Implicit attitudes, physical activity and self-regulatory capacity

THESIS

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Abstract

Dual-process models of health behavior posit that conscious and non-conscious modes of processing independently influence whether or not a person chooses to engage in a target behavior. Prior research suggests that an individual’s implicit attitudes may influence their physical activity level above and beyond the effect of explicit attitudes. The current study examined the extent to which implicit attitudes were associated with physical activity and explored potential moderators of this association. Undergraduate students (N= 150) completed a personalized, Single-Category Implicit Association Test (SC-IAT) in order to measure their implicit attitudes towards physical activity. Participants also provided heart rate variability (HRV) data and self-reported their physical activity level and explicit attitudes towards exercise. Contrary to prior literature, implicit attitudes were not significantly associated with individuals’ reports of their total physical activity level, moderate-to-vigorous physical activity, or leisure-time physical activity (LTPA). The association between implicit attitudes and PA was not moderated by HRV or EC. Subscales of EC measures were explored in order to determine whether a particular facet of EC attenuated the association between implicit attitudes and PA. While individual facets of EC did not emerge as moderators, activation control was associated with LTPA. Implicit attitudes and EC may influence the extent to which an individual engages in physical activity. However, prospective studies using objective measures of PA are necessary.
Dedication

To my parents, brother, and friends:

Thank you all for your never-ending support and encouragement
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Thank you to my advisor, Dr. Janice Kiecolt-Glaser, for her guidance during the completion of this project and throughout my first two years in this program. Her mentorship has been a crucial factor in my development as a researcher and professional, and I appreciate the time and resources that she has expended for my benefit.

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Chapter 1: Background and Significance

Introduction

The Centers for Disease Control estimate that 1.25 million Americans died from obesity-related diseases in 2013, including heart disease, cancer, and diabetes. Understanding the factors that influence obesity-related health behaviors is crucial for developing interventions to address this major public health concern. Negative attitudes towards eating and exercise may be an important target for such interventions. Indeed, researchers have developed numerous interventions that attempt to change self-reported (explicit) attitudes about food choice and exercise. Unfortunately, these interventions typically do not result in long term, objective behavior changes (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003; Callahan, 2013; Ogden, Karim, Choudry, & Brown, 2007). Accordingly, consideration of other pathways through which attitudes influence eating and exercise behavior may help increase the effectiveness of current interventions. The proposed research will examine one such potential influence of physical activity level: implicit attitudes.

The dual-process model of health behavior

Research examining factors related to health behaviors has primarily focused on conscious processes such as explicit attitudes, risk perception, and motivation. Unfortunately, empirical studies investigating the behavioral effects of these conscious processes have been discouraging. Meta-analyses indicate that large changes in explicit
processes and risk perception predict only small-to-medium changes in health behaviors (Sheeran, Harris, & Epton, 2011; Webb & Sheeran, 2006). These results suggest that other processes may have an important impact on health behavior, and thus the identification of these processes may help to create more efficacious interventions.

Dual-process models of health behavior identify two systems of information processing that impact behavior (e.g., Friese, Hofmann, & Wiers, 2008; Friese et al., 2008; Gerrard, Gibbons, Houlihan, Stock, & Pomery, 2008). The first system, the deliberate mode, is related to conscious processes. The deliberate mode refers to the slow, logical contemplation that occurs when a person decides whether to engage in a behavior. The second system, the automatic system, refers to reliance on heuristics and associations learned from experience to make quick, non-conscious decisions about engaging in a health behavior (Hyde, Doerksen, Ribeiro, & Conroy, 2010). Researchers hypothesize that explicit modes of processing regulate behavior when individuals have more time and self-regulatory skills, whereas implicit modes of processing take over when individuals are pressed for time or are deficient in self-regulatory capacities (Hyde, Elavsky, Doerksen, & Conroy, 2012).

Critics of dual-process theories believe that the model overstates the simplicity of health behavior decision-making given the lack of evidence that directly tests the assumptions underlying the theory (e.g., Evans, 2009; Keren & Schul, 2009). However, recent findings suggest that non-conscious processes influence health behaviors even after accounting for explicit processes, providing support for the model (e.g., Prestwich, Hurling, & Baker, 2011; Rebar, Ram, & Conroy, 2015). Given these promising results,
researchers have called for more research on non-conscious influences on health behavior (Sheeran, Gollwitzer, & Bargh, 2013).

**Implicit attitudes and health behaviors**

Non-conscious processes that impact health behavior can be broken down into three types: implicit affect, implicit cognition (e.g., attention), and implicit motivation (Sheeran et al., 2013). Implicit affect, or implicit attitude, refers to an automatic, emotional response that an individual has when confronted with a stimulus. This attitude is believed to be the result of prior experience with the stimulus, and may differ in magnitude and direction from an individual’s explicit attitude. Evidence supports conceptualizing implicit attitudes and explicit attitudes as two, independent systems that influence behavior. For example, one meta-analysis reported that the average correlation between implicit and explicit attitudes was $r = .21$ (Greenwald, Poehlman, Uhlmann, & Banaji, 2009). In regard to physical activity, numerous studies found no relationship between implicit attitudes and explicit attitudes, including affective attitudes, instrumental attitudes, and intent to exercise (Calitri, Lowe, Eves, & Bennett, 2009; Conroy, Hyde, Doerksen, & Ribeiro, 2010; Hyde et al., 2010).

Explicit and implicit attitudes make independent contributions to health behavior (e.g., Reich, Below, & Goldman, 2010). The majority of this work has focused on alcohol, nicotine, and substance use. In meta-analyses, implicit attitudes were associated with behavior, with overall correlations ranging from $r = .26$ to $r = .31$ (Greenwald et al., 2009; Reich et al., 2010; Rooke, Hine, & Thorsteinsson, 2008). For example, positive implicit attitudes towards cigarettes and alcohol were related to self-reported smoking ($r = .37$) and alcohol use ($r = .19$; McCarthy & Thompsen, 2006). Additionally, implicit
attitudes accounted for a significant portion of the variance in substance use behavior even after controlling for explicit attitudes, with effect size estimates as high as $\beta = .26$ (Greenwald et al., 2009; Reich et al., 2010).

