Published in final edited form as:

J Sport Exerc Psychol. 2017 August 01; 39(4): 237–248. doi:10.1123/jsep.2017-0056.

Self-regulation and implicit attitudes towards physical activity influence exercise behavior

Avelina C. Padin, MA^{1,2}, Charles F. Emery, PhD^{1,2}, Michael Vasey, PhD¹, and Janice K. Kiecolt-Glaser, PhD^{1,2,3}

(1) Department of Psychology, The Ohio State University

(2) Institute for Behavioral Medicine Research, The Ohio State University Wexner Medical Center

(3) Department of Psychiatry, The Ohio State University Wexner Medical Center

Abstract

Dual-process models of health behavior posit that implicit and explicit attitudes independently drive healthy behaviors. Prior evidence indicates that implicit attitudes may be related to weekly physical activity levels, but the extent to which self-regulation attenuates this link remains unknown. This study examined associations between implicit attitudes and self-reported physical activity during leisure-time among 150 highly active young adults, and evaluated the extent to which effortful control (one aspect of self-regulation) moderated this relationship. Results indicated that implicit attitudes toward exercise were unrelated to average workout length among individuals with higher effortful control. However, those with lower effortful control and more negative implicit attitudes reported shorter average exercise sessions compared to those with more positive attitudes. Implicit and explicit attitudes were unrelated to total weekly physical activity. A combination of poorer self-regulation and negative implicit attitudes may leave individuals vulnerable to mental and physical health consequences of low physical activity.

Keywords

Attitudes; self-regulatory capacity; effortful control; inhibitory control

Introduction

Regular exercise promotes physical and mental health; however, fewer than 25% of Americans meet national physical activity guidelines (Centers for Disease Control, 2013). Understanding the factors that influence exercise behavior is crucial for improving regular exercise adherence. Self-reported attitudes about exercise influence whether people decide to engage in physical activity or avoid it (Rhodes, Fiala, & Conner, 2009). However, attitudes alone do not determine exercise behavior, and interventions targeting self-reported exercise attitudes do not typically result in long-term increases in physical activity (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003; Callahan, 2013; Ogden, Karim, Choudry,

& Brown, 2007). Accordingly, consideration of other pathways through which attitudes influence exercise initiation and adherence is necessary. Implicit attitudes may play a role in whether and for how long individuals choose to exercise.

Implicit attitudes and physical activity

Implicit attitudes are automatic, emotional responses to stimuli (Gawronski & Bodenhausen, 2006). Researchers have examined these automatic attitudes in response to a variety of targets such as political candidates, feared animals like spiders, or racially diverse people. These attitudes cannot be self-reported, as they are outside of a person's awareness (although some researchers contend implicit attitudes may be consciously accessible to some degree, see Hahn & Gawronski, 2014). Implicit attitudes are believed to be the result of prior direct or indirect experience with the target object or activity, and may differ in magnitude and direction from an individual's explicit attitude. People who exercise more frequently tend to have more positive implicit attitudes about exercise (Markland, Hall, Duncan, & Simatovic, 2015). In one study, individuals whose attitudes towards physical activity improved over one week became more physically active throughout the week compared to those whose attitudes worsened or remained the same (Hyde, Elavsky, Doerksen, & Conroy, 2012).

Further, results from prospective studies provide evidence that implicit attitudes about exercise predict subsequent physical activity, even after controlling for explicit attitudes. In one study, participants completed measures of implicit attitudes and explicit motivation towards exercise and wore a pedometer for one week (Conroy, Hyde, Doerksen, & Ribeiro, 2010). Implicit attitudes predicted daily step count after controlling for explicit processes such as motivation, perceived control, and exercise self-efficacy. In a more recent study, participants wore an accelerometer for two weeks after completing tests of implicit and explicit attitudes toward physical activity (Rebar, Ram, & Conroy, 2015). Individuals with more favorable implicit attitudes exercised more on average than those with unfavorable attitudes, even after controlling for forms of explicit attitudes such as affective and instrumental attitudes.

Self-regulation and implicit attitudes

Effortful control, an important component of self-regulatory capacity, is the ability to control impulses in order to engage in an alternative behavior, as well as to develop and execute plans (Rothbart, Ellis, Rueda, & Posner, 2003). Effortful control is a personality trait consisting of three aspects: attentional control, activation control, and inhibitory control (Muris & Meesters, 2009; Verstraeten, Vasey, Claes, & Bijttebier, 2010). Attentional control is the ability to focus and shift one's attention when necessary. Activation control is the ability to initiate a behavior despite low motivation or a desire to avoid the behavior. Inhibitory control refers to the ability to suppress a dominant approach behavior when the behavior is inappropriate. Prior research has not investigated the relationship between these facets of effortful control and average workout duration.

Effortful control may influence physical activity by equipping individuals to overcome negative implicit attitudes toward exercise to achieve the longer-term goal of improved

health or weight loss. Indeed, authors of the Systems of Evaluation Model (SEM model; McConnell & Rydell, 2014; Rydell & McConnell, 2006), posit that while both explicit and implicit processes guide behavior, goal-directed health behaviors may be more strongly governed by non-conscious processes than conscious thought among individuals with poor self-regulatory capacity. Therefore, it is reasonable to expect that individuals with low self-regulatory capacity are more likely to act in line with their implicit attitudes about physical activity, whether positive or negative. Among those with negative implicit attitudes, low self-regulatory capacity would ultimately make it more difficult to exercise for the sake of a desirable goal, such as improved physical health.

Although past studies have not applied this self-regulation theory to exercise, research on eating behavior provides some support for the theory. For example, in one study researchers manipulated participants' self-regulatory capacity in the moment by asking them to engage in a demanding memory task (Frieze, Hofmann, & Wänke, 2008). Participants with more favorable implicit attitudes towards chocolate consumed more chocolate following the memory task compared to those with less favorable attitudes; however there was no association between implicit attitudes and consumption among those who did not complete the memory task. Hofmann and Frieze reported similar findings from another study in which self-regulatory capacity was depleted through alcohol consumption: individuals who consumed alcohol were less able to overcome their positive implicit attitudes towards food, and consumed more chocolate on average than those in the control condition (Hofmann & Frieze, 2008). These data suggest that implicit attitudes are more strongly related to unhealthy choices when self-regulatory capacity is diminished.

Research in substance and alcohol use has provided further evidence that the association between implicit attitudes and health behavior is moderated by self-regulatory skills such as response inhibition or working memory capacity. In a study of college students, positive alcohol-related implicit attitudes predicted drinking behavior among those with low response inhibition (as measured by the Stroop task), but not among those with high response inhibition (Houben & Wiers, 2009). Similarly, high working memory capacity dampened the association between positive implicit attitudes towards drugs and self-reported substance use (Grenard et al., 2008). Thus, although evidence suggests that maladaptive implicit attitudes are more strongly associated with unhealthy behavior among poorer self-regulators, this tenet of dual-process models has not been tested in the context of physical activity.

