2014) and individuals who perform low levels of exercise (i.e., less than the recommended 2.5 hr of exercise per week) during their leisure time. We predicted that high exercisers would display a stronger approach bias for exercise cues than low exercisers. In addition, the incremental validity of the IAT-RF was also tested. We tested the prediction that once explicit exercise intentions and self-determined exercise motivation were statistically controlled for, implicit approach-avoidance associations would explain additional variance in self-reported leisure-time exercise.

## Method

### Participants

Participants were 124 (72% female) members of the general public ( $n = 47$ ) and undergraduate psychology students ( $n = 77$ ). The age of the sample ranged from 18 to 61 years ( $M = 28.12$ ,  $SD = 10.99$ ), and the mean body mass index ( $M = 24.82$  kg/m<sup>2</sup>,  $SD = 4.48$ , range = 16.56–37.29) fell within the “normal” classification range. Eligibility criteria for participation were as follows: speak English as first language, no medical conditions that impaired word perception, and no medical conditions that restricted the ability to engage in exercise. Members of the general public were recruited via public advertisements and were given the opportunity to win one of four AUD\$100 gift vouchers. Students were recruited through an online recruitment system (Sona) and were awarded partial course credit for participating in the study. The study protocol was approved by the Institutional Research Ethics Committee.

### Materials

**Word stimuli.** The two target categories consisted of 10 exercise and 10 nonexercise matched control words adapted from a previous research study (Berry, 2006; Calitri et al., 2009) and refined through a pilot study. In the pilot study, 30 undergraduate students (25 females) aged 18 to 46 years ( $M = 25.60$ ,  $SD = 9.09$ ) rated 23 exercise and 23 nonexercise words on a 5-point scale that assessed exercise related-

ness and ranged from 1 (*not at all associated with exercise*) to 5 (*very much associated with exercise*). Stimuli were also rated for pleasure using a 9-point scale ranging from 1 (*extremely unpleasant*) to 9 (*extremely pleasant*). Control stimuli were selected from heterogeneous categories and matched on word length and number of syllables. Using control words from heterogeneous categories has been suggested to increase the importance of the target category (i.e., exercise) and also reduce any systematic influence from the contrast category on the overall IAT effect (Robinson, Meier, Zetocha, & McCaul, 2005). The top 10 exercise-related words (workout, exercise, running, sprinting, sport, swim, athletic, gymnastics, fit, physical) and their matching controls (journal, acoustic, passage, headlight, coast, news, occasion, lighthouses, art, domestic) were selected to represent the exercise and nonexercise categories, respectively. The resulting exercise and nonexercise target stimuli significantly differed in their relatedness to the concept of exercise (exercise  $M = 4.73$ ,  $SD = .14$ ; nonexercise  $M = 1.59$ ,  $SD = .36$ ),  $t(18) = 25.56$ ,  $p < .001$ . However, the two sets of stimuli did not differ in their ratings of pleasantness (exercise  $M = 6.18$ ,  $SD = .57$ ; nonexercise  $M = 5.84$ ,  $SD = .73$ ),  $t(18) = 1.16$ ,  $p = .26$ . Two sets of 10 stimuli used to represent the contrasting attribute categories of approach (near, toward, advance, forward, proceed, reach, closer, attract, want, come) and avoidance (evade, escape, withdraw, away, flee, leave, retreat, afar, abstain, remove) were the same as those used in previous research (Kemps et al., 2013; Palfai & Ostafin, 2003).

**Approach-avoidance IAT-RF.** Approach-avoidance associations were assessed using an approach-avoid IAT-RF similar to that used in previous studies (Kraus & Piqueras-Fiszman, 2016). The IAT-RF consisted of three blocks. In Block 1, participants were required to categorize stimuli according to attribute only (e.g., left = approach, right = avoid). In Block 2, participants were required to categorize stimuli according to concept only (i.e., exercise or nonexercise) with the position of the response labels (i.e., left and right) alternating randomly between trials. During the critical phase (Block 3), participants categorized stimuli according to both concept and attribute. Response assignment for the concept categories alternated to

combine the critical congruent (i.e., exercise + approach vs. nonexercise + avoid) and incongruent (i.e., nonexercise + approach vs. exercise + avoid) categorization phases, with half of the trials being congruent and the other half incongruent. During each block, target stimuli were presented in a white font on a black screen with response labels positioned in the upper-left and right corners of the screen. Response labels appeared 1,500 ms prior to target presentation to ensure that participants were aware of the correct response. Participants were required to indicate which category the target word belonged to by pressing either the left (“Z”) or the right (“/”) key on the keyboard. Each attribute and concept stimulus was presented twice during Blocks 1 and 2, respectively, resulting in 40 trials per block. Block 3 consisted of 80 trials with each attribute and concept stimulus presented twice (Ostafin & Pal-fai, 2006). The intertrial interval was 250 ms.

