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Using implicit attitudes of exercise importance to predict explicit exercise dependence symptoms and exercise behaviors

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Abstract

Objectives—“Fast” (i.e., implicit) processing is relatively automatic; “slow” (i.e., explicit) processing is relatively controlled and can override automatic processing. These different processing types often produce different responses that uniquely predict behaviors. In the present study, we tested if explicit, self-reported symptoms of exercise dependence and an implicit association of exercise as important predicted exercise behaviors and change in problematic exercise attitudes.

Design—We assessed implicit attitudes of exercise importance and self-reported symptoms of exercise dependence at Time 1. Participants reported daily exercise behaviors for approximately one month, and then completed a Time 2 assessment of self-reported exercise dependence symptoms.

Method—Undergraduate males and females (Time 1, N = 93; Time 2, N = 74) tracked daily exercise behaviors for one month and completed an Implicit Association Test assessing implicit exercise importance and subscales of the Exercise Dependence Questionnaire (EDQ) assessing exercise dependence symptoms.

Results—Implicit attitudes of exercise importance and Time 1 EDQ scores predicted Time 2 EDQ scores. Further, implicit exercise importance and Time 1 EDQ scores predicted daily exercise intensity while Time 1 EDQ scores predicted the amount of days exercised.

Conclusion—Implicit and explicit processing appear to uniquely predict exercise behaviors and attitudes. Given that different implicit and explicit processes may drive certain exercise factors (e.g., intensity and frequency, respectively), these behaviors may contribute to different aspects of exercise dependence.

Keywords

Exercise; exercise dependence; implicit association test

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Introduction

Physical activity is a central component to leading a healthy lifestyle. The benefits of regular, moderate physical activity range from decreasing the risk of cancer (Brown, Winters-Stone, Lee, & Schmitz, 2012) to improving cognition (Hogan, Mata, & Carstensen, 2013; Karr, Areshenkoff, Rast, & Garcia-Barrera, 2014) and improving outcomes for treatment-resistant major depression (Stanton & Reaburn, 2014). However, not all amounts and types of physical activity confer health benefits. In fact, engaging in excessive and compulsive exercise has been associated with dangerous conditions like cardiomyopathy (O'Keefe, Patil, Lavie, Magalski, Volgel, & McCullough, 2012; Williams & Thompson, 2014) and eating disorders (Mond, Hay, Rodgers, Owen, & Beumont, 2004).

Many terms have been used to describe the qualities of excessive exercise that might be harmful, with each term implying a slightly different conceptualization. "Exercise dependence" is generally the preferred term, and refers to a preoccupation with exercise that is so *intense* it becomes problematic (Bamber, Cockerill, & Carroll, 2003). Holland, Brown, and Keel (2014)s state that defining how exercise behaviors can be unhealthy requires the examination of both quantitative (e.g., duration, intensity, amount) and attitudinal (e.g., importance, compulsiveness) elements, as each component can predict negative mental health consequences, like exercise dependence and eating disorder pathology (Mond et al., 2004; Taranis & Meyer, 2011). However, there is a lack of understanding with regard to the quantitative and attitudinal elements that lead exercise to transition from being normative to excessive. Congruent with a developmental psychopathology approach of identifying when normative processes become abnormal, the purpose of the current project was to examine one factor that may differentiate individuals who engage in normative exercise versus dependent exercise behavior—implicit attitudes about exercise. Specifically, we examined whether implicit attitudes about the importance of exercise predicted change in explicit, self-reported exercise dependence symptoms.

Dual-Process Theories: Implicit and Explicit Processing

Assessing implicit and explicit attitudes about exercise allows for a comprehensive examination of attitude–behavior interplay. Dual-process theories posit that there are two 'systems' of thinking and processing (for reviews, see Evans, 2008; Kahneman, 2011). The first system (i.e., implicit) operates automatically and with speed relative to the second system (i.e., explicit), which operates through slower and more controlled, reflective processing (e.g., Evans, 2008). Kahneman (2011) described these systems' processing as "fast" and "slow," respectively. Given the quick processing speed of the first system, the thoughts and responses stemming from its processing are relatively automatic—in other words, "fast" thinking often produces a person's gut reactions (e.g., Evans, 2008; Kahneman, 2011). On the other hand, given the deliberate and thoughtful processing involved in the second system, a person's automatic processing may be reflected upon and potentially overcome according to one's critical thinking (e.g., Evans, 2008; Kahneman, 2011). For instance, a person trying to increase fiber intake may inherently enjoy eating potato chips but knows that eating an apple instead is more nutritive. When deciding between these two food choices, a person's "fast" thinking may produce a response to eat

the chips, whereas a person's "slow" and critical thinking may produce a response to eat the apple. Thus, the responses generated via relatively automatic (i.e., implicit) versus controlled (i.e., explicit) processes may conflict with or differ from one another in alignment, valence, or strength.