Leisure-time physical activity

In prior studies, researchers have investigated the effects of implicit attitudes on overall physical activity level, often using pedometers. In these studies, participant step counts were averaged across days or weeks (Conroy et al., 2010; Hyde et al., 2012). However, little is known about the association between implicit attitudes and exercise during leisure time. Leisure-time physical activity (LTPA) is planned exercise that occurs during a person's free time and includes walking, sport participation, and working out in a gym or group class. Compared to total physical activity and activity in other domains (e.g., work-related physical activity), LTPA is more strongly associated with cardiovascular fitness (Schmidt, Cleland, Thomson, Dwyer, & Venn, 2008).

Moreover, implicit attitudes and self-regulation should be particularly important for average LTPA duration. According to the Systems of Evaluation Model, individuals rely more on explicit attitudes when engaging in deliberate, planned behavior (Rydell & McConnell, 2006). Therefore, explicit attitudes may be more important in the planning of future exercise activity, while implicit attitudes may guide a person's decision to persist in an exercise session despite negative outcomes, such as discomfort or boredom. Given this, implicit attitudes may be more closely related to the average amount of time a person spends exercising instead of the total number of steps one takes each day, which may be related to factors outside individual control, such as a person's schedule or work demands. This may be especially true when self-regulation is low, due to deficits in planning, persistence, and the ability to suppress negative impulses.

Current study

This study of active, young adults assessed whether implicit attitudes towards exercise were associated with average, weekly leisure-time physical activity as well as the amount of time individuals reported exercising during a typical leisure-time workout session. Young adults were recruited to maximize variability in physical activity levels, as estimations of physical activity variance appear to decrease with older age (Troiano et al., 2008). Consistent with prior research on overall physical activity levels, we hypothesized that both explicit and implicit attitudes would be associated with average LTPA and workout duration.

Effortful control (indicative of self-regulatory capacity) was tested as a moderator of these relationships in order to explore whether individuals high in effortful control were better able to suppress the effects of negative implicit attitudes on average LTPA and workout length. We hypothesized that effortful control would emerge as a moderator, because individuals low in this capacity may have a harder time persisting in an exercise session if they have negative implicit attitudes. For any outcomes in which effortful control significantly moderated the association between implicit attitudes and LTPA, attentional control, inhibitory control, and activation control were also tested as moderators in order to determine facets of effortful control that may be relevant in this relationship. Given prior literature suggesting that strong inhibitory control weakens the relationship between implicit attitudes and maladaptive health behaviors (e.g., Houben & Wiers, 2009; Haynes, Kemps, & Moffitt, 2015), we hypothesized that inhibitory control would be the facet of effortful control most likely to explain any effect.

Another tenet of the SEM model is the idea that discrepancies between explicit and implicit attitudes may be important in predicting exercise behavior, and resolving these discrepancies may be especially difficult among those low in effortful control (McConnell & Rydell, 2014). As such, the interaction between implicit and explicit attitudes was explored, as well as a three-way interaction between implicit attitudes, explicit attitudes, and effortful control. We hypothesized that individuals with positive implicit and explicit attitudes would be the most active, and that attitude discrepancies would result in lower physical activity levels among those with less effortful control.

Methods

Participants

The sample consisted of 150 undergraduate students at a large, Midwest university, who received course credit for study participation. The majority of participants were Caucasian (70.3%), women (59.5%), and in their first academic year of college (63.5%). Additional sample characteristics are included in Table 1.

Procedure

All participants completed informed consent. Following a brief relaxation period, participants completed a computerized implicit attitudes task, a personalized Single Category Implicit Association Test. Participants then completed a packet of questionnaires including demographic information, physical activity level, effortful control, and explicit attitudes.

Self-report measures

Leisure-time physical activity.—The International Physical Activity Questionnaire (IPAQ; long form) was used to assess how often participants engage in various physical activities (Booth, 2000). Participants were asked to report how much time they spent engaging in vigorous activity, moderate activity, or walking over the past 7 days across four domains of living. The IPAQ uses metabolic equivalents (METs) to allow for calculation of the energy expended while engaging in physical activity over the past week. One MET is defined as one's metabolic rate during rest or quiet sitting. Activity METs index the energy expended during various physical activities relative to energy expended at rest. For example, the MET for singles tennis is 8.0 (Ainsworth et al., 1993), indicating that, on average, eight times more energy is expended playing singles tennis than at rest. The LTPA MET mins/week score was generated by weighting the products of each leisure activity's duration and intensity using metabolic equivalents from the 2000 Compendium of Physical Activities (Ainsworth et al., 1993). Therefore, LTPA MET mins/week index the total energy expended during leisure-time physical activity throughout the week.

An additional outcome variable was created for the current study in order to index the average number of minutes a participant spent engaging in a single bout of leisure-time physical activity. This variable was computed by averaging the number of minutes participants reported that they “usually” spent in a single session of walking or moderate-to-vigorous PA during their leisure time. Leisure-time physical activity was chosen in an effort to reduce the effect of double-counting and unreliable reporting errors of self-reported physical activity (Rzewnicki, Vanden Auweele, & De Bourdeaudhuij, 2003). The IPAQ is appropriate for use among college students. For example, the IPAQ has been associated with physical activity log data (Spearman's $p = 0.55$) and aerobic fitness levels (Spearman's $p = 0.21$), and its performance is consistent with other physical activity self-report measures (Craig et al., 2003; Hagströmer, Oja, & Sjöström, 2006).

Explicit attitudes towards exercise.—Explicit attitudes were assessed with a self-report scale commonly used in health behavior research, adapted from Ajzen and Driver's

theory of planned behavior (Ajzen & Driver, 1991; Courneya & Bobick, 2000). The scale assessed participants' explicit attitudes towards exercise by asking them to identify the extent to which they believe exercise is: important/unimportant, harmful/beneficial, healthy/unhealthy, enjoyable/unenjoyable, pleasant/unpleasant, satisfying/unsatisfying, interesting/boring, and foolish/wise on a 5-point Likert scale. The internal consistency estimate for this scale was $\alpha = .85$.