## Measures

**Approach bias.** Prior to analyses, the IAT-RF RT data were analyzed using the procedure outlined by Greenwald et al. (2003). Only response latencies from the combined critical block were used. In addition, response latencies less than 350 ms or greater than 10,000 ms (1.85% of trials) were considered anticipatory or delayed responses, respectively, and were discarded (Greenwald et al., 2003; Haynes, Kemps, & Moffitt, 2015; Karpinski, Steinman, & Hilton, 2005). All incorrect responses (8.6% of trials) were replaced with the individual’s mean response latency + 600 ms. Difference scores were then calculated by subtracting the mean response latency of congruent trials (exercise + approach vs. nonexercise + avoid) from the mean response latency of incongruent trials (exercise + avoid vs. nonexercise + approach). To account for within-person variability in response time, the resulting difference between congruent and incongruent trials was divided by the participant-specific standard deviation of all correct responses (Greenwald et al., 2003). The resulting score is comparable with Cohen’s (1988) *d* measure of effect size (i.e., small = .20, medium = .50, large = .80) and indicates the direction and strength of the IAT effect. A positive resulting bias score is indicative of stronger implicit exercise–approach versus exercise–avoid memory associations and an ap-

proach bias for exercise, whereas a negative bias score indicated the opposite effect (i.e., stronger exercise–avoid versus exercise–approach associations and an avoidance bias away from exercise).

**Intentions.** Intentions to exercise were assessed using four items (e.g., “I have thought about exercising on at least 3 days over the next 7 days”) that were rated on a 7-point scale that ranged from 1 (*strongly disagree*) to 7 (*strongly agree*; González, López, Marcos, & Rodríguez-Marín, 2012). Scores were averaged, with higher scores indicating stronger intentions to exercise.

**Exercise motivation.** Explicit exercise motivation was assessed using the Behavioral Regulation for Exercise Questionnaire–2 (BREQ-2; Markland & Tobin, 2004). The BREQ-2 contains 19 items scored on a 5-point response scale ranging from 1 (*not at all true of me*) to 5 (*very true of me*). The subscales of this measure indicate levels of Amotivation (e.g., “I don’t see why I should have to exercise”), External Regulation (e.g., “I exercise because others say I should”), Introjected Regulation (e.g., “I feel guilty when I don’t exercise”), Identified Regulation (e.g., “I value the benefits of exercise”), and Intrinsic Regulation (e.g., “I exercise because it’s fun”). From these, a composite relative autonomy index (RAI) can be calculated that indicates the level of self-determined motivation to exercise. Individual RAI scores were calculated by summing the scores of each weighted subscale (Markland & Ingledew, 2007):  $(-3 \times \text{Amotivation}) + (-2 \times \text{External Regulation}) + (-1 \times \text{Introjected Regulation}) + (2 \times \text{Identified Regulation}) + (3 \times \text{Intrinsic Regulation})$ .

**Exercise engagement.** Exercise engagement was assessed using the leisure-time portion of the International Physical Activity Questionnaire and was adapted to measure exercise performed during a “usual week” (Craig et al., 2003). Participants were asked to report the number of days they typically engage in leisure-time moderate and vigorous exercise and for how long on each occasion. Moderate exercise was described as any activity that makes you breathe somewhat harder than usual and requires moderate physical effort. Vigorous exercise was described as any activity that makes you breathe a lot harder than usual and requires hard physical effort. Average amount of time (in hours) spent engaging in lei-

sure-time exercise per week was calculated by multiplying the frequency of exercise sessions by usual session duration. The resulting score was a continuous variable representing “usual” exercise engagement. In addition, a second variable was created by dichotomizing the sample into “high exercisers” and “low exercisers.” The high exercisers reported meeting global recommendations of weekly exercise (i.e., performed 2.5 hr or more of exercise per week; WHO, 2014), whereas the low exercisers reported not meeting these recommendations (i.e., performed less than 2.5 hr of exercise per week; Cary et al., 2016). The International Physical Activity Questionnaire has demonstrated good convergent validity against objective measures of exercise (Craig et al., 2003). Usual exercise engagement was log transformed to normalize the distribution of this variable (before transformation: skewness = 1.00,  $SE = .24$ ; after transformation: skewness =  $-.18$ ). However, the raw untransformed descriptive statistics are reported for ease of interpretation.