Implicit and Explicit Attitudes toward Health-Related Stimuli

Implicit and explicit processes may align in the overall prediction of health-related behavior, but these processes may uniquely predict particular types of health-related behaviors (see discussion in Teachman, Cody, & Clerkin, 2010; Wiers, Housben, Roefs, DeJong, Hofmann, & Stacy, 2010). For example, one study testing implicit versus explicit (i.e., self-reported, thereby self-reflected) attitudes in the prediction of food consumption found that implicit attitudes predicted impulsive eating behavior whereas explicit attitudes predicted consciously controlled eating behavior (Frieze, Hofmann, & Wänke, 2008). In regard to exercise behaviors, Calitri and colleagues (2009) demonstrated in a sample of university students that both explicit reports and implicit associations between stimuli for "physical activity" and positive versus negative words were associated with self-reported, retrospective physical activity. In this study, implicit attitudes accounted for variability in exercise behavior above and beyond the effects explained by explicit attitudes. In another study, Conroy and colleagues (2010) found that implicit associations between stimuli for "good" (versus "bad") and "physical activity" predicted seven-day physical activity; this relation was independent of the effects accounted for by explicit measures of exercise self-efficacy and outcome-expectancies. Physical activity was calculated by pedometer-measured daily step counts; though type, intensity, and duration of physical activities were not measured. Similar to findings from Calitri et al. (2009), Conroy et al. (2010) found that implicit and explicit responses aligned in valence, but there were differences in the strength of the associations. Consistent with dual-process theories that predict a potential difference between relatively automatic (i.e., implicit) versus relatively controlled (i.e., explicit) processes in response to health-relevant stimuli, these studies demonstrate that implicit, quickly processed attitudes toward physical activity may be uniquely predictive of certain exercise behaviors (i.e., quantitative) even when controlling for the effects accounted for by explicit, self-report measures.

In addition to implicit versus explicit assessments independently predicting exercise behaviors, implicit and explicit assessments also capture different underlying processes, which drive different action tendencies. Examining different action tendencies may inform how normative behavior (e.g., regular exercise) may become non-normative (e.g., exhibiting exercise dependence symptoms). Namely, research suggests that implicit assessments, which capture impulsive, "fast" processes, capture an action tendency to approach (see Strack & Deutsch, 2004; discussion in Lindgren et al., 2013). Research in the addictions field demonstrates that one's implicit drinking identity (automatic associations between "drinker" and "me") is a robust predictor of alcohol consumption, alcohol problems, and alcohol cravings (Lindgren et al., 2013). Similarly, it is possible that one's implicit attitudes toward exercise may predispose someone to continue "approaching" exercise to a potentially exercise dependent degree, such as exercising so much that it interferes with work or family life, or so much that being unable to exercise produces feelings of irritability. Thus, implicit

and explicit assessments of attitudes toward exercise may not only predict different health behaviors, but may also clarify the relation between normative exercise versus dependent exercise behaviors.

Attitudinal Importance of Exercise

Previous investigations provide an important foundation for studying implicit associations of exercise and corresponding behaviors; however, research has yet to test implicit attitudes regarding the importance of exercise. Attitudinal importance provides information about attitude intensity and behavioral intentions (Boninger, Krosnick, Berent, & Fabrigar, 1995). Decades of research suggest that assigning significant import to a belief fuels the development of more resolute attitudes toward that belief (Boninger et al., 1995; for a review, please see Petty & Krosnick, 1995). Not surprisingly, more resolute attitudes then influence consequent behaviors (Fishbein & Azjen, 1975). According to the components model of behavioral addictions, exercise dependence is thought to be developed, in part, if exercise becomes so important that it takes precedence over other key areas of functioning (e.g., social or occupational activities; Griffiths, 2005; Griffiths, Szabo, & Terry, 2005). For example, if one finds exercise to be moderately important, one may be more likely to regularly engage in exercise than someone with more ambivalent attitudes toward exercise. But if one finds exercise to be extremely important, one may “approach” exercise more frequently or more intensely than someone exhibiting moderate exercise importance, and may thus exhibit more exercise dependent behaviors and symptoms. When applying this logic to the empirical study of implicit and explicit attitudes toward exercise, examining implicit attitudinal associations of the *importance* of exercise—instead of classifying exercise as good/positive or bad/negative—may be particularly informative in prospectively predicting exercise behaviors, and potentially exercise dependence symptoms.