Effortful control.—The Adult Temperament Questionnaire – Long Form (ATQ; Evans & Rothbart, 2007) is a 177-item questionnaire that assesses personality facets such as effortful control, negative affect, and extraversion. Participants responded to items such as “I hardly ever finish things on time” and “I can keep performing a task even when I would rather not do it” on a 7-point Likert scale, where 1 indicated “extremely untrue of you” and 7 indicated “extremely true of you”. Responses from the 35 items addressing effortful control are averaged to create an effortful control score. Individual subscales that make up the effortful control score (attentional control, activation control, and inhibitory control) were also explored to determine if facets of effortful control were associated with the attenuation of implicit attitudes. In the current study, internal consistency estimates were as follows: overall scale $\alpha = .87$; attentional control subscale $\alpha = .77$; activation control subscale $\alpha = .80$; inhibitory control subscale $\alpha = .66$.

Implicit attitudes towards exercise task

A personalized Single Category Implicit Association Test (SC-IAT; Karpinski & Steinman, 2006), a computerized task, was utilized to measure participants' implicit attitudes towards physical activity. Participants were presented with words on a computer monitor and asked to sort them into categories labelled “I like” or “I don't like” as quickly as possible by pressing marked keys on the computer. Words were randomly sequenced. There were three blocks composed of 39 trials: a practice block, physical activity + “I like”, and physical activity + “I don't like”. For example, in the physical activity + “I like” block, participants were asked press the key corresponding with “I like” for all physical activity stimuli (e.g., run, lift weights) and to press the “I like” or “I don't like” keys for non-physical activity normative stimuli (e.g., love, death). The order in which participants sorted physical activity words into either “I don't like” or “I like” categories for the second and third blocks was counter-balanced. Physical activity stimuli were drawn from prior research demonstrating an association between implicit attitudes and physical activity level (Conroy et al., 2010; Hyde, Doerksen, Ribeiro, & Conroy, 2010). Non-physical activity normative items were those used in traditional IAT research (Greenwald, McGhee, & Schwartz, 1998).

The SC-IAT is a modification of the original Implicit Association Test (IAT; Greenwald et al., 1998). Unlike the original IAT, participants are not forced to make comparisons between complementary pair words (e.g., positive-negative, male-female, black-white) when using the SC-IAT. Previous work investigating the association between implicit attitudes and physical activity used a traditional SC-IAT to measure implicit attitudes (Calitri, Lowe, Eves, & Bennett, 2009; Conroy et al., 2010). In a traditional SC-IAT, participants are asked to classify words into either a “pleasant” or “unpleasant” category, and receive feedback for all incorrect responses. Critics of the traditional IAT and SC-IAT contend that extrapersonal

factors (e.g., social influence) may distort the measurement of an individual's personally held attitude (Olson & Fazio, 2004). For example, when someone is asked to place a stimulus into a "good" or "bad" category, they may draw on societal norms to place the stimulus as opposed to their own personal attitude. In order to obtain a more "pure" measurement of participants' implicit attitudes, a personalized SC-IAT was used. The personalized SC-IAT has different category labels (e.g., "I like" instead of "pleasant/good") and removes error feedback. The personalized IAT was more strongly associated with eating and voting behavior compared to a traditional IAT (Olson & Fazio, 2004). The personalized IAT was also more stable following a brief priming manipulation compared to the traditional IAT (Han, Czellar, Olson, & Fazio, 2010).

Data analysis

Implicit attitude scores were derived from the SC-IAT D-score algorithm (Karpinski & Steinman, 2006), which involves subtracting the average response time of the physical activity + "I don't like" block from the physical activity + "I like" block. This difference score was then divided by the pooled standard deviation of the test trials. Higher scores indicate that the participant was more quickly able to associate physical activity words with the "I like" category than the "I don't like" category, therefore representing more favorable implicit attitudes towards physical activity. To adapt the scoring algorithm to our personalized IAT procedure, two changes were made to the D-score calculation outlined by Greenwald and colleagues (2003). First, all SC-IAT reaction times were natural log transformed to correct for skew (Greenwald et al., 1998; Olson & Fazio, 2004). Although the traditional D-score algorithm does not include log-transformed response latencies, prior research using the personalized IAT includes log-transformation of all response latencies prior to D-score calculation. Additionally, the traditional D-score algorithm includes an error penalty of 400ms added to incorrect responses, and prior work indicates that removing error penalties may reduce the validity and reliability of IAT scores (Richetin, Costantini, Perugini, & Schönbrodt, 2015). However, the personalized SC-IAT does not include error feedback, and therefore no error penalty was added to response latencies. In prior research using this amended D-score calculation method, the personalized IAT was more highly correlated with explicit measures of attitudes and behavioral intention compared to a traditional IAT (Olson & Fazio, 2004).

Two outliers were identified and subsequently excluded from analyses based on excessively high self-reported workout durations (average workout duration greater than 250 minutes). The excluded participants did not differ significantly from the remainder of the sample on measures of BMI ($t = -0.69, p = .631$), explicit attitudes ($t = 0.83, p = .518$), or implicit attitudes ($t = -0.52, p = .517$).

Hierarchical multiple regressions (i.e., successive linear regression models) were conducted in SPSS version 22 to test hypotheses. In the first step, affective and instrumental attitudes were entered as predictors of the outcome variable (either LTPA MET mins/week or average LTPA duration). In the second step, implicit attitudes were added to the model in order to determine if they accounted for a significant portion of the variance in LTPA after accounting for explicit attitudes. Effortful control was tested as a moderator using the

PROCESS macro for SPSS (Hayes, 2012). The Johnson-Neyman approach (Johnson & Neyman, 1936) was used to probe significant interactions. These analyses were repeated to test each individual facet of effortful control (inhibitory control, activation control, and attentional control). Implicit attitudes and effortful control data were standardized in moderation analyses in order to meaningfully interpret any interactions.

Assumptions of linear regression were tested for each model and indicated that all regression assumptions were met. Specifically, visual inspection of residual plots of regression models indicated that the regression assumption of homoscedasticity was met. Calculation of the variance inflation factor and tolerance indicated that multicollinearity was not present.

Results

Attitudes and average physical activity duration

Implicit and explicit attitudes towards physical activity were not significantly related ($r = .074$, $p = .373$; see Table 2 for bivariate correlations between all study variables). Instrumental ($b = -0.34$, $SE = 1.62$, $p = .832$) and affective attitudes ($b = 0.05$, $SE = 0.87$, $p = .958$) were not associated with average workout duration. However, implicit attitudes significantly improved model fit when entered into step 2 of the model, and the full model accounted for 3% of the variance in average workout duration ($b = 12.45$, $SE = 5.88$, $p = .036$, $R^2 = .030$). That is, for every one unit increase on the implicit attitudes task (indicating a more favorable attitude) individuals exercised 12.45 minutes longer during a typical LTPA session. Instrumental ($b = -108.47$, $SE = 120.37$, $p = .369$) and affective attitudes ($b = 24.57$, $SE = 64.72$, $p = .705$) were not associated with LTPA MET mins/week, and implicit attitudes did not significantly improve model fit; however the non-significant effect was in the hypothesized direction ($b = 676.59$, $SE = 441.12$, $p = .127$).