Implicit attitudes may also influence eating, but the literature is mixed. In one study, individuals were given measures of implicit and explicit attitudes towards candy and fruit and found that implicit attitudes were related to food choice, but this effect disappeared when controlling for explicit measures of food palatability (Ayres, Conner, Prestwich, & Smith, 2012). On the other hand, another study found that implicit attitudes towards certain foods predicted objective food purchase choice while explicit attitudes did not (Prestwich et al., 2011). Individuals with strong positive implicit attitudes towards fruit were more likely to purchase fruit (as opposed to chocolate) than those with stronger positive implicit attitudes towards candy. Conflicting results such as these make it difficult to pinpoint the role of implicit attitudes in influencing food consumption and purchase choice.

**Implicit attitudes and physical activity**

Despite preliminary evidence that implicit attitudes can influence health behaviors, the literature is mixed, and the impact of implicit attitudes on physical activity level has not been well studied. Physical activity is typically thought of as a planned behavior heavily influenced by explicit thought processes. On the other hand, a meta-analysis investigating the effects of implicit and explicit attitudes on behavior found that explicit attitudes were less able to predict behavior when assessing attitudes governed by social influence (Greenwald et al., 2009). Sedentary lifestyles have become stigmatized in recent years (Berry & Spence, 2009; Puhl, Peterson, DePierre, & Luedicke, 2013;
Sikorski, Luppa, Brähler, König, & Riedel-Heller, 2012), so it is possible that measures of explicit attitudes are not gathering honest information about individual attitudes towards physical activity.

Correlations between explicit thought processes and observable health behaviors are weak ($r = .18-.27$; Calitri, Lowe, Eves, & Bennett, 2009; Conroy et al., 2010). Thus, automatic processes may help to further explain how individuals choose whether to engage in physical activity. Correlational studies link implicit attitudes with exercise. For example, people who exercise more frequently tend to have more positive implicit attitudes about exercise (Markland, Hall, Duncan, & Simatovic, 2015). In another study, residualized change in implicit attitudes was associated with change in physical activity level over one week (Hyde et al., 2012). Individuals whose implicit attitudes became more favorable demonstrated increased physical activity across the week. However, these studies cannot explain the directionality of this relationship – do individuals who exercise more tend to view physical activity more positively as a function of the exercise, or do attitudes predict physical activity level?

Evidence from prospective studies suggests that implicit attitudes about exercise predict subsequent, objective measures of physical activity. Conroy et al. (2010) asked participants to complete measures of implicit attitudes and explicit motivation towards exercise and then wear a pedometer for one week. Implicit attitudes predicted daily step count even after controlling for explicit processes such as motivation, perceived control, and exercise self-efficacy. In a more recent study, Rebar, Ram, and Conroy (2015) asked participants to wear an acceleratorometer for two weeks after completing a test of implicit attitudes and measures of explicit attitudes towards physical activity. Individuals with
more favorable implicit attitudes exercised more on average than those with unfavorable attitudes, even after controlling for conscious processes such as affective and instrumental attitudes.

Few studies 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. Although these results are promising, it is unclear whether interventions such as these can produce long-lasting changes in implicit attitudes, and whether these attitude adjustments predict subsequent changes in exercise behavior. Understanding personality variables that predict who stands to benefit from these interventions may help researchers generate more targeted, effective interventions.

The current study extended research on implicit attitudes and physical activity, with key methodological differences. Specifically, prior studies controlling for explicit motivation or intent to exercise may not have captured the role of implicit attitudes independently from explicit affective and instrumental attitudes, concepts which are distinct from motivation. Additionally, this study utilized a more appropriate measure of implicit attitudes, in order to remove the potential influence of extrapersonal factors that may be present in traditional measures of implicit attitudes (Olson & Fazio, 2004). Finally, this study expanded prior research by investigating whether self-regulatory
capacity may influence the relationship between implicit attitudes and exercise. Self-regulatory capacity had not been previously examined as a potential moderator of this relationship, and may provide a novel conceptualization of how attitudes and self-regulation may interact to influence physical activity.

**The influence of self-regulatory capacity over implicit attitudes**

Self-regulation, also referred to as self-control, is the ability to self-direct behavior and modulate impulses that may lead one away from achieving a goal or performing a planned behavior. Individuals with high self-regulatory capacity are better able to override their automatic behavioral response (when it is inconsistent with their goal) and instead choose a more adaptive response. Self-regulatory capacity plays a large role in physical health. For example, children with lower self-control were more likely to have health problems as adults than those with higher self-control even after controlling for socioeconomic status and IQ (Moffitt et al., 2011). Among cardiac rehabilitation patients, self-regulatory strategies helped explain the relationship between intent to increase exercise and subsequent physical activity level two and four months later, indicating that self-regulatory capacity plays an important role in whether an individual carries out health behavior change or not (Sniehotta, Scholz, & Schwarzer, 2005).

Self-regulatory capacity may influence health behavior by allowing individuals to overcome implicit attitudes against a behavior in an effort to achieve a goal, such as improved health or weight loss. Indeed, dual-process models of health behavior theorize that health behaviors may be more strongly governed by non-conscious processes than conscious thought among individuals deficient in self-regulatory capacity (Hyde et al., 2012). Therefore, it is reasonable to expect that individuals with low self-regulatory
capacity are less able to override negative implicit attitudes about physical activity, ultimately rendering them unable to exercise for the sake of a desirable goal, such as improved physical health. This tenet of dual-process models could help to explain previous findings that individuals with poor self-regulation tend to be in poorer health.

Very few studies have empirically tested Hyde and colleagues’ theory (2012), and thus its utility regarding exercise has not been explored. Research on eating behavior provides some support for the theory. In a study that manipulated participants’ self-regulatory capacity by increasing cognitive load via a memory distraction task, there was a moderate correlation between implicit attitude and chocolate consumption among participants with depleted self-regulatory capacity; the relationship was non-significant in the control group (Friese, Hofmann, & Wänke, 2008). Another study reported similar findings when 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 & Friese, 2008). These data suggest that implicit attitudes are more strongly related to food consumption when self-regulatory capacity is diminished.