### Design and Procedure

The study used a cross-sectional design. Upon arrival at the laboratory, participants received an information letter and were asked to provide written informed consent. Participants then completed the IAT-RF followed by the questionnaires. Testing was completed using a 16.2" Dell 75 Hz monitor docked to a personal laptop running on an Intel Core i-5 CPU. The testing session lasted ~45 min.

### Data Reduction

Of the 124 participants, data from four participants were removed because English was not their first language. Using a single yes/no item, 11 participants were removed from the analyses because they indicated that they did not understand the meaning of the stimuli used in the

IAT-RF. A further five participants were removed for not following the IAT-RF instructions. As a result, analyses were performed on data from 104 participants.

### Statistical Analyses

All analyses were performed with IBM SPSS Statistics 22. Pearson's  $r$  was calculated to assess the strength of the bivariate relationships between the study variables. Mean RTs of the IAT-RF were analyzed using a 2 (group: high exercisers, low exercisers)  $\times$  2 (trial type: congruent, incongruent) mixed-model analysis of variance, with group as the between-subjects variable and trial type as the within-subjects variable. Independent samples  $t$  tests were used to explore differences in IAT-RF approach bias scores between high exercisers and low exercisers and a one-sample  $t$  test was performed to examine if the overall approach bias differed significantly from zero. A hierarchical regression analysis was conducted to examine whether the implicit approach bias predicted unique variance in levels of leisure-time exercise after controlling for explicit exercise intentions and self-determined motivation. Intentions and RAI scores (i.e., self-determined motivation) were entered into the analysis at Step 1 and IAT-RF approach scores were entered into the analysis at Step 2. Usual exercise engagement was entered as the continuous outcome variable. As there was a slight violation to the assumption of homoscedasticity, a heteroscedasticity-consistent standard error SPSS macro (Hayes & Cai, 2007) was used for the regression analysis.

## Results

### Descriptive Statistics

Descriptive statistics and correlation coefficients are displayed in Table 1. Results revealed

Table 1  
*Descriptive Statistics and Bivariate Correlations Between the Study Variables*

Variables	<i>M</i>	<i>SD</i>	1	2	3	4
1. Approach bias	0.30	0.25	—			
2. Exercise engagement (hr)	3.91	3.71	.25*	—		
3. Relative autonomy index	8.31	6.78	.12	.45***	—	
4. Intentions	5.28	1.65	-.001	.34***	.47***	—

\*  $p < .05$ . \*\*\*  $p < .001$ .

that the sample performed, on average, more than the recommended amount of weekly exercise (i.e., more than 2.5 hr of exercise per week). However, there was substantial variability in exercise engagement across the sample. The sample also reported exercising for more self-determined reasons and reported positive intentions to exercise. Age, gender, and body mass index were not associated with any of the study variables (all  $ps > .05$ ). Cronbach's  $\alpha$  (Cronbach, 1951) for the measure of intention was  $\alpha = .94$ , and for the BREQ-2 subscales were as follows: Amotivation,  $\alpha = .82$ ; External Regulation,  $\alpha = .84$ ; Introjected Regulation,  $\alpha = .78$ ; Identified Regulation,  $\alpha = .85$ ; Intrinsic Regulation,  $\alpha = .95$ .

### Approach–Avoidance IAT-RF

Results of the 2 (group: high exercisers, low exercisers)  $\times$  2 (trial type: congruent, incongruent) mixed-model analysis of variance revealed a significant main effect of trial type,  $F(1, 102) = 130.98, p < .001$ , partial  $\eta^2 = .56$ . Mean RTs were faster during the congruent ( $M = 1,134$  ms,  $SD = 311$  ms) than the incongruent ( $M = 1,263$  ms,  $SD = 352$  ms) categorization trials. Further inspection of the RT data revealed that this effect was driven by faster RTs when exercise words were paired with approach ( $M = 1,061$  ms,  $SD = 279$  ms) than with avoid words ( $M = 1,164$  ms,  $SD = 294$  ms), and when nonexercise words were paired with avoid ( $M = 1,207$  ms,  $SD = 357$  ms) than with approach words ( $M = 1,363$  ms,  $SD = 439$  ms). There was no significant main effect of group on overall mean RTs,  $F(1, 102) = .71, p = .71$ , nor was there a significant Group  $\times$  Trial Type interaction,  $F(1, 102) = 3.13, p = .08$ .<sup>1</sup>