Present Study

In the present study we tested a novel Implicit Association Test (IAT) to (1) examine whether implicit attitudes of exercise importance predicted change in explicit, self-reported exercise dependence symptoms and (2) test how implicit exercise importance and self-reported exercise dependence symptoms longitudinally predict exercise behaviors. Here, we used “exercise” as the target concept; stimuli for “exercise” included words such as exercise, aerobics, and fitness. Past research has used primarily sports-related word stimuli to represent physical activity (e.g., badminton, hockey, football, cricket; Calitri et al., 2009), and found that these stimuli may not be accurate representations of the target concept. Broader stimuli, as used in this task and Conroy and colleague’s (2010) study, may more accurately measure the implicit construct of exercise. Additionally, in contrast to prior research (Calitri et al., 2009; Conroy et al., 2010), the current IAT followed the original or full IAT paradigm (Greenwald, McGhee, & Schwartz, 1998), to capitalize on the relatively strong psychometric properties of the full IAT (Nosek, Greenwald, & Banaji, 2007). Finally, to capture the critical aspect of attitudinal *importance* (as compared to attitudinal *valence*, as measured previously), our IAT required participants to pair exercise and rest stimuli with words signifying “important” or “unimportant.”

In sum, there were two main aims of the present longitudinal study. Aim 1 evaluated the predictive utility of implicit attitudes of exercise importance (assessed via the IAT) and Time 1 exercise dependence symptoms in the prediction of Time 2 exercise dependence symptoms. Given that placing utmost importance on exercise is a symptom of exercise dependence (Griffiths, Szabo, & Terry, 2005), we predicted that relatively stronger implicit associations toward exercise as important at Time 1 would predict self-reported exercise dependence symptoms at Time 2, controlling for Time 1 exercise dependence symptoms. Aim 2 tested if implicit and explicit attitudes about exercise uniquely predicted exercise behaviors. To investigate Aim 2, we measured quantitative elements of exercise behaviors (i.e., frequency, intensity, and duration) for approximately one month and tested how Time 1 implicit exercise importance and Time 1 exercise dependence symptoms predicted exercise behaviors between Times 1 and 2. Consistent with previous findings (Calitri et al., 2009; Conroy et al., 2010) and research demonstrating that attitudinal importance influences attitude intensity and consequent behaviors (Boninger et al., 1995; Fishbein & Azjen, 1975) we predicted that Time 1 exercise dependence and implicit exercise importance would independently predict exercise behaviors.

Method

Participants

Our Time 1 sample consisted of 93 undergraduates (59.1% female, $n = 55$). Eighty-five participants completed the daily diary portion of the study, and of them, 74 participants returned for Time 2 (59.5% female, $n = 44$). A one-way ANOVA was performed to test for differences between those who completed both Time 1 and Time 2 and those who only completed Time 1. This test revealed no significant differences between completers and non-completers on any of the dependent variables used in the analyses (all $ps > .10$). The ethnic composition was predominantly Non-Hispanic (97.8%). The racial composition was: 86.0% Caucasian, 3.2% African American, 8.6% Asian American, 1.1% Native Hawaiian/Other Pacific Islander, and 1.1% did not report a race. The participants' ages ranged from 18 to 22 ($M = 18.78$, $SD = .88$).

Procedure

In return for course credit, undergraduate students participated in a two-part study requiring them to complete an IAT assessing implicit exercise importance at Time 1 and fill out questionnaires on two separate occasions separated by four to five weeks (average time between Time 1 and 2 was 30.73 days [$Range = 24-39$; $SD = 3.03$]). Additionally, between Time 1 and 2 participants were asked to complete a short daily survey on their exercise behaviors and mood for the previous day (described below). Participants received a daily email reminder asking them to complete the daily survey. Participants completed the IAT (Time 1) and questionnaires (Times 1 and 2) on a laboratory computer. The daily exercise survey was completed on-line with a computer, tablet, or smartphone via a secure website. All procedures were approved by the university's Institutional Review Board, and all participants provided informed consent prior to participating.

Measures

Body Mass Index—Height and weight were measured by a research assistant at Time 1 and Time 2 using a stadiometer and digital scale, respectively. We used this information to create body mass index (BMI; kg/m^2) scores for participants at Time 1 and Time 2 and then computed an average BMI for each subject.