The current study explored the extent to which self-regulatory capacity influences implicit attitudes’ influence over physical activity. Effortful control and heart rate variability provided psychological and physiological measures of self-regulatory capacity.

**Effortful control.** Effortful control (EC) is defined as the ability to subvert a dominant behavior in order to engage in an alternative behavior, as well as to recognize
errors and engage in planning (Rothbart, Ellis, Rueda, & Posner, 2003). EC is a trait that is strongly influenced by genetic factors (Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005; Sheese, Voelker, Posner, & Rothbart, 2009). Individual differences in EC are evident from early childhood and have important implications for development. For example, high levels of EC in childhood appear to be a protective factor against the development of mood disorders and externalizing disorders (Dinovo & Vasey, 2011; Rothbart et al., 2003). Although children are primarily the focus of EC research, evidence suggests that EC is stable across time and represents a persisting pattern of self-regulation (Dinovo & Vasey, 2011; Evans & Rothbart, 2007).

Although EC is often described as a unidimensional trait, factor analyses of questionnaires measuring EC reveal three aspects of the trait: 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 engage in 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.

Research over the last decade provides support for a neurobiological basis of EC. Specifically, work in neuropsychology identified the anterior cingulate gyrus and the prefrontal cortex as neurological structures involved in the executive attention (i.e. self-regulation) network (Posner, Rothbart, & Rueda, 2013). The anterior cingulate gyrus activates when an individual is asked to inhibit their natural response to a strong positive or negative emotion (Beauregard, Lévesque, & Bourgouin, 2001; Ochsner, Bunge, Gross, & Gabrieli, 2002). The prefrontal cortex is an important structure of the executive
attention network and aids in the inhibition of undesired behaviors on performance tasks (Posner et al., 2013).

Preliminary evidence suggests a relationship between EC and physical health. In addition to protecting against high-risk health behaviors such as substance abuse, higher EC appears to serve a protective function against obesity. In a longitudinal study, children with higher levels of self-control at age 9 were less likely to be overweight at age 15 compared to children with low self-control, after controlling for baseline overweight status, age, IQ, sex, ethnicity, and SES (Tsukayama, Toomey, Faith, & Duckworth, 2010). Additionally, a systematic review suggested that deficits in executive functioning are related to higher caloric intake, impulsive eating, and decreased physical activity (Liang, Matheson, Kaye, & Boutelle, 2014). More research is necessary to determine the relationship between effortful control and physical activity.

**Heart rate variability.** Heart rate variability (HRV) measures variation in the intervals between heart beats, and is governed by the autonomic nervous system (ANS). The parasympathetic nervous system (PNS), one division of the ANS, decelerates heart rate while the sympathetic nervous system (SNS) accelerates it. The PNS communicates with the heart via tonic inhibitory control from the vagus nerve to slow down heart rate. Higher HRV and deceleration of heart rate indicate greater vagal activity (Thayer, Hansen, Saus-Rose, & Johnsen, 2009). Flexible fluctuation (as opposed to rigidity) in beat-to-beat rhythm is thought to be adaptive, and is associated with better mental and physical health. For example, low HRV is associated with higher cardiac event risk (Tsuji et al., 1996), coronary heart disease risk (Dekker et al., 2000), depression (Carney et al., 2001), and all-cause mortality (Tsuji et al., 1994).
The vagus nerve is connected to neural structures that are part of the central autonomic network, such as the prefrontal cortex and anterior cingulate cortex (Benarroch, 1997). These structures are associated with self-regulatory processes and have been linked with EC (Aron, Robbins, & Poldrack, 2004; Chambers et al., 2006; Posner et al., 2013). It is thought that these neural structures exert top-down control over the SNS via the vagus nerve in order to inhibit heart rate acceleration. Therefore, by measuring HRV, researchers indirectly measure neural activity in brain structures related to self-regulation, such as the amygdala and the prefrontal cortex. For this reason, the neurovisceral integration model posits that HRV serves as an index of neural activity involved in cognitive, affective, and physiological self-regulation (Thayer et al., 2009; Thayer & Lane, 2009), where higher HRV represents higher self-regulatory capacity.

Important connections between HRV and health behaviors, particularly eating and physical activity, have been well documented. In a sample of 1712 older participants, those with lower HRV were less physically active than those with higher HRV (Dietrich et al., 2008). Additionally, results showed that physical activity protected against decreases in HRV related to weight gain. In a longitudinal study, obese women who participated in an intervention aimed at increasing physical activity and restricting caloric intake evidenced greater HRV increases compared to controls (Ito et al., 2001). Physical activity and healthy eating are related to higher HRV across various populations including children, adults, obese individuals, stroke victims, and cancer patients (e.g., Kaikkonen et al., 2014; Niederer et al., 2012; Santos-Magalhaes et al., 2015; Usui & Nishida, 2015). However, no research has addressed the relationship between EC or HRV
and implicit attitudes, or whether individuals with high or low self-regulatory capacity differ in the extent to which implicit attitudes influence health behavior.

Current study

Prior literature suggests a relationship between implicit attitude and physical activity, and the present study sought to replicate this finding as well as explore the role of implicit attitudes across different domains of physical activity. The current study also addressed gaps in the literature by exploring potential moderators of the association between implicit attitudes and self-reported physical activity level. Effortful control and HRV, two indicators of self-regulatory capacity, were assessed as moderators. Specific facets of EC (attentional control, inhibitory control, and activation control) were further explored in post-hoc analyses to determine the extent to which these facets attenuate the association between implicit attitudes and PA.

Hypotheses

The following hypotheses were tested:

1) Individuals’ implicit and explicit attitudes will be positively associated with their physical activity levels.
   a. Consistent with prior research, explicit attitudes will be more strongly associated with physical activity than implicit attitudes.
   b. Implicit attitudes will be associated with physical activity even after controlling for the strong effect of explicit attitudes.