A test of the interaction between instrumental attitudes and implicit attitudes was significant for LTPA MET mins/week ($b = -605.25$, $SE = 270.13$, $p = .027$) but not significant for average workout duration ($b = -5.05$, $SE = 3.64$, $p = .167$). Individuals with negative implicit and instrumental attitudes were the least active group, whereas those with positive implicit attitudes and negative instrumental attitudes were the most active. The test of the interaction between affective attitudes and implicit attitudes was nonsignificant in predicting both LTPA MET mins/week and average workout duration. See Table 3 for a summary of these results.

Effortful control capacity as a moderator

The interaction between implicit attitudes and effortful control was a significant predictor of average LTPA duration ($b = -6.27$, $SE = 2.42$, $p = .011$). The Johnson-Neyman technique was used to probe the interaction, which identifies the range of values of the moderator at which the conditional association between implicit attitudes and average LTPA duration is significant. As shown in Fig. 1, individuals who scored 0.24 standard deviations below the effortful control mean or lower (i.e., effortful control -0.24 SDs) evidenced a significant, positive association between implicit attitudes and average LTPA duration ($p < .05$), such that low-effortful control individuals with stronger negative attitudes had the shortest predicted average LTPA duration. Those with effortful control scores greater than 0.24 SDs

below the effortful control mean (i.e., effortful control > -0.24 SDs) evidenced no association between implicit attitudes and average LTPA duration. The interaction between implicit attitudes and effortful control did not emerge as a significant predictor of LTPA MET mins/week ($b = -82.90$, $SE = 183.70$, $p = .653$).

Three-way interactions between implicit attitudes, explicit attitudes, and effortful control were tested to investigate whether discrepancies in implicit and explicit attitudes predicted exercise behavior under varying levels of effortful control. The three-way interaction between implicit attitudes, instrumental attitudes, and effortful control was nonsignificant in predicting LTPA MET mins/week ($b = 243.69$, $SE = 432.78$, $p = .574$) and average workout duration ($b = 4.45$, $SE = 5.74$, $p = .440$). Results were also nonsignificant for the three-way interaction between implicit attitudes, affective attitudes, and effortful control in predicting LTPA MET mins/week ($b = 20.96$, $SE = 203.75$, $p = .918$) and average workout duration ($b = 0.96$, $SE = 2.68$, $p = .721$).

Attentional control, activation control, and inhibitory control were tested to investigate whether individual effortful control facets attenuated the association between implicit attitudes and average LTPA duration (see Table 4). Only inhibitory control emerged as a significant moderator ($b = -6.50$, $SE = 2.12$, $p = .003$). As seen in Fig. 2, individuals who fell 0.23 SDs below the mean or lower on inhibitory control (i.e., inhibitory control -0.23 SDs) evidenced a significant, positive relationship between implicit attitudes and average LTPA duration ($p < .05$). Those with inhibitory control scores > -0.23 SDs evidenced no association between implicit attitudes and average LTPA duration. The full model including the interaction between implicit attitudes and inhibitory control accounted for 9% of the variance in average workout duration. Attentional control was a marginally significant moderator ($b = -4.57$, $SE = 2.55$, $p = .076$), and activation control did not emerge as a significant moderator ($b = -3.62$, $SE = 2.91$, $p = .215$).

Discussion

In this study of active, young adults, individuals with more negative implicit attitudes towards physical activity reported spending less time in leisure-time physical activity during an average workout. Implicit attitudes and average workout duration were related among lower-effortful control individuals but not among those higher in effortful control.

These data are consistent with prior evidence indicating that implicit attitudes predict overall physical activity when measured objectively with pedometers (Conroy et al., 2010; Rebar et al., 2015). However, this study extends prior research by specifically addressing workout duration as an outcome. Evidence suggests that workout duration has important effects on mood and health. For example, in a study of 135 young adults, participants engaging in longer low-impact workouts reported less negative mood post-exercise compared to those who worked out for shorter durations (Rocheleau, Webster, Bryan, & Frazier, 2004). Longer workout durations are also associated with greater muscular secretions of interleukin-6 (IL-6) into the blood. Although IL-6 is considered a proinflammatory cytokine, it appears to improve insulin sensitivity and decrease acute inflammation following exercise (Fisman & Tenenbaum, 2010; Petersen & Pedersen, 2006). Given the health benefits associated with

longer workout durations, continued research of factors that drive this specific exercise behavior is warranted.

As hypothesized, individuals with higher levels of effortful control capacity relied less on implicit attitudes towards physical activity to guide behavior than those with lower effortful control. These results extend an important tenet of the Systems of Evaluation Model to the case of exercise, as implicit attitudes were associated with workout duration, but only among poorer self-regulators.

Additional analyses were conducted to explore the role of specific effortful control skills as moderators of the relationship between implicit attitudes and LTPA duration. The results of the current study provide evidence suggesting that this association was moderated by a person's inhibitory control, or their ability to forgo a dominant response in order to choose a more appropriate one. Individuals with negative implicit attitudes may be using these skills to shift attention away from thoughts and reactions associated with those negative attitudes, and focus instead on thoughts/observations that may foster persistence, such as one's progress towards long term goals. Activation control, the ability to initiate a behavior despite low motivation, did not influence the extent to which implicit attitudes influence physical activity duration. Activation control may be more important in determining the number of workouts a person engages in per week, as opposed to workout duration.

Although inhibitory control has not been studied as a moderator of the link between implicit attitudes and physical activity, prior research in other areas has demonstrated the importance of inhibitory control in attenuating the effects of implicit attitudes. For example, in one prior study, inhibitory control moderated the effect of implicit attitudes on food intake, such that positive implicit attitudes were only associated with increased food intake among those low in inhibitory control capacity (Haynes, Kemps, & Moffitt, 2015). Another research group examining the dual-process model in the context of employee safety found that individuals' automatic bias towards risk predicted failure to comply with safety regulations in the workplace, but only for those with poor inhibitory control (Xu, Li, Ding, & Lu, 2014). Also, in a study examining implicit attitudes towards alcohol and self-reported drinking behavior, the association between implicit attitudes and behavior was moderated by activity in the lateral prefrontal cortex, a neural correlate of inhibitory control (Frieze, Gianotti, & Knoch, 2016). Data from the current study extend prior research by suggesting that high inhibitory control may also weaken the association between implicit attitudes and average workout duration.