Exercise Importance IAT—Implicit exercise importance was assessed with an IAT (Greenwald et al., 1998), which reflects relatively automatic (i.e., outside one's conscious control) associations in a person's memory (Teachman, Joorman, Steinman, & Gotlib, 2012). Similar to other methods frequently used by social cognition researchers (e.g., Fazio, 2001), the IAT is a reaction time test that evaluates the *relative* strength of association between two concepts in a person's memory. In particular, the IAT compares the time it takes for an individual to classify stimuli when paired categories match (versus contradict) one's relatively implicit associations. Individuals are expected to classify stimuli more quickly when paired categories are consistent (versus inconsistent) with their relatively implicit associations.

During critical IAT blocks, one category pairing is shown on the upper left side of the computer screen (e.g., Exercise + Important), and the other category pairing is shown on the upper right side of the screen (e.g., Rest + Unimportant). In a later critical block, category pairings switch (e.g., now Exercise + Unimportant and Rest + Important are paired). Participants are asked to classify stimuli that appear in the middle of the screen as quickly and accurately as possible into one of the two category pairings. Thus, the IAT score reflects the difference in time to classify stimuli into paired categories when categories match (versus contradict) one's implicit associations. Rest/Exercise and Important/Unimportant stimuli were selected from a larger pool of stimuli that were rated by a small sample of undergraduate students for how easy they were to categorize into their respective category labels. Using a scale ranging from 1 (*very hard to classify*) to 7 (*very easy to classify*), mean ease of categorization ratings were as follows: Rest stimuli: $M = 6.36$; Exercise stimuli: $M = 6.44$; Important stimuli: $M = 6.28$; Unimportant stimuli: $M = 5.94$). See Table 1 for IAT category labels and corresponding stimuli.

Exercise Dependence Questionnaire—The Exercise Dependence Questionnaire (EDQ; Ogden et al., 1997) is a 29-item self-report assessment measuring exercise dependence. The EDQ is composed of 8 subscales: interference with social/family/work life; positive reward; withdrawal symptoms; exercise for weight control; insight into problem; exercise for social reasons; exercise for health reasons; and stereotyped, repetitive behavior. Example items include “The rest of my life has to fit in around my exercise” (interference subscale) and “If I cannot exercise I feel irritable” (withdrawal subscale). Respondents rate each item on a Likert-type scale from one (*strongly disagree*) to seven (*strongly agree*). Higher scores represent more exercise dependent attitudes and behaviors, and total scores 116 suggest the presence of exercise dependence (Bamber, Cockerill, & Carroll, 2003).

Some EDQ subscales measure attitudes and behaviors that are not necessarily problematic (e.g., exercising for health, appearance, or social reasons; positive reward; stereotyped

behavior). Given this, the present study combined the interference and withdrawal subscales, as each assesses problematic and exercise dependent attitudes and behaviors, to compute a problematic exercise score. The problematic exercise score was used in all analyses. Across both study time points, reliability was good for the interference subscale (Time 1 $\alpha = .84$, Time 2 $\alpha = .82$), acceptable for the withdrawal subscale (Time 1 $\alpha = .76$, Time 2 $\alpha = .72$), and good for the combined interference and withdrawal subscales (Time 1 $\alpha = .87$, Time 2 $\alpha = .83$).

Daily Diary Report of Exercise Behaviors—For the purposes of this study we created a short online survey that participants were instructed to complete each day. The survey asked participants questions about their exercise behaviors from the day before. Specifically, participants were asked if they exercised yesterday. If they did not engage in exercise, the survey ended. If they did exercise, they were asked to answer questions about how long they exercised (in minutes) and how intensely they exercised (0–100).

Data Analysis and Reduction

All analyses were conducted with SPSS version 21.0. For Aim 1, data analyses included only Time 2 completers. Aim 2 analyses included participants who completed the Time 1 questionnaires and the daily exercise survey, thus the sample numbers differ slightly. Variance inflation factor (VIF) and tolerance statistics indicated that multicollinearity was not present within the data (Field, 2013).

IAT scoring—IAT data were scored according to the algorithm outlined by Greenwald, Nosek, and Banaji (2003). This method creates a D score, conceptually similar to a Cohen's d, which is comprised of the difference in mean reaction time across critical blocks divided by the standard deviations across blocks (see for more information: www.millisecond.com/download/library/IAT/). Higher numbers here indicate a relatively stronger implicit association between Exercise + Important (vs. Rest + Unimportant).