2) Effortful control will moderate the relationship between implicit attitudes and physical activity, such that implicit attitudes will be more strongly associated with physical activity level among people with low effortful control.
3) Heart rate variability will moderate the relationship between implicit attitudes and physical activity, such that implicit attitudes will be more strongly associated with physical activity level among people with low heart rate variability.
Chapter 2: Research Design and Methods

Research protocol

Subjects. Participants were recruited from the Research Experience Program (REP) for undergraduate students enrolled in Introduction to Psychology at the Ohio State University. Participants volunteered for the study through the REP website. Both men and women were recruited, and all participants were over the age of 18. Students received course credit from this program in exchange for their participation in the proposed study. Sessions occurred in the Psychology Building, and each session was run individually or in pairs, so that baseline resting heart rate could be obtained without the distraction of other participants. A total of 150 individuals participated in the study between January and April 2016.

Study protocol. The participants arrived at the assigned room, and informed consent was obtained before beginning the session. A timeline was used to record exact times for the 10-minute resting heart rate reading. Following obtaining informed consent, the heart rate monitor was attached to the participant. The session start time was recorded on the timeline as soon as the monitor began measuring (indicated by a green light on the device). Before beginning a 10-minute rest period, the experimenter instructed the participant to remain as still as possible in an upright, seated position and breathe slowly (2 seconds for inhalation and 2 seconds for exhalation) in time with a pre-recorded tape. Paced breathing was used to standardize respiration, thus improving the accuracy of
between-person comparisons of HRV (Grossman, Stemmler, & Meinhardt, 1990). The experimenter indicated on the timeline the start time for the resting period as well as the end time. During the 10-minute interval, the experimenter remained in the room and noted any movements the participant made and the time of the movement, so that these could be noted and taken into consideration during data analysis.

Following the 10-minute rest period, participants completed a computerized implicit attitudes task, the Single Category Implicit Association Test. Finally, participants completed a packet of questionnaires including demographic information, physical activity level, effortful control, depression, and explicit attitudes. Following the session, participants received course credit for completing the experiment.

**Self-report measures**

**Demographic information.** Participants provided the following information: age, gender, race, ethnicity, academic year, living arrangement, weight, and height. All demographic information was self-report, including height and weight. Please see Appendix C for all self-report questionnaires.

**Physical activity.** The International Physical Activity Questionnaire (IPAQ; long form) was used to assess how often participants engage in various physical activities (M. 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 defines vigorous physical activities as any activities that “take hard physical effort and make you breathe much harder than normal” and provides examples such as heavy lifting, shoveling snow, running, or fast bicycling. Moderate physical activities “take moderate physical effort and make you breathe somewhat harder than
normal”, and the IPAQ provides examples such as lifting light loads, sweeping, and playing doubles tennis. Participants were then asked to report how much time they spent sitting during the last 7 days.

Multiple outcome variables were calculated from the IPAQ, including weekly PA minutes and weekly metabolic equivalents (METs). The total MET mins/week score was generated by weighting the products of each activity’s duration and intensity using metabolic equivalents from the 2000 Compendium of Physical Activities (Ainsworth et al., 2000; Hyde et al., 2012). In addition to total weekly PA, outcomes from two additional domains of living were assessed: moderate-to-vigorous PA and leisure-time PA. According to the IPAQ instructions, moderate-to-vigorous PA includes activities that result in a noticeable increase in heart rate and respiration rate. Leisure-time PA (LTPA) was chosen in an effort to reduce the effect of double-counting and unreliable reporting errors of self-reported PA. Studies separating LTPA out from other domains have found that LTPA is more strongly associated with physical fitness than other domains and total PA (Schmidt, Cleland, Thomson, Dwyer, & Venn, 2008). LTPA minutes were assessed separately in order to reduce error that may have resulted from participants attempting to classify exercise into moderate or vigorous categories (e.g., “fast bicycling” vs “bicycling at a regular pace”).

The IPAQ is appropriate for use among college students. For example, one validation study provided estimates of reliability, concurrent validity, and criterion validity across twelve countries that render the IPAQ comparable to other established measures of physical activity (Craig et al., 2003). A significant relationship was found between the IPAQ and a physical activity log for both total physical activity (Spearman’s
$p = 0.55$) and aerobic fitness level (Spearman’s $p = 0.21$), data consistent with other physical activity self-report measures physical activity (Hagströmer, Oja, & Sjöström, 2006). An additional question was added to the IPAQ in order to assess whether the participant’s report of his or her physical activity over the last week was similar to their average, weekly physical activity level. In order to assess this, participants were asked “Was your physical activity level this week similar to a typical week?” Participants chose “Yes”, “No, I am typically more active than I was this week”, or “No, I am typically less active than I was this week.”

**Explicit attitudes.** Explicit attitudes were assessed using a self-report scale commonly used in health behavior research and adapted from Ajzen and Driver's (1991) theory of planned behavior (Courneya & Bobick, 2000). The scale is designed to measure two types of explicit attitudes: instrumental attitudes and affective attitudes. Instrumental attitudes capture the extent to which the participant believes physical activity is beneficial, while affective attitudes are the emotional response an individual has to physical activity. Instrumental attitudes were assessed by asking participants to identify the extent to which they believe exercise is: important/unimportant, harmful/beneficial, healthy/unhealthy, and foolish/wise on a 7-point Likert scale. To assess affective attitudes, participants were asked the extent to which they believe exercise is: enjoyable/unenjoyable, pleasant/unpleasant, satisfying/unsatisfying, interesting/boring.

Appropriate items were reverse scored, and item scores were summed to create a measure of explicit attitude toward physical activity. Scores from this scale demonstrated adequate internal consistency in the current study ($\alpha = .85$). Scores on the instrumental attitudes subscale demonstrated questionable internal consistency ($\alpha = .62$), while scores
reflecting affective attitudes demonstrated good internal consistency ($\alpha = .90$). Removing one item (important/unimportant) improved internal consistency of the instrumental attitudes subscale ($\alpha = .70$); however, it did not improve internal consistency of the scale overall ($\alpha = .83$). Therefore, the total score consisting of all items was used in analyses.