### Approach Bias and Exercise Status

Overall, the sample displayed an implicit approach bias for exercise that was significantly different from zero  $t(103) = 12.56, p < .001, d = 1.23$ . Results of an independent-samples  $t$  test demonstrated that high exercisers ( $M = 0.38, SD = 0.26$ ) showed a significantly stronger approach bias for exercise than low exercisers ( $M = 0.22, SD = 0.21$ ), with a moderately large effect size,  $t(102) = -3.43, p = .001, d = .68$ . Figure 1 shows the differences in the density distributions of approach bias between low exercisers and high exercisers. Density plots

provide a precise visualization of trends in the data by estimating the probability density function (i.e., the probability that a score will fall within a particular range; Cohen & Cohen, 2006). As can be seen, and supporting the statistical comparison of the mean scores, there is a clear separation in the peak of the distributions between the low and high exercisers. Examining approach bias separately for each group revealed that approach bias was significantly different from zero for both low exercisers,  $t(45) = 7.11, p < .001, d = 1.05$ , and high exercisers,  $t(57) = 11.15, p < .001, d = 1.46$ .

### Approach Bias Predicting Exercise Engagement

As can be seen in Table 1, exercise engagement significantly and positively correlated with approach bias, RAI scores, and intentions. However, approach bias was not significantly correlated with either RAI scores or intentions. A hierarchical regression analysis was performed to examine the incremental validity of the IAT-RF in predicting exercise engagement. The results of the regression analysis are displayed in Table 2. Step 1 of the regression model containing exercise intentions and RAI scores explained a significant 22.1% of the variance in exercise engagement,  $F(2, 101) = 18.24, p < .001$ . As shown in Table 2, RAI scores ( $\beta = .37$ ) but not exercise intentions ( $\beta = .16$ ) significantly predicted exercise at Step 1. The inclusion of IAT-RF approach scores at Step 2 significantly improved the model fit and explained an additional 4% of the variance in exercise behavior,  $\Delta F(1, 100) = 5.58, p = .02, \Delta R^2 = .04$ . The final model explained a significant 26.2% of the variance in exercise engagement,  $F(3, 100) = 15.13, p < .001$ . Results revealed that exercise engagement was significantly predicted by RAI scores ( $\beta = .34$ ) and IAT-RF approach scores ( $\beta = .21$ ), and mar-

<sup>1</sup> Additional analyses using exercise as a continuous variable indicated that exercise engagement was not significantly associated with mean RTs of either congruent ( $r = -.03, p = .75$ ) or incongruent categorization trials ( $r = .02, p = .86$ ). However, results revealed a significant positive correlation between exercise engagement and IAT-RF approach bias scores (Table 1), indicating that exercise engagement was positively correlated with the patterned effects of both faster RTs on congruent trials and slower RTs on incongruent trials.

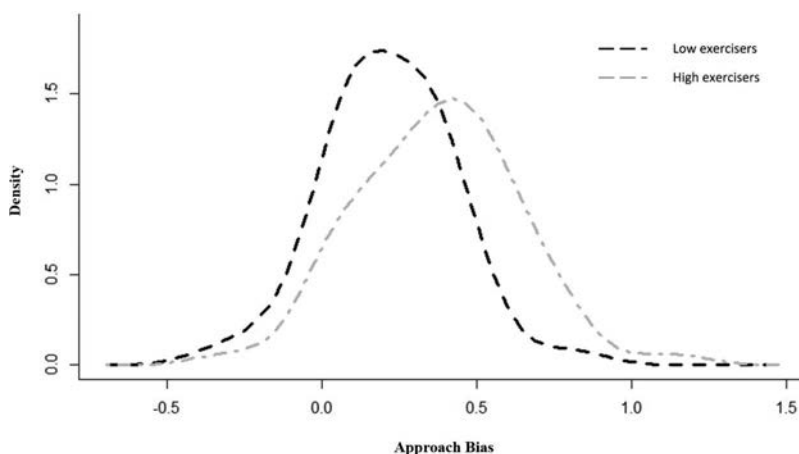


Figure 1. The density distribution of approach bias scores for individuals who engage in low levels of leisure-time exercise (“low exercisers”) against the distribution of approach bias scores for individuals who engage in high levels of leisure-time exercise (“high exercisers”).

ginally predicted by exercise intentions ( $\beta = .18, p = .06$ ) in the final model.