Daily Exercise Survey—The completion rate of the daily survey was high. On average, participants completed the daily survey 89.1% of the study period (percentage scores were calculated by dividing the number of days the daily survey was completed by the number of days each participant was in the study). Further, participants exercised on average 39.0% of the days during the study interval (percentage scores were calculated by dividing the number of days exercised by the number of days each participant completed the daily survey); the average intensity of daily workouts was 57.7% and the average duration was slightly over one hour ($M = 63.6$ minutes).

Descriptive Statistics

While the full EDQ score was not appropriate to test our study aims, the full scale was administered to participants at Time 1 and Time 2 to identify the proportion of participants that may have met diagnostic criteria for exercise dependence (i.e., having an EDQ total score > 116). Twenty percent of the Time 1 sample ($n = 19$) and 18.9% of the Time 2 sample ($n = 14$) had total scores ≥ 116 .

Correlations indicated that EDQ problematic exercise scores at Time 1 and Time 2 were significantly and positively associated with the percentage of days exercised (see Table 2). EDQ problematic exercise scores at Time 1 were also significantly and positively associated with mean exercise intensity. As expected, exercise importance D scores showed small, positive relationships with EDQ scores, percentage of days exercised and mean exercise intensity.

Results

Aim 1

In the prediction of Time 2 exercise dependence symptoms, we conducted a hierarchical linear regression with demographic variables (age, BMI) and the number of days between Time 1 and Time 2 entered in Step 1, Time 1 exercise dependence symptoms (as measured by the EDQ problematic exercise score) in Step 2 (thereby creating residual change scores in EDQ from baseline to follow-up [Cohen, Cohen, West, & Aiken, 2003]), and implicit exercise importance D scores in Step 3. Time 1 exercise dependence symptoms predicted Time 2 exercise dependence symptoms, $t(62) = 8.43, p < .001, R^2 = .51$, and as expected, implicit exercise importance predicted Time 2 exercise dependence symptoms controlling for Time 1 exercise dependence symptoms, $t(61) = 2.49, p = .02, R^2 = .05$, see Table 3.

Aim 2

Percentage of days exercised—We next examined if implicit exercise importance and self-reported exercise dependence symptoms predicted the percentage of days exercised using a hierarchical linear regression model with demographic variables (age, BMI) and the number of days between Time 1 and Time 2 entered in Step 1, Time 1 exercise dependence symptoms (as measured by the EDQ problematic exercise score) in Step 2, and implicit exercise importance D scores in Step 3. In partial support of hypotheses, EDQ problematic exercise scores, but not implicit exercise importance scores, predicted the percentage of days exercised over the course of the study, $t(76) = 3.30, p = .001, R^2 = .11$.

Exercise intensity—To test implicit exercise attitudes and self-reported exercise dependence symptoms in the prediction of daily exercise intensity and duration, data were analyzed using hierarchical linear modeling (HLM), which allowed us to consider participants' data in the context of each participants' daily variation in exercise intensity and duration. Specifically, in repeated measures designs, HLM allows for data collected at multiple time points to be nested within each participant and was thus utilized to examine how implicit and explicit measures predicted daily exercise intensity and duration. Model testing proceeded in 3 phases: unconstrained (null) model, random intercepts model, and random intercepts and slopes model.

The ICC for the intercept-only model was .48, indicating that variance existed at both levels of the data. Specifically, 48% of the variance in exercise intensity scores is between participants and 52% of the variance is within participant. In the next step of model testing, daily exercise intensity was predicted from age, BMI, implicit exercise importance D scores, and Time 1 EDQ problematic exercise score (continuous, fixed effects factors); intercepts

were included for both fixed and random effects. In this model, only EDQ problematic exercise predicted daily exercise intensity, $t(72.78) = 2.84, p = .01$. We next tested a similar model, but allowed the intercept and EDQ problematic exercise scores to include both fixed and random effects. This model appeared to fit the data better as there was a reduction in the negative two log likelihood value (Heck, Thomas, & Tabata, 2010). In this model, both implicit exercise importance, $t(63.64) = 2.14, p = .04$, 95% CI [0.80, 23.48] and EDQ problematic exercise, $t(64.97) = 2.19, p = .03$, 95% CI [0.04, 0.90] predicted exercise intensity. In other words, as hypothesized, implicit attitudes about exercise as important predicted exercise intensity beyond the effects accounted for by explicit exercise dependence symptoms.