**Effortful Control.** The Effortful Control Scale (ECS; Lonigan & Phillips, 2001) is a self-report questionnaire consisting of 24 items designed to tap into an individual’s self-regulatory capacity. Participants were asked to evaluate statements using a 5-point Likert scale in regards to how much the statement describes the individual “most of the time”. Half of the items are designed to tap into Persistence/Low Distractibility (P/LD; e.g., “When an activity is difficult, I give up”), or the ability of an individual to maintain attention on a target stimulus in the presence of distractors. The other half tap into Impulsivity (e.g., “I am able to resist laughing or smiling when it isn’t appropriate”). Division of this scale into two factors has been supported by factor analysis (Verstraeten et al., 2010). The ECS was originally designed for use with child and adolescent samples. However, among adults, scores from this scale demonstrated adequate internal consistency across 6 weeks ($\alpha = .85$) as did the two subscales: Persistence/Low Distractibility ($\alpha = .86$) and Impulsivity ($\alpha = .75$; Gillie, 2012). In the current study, the P/DL ($\alpha = .78$) and Impulsivity ($\alpha = .66$) subscales demonstrated adequate internal validity.

The Adult Temperament Questionnaire – Long Form (ATQ, Evans & Rothbart, 2007) is a 177-item questionnaire that assesses constructs such as effortful control, negative affect, and extraversion. Participants were asked to assess statements on a 7-point Likert scale (1 = extremely untrue of you, 7 = extremely true of you). For this
study, the subscales of attentional control, activation control, and inhibitory control were used to create a composite measure of effortful control. An exploratory factor analysis demonstrated that these subscales load on a single factor of effortful control, supporting the use of a composite measure (Evans & Rothbart, 2007). Individual subscales were also explored to determine if one facet of effortful control is more strongly associated with the attenuation of implicit attitudes. In the current study, scores from this scale demonstrated adequate internal consistency (α = .87).

A composite score was calculated from the ATQ and ECS to create a measure of general effortful control (Dinovo & Vasey, 2011). Scores from both scales were standardized and averaged to create this composite measure.

**Depression.** The widely used Center for Epidemiologic Studies Depression Scale (CES-D) measured participants’ depressive symptoms (Radloff, 1977). The CES-D consists of 20 items asking the participant how many days in the last week they felt or behaved in a particular way. Participants indicated if these behaviors or mood states lasted for less than 1 day, 1-2 days, 3-4 days, or 5-7 days. This scale is appropriate for use with college-age students (Radloff, 1991; Shean & Baldwin, 2008). Evidence suggests that high levels of depressive symptoms are related to lower HRV (Agelink, Boz, Ullrich, & Andrich, 2002; Carney et al., 2001), lower EC (Verstraeten, Vasey, Raes, & Bijttebier, 2009), and negative attitudes (Beevers & Miller, 2004). In the current sample, scores on this measure demonstrated excellent internal consistency (α = .91).

**State self-regulatory capacity.** The State Self-Control Capacity Scale (SSCCS) was used to collect a state measure of self-regulatory capacity (Ciarocco, Twenge, Muraven, & Tice, 2004). The questionnaire consists of 21 items asking individuals to
gauge the extent to which they could utilize self-control at the time of administration (e.g. “Right now I would find it difficult to plan ahead”). Individuals indicated to what extent they agreed with the items using a 7-point Likert scale ranging from 1 (not true) to 7 (very true). Scores on the SSCCS demonstrated adequate internal consistency and validity in prior samples (Ciarocco et al., 2004), and demonstrated excellent internal consistency in the current sample ($\alpha = .94$).

**Heart rate variability**

Heart rate variability was collected during a 10-minute rest period from a FirstBeat BodyGuard 2 device (Firstbeat Technologies Ltd, Jyväskylä, Finland). The Firstbeat records heart rate interval data with 1ms resolution through an artifact filter. The FirstBeat has been validated as an accurate HRV measure, and has a .02% missed beat rate and a .04% extra detection rate after artifact corrections (Parak & Korhonen, n.d.).

Data from the FirstBeat was extracted in two minute intervals and transferred to KUBIOS software (Tarvainen, Niskanen, Lipponen, Ranta-Aho, & Karjalainen, 2014). The software was used to remove artifacts and obtain a power spectral density measure of high frequency HRV for each two-minute interval (HF-HRV; 0.15-0.40 Hz). An average was created across the two-minute intervals to reflect the participant’s average HF-HRV during the rest period.

**Implicit attitudes task**

The Single Category Implicit Association Test (SC-IAT; Karpinski & Steinman, 2006), a computerized task, was utilized to measure participants’ implicit attitudes towards physical activity. The SC-IAT is a modification of the original Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). A limitation of the
original IAT is that it forces participants to make comparisons between complementary pair words (e.g., positive-negative, male-female, black-white). The SC-IAT was developed to measure implicit attitudes towards constructs with no obvious complementary category. Previous research has indicated that single category comparison tests may be the best option for measuring implicit attitudes towards physical activity, given its lack of an appropriate contrasting category (Calitri et al., 2009; Conroy et al., 2010). A validation study demonstrated that the SC-IAT has similar internal consistency to the IAT (α = .69; Karpinski & Steinman, 2006).

Previous work investigating the association between implicit attitudes and physical activity used a traditional Single Category Implicit Association Test (SC-IAT) to measure implicit attitudes. Critics of the traditional IAT contend that the measure may contain contamination from extrapersonal factors (e.g., social influence) that distort the measurement of an individual’s personally held attitude (Olson & Fazio, 2004). In order to obtain a more “pure” measurement of participants’ implicit attitudes, a personalized IAT was used. 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. In contrast, a personalized SC-IAT has different category labels (e.g., “I like” instead of “pleasant”) and removes error feedback. The personalized IAT was more strongly associated with explicit measures of attitude as well as behavior in studies of eating and voting behavior compared to a traditional IAT (Olson & Fazio, 2004). The personalized IAT was also less susceptible to measurement malleability following a brief priming manipulation compared to the traditional IAT, further demonstrating that the traditional
IAT is subject to extrapersonal factors unrelated to attitudes (Han, Czellar, Olson, & Fazio, 2010).