Unlike prior studies' findings (Calitri et al., 2009; Conroy et al., 2010; Hagger, Chatzisarantis, & Biddle, 2002), explicit attitudes were unrelated to weekly physical activity and average workout length, possibly due to our sample's low variability in explicit attitude scores and the high levels of physical activity in our sample. Indeed, the vast majority of participants in the current study reported very positive attitudes towards physical activity, with many responding as positively as possible, indicating that social desirability may have influenced explicit attitude responses in this sample. Unfortunately, the current study did not assess participants' tendency towards social desirability bias, and therefore cannot address

whether this altered their responses. Explicit attitudes were also unrelated to implicit attitudes; however, this finding is consistent with prior research (Hyde et al., 2010).

Contrary to hypotheses, the current study also did not find a significant association between implicit attitudes and LTPA energy expenditure. A power analysis conducted prior to study initiation indicated that 135 participants would provide 80% power to detect an association between implicit attitudes and energy expenditure, assuming a small effect size. However, given that the relationship was non-significant but in the expected direction, it is possible that the study did not have sufficient power to detect a significant relationship between implicit attitudes and weekly LTPA. The null association between implicit attitudes and total LTPA energy expenditure may also be due to high rates of physical activity reported by our sample. On average, participants reported engaging in over 350 minutes of leisure time physical activity per week. In contrast, the American College of Sports Medicine recommends 150 minutes of weekly physical activity, a goal reached by only 25% of American adults (CDC, 2013). Therefore, differences in results could be due, in part, to sample differences between the current study and prior studies.

Limitations

Ideally physical activity would have been objectively monitored using actigraphs or pedometers, as self-report measures of physical activity are susceptible to over-reporting and memory errors (Sallis & Saelens, 2000; Rzewnicki et al., 2003). Objective physical activity data may help to increase accuracy of physical activity estimates in subsequent studies of implicit attitudes and physical activity. However, it should be noted that most individuals tend to recall physical activity during leisure time fairly reliably (Booth, Owen, Bauman, & Gore, 1996). Participants also self-reported their effortful control as an index of self-regulatory capacity. Although self-report and behavioral measures of self-regulatory capacity (e.g., Stroop task) are frequently not correlated, this is likely because these measures capture different aspects of self-regulatory capacity. Recent findings suggest that behavioral measures are likely to gauge specific self-control processes (e.g., working memory capacity), whereas self-report measures tap into global, trait self-regulatory capacity (Allom, Panetta, Mullan, & Hagger, 2016). Given that trait self-regulatory capacity appears to be more strongly related to physical activity than behavioral tasks (Allom et al., 2016), a self-report measure was chosen for the current study.

Another limitation may be the use of an amended D-score algorithm for calculating implicit attitude scores from the IAT. Recent research indicates that alternative scoring methods (e.g., the EZ-diffusion model; Rebar et al., 2015) may be more strongly related to physical activity measures compared to the traditional D-score algorithm. However, our use of the amended D-score algorithm is consistent with prior research using a personalized IAT, which indicates that personalized IAT scores calculated using the amended D-score algorithm were more closely tied to explicit attitudes and behavior compared to traditional IAT scores (Olson & Fazio, 2004).

An important limitation of the current study is the cross-sectional design. Therefore, one cannot rule out the possibility that with increased leisure-time physical activity, individuals experience more positive attitudes towards physical activity over time. Also, participants in

this study were highly active undergraduate students. Although participants reported broad ranges of physical activity levels, approximately 75% of our sample met national physical activity guidelines of 150 minutes of moderate-to-vigorous activity per week. In contrast, a large study of U.S. adults found that only 64% of young adults, ages 20 to 29, met national recommendations (Tucker, Welk, & Beyler, 2011). Given this important limitation, results should be replicated in other samples in order to support generalizability to less active populations.

Implications and Future Directions

Novel results of the current study indicate that implicit attitudes relate to workout duration, an outcome important for mood and long-term physical health. Additionally, these results are the first evidence of a moderation effect of effortful control on the relationship between implicit attitudes and average LTPA duration.

The current study included a trait measure of effortful control in order to determine whether individual differences in cognitive control capacity influence the relationship between implicit attitudes and exercise behavior. These findings help identify an individual characteristic that may drive the extent to which people rely on implicit attitudes to guide their decisions. However, self-regulatory capacity is a limited resource that can fluctuate drastically from day to day (Baumeister, Vohs, & Tice, 2007). An individual's self-regulatory capacity at any given time may influence how individuals use implicit and explicit attitudes to guide their decisions. Additionally, there is some evidence to suggest that implicit attitudes have both stable and time-varying components (Hyde et al., 2012), and new evidence suggests that implicit attitudes are malleable in response to intervention (Berry, 2016). Given findings suggesting that both implicit attitudes and self-regulatory capacity may fluctuate over time, future studies should investigate the role of state cognitive control in the relationship between attitudes and exercise behavior, perhaps using ecological assessment techniques.

Importantly, the interaction between implicit and explicit attitudes was tested as a predictor of exercise behavior, because the Systems of Evaluation Model suggests that discrepancies between implicit and explicit attitudes may be important predictors of behavior. Interestingly, the significant interaction between instrumental and implicit attitudes in our sample was contrary to expectations. As hypothesized, individuals with negative instrumental and implicit attitudes were the least active; however those with positive instrumental and implicit attitudes were not the most active. Instead, those with negative instrumental attitudes and positive implicit attitudes were the most active. We suspect that differences in self-regulatory capacity contribute to variability in exercise behavior among those with discrepant attitudes. The SEM asserts that poor self-regulatory capacity may be especially detrimental among those with larger discrepancies between their implicit and explicit attitudes, because resolving such discrepancies is cognitively demanding (McConnell & Rydell, 2014). We attempted to test this theory directly by looking at three-way interactions between implicit attitudes, explicit attitudes, and effortful control, hypothesizing that attitude discrepancies would result in the less physical activity compared to positive implicit and explicit attitudes, particularly among poor self-regulators. We did not

find a significant three-way interaction; however, three-way interactions can be difficult to detect without a large sample size. The theory that self-regulatory capacity moderates the relationship between implicit and explicit attitude discrepancies and behavior should be tested in larger sample sizes, where there is sufficient power to detect a three-way interaction, should one exist.