Exercise duration—A similar series of model testing proceeded for the prediction of daily exercise duration. The ICC for the intercept-only model was .33, indicating that variance existed at both levels of the data. In model 2, age, BMI, implicit exercise importance D scores, and Time 1 EDQ problematic exercise score were entered in the prediction of daily exercise intensity (continuous, fixed effects factors); intercepts were included for both fixed and random effects. In this model, EDQ problematic exercise, but not implicit exercise importance, predicted exercise duration, $t(70.27) = 2.36, p = .02$. We next tested a random effects model including EDQ problematic exercise scores (model 3); this model fit the data better as there was a significant reduction in the negative two log likelihood value [diff = 6.13, $\chi^2(1)$ critical value = 3.84]. In this model, neither implicit exercise importance ($p = .40$) nor EDQ problematic exercise were significant ($p = .09$), although EDQ problematic exercise scores trended toward predicting the duration of exercise sessions.

Discussion

The goal of the current investigation was to test relations between implicit attitudes towards exercise importance, an explicit measure of exercise dependence symptoms, and daily exercise behaviors. Regular exercise results in physical and psychological benefits (Bouchard, Shephard & Stephens, 1994); however, compulsive, excessive, or obligatory exercise is linked to deleterious outcomes, including increased psychopathology (Hausenblas & Downs, 2002). To date, research has demonstrated that implicit attitudes towards exercise predict engagement in exercise behaviors (Calitri et al., 2009; Conroy et al., 2010), yet has neglected to test multiple components of exercise behaviors (e.g., duration and intensity of exercise) or implicit attitudinal importance. The current study extends this literature by assessing implicit attitudinal importance of exercise and measuring quantitative aspects of exercise behavior via a daily diary study. Findings suggested that both implicit attitudes towards exercise importance and previous exercise dependence symptoms predict later exercise dependence symptoms and daily exercise intensity.

As predicted in Aim 1, Time 1 exercise dependence symptoms and implicit exercise importance predicted Time 2 self-reported exercise dependence symptoms. Implicit exercise importance predicted later exercise dependence symptoms beyond the effects accounted for by previous exercise dependence symptoms. Results were consistent with previous literature demonstrating a positive association between implicit attitudes towards physical activity and

engagement in normative physical activity, beyond explicit attitudes (Calitri et al., 2009; Conroy et al., 2010). The present results extend this literature in at least two ways. First, by studying implicit associations of the importance of exercise rather than the evaluation of exercise, the present study tapped into an attitude construct (i.e., importance) that typically produces stronger attitudes as compared to other constructs (i.e., evaluative; Boninger et al., 1995). Second, we demonstrated that implicit attitudes of exercise importance—in addition to explicit measures of exercise dependence—are strong predictors of potentially non-normative exercise behaviors.

Aim 2 was partially supported as implicit exercise importance and self-reported exercise dependence symptoms uniquely predicted daily exercise intensity. However, only self-reported exercise dependence symptoms predicted the percentage of days exercised and trended toward predicting the duration of exercise sessions, while implicit exercise importance did not significantly predict the frequency or duration of exercise sessions. These findings are in line with a dual-process theory framework and highlight the importance of assessing both implicit and explicit attitudes, as each type of attitude and processing predicts different aspects of health behaviors (Friesen et al., 2008). For example, the percent of days exercised may reflect a more “slow,” consciously controlled, deliberative process (e.g., one must put on appropriate clothing, drive or walk to the gym) whereas the intensity of exercise may be more “fast,” spontaneous, or ‘in the moment.’ By measuring each type of processing, we gain specificity in understanding how implicit and explicit assessments complement and diverge from one another in the prediction of health-relevant behaviors.

Moreover, assessing “fast” processing sheds light on action tendencies that may drive particular behaviors. Specifically, implicit associations of exercise importance may activate action tendencies to approach exercise (Strack & Deutsch, 2004). Implicit associations between exercise and important may help to explain how people can continue “approaching” exercise to the point where it interferes with other important areas of functioning and causes impairment. Therefore, continued investigation is needed to clarify the relation between implicit and explicit attitudes of exercise importance and exercise dependence symptoms.

Implications and Future Directions

The findings of the present investigation extend previous studies while addressing gaps in the literature. The present study employed a novel IAT to assess implicit attitudes towards exercise importance and used a daily diary method to assess exercise behaviors for approximately one month. Assessing implicit attitudes in relation to pathological behavior elucidates potential areas for intervention while also highlighting several areas of future research. For example, using cognitive restructuring skills to challenge ideas about the importance of exercise may be fruitful for clients seeking treatment for exercise dependence. Research in other domains (i.e., treatment of panic disorder) has found that cognitive changes in automatic associations during Cognitive Behavioral Therapy predict later symptom changes (Teachman, Marker, & Smith-Janik, 2008). Regarding future research, more work is needed to better understand when exercise transitions from healthful to harmful. Moderate exercise confers a multitude of health benefits (Brown et al., 2012;