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 will be three blocks composed of multiple stimuli: a practice block, physical activity + “I like”, and physical activity + “I don’t like”. After the practice block, participants were asked to sort physical activities into either the “I like” or “I don’t like” category. For example, for the entire second block, physical activities should only be sorted into the “I like” category. Participants were asked to do the opposite for the third and final block. For example, for the entire third block, participants were instructed to sort physical activities only into the “I don’t like” category. The order in which participants sorted physical activity into either “I don’t like” or “I like” categories for the second and third blocks were counterbalanced. Physical activity stimuli were drawn from prior research demonstrating an association between implicit attitudes and physical activity level (See Appendix D; Conroy et al., 2010; Hyde et al., 2010). Normative items were those used in traditional IAT research (Greenwald et al., 1998).

**Statistical analyses**

**Data management.** Data from the implicit attitudes task were checked for nonresponses and outliers, in keeping with conventional IAT scoring methodology (Greenwald, Nosek, & Banaji, 2003). No participants had to be excluded based on nonresponses or short response times; therefore, all trials were used in analyses. An error penalty of 600 ms is typically added to response times for incorrect trial responses
(Greenwald et al., 2003). However, erroneous responses are impossible to obtain using a personalized IAT as responses are subjective; therefore, no error penalty was used (Olson & Fazio, 2004). All response times were natural log transformed (Greenwald et al., 1998; Olson & Fazio, 2004). 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 more favorable implicit attitudes towards physical activity.

All self-report data were treated as continuous variables. High frequency HRV values were log-transformed in order to address a non-normal distribution. Implicit attitudes, HRV, and EC data were standardized in moderation analyses in order to meaningfully interpret their interaction.

**Hypothesis 1: Implicit attitudes, explicit attitudes, and physical activity level.**

Linear regression was used to test whether physical activity level was related to attitudes. SPSS version 22 was used to test for main effects. Four dependent variables were assessed as measures of PA level: total weekly METs (MET mins/week), moderate to vigorous physical activity METs (MVPA MET mins/week), leisure-time PA minutes, and leisure-time METs. Hierarchical multiple linear regression was used to test whether the association between implicit attitudes and physical activity level existed above and beyond the influence of explicit attitudes. Groups of variables were added to the model in separate steps. In the first step, explicit attitudes were entered as a predictor of physical activity level. In the second step, implicit attitudes were added to the models in order to
determine if this variable accounted for a significant portion of the variance in physical activity level after accounting for explicit attitudes. The same models were then retested; excluding all participants who indicated that their PA over the past week was atypical.

**Hypothesis 2: Effortful control as a moderator between negative implicit attitudes and physical activity.** In order to assess whether EC moderates the relationship between implicit attitudes and PA, the interaction between EC and attitudes was examined (EC x Implicit Attitudes) using hierarchical multiple linear regression in the PROCESS macro for SPSS version 22 (Hayes, 2012). In step one of the model, EC, explicit attitudes, and implicit attitudes were entered as independent variables. In step two, the interaction term was added as a predictor of PA level. The Johnson-Neyman approach (1936) was used to probe significant interactions. This approach indicated over what range of moderator (e.g., HRV) the effect of implicit attitudes was significantly positive, nonsignificant, or significantly negative (D’Alonzo, 2004).

**Hypothesis 3: Heart rate variability as a moderator between implicit attitudes and physical activity.** Statistical analyses used to investigate HRV as a moderator of the association between implicit attitudes and PA level were similar to those investigating EC as a potential moderator. In order to assess whether HRV moderated the relationship between implicit attitudes and PA, the interaction between HRV and attitudes was examined (HRV x Implicit Attitudes). Using hierarchical multiple linear regression, HRV, explicit attitudes, and implicit attitudes were entered as predictors of physical activity level. Then, the interaction term was added as a predictor of PA level. Significant interactions were probed using the Johnson-Neyman technique (D’Alonzo, 2004).
**Post-hoc analyses with EC components.** Evidence suggests that certain facets of EC may be more likely than others to attenuate the effect of implicit attitudes on behavior (e.g., Haynes, Kems, & Moffitt, 2015). Given this, post-hoc analyses examined whether different types of EC differentially moderated the association between implicit attitudes and LTPA. Hierarchical multiple linear regression was used to test the interaction between implicit attitudes and all subscales of the ECS and ATQ. All significant interactions were probed using the Johnson-Neyman technique (D’Alonzo, 2004).
Chapter 3: Results

Demographics

Participants (N=150) were undergraduate students at the Ohio State University. The majority were Caucasian (70.5%), women (59.6%), and in their first academic year of college (63.7%). Additional demographic information is listed in Table 1.

Preliminary Analyses

Based on the IPAQ scoring protocol, four cases were excluded from all analyses due to excessively high self-reported PA (greater than 6720 minutes per week, an average of 16 hours per day). The excluded group did not differ significantly from the remainder of the sample on measures of BMI ($t = 1.29, p = .512$), explicit attitudes ($t = 0.64, p = .756$), or implicit attitudes ($t = 0.02, p = .888$). On average, participant scores on self-report measures were similar to those from other college samples (see Table 2). Descriptive statistics for self-reported physical activity are listed in Table 3.

Correlations among study variables are listed in Table 4. Implicit and explicit attitudes were not significantly related to each other, and neither was significantly related to an individual’s self-report of their total physical activity, MVPA, or leisure-time physical activity. However, there was a marginally significant association between implicit attitudes and BMI, such that individuals with more positive implicit attitudes towards physical activity tended to have lower BMIs ($r = -0.14, p = .097$). Explicit attitudes were marginally associated with MVPA, but not in the hypothesized direction ($r$
individuals with more positive explicit attitudes reported less moderate to vigorous activity than those with negative attitudes.

Contrary to expectation, HRV was not significantly related to EC. Additionally, neither HRV nor the composite measure of EC was significantly related to PA levels. However, individuals with higher levels of activation control tended to report more MVPA ($r = 0.15, p = .068$) and LTPA METs per week ($r = 0.22, p = .009$). Depressive symptoms were significantly related to self-reported measures of state and trait self-regulatory capacity, such that individuals with more depressive symptoms evidenced lower self-regulatory capacity (all $rs > .23$).