Our evidence suggests that stronger inhibitory control may weaken the relationship between implicit attitudes and workout duration, and these results have important implications for intervention development. Improving implicit attitudes may be an important target for intervention, particularly for people with lower effortful control, or poorer self-regulatory capacity more broadly. Few researchers have explored the malleability of implicit attitudes towards physical activity and the behavioral effects of attitude change. However, research thus far suggests that interventions may be effective in altering implicit attitudes about exercise. Markland et al. (2015) administered a guided imagery intervention aimed at improving both implicit and explicit affective attitudes towards exercise. Regardless of physical activity level, individuals who completed the guided imagery intervention had more positive implicit attitudes towards exercise immediately following the intervention. Additionally, findings from this study indicate that inhibitory control may serve as an intervention target. Intervention studies have found support for a number of different strategies for improving executive functioning performance,. In conclusion, implicit attitudes may uniquely influence workout duration, specifically among those lower in self-regulatory capacity. These results have important implications for the development of interventions targeting exercise behavior.

Acknowledgements:

Work on this project was supported by National Institutes of Health grant R01 CA 186720-02S2. The first author would also like to thank Nikki Killman, Alivia Ball, and Emily Lewis for their time and dedicated work on this project.

References

- Ainsworth BE, Haskell WL, Leon AS, Jacobs DR, Montoye HJ, Sallis JF, & Paffenbarger RS (1993). Compendium of physical activities: Classification of energy costs of human physical activities. *Medicine and Science in Sports and Exercise*, 25(1), 71–80. [PubMed: 8292105]
- Ajzen I, & Driver BL (1991). Prediction of leisure participation from behavioral, normative, and control beliefs: An application of the theory of planned behavior. *Leisure Sciences*, 13(3), 185–204. 10.1080/01490409109513137
- Allom V, Panetta G, Mullan B, & Hagger MS (2016). Self-report and behavioural approaches to the measurement of self-control: Are we assessing the same construct? *Personality and Individual Differences*, 90, 137–142. 10.1016/j.paid.2015.10.051
- Baranowski T, Cullen KW, Nicklas T, Thompson D, & Baranowski J (2003). Are current health behavioral models helpful in guiding prevention of weight gain efforts? *Obesity Research*, 11(S10), 23S–43S. 10.1038/oby.2003.222 [PubMed: 14569036]
- Baumeister RF, Vohs KD, & Tice DM (2007). The strength model of self-control. *Current Directions in Psychological Science*, 16(6), 351–355. 10.1111/j.1467-8721.2007.00534.x
- Berry TR (2016). Changes in implicit and explicit exercise-related attitudes after reading targeted exercise-related information. *Psychology of Sport and Exercise*, 22, 273–278. 10.1016/j.psychsport.2015.09.001

- Booth M (2000). Assessment of physical activity: an international perspective. *Research Quarterly for Exercise and Sport*, 71(2 Suppl), S114–120. [PubMed: 10925833]
- Booth ML, Owen N, Bauman AE, & Gore CJ (1996). Retest reliability of recall measures of leisure-time physical activity in Australian adults. *International Journal of Epidemiology*, 25(1), 153–159. [PubMed: 8666485]
- Calitri R, Lowe R, Eves F, & Bennett P (2009). Associations between visual attention, implicit and explicit attitude and behaviour for physical activity. *Psychology & Health*, 24(9), 1105–1123. 10.1080/08870440802245306 [PubMed: 20205048]
- Callahan D (2013). Obesity: Chasing an elusive epidemic. *Hastings Center Report*, 43(1), 34–40. 10.1002/hast.114
- Conroy DE, Hyde AL, Doerksen SE, & Ribeiro NF (2010). Implicit attitudes and explicit motivation prospectively predict physical activity. *Annals of Behavioral Medicine: A Publication Of The Society Of Behavioral Medicine*, 39(2), 112–118. 10.1007/s12160-010-9161-0 [PubMed: 20140542]
- Courneya KS, & Bobick TM (2000). Integrating the theory of planned behavior with the processes and stages of change in the exercise domain. *Psychology of Sport and Exercise*, 1(1), 41–56. 10.1016/S1469-0292(00)00006-6
- Craig CL, Marshall AL, Sjostrom ML, Bauman AE, Booth ML, Ainsworth BE, ... Oja P (2003). International Physical Activity Questionnaire: 12-Country reliability and validity. *Medicine & Science in Sports & Exercise*, 35(8), 1381–95. [PubMed: 12900694]
- Evans DE, & Rothbart MK (2007). Developing a model for adult temperament. *Journal of Research in Personality*, 41(4), 868–888. 10.1016/j.jrp.2006.11.002
- Facts about Physical Activity | Physical Activity | CDC. (n.d.). Retrieved July 28, 2016, from <https://www.cdc.gov/physicalactivity/data/facts.htm>
- Fisman EZ, & Tenenbaum A (2010). The ubiquitous interleukin-6: a time for reappraisal. *Cardiovascular Diabetology*, 9, 62. 10.1186/1475-2840-9-62 [PubMed: 20937099]
- Frieze M, Gianotti LRR, & Knoch D (2016). The association between implicit alcohol attitudes and drinking behavior is moderated by baseline activation in the lateral prefrontal cortex. *Health Psychology*, 35(8), 837–841. 10.1037/hea0000179 [PubMed: 25915432]
- Frieze M, Hofmann W, & Wänke M (2008). When impulses take over: Moderated predictive validity of explicit and implicit attitude measures in predicting food choice and consumption behaviour. *The British Journal Of Social Psychology / The British Psychological Society*, 47(Pt 3), 397–419.
- Gawronski B, & Bodenhausen GV (2006). Associative and propositional processes in evaluation: An integrative review of implicit and explicit attitude change. *Psychological Bulletin*, 132(5), 692–731. 10.1037/0033-2909.132.5.692 [PubMed: 16910748]
- Greenwald AG, McGhee DE, & Schwartz JLK (1998). Measuring individual differences in implicit cognition. *Journal of Personality and Social Psychology*, 74(6), 1464–1480. 10.1037//0022-3514.74.6.1464 [PubMed: 9654756]
- Greenwald AG, Nosek BA, & Banaji MR (2003). Understanding and Using the Implicit Association Test. *Journal of Personality and Social Psychology*, 85(2), 197–216. 10.1037/0022-3514.85.2.197 [PubMed: 12916565]
- Grenard JL, Ames SL, Wiers RW, Thush C, Sussman S, & Stacy AW (2008). Working memory capacity moderates the predictive effects of drug-related associations on substance use. *Psychology of Addictive Behaviors*, 22(3), 426–432. 10.1037/0893-164X.22.3.426 [PubMed: 18778136]
- Hagger MS, Chatzisarantis NLD, & Biddle SJH (2002). A meta-analytic review of the Theories of Reasoned Action and Planned Behavior in physical activity: Predictive validity and the contribution of additional variables. *Journal of Sport & Exercise Psychology*, 24(1), 3–32.
- Hagströmer M, Oja P, & Sjöström M (2006). The International Physical Activity Questionnaire (IPAQ): A study of concurrent and construct validity. *Public Health Nutrition*, 9(6), 755–762. 10.1079/PHN2005898 [PubMed: 16925881]
- Hahn A, & Gawronski B (2014). Do implicit evaluations reflect unconscious attitudes? *Behavioral and Brain Sciences*, 37(01), 28–29. 10.1017/S0140525X13000721