### Discussion

Increasing evidence suggests that exercise can be influenced by both controlled and automatic cognitive processes (Brand & Ekkekakis, 2018; Conroy & Berry, 2017; Rebar et al., 2016; Schinkoeth & Antoniewicz, 2017). Using an approach-avoid IAT-RF, the current study examined the relationship between implicit approach-avoidance memory associations and participation in leisure-time exercise. Results revealed that an approach bias for exercise was demonstrated using the modified IAT-RF. Consistent with our predictions, the results also revealed that high exercisers displayed stronger

exercise-approach versus exercise-avoid memory associations than low exercisers. Moreover, such an approach bias for exercise cues was found to explain unique variance in self-reported exercise behavior after controlling for explicit exercise intentions and self-determined exercise motivation. These findings are consistent with RIM, which proposes that implicit exercise associations are at least partly involved in motivating exercise behavior (Rothman et al., 2009; Strack & Deutsch, 2004).

The current study has several unique contributions. First, we have extended previous research (Cheval et al., 2014, 2015) by examining approach bias for exercise cues using an approach-avoid variant of the IAT-RF. The studies conducted by Cheval et al. (2014, 2015)

Table 2  
Hierarchical Regression Analysis Predicting Exercise Engagement

Variables	Model 1				Model 2			
	B	SE(HC)	$\beta$	t	B	SE(HC)	$\beta$	t
Relative autonomy index	.05	.01	.37	4.56***	.04	.01	.34	3.84***
Exercise intentions	.08	.05	.16	1.69	.09	.05	.18	1.91
Approach bias					.69	.32	.21	2.14*
R <sup>2</sup>	.221				.262			
F	18.24***				15.13***			
$\Delta R^2$					.01			

Note. HC = heteroscedasticity-consistent.  
\*  $p < .05$ . \*\*\*  $p < .001$ .

demonstrated that exercise-related stimuli are able to automatically trigger impulsive approach or avoidant behavioral responses. Using the IAT-RF, our study demonstrates that approach–avoid dispositions can be measured at the implicit associative level in the exercise context. These findings suggest that the presentation of exercise cues in one’s environment can automatically and unintentionally elicit associations in memory, which may subsequently motivate approach or avoidant actions (Brand & Ekkekakis, 2018; Strack & Deutsch, 2004). By assessing implicit approach–avoidance associations, these findings thus extend our current understanding of the different implicit associations that can be triggered by exercise-related cues in our environment (Rebar, 2017).

Second, results revealed that IAT-RF approach scores were positively correlated with self-reported levels of exercise, and were able to discriminate between individuals who perform high versus low levels of exercise during their leisure time. These differences were observed in a comparison of the mean bias scores and by the visual inspection of the density distributions for each group. According to the RIM (Strack & Deutsch, 2004), implicit associations strengthen through repetition and coactivation with environmental cues. Consistent with this perspective, we found that individuals who reported engaging in more than the recommended amount of physical exercise on a “usual” basis displayed a stronger approach bias for exercise than individuals who typically do not meet these recommendations. Previous studies have similarly found that those performing higher levels of exercise display an attentional bias toward exercise-related stimuli (Berry, 2006; Calitri et al., 2009) and have more favorable implicit attitudes toward exercise than less active individuals (Bluemke et al., 2010). The present findings provide further insight into why some people may have greater difficulty than others when it comes to engaging in exercise behavior; individuals who engage in higher levels of exercise have a stronger cognitive bias to approach exercise cues in their environment which may subsequently motivate future behavioral engagement (Cheval et al., 2015). Due to the cross-sectional design of this study, however, inferences of causality cannot be made. As such, further studies using prospective longitu-

dinal designs are needed to explore whether or not the strength of approach–avoidance associations can indeed predict long-term exercise behavior (Antoniewicz & Brand, 2016a; Chevalance, Héraud, Varray, & Boiché, 2017).