**Hypothesis 1: Implicit attitudes, explicit attitudes, and physical activity level**

Hierarchical multiple linear regression was used to test the association between attitudes and PA level (Table 5). In step 1 of the model, explicit attitudes were not associated with total MET mins/week ($b = -142.68, t = -1.58, p = .117$) and were marginally associated with MVPA MET mins/week ($b = -131.25, t = -1.85, p = .066$). However, explicit attitudes were not associated with MVPA in the hypothesized direction. Implicit attitudes did not significantly improve model fit when entered into step 2 of the model predicting total MET mins/week ($b = 319.73, \Delta R^2 = .001, p = .752$) or MVPA MET mins/week ($b = 985.08, \Delta R^2 = .011, p = .213$).

Hierarchical multiple linear regression was also used to test the association between attitudes and leisure time physical activity. In step 1 of the model, explicit attitudes were entered as a predictor of LTPA. Explicit attitudes were not associated with total LTPA minutes or MET mins/week (all $ps > .10$). Implicit attitudes did not improve model fit in the model predicting LTPA minutes. Additionally, implicit attitudes did not
significantly improve model fit in the model predicting LTPA MET mins/week; however the non-significant effect was in the hypothesized direction \((b = 677.65, \Delta R^2 = .016, p = .127)\).

All models were rerun after excluding all participants who indicated that their exercise level for the week was atypical. Excluding these participants did not change results.

**Hypotheses 2 and 3: Self-regulatory capacity as a moderator between implicit attitudes and PA**

Hierarchical linear regression was used to examine whether measures of self-regulatory capacity moderated the association between implicit attitudes and PA. Explicit attitudes were not included in moderation analyses as they failed to demonstrate an association between PA and implicit attitudes. The interaction between implicit attitudes and EC was not a significant predictor of total PA, MVPA, or LTPA (all \(ps > .159\); see Table 6). However, effortful control was marginally associated with LTPA \((b = 348.55, t = 1.85, p = .066)\). A visual depiction of the non-significant interaction between implicit attitudes and EC is shown in Figure 1. Implicit attitudes, HRV, and the implicit attitude by HRV interaction were not significant predictors of total PA, MVPA, or LTPA (all \(ps > .517\); see Table 7). Given the lack of support for a moderation effect of self-regulatory capacity, interactions were not probed. These models were also rerun using state self-control capacity as a moderator, which did not change results (all \(ps > .582\)).

**Post-hoc analyses**

Following these analyses, subcategories of EC were investigated to determine whether one facet may be a moderator of the association between implicit attitudes and
LTPA METs (see Table 8). The relationship between implicit attitudes and LTPA was not significantly moderated by attentional control ($b = 99.64, t = 0.51, p = .609$) or inhibitory control ($b = -109.06, t = -0.66, p = .512$). Additionally, the relationship between an individual’s implicit attitudes and LTPA did not depend on their level of activation control ($b = -99.59, t = -0.46, p = .646$). However, individuals with higher levels of activation control reported more LTPA METs, regardless of implicit attitudes ($b = 444.34, t = 2.48, p = .014$). The association between implicit attitudes and LTPA time was not moderated by the Persistence/Low Distractibility or Impulsivity subscales of the Effortful Control Scale (all $ps > .10$).
Chapter 4: Discussion

The relationship between attitudes and physical activity

In this adequately-powered study of 150 undergraduate students, implicit attitudes and explicit attitudes towards physical activity were unrelated, consistent with prior research. However, the primary hypothesis of the current study was that both explicit and implicit attitudes would be associated with physical activity level, and this was largely unsupported. Explicit attitudes were unrelated to an individual’s report of their total physical activity and their physical activity during leisure time. In regards to moderate to vigorous physical activity, individuals who reported more positive attitudes were slightly less active. These results directly contradict evidence from individual studies and large meta-analyses that suggest that more positive explicit attitudes, and affective attitudes in particular, consistently predict higher levels of physical activity (Calitri et al., 2009; Conroy et al., 2010; Hagger, Chatzisarantis, & Biddle, 2002).

A possible explanation for this discrepancy could be the influence of social desirability bias on participants’ self-report. Social desirability bias occurs when individuals alter their responses on a survey in order present themselves positively to researchers (Edwards, 1957). For example, if there is a social expectation that one should view exercise as positive and beneficial, a participant may be more apt to report a positive attitude towards physical activity, even if this deviates from their true attitude, in order to avoid negative evaluation from the researcher. Evidence suggests that social
desirability only minimally biases self-report of physical activity; however, it can heavily influence reports of explicit attitudes (King & Bruner, 2000; Motl, McAuley, & DiStefano, 2005). Indeed, the vast majority of participants in the current study reported very positive attitudes towards physical activity, with many responding as positively as possible, which indicates 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.

However, social desirability does not explain the non-significant association between non-conscious attitudes and physical activity. Implicit attitudes should be less affected by social desirability, especially when measured using a personalized IAT. The current study did not find a significant association between implicit attitudes and PA; however, the relationship was in the expected direction when assessing leisure-time METs. One possibility is that participants were better able to recall PA during leisure time because leisure-time PA tends to be associated with an event (e.g., going to the gym or playing a sport with a friend). Indeed, prior literature has demonstrated that most individuals tend to recall PA during leisure time fairly reliably (Booth, Owen, Bauman, & Gore, 1996). Additionally, one study separating leisure PA from other domains found LTPA to be more strongly associated with measures of objective physical fitness than total, moderate, or vigorous self-reported PA (Schmidt et al., 2008). 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 LTPA.
The role of HRV and EC as moderators

It was hypothesized that HRV and EC would moderate the association between implicit attitudes, and that individuals with higher levels of self-regulatory capacity would be better able to disregard negative implicit attitudes towards physical activity than those with lower HRV or EC. The current results did not support these hypotheses. However, a marginally significant main effect was found between EC and LTPA. Individuals with higher levels of effortful control were more likely to engage in leisure-time physical activity, regardless of their implicit attitudes. Although the extent to which an individual relied on their implicit attitude did not depend on their level of effortful control, EC still appears to play some role in determining whether or not an individual chooses to engage in a behavior.