- Han HA, Czellar S, Olson MA, & Fazio RH (2010). Malleability of attitudes or malleability of the IAT? *Journal of Experimental Social Psychology*, 46(2), 286–298. 10.1016/j.jesp.2009.11.011 [PubMed: 20401162]
- Hayes AF (2012). PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling Retrieved from <http://www.afhayes.com/public/process2012.pdf>
- Haynes A, Kemps E, & Moffitt R (2015). Inhibitory self-control moderates the effect of changed implicit food evaluations on snack food consumption. *Appetite*, 90, 114–122. 10.1016/j.appet.2015.02.039 [PubMed: 25765247]
- Hofmann W, & Friese M (2008). Impulses got the better of me. *Journal of Abnormal Psychology*, 117(2), 420–427. 10.1037/0021-843X.117.2.420 [PubMed: 18489218]
- Houben K, & Wiers RW (2009). Response inhibition moderates the relationship between implicit associations and drinking behavior. *Alcoholism: Clinical and Experimental Research*, 33(4), 626–633. 10.1111/j.1530-0277.2008.00877.x
- Hyde AL, Doerksen SE, Ribeiro NF, & Conroy DE (2010). The independence of implicit and explicit attitudes toward physical activity: Introspective access and attitudinal concordance. *Psychology of Sport and Exercise*, 11(5), 387–393. 10.1016/j.psychsport.2010.04.008
- Hyde AL, Elavsky S, Doerksen SE, & Conroy DE (2012). The stability of automatic evaluations of physical activity and their relations with physical activity. *Journal of Sport & Exercise Psychology*, 34(6), 715–736. [PubMed: 23204356]
- Johnson OP, & Neyman J (1936). Tests of certain linear hypotheses and their application to some educational problems. *Statistical Research Memoirs*, 1, 57–93.
- Karpinski A, & Steinman RB (2006). The Single Category Implicit Association Test as a measure of implicit social cognition. *Journal of Personality and Social Psychology*, 91(1), 16–32. 10.1037/0022-3514.91.1.16 [PubMed: 16834477]
- Markland D, Hall CR, Duncan LR, & Simatovic J (2015). The effects of an imagery intervention on implicit and explicit exercise attitudes. *Psychology of Sport and Exercise*, 17, 24–31. 10.1016/j.psychsport.2014.11.007
- McConnell AR, & Rydell RJ (2014). The Systems of Evaluation Model: A dual-systems approach to attitudes. In Sherman JW, Gawronski B, & Trope Y (Eds.), *Dual process theories of the social mind* (pp. 204–217). New York: Guilford Press.
- Muris P, & Meesters C (2009). Reactive and regulative temperament in youths: Psychometric evaluation of the early adolescent temperament questionnaire-revised. *Journal of Psychopathology and Behavioral Assessment*, 31(1), 7–19. 10.1007/s10862-008-9089-x
- Ogden J, Karim L, Choudry A, & Brown K (2007). Understanding successful behaviour change: the role of intentions, attitudes to the target and motivations and the example of diet. *Health Education Research*, 22(3), 397–405. 10.1093/her/cyl090 [PubMed: 16971672]
- Olson MA, & Fazio RH (2004). Reducing the influence of extrapersonal associations on the Implicit Association Test: Personalizing the IAT. *Journal of Personality and Social Psychology*, 86(5), 653–667. 10.1037/0022-3514.86.5.653 [PubMed: 15161392]
- Petersen AMW, & Pedersen BK (2006). The role of IL-6 in mediating the anti-inflammatory effects of exercise. *Journal of Physiology and Pharmacology: An Official Journal of the Polish Physiological Society*, 57 Suppl 10, 43–51.
- Rebar AL, Ram N, & Conroy DE (2015). Using the EZ-diffusion model to score a Single-Category Implicit Association Test of physical activity. *Psychology of Sport and Exercise*, 16, Part 3, 96–105. 10.1016/j.psychsport.2014.09.008 [PubMed: 25484621]
- Rhodes RE, Fiala B, & Conner M (2009). A review and meta-analysis of affective judgments and physical activity in adult populations. *Annals of Behavioral Medicine*, 38(3), 180–204. 10.1007/s12160-009-9147-y [PubMed: 20082164]
- Richetin J, Costantini G, Perugini M, & Schönbrodt F (2015). Should we stop looking for a better scoring algorithm for handling Implicit Association Test data? Test of the role of errors, extreme latencies treatment, scoring formula, and practice trials on reliability and validity. *PLOS ONE*, 10(6), e0129601 10.1371/journal.pone.0129601 [PubMed: 26107176]

- Rocheleau CA, Webster GD, Bryan A, & Frazier J (2004). Moderators of the relationship between exercise and mood changes: Gender, exertion level, and workout duration. *Psychology & Health*, 19(4), 491–506. 10.1080/08870440310001613509
- Rothbart MK, Ellis LK, Rueda MR, & Posner MI (2003). Developing mechanisms of temperamental effortful control. *Journal of Personality*, 71(6), 1113–1143. 10.1111/1467-6494.7106009 [PubMed: 14633060]
- Rydell RJ, & McConnell AR (2006). Understanding implicit and explicit attitude change: A systems of reasoning analysis. *Journal of Personality and Social Psychology*, 91(6), 995–1008. 10.1037/0022-3514.91.6.995 [PubMed: 17144760]
- Rzewnicki R, Vanden Auweele Y, & De Bourdeaudhuij I (2003). Addressing overreporting on the International Physical Activity Questionnaire (IPAQ) telephone survey with a population sample. *Public Health Nutrition*, 6(3), 299–305. 10.1079/PHN2002427 [PubMed: 12740079]
- Sallis JF, & Saelens BE (2000). Assessment of physical activity by self-report: Status, limitations, and future directions. *Research Quarterly for Exercise and Sport*, 71(sup2), 1–14. 10.1080/02701367.2000.11082780
- Schmidt MD, Cleland VJ, Thomson RJ, Dwyer T, & Venn AJ (2008). A comparison of subjective and objective measures of physical activity and fitness in identifying associations with cardiometabolic risk factors. *Annals of Epidemiology*, 18(5), 378–386. 10.1016/j.annepidem.2008.01.005 [PubMed: 18433666]
- Troiano RP, Berrigan D, Dodd KW, Mâsse LC, Tilert T, & McDowell M (2008). Physical activity in the United States measured by accelerometer. *Medicine & Science in Sports & Exercise*, 40(1), 181–188. 10.1249/mss.0b013e31815a51b3 [PubMed: 18091006]
- Tucker JM, Welk GJ, & Beyler NK (2011). Physical activity in U.S. adults. *American Journal of Preventive Medicine*, 40(4), 454–461. 10.1016/j.amepre.2010.12.016 [PubMed: 21406280]
- Verstraeten K, Vasey MW, Claes L, & Bijttebier P (2010). The assessment of effortful control in childhood: Questionnaires and the Test of Everyday Attention for Children compared. *Personality and Individual Differences*, 48(1), 59–65. 10.1016/j.paid.2009.08.016
- Xu Y, Li Y, Ding W, & Lu F (2014). Controlled versus automatic processes: Which is dominant to safety? The moderating effect of inhibitory control. *PLoS ONE*, 9(2). 10.1371/journal.pone.0087881