Third, an important finding of the current study was that IAT-RF approach scores significantly predicted self-reported exercise behavior after controlling for different forms of explicit exercise motivation. Previous research has demonstrated that automatic processes can influence immediate exercise-related decision-making (Antoniewicz & Brand, 2016b) and predict exercise behavior independently of explicit intention (Cheval et al., 2014, 2015; Conroy et al., 2010; Forrest et al., 2016). The current study is the first, however, to examine the relationship between implicit approach–avoidance associations and exercise behavior, after accounting for explicit intentions and self-determined exercise motivation. The results of this study suggest that implicit approach–avoidance associations may automatically motivate an individual to approach or to avoid exercise-related cues, independently of explicitly held exercise goals or motives. Thus, failure to perform regular exercise may not be due to a lack of explicit exercise motivation, but an automatic bias to avoid exercise cues in one’s environment (Brand & Ekkekakis, 2018). The fact that explicit intentions did not predict exercise behavior in the current study might suggest that for this sample, exercise was largely regulated by automatic processes. Theoretically, the present study contributes to the growing body of research exploring automatic processes in the context of exercise (Rebar et al., 2016; Schinkoeth & Antoniewicz, 2017). By using an approach–avoid IAT-RF, we demonstrated that variation in the strength of implicit approach–avoidance memory associations is linked to differences in exercise behavior. In so doing, these results extend previous research that has primarily focused on implicit affective associations (Bluemke et al., 2010; Calitri et al., 2009). In addition, this study is among the few to investigate approach bias outside of the domains of addiction and consumption research by exploring approach bias toward a health-promoting behavior, namely, exercise (Cheval et al., 2018). Further, these findings support recent calls for the incorporation of automatic processes into traditional theoretical models of human motivation and be-

havior (Dimmock & Banting, 2009; Rothman et al., 2009). The present findings demonstrated that although a measure of self-determined exercise motivation was useful in the prediction of exercise engagement, behavior was at least partly motivated by processes that are not captured by traditional self-report questionnaires.

The current findings also have practical implications. In particular, the finding that both explicit and implicit processes explained unique variance in exercise behavior suggests that interventions that target both forms of motivational processes may be more effective in creating lasting behavioral change (Hofmann et al., 2008). For instance, recent evidence has demonstrated that by experimentally manipulating implicit processes using cognitive bias modification techniques (Kemps et al., 2013), exercise-related decision-making and behavior can be positively influenced (Antoniewicz & Brand, 2016b; Cheval et al., 2018). In addition, fluctuations in the strength of implicit exercise associations have been found to correspond with changes in exercise behavior (Hyde et al., 2012). Thus, future research could explore how changes in approach-avoidance associations influence prospective exercise behavior or, conversely, examine whether or not changes in exercise behavior influence the strength of approach-avoidance associations (Chevance et al., 2017; Wiers et al., 2013). Research and interventions would also benefit from examining implicit approach-avoidance associations for sedentary cues to identify how implicit behavioral associations influence the automatic regulation of sedentary behavior (Cheval et al., 2018).

Like all studies, the current study carries a number of limitations. First, the sample consisted of predominantly healthy, highly active individuals. However, these were all members of the general public which does allow for some level of generalizability of the current findings. Nevertheless, future research could usefully examine the strength of implicit approach-avoidance associations in more diverse populations. For example, measuring approach-avoidance associations may be useful in understanding exercise behavior among obese individuals (Chevance et al., 2018) or people with chronic health conditions (Chevance et al., 2017). Second, the current study used a self-reported measure of exercise behavior which

makes it susceptible to memory errors and self-presentation biases (Adams et al., 2005; Sallis & Saelens, 2000). As such, future research could investigate whether approach-avoidance associations are linked to objectively measured exercise behavior (i.e., using an accelerometer; Cheval et al., 2015).

In conclusion, this study is the first to demonstrate a link between differences in exercise engagement and implicit approach-avoidance memory associations. Findings provide evidence to suggest that the strength of implicit behavioral memory associations plays a role in automatically motivating participation in leisure-time exercise. In addition, they offer preliminary evidence that approach bias for exercise may influence exercise engagement independently of one's consciously held exercise goals and motives. Combined, these findings have important theoretical and practical implications for interventions that attempt to increase exercise engagement in less active individuals and highlight the potential impact of environmental cues on an individual's ability to engage in exercise behavior.

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