Hogan et al., 2013; Karr et al., 2014; Stanton & Reaburn, 2014), yet excessive exercise has extremely deleterious effects (Mond et al., 2004; O’Keefe et al., 2012; Williams & Thompson, 2014). Thus, it is possible that the relationship between exercise and health is curvilinear—this would mean that after reaching a certain threshold, exercise becomes exponentially more harmful. It would be useful for future research to examine quadratic relations between exercise importance, exercise behaviors, and the consequences of those behaviors. Specifically, examining if there is a threshold at which exercise importance transitions from being normative to pathological could contribute to the field’s conceptualization of exercise dependence and “how much is too much.”

In addition, research demonstrates that both implicit and explicit processes are involved in motivating physical activity (Conroy et al., 2010), and that both of these processes predict unique types of health-related behaviors (Friese et al., 2008). Given that different implicit and explicit processes may drive certain exercise factors (e.g., intensity and frequency, respectively), these behaviors may contribute to different aspects of exercise dependence. Future research would benefit from clarifying if impulsive versus controlled exercise behaviors are uniquely related to positive and negative outcomes, and investigating the most effective treatments for impulsive and controlled exercise behaviors.

Finally, our study examined implicit exercise importance, self-reported exercise dependence symptoms, and exercise behaviors among undergraduates. Studying implicit and explicit exercise importance in clinical samples would provide further information on the relation between implicit exercise importance, explicit symptoms of exercise dependence, and exercise behaviors. In particular, it would be fruitful to extend this research to individuals with eating disordered symptoms. Research has consistently demonstrated that people with disordered eating symptoms more frequently utilize compulsive exercise or unhealthy exercise habits compared to controls (e.g., Davis et al., 1997). Exercise dependence certainly appears to exist in the absence of eating disordered symptoms, but exercise dependence may be particularly prevalent in those with comorbid eating disordered symptoms (for a review, see Berczik et al., 2012). Given this, future research should assess if individuals with eating disordered symptoms respond differently than non-eating disordered individuals on the exercise importance IAT employed in the present study, and how relatively “fast” versus relatively “slow” processes may relate to exercise related behaviors manifested among people with eating disorders.

Strengths and Limitations

Several methodological limitations should be considered when interpreting these results. Generalizability of the present findings is limited due to the relatively small sample size and demographic homogeneity (i.e., all participants were college students within a limited age range, and a substantial majority of participants were Caucasian). Previous research suggests that motivation to exercise differs across age groups (Brunet & Sabiston, 2011), likely due to changing values, goals, and health concerns across the lifespan. Therefore, it is possible that attitudes regarding exercise importance, and their relation to exercise behaviors, are also differentially associated with age or other demographic variables. Additional research is needed to clarify the generalizability of these findings to groups not represented in the

current sample. A second limitation of the present study was the use of self-reported daily exercise behaviors. When possible, future studies should employ more objective methods of exercise measurement, such as activity trackers or heart rate monitors. Finally, researchers have found a positive association between self-monitoring of exercise behaviors and physical activity levels (e.g., Carels, Darby, Rydin, Douglass, Cacciapaglia, & O'Brien, 2005; Conroy et al., 2011). It is therefore possible that participants' exercise behavior was influenced by their participation in the daily diary portion of the study. Thus, relations between these variables may operate differently among those who are not self-monitoring exercise.

Despite these limitations, the present study has several notable strengths. Through the use of a novel IAT, we conducted the first examination of the association between implicit exercise importance, self-reported symptoms of exercise dependence, and specific exercise behaviors. By assessing implicit attitudes towards exercise and explicit, self-report symptoms of exercise dependence we were able to examine the unique predictive validity of each type of assessment, and more clearly understand the complementary yet distinct relations that implicit and explicit attitudes have with exercise behavior. The longitudinal nature of the study was a second important strength; previous research that examined relations between implicit and explicit beliefs about exercise and subsequent physical activity (i.e., Conroy et al., 2010) spanned only one week, whereas the present study utilized daily diary methodology to examine one full month of exercise behaviors. Thus, the present study offers evidence for longer-term effects of implicit and explicit exercise attitudes predicting exercise behavior. Finally, the present study assessed multiple dimensions of physical activity; this allowed for more fine-grained conclusions regarding relations between implicit attitudes and specific aspects of exercise behavior.