Figure 1. Johnson- Neyman plot depicting the conditional effect of implicit attitudes on average LTPA duration at different effortful control values. Individuals who fell 0.24 SDs below the effortful control mean or lower evidenced a positive, significant ($p < .05$) relationship between implicit attitudes and average LTPA duration. All those that fell above 0.24 SDs did not evidence a relationship between implicit attitudes and workout duration.

Figure 2. Johnson- Neyman plot depicting the conditional effect of implicit attitudes on average LTPA duration at different inhibitory control values. Individuals who fell 0.23 SDs below the inhibitory control mean and lower evidenced a positive, significant ($p = .05$) relationship between implicit attitudes and average LTPA duration.

Table 1

Demographic information for the sample without outliers (n=148)

Measure	M	(SD)	Range
Age	19.28	(1.63)	18–31
BMI (kg/m ²)	23.46	(4.09)	14.86–41.19
Implicit attitude (D-score)	0.21	(0.41)	–0.74–1.59
Explicit attitude	34.76	(4.62)	18–40
Affective attitude	16.14	(3.36)	5–20
Instrumental attitude	18.63	(1.80)	13–20
Effortful control (ATQ)	4.42	(0.70)	2.72–6.47
Effortful control subscales			
Inhibitory control	4.45	(0.83)	2.64–6.82
Attentional control	3.94	(0.87)	1.92–6.17
Activation control	4.86	(0.86)	2.17–7.00
LTPA MET [*] mins/week (IPAQ)	2123.15	(2162.93)	0–10788.00
Average LTPA duration (IPAQ)	35.60	(28.97)	0–140

* Note: MET mins/week is a measure of total weekly energy expenditure

Table 2

Bivariate correlations between study variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Implicit attitude	--											
2. Explicit attitude	.07	--										
3. Affective attitude	.04	.95 [*]	--									
4. Instrumental attitude	.11	.80 [*]	.57 [*]	--								
5. Effortful control	.06	.10	.13	.01	--							
6. Inhibitory control	.13	.10	.08	.11	.83 [*]	--						
7. Attentional control	-.01	.13	.17 [*]	.02	.84 [*]	.58 [*]	--					
8. Activation control	.04	.01	.08	-.11	.79 [*]	.47 [*]	.48 [*]	--				
9. LTPA MET mins/week	.12	-.04	-.01	-.07	.15 [†]	.06	.11	.21 [*]	--			
10. Average LTPA duration	.17 [*]	-.01	-.01	-.02	.07	-.01	.03	.16 [†]	.77 [*]	--		
11. Age	-.02	.12	.15 [†]	.04	.05	.04	.06	.02	-.13	-.08	--	
12. BMI	-.15 [†]	.12	.11	.09	-.03	.01	.02	-.11	-.08	-.12	.17 [*]	--

* $p < .05$

[†] $p < .1$

Table 3

Results of multiple regressions predicting LTPA MET/mins and average LTPA duration from implicit and explicit attitudes

Predictor	Outcome							
	LTPA MET/mins per week				Average LTPA duration			
	<i>R</i> ²	<i>b</i>	<i>SE</i>	<i>p</i>	<i>R</i> ²	<i>b</i>	<i>SE</i>	<i>p</i>
Model 1	.006				<.001			
Intercept		3747.28	1871.21	.047		41.24	25.13	.103
Instrumental attitudes		−108.47	120.37	.369		−0.34	1.62	.832
Affective attitudes		24.57	64.72	.705		0.05	0.87	.958
Model 2	.022				.030			
Intercept		3926.24	1866.20	.037		44.54	24.88	.076
Instrumental attitudes		−127.65	120.47	.291		−0.70	1.61	.666
Affective attitudes		26.91	64.44	.677		0.09	0.86	.918
Implicit attitudes		676.59	441.12	.127		12.45	5.88	.036
Model 3	.054				.043			
Intercept		2617.87	1901.00	.171		34.09	25.60	.185
Instrumental attitudes		−31.79	102.30	.756		−0.04	1.38	.978
Implicit attitudes		11976.94	5064.10	.019		106.75	68.19	.120
Instrumental x implicit attitudes		−605.25	270.13	.027		−5.05	3.64	.167
Model 4	.026				.035			
Intercept		1742.60	932.86	.064		31.00	12.44	.014
Affective attitudes		16.46	56.96	.773		0.14	0.76	.857
Implicit attitudes		3496.16	2161.91	.108		38.52	28.83	.184
Affective x implicit attitudes		−179.30	132.36	.178		−1.65	1.77	.352

Table 4

Results of multiple regressions predicting average LTPA duration from individual effortful control subscales

Predictor	R^2	b	SE	p
Attentional control Model .053				
Intercept		35.54	2.36	<.001
Instrumental attitudes		-1.40	2.90	.630
Affective attitudes		0.24	2.92	.933
Implicit attitudes		3.65	2.52	.149
Attentional control (Att)		0.44	2.41	.856
Implicit attitudes x Att		-4.57	2.55	.076
Activation control Model .062				
Intercept		35.78	2.35	<.001
Instrumental attitudes		-0.20	2.93	.945
Affective attitudes		-0.42	2.90	.885
Implicit attitudes		4.45	2.40	.065
Activation control (Act)		3.92	2.44	.110
Implicit attitudes x Act		-3.62	2.91	.215
Inhibitory control Model .092				
Intercept		36.40	2.32	<.001
Instrumental attitudes		-0.61	2.84	.829
Affective attitudes		0.65	2.81	.819
Implicit attitudes		3.19	2.44	.194
Inhibitory control (Inh)		-0.63	2.33	.787
Implicit attitudes x Inh		-6.50	2.12	.003

Note: b represents unstandardized regression coefficients; Attentional, Activation, and Inhibitory control subscales come from the ATQ