The current study examined how implicit attitudes about the importance of exercise relate to quantitative exercise behaviors and self-reported symptoms of exercise dependence among a sample of college students followed for one month. Implicit exercise importance and previous exercise dependence symptoms predicted increases in later exercise dependence symptoms, as well as intensity of workouts. Understanding the association between implicit exercise importance and exercise dependence symptoms can inform not only our understanding of exercise dependence, but also unique treatment approaches for this problematic condition.

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Highlights

- Implicit exercise importance predicted change in exercise dependence symptoms.
- Implicit and explicit measures predicted unique exercise behaviors.
- Implicit and explicit measures predicted daily exercise intensity.
- Exercise dependence symptoms predicted the frequency of daily workouts.

Table 1

Labels and Stimuli for Implicit Exercise + Importance IAT

Label	Stimuli
Unimportant	Unimportant, Minor, Insignificant, Unnecessary
Important	Important, Crucial, Essential, Vital
Exercise	Exercise, Fitness, Workout, Aerobics
Rest	Rest, Sleep, Nap, Relaxation

Table 2

Means and Standard Deviations for, and Intercorrelations between, Measures

Measure	1	2	3	4	5	6	7
1. EDQ T1	--						
2. EDQ T2	.71**	--					
3. Exercise + Important D score	.05	.15	--				
4. Percent Exercised	.32**	.28*	.14	--			
5. Mean Duration	.21	-.01	-.07	.21	--		
6. Mean Intensity	.34**	.18	.12	.32**	.32**	--	
7. Days between T1 and T2	-.17	-.05	-.14	-.03	-.06	-.06	--
<i>M</i>	22.53	22.37	0.73	0.39	63.58	57.67	30.21
<i>SD</i>	10.00	9.06	0.38	0.24	22.93	19.59	4.83

Note: EDQ = Exercise Dependence Questionnaire problematic exercise score; Important D score = measure of implicit association of Exercise + Important; Percent Exercised = Percentage of days exercised; Mean Duration = Average length of exercise session (in minutes); Mean Intensity = Average exercise intensity;

* = $p < .05$,

** = $p < .001$.

Table 3
Time 1 Exercise Dependence and Implicit Exercise Importance Predict Time 2 Exercise Dependence

Step	B	St. Error	t	Partial r	p	R ²
1						
(Constant)	13.43	25.63	0.52		.60	.006
Age	0.65	1.25	0.52	.07	.61	
BMI	-0.03	0.41	-0.07	-.01	.94	
Days between T1 and T2	-0.09	0.32	-0.29	-.04	.77	
2						
Age	-0.44	0.89	-0.50	-.06	.62	.510
BMI	-0.16	0.29	-0.57	-.07	.57	
Days between T1 and T2	-0.22	0.23	-0.95	-.12	.34	
EDQ T1	0.65	0.08	8.14	.72	<.001	
3						
Age	0.31	0.86	-0.36	-.05	.72	.039
BMI	-0.27	0.28	-0.96	-.12	.34	
Days between T1 and T2	-0.05	0.23	-0.20	-.03	.85	
EDQ T1	0.65	0.08	8.37	.73	<.001	
Exercise + Important D score	5.53	2.37	2.34	.28	.02	

Note: BMI = Body Mass Index; EDQ T1 = Exercise Dependence Questionnaire problematic exercise score at Time 1; Important D score = measure of implicit association of Exercise + Important.

Table 4

Time 1 Exercise Dependence Predicts Percentage of Days Exercised

Step	B	St. Error	t	Partial r	p	R ²
1						
	(Constant)	85.04	60.61	1.40	.17	.028
	Age	−0.48	3.11	−0.15	−.02	.88
	BMI	−0.87	0.97	−0.89	−.10	.38
	Days between T1 and T2	−0.59	0.56	−1.06	−.12	.30
2						
	Age	−2.12	2.99	−0.71	−.08	.48
	BMI	−1.11	0.92	−1.21	−.14	.23
	Days between T1 and T2	−0.35	0.54	−0.65	−.07	.52
	EDQ T1	0.81	0.26	3.17	.34	.002
3						
	Age	−2.04	2.97	−0.69	−.08	.49
	BMI	−1.32	0.93	−1.42	−.16	.16
	Days between T1 and T2	−0.21	0.54	−0.38	−.04	.70
	EDQ T1	0.84	0.26	3.30	.36	.001
	Exercise + Important D score	10.23	7.25	1.41	.16	.16

Note: BMI = Body Mass Index; EDQ T1 = Exercise Dependence Questionnaire problematic exercise score at Time 1; Important D score = measure of implicit association of Exercise + Important.