Contrary to Hypothesis 3, an individual’s HRV did not influence the extent to which his or her implicit attitudes were associated with his or her physical activity level. Additionally, it was expected that HRV and EC would both serve as indicators of self-regulatory capacity. However, HRV and EC were not significantly associated. Although this was contrary to expectation, other studies of HRV and EC have also found non-significant associations between them (Gillie, 2012). In studies that have found associations between measures of self-regulatory capacity, these associations are typically weak (Dinovo, 2009; Duckworth & Kern, 2011). Therefore, it is possible that the study was underpowered to detect an association between EC and HRV.

Contrary to prior literature, HRV was also not associated with BMI, physical activity, or depressive symptoms in the current study. The use of a paced breathing protocol may explain why HRV was not associated with expected variables Considerable
controversy exists in the literature as to whether paced breathing should be used when assessing HRV. Some researchers contend that paced breathing improves measurement reliability of HRV (Pinna et al., 2007). However, other studies found that paced breathing did not improve reliability (Kobayashi, 2009), and some studies indicate that paced breathing may negatively influence validity of HRV measurements by altering baseline measures of HRV and eliminating between-person variability of interest (Bornas et al., 2006; McCraty & Shaffer, 2015; Song & Lehrer, 2003). Given this, the use of paced breathing in the current study may have eliminated important variability in HRV and therefore restricted ability to find significant associations between HRV and expected outcomes.

Post-hoc analyses explored the role of various EC components as moderators of the relationship between implicit attitudes and leisure PA. Individual facets of EC did not emerge as moderators in the current study. However, a number of main effects emerged. Individuals with higher levels of activation control engaged in more leisure-time PA than those with lower activation control. Activation control is the ability for a person to engage in a goal-directed behavior despite lack of motivation or dislike for the activity. Prior studies have not investigated the specific role that activation control may play in influencing exercise behavior. However, in the current study it appears that individuals who are better able to engage in behavior despite low motivation were more likely to use their leisure time for physical activity.

Limitations

The use of a self-report measure of physical activity is a major limitation of the current study. The gold standard for measuring physical activity is objective activity
monitoring using actigraphs or pedometers, because self-report measures of PA are susceptible to over-reporting and memory errors (Sallis & Saelens, 2000). Indeed, prior research demonstrates that over-reporting is common on the IPAQ. A study comparing the IPAQ short form to a revised IPAQ interviewing procedure (including probes for detail and exactness), found that 74% of the study sample reported more physical activity when using the short form compared to the probed interview (Rzewnicki, Vanden Auweele, & De Bourdeaudhuij, 2003). Given this, it appears that the accuracy of self-report data can be enhanced using such procedures. A thorough interview or objective physical activity data may help to increase accuracy of PA estimates in subsequent studies of implicit attitudes and PA.

It is also important to note that the distributions of the total MET mins/week and MVPA MET mins/week were positively skewed. Unfortunately log-transformations did not completely correct for the skew. Therefore, untransformed outcome variables were used for all analyses in order to allow for meaningful interpretations of regression coefficients. Given this, the assumption of normality upon which regression is based may have been violated, and results should be interpreted with caution. Additionally, the study design was cross-sectional. Therefore, one cannot rule out that possibility that with increased leisure-time physical activity, individuals experience more positive attitudes towards PA over time. Finally, the sample collected in the current study is young, healthy, and expected to be relatively active. Therefore, results from this study may not generalize to the general U.S. population, most of whom are sedentary.

Implications and Future Directions
Further investigation of the association between implicit attitudes and objective physical activity is warranted. Prior literature suggests a potential link between non-conscious attitudes and LTPA; however, this association was not present in the current study. It is possible that implicit attitudes influence self-reported PA differently from objectively-measured PA, making it important to collect both subjective and objective PA data in future studies.

If future studies can provide further evidence that activation control is associated with physical activity, it would have important implications for intervention development. Improving implicit attitudes may be an important target for intervention, but studies have not yet demonstrated that it is possible to produce long-lasting changes in implicit attitudes. Therefore, activation control may serve as an additional intervention target. Intervention studies have found support for a number of different strategies for improving executive functioning performance, including mindfulness training (Tang, Yang, Leve, & Harold, 2012). However, it remains to be seen whether interventions aimed at improving general cognitive control have long-lasting effects, and whether these changes would have any effect on physical activity. Although intervention research will eventually be important for producing changes in physical activity among those with negative implicit attitudes, there is much more to be done to fully understand the association between attitudes and activity and the role of self-regulatory capacity.
References


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http://doi.org/10.1016/j.neubiorev.2008.08.004


http://doi.org/10.1016/j.jstrokecerebrovasdis.2014.11.026


http://doi.org/10.1016/j.paid.2009.08.016


Appendix A: Tables
Table 1

*Demographic information for the sample without outliers (n=146)*

<table>
<thead>
<tr>
<th>Measure</th>
<th>%</th>
<th>M(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td>19.19(1.32)</td>
</tr>
<tr>
<td>Sex (% female)</td>
<td>59.6</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td></td>
<td>23.50(4.09)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>70.5</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>14.4</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>10.3</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td>Hispanic (% yes)</td>
<td>6.2</td>
<td></td>
</tr>
<tr>
<td>Academic year</td>
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<td></td>
</tr>
<tr>
<td>First year</td>
<td>63.7</td>
<td></td>
</tr>
<tr>
<td>Second year</td>
<td>21.9</td>
<td></td>
</tr>
<tr>
<td>Third year</td>
<td>9.6</td>
<td></td>
</tr>
<tr>
<td>Fourth year</td>
<td>4.8</td>
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</tr>
<tr>
<td>Living arrangement</td>
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<tr>
<td>On campus</td>
<td>76.7</td>
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<tr>
<td>Off campus</td>
<td>23.3</td>
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</tr>
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</table>
Table 2

*Descriptive statistics for attitudes and psychosocial variables*

<table>
<thead>
<tr>
<th>Variable (measure)</th>
<th>M</th>
<th>(SD)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implicit attitude (D-score)</td>
<td>0.21</td>
<td>(0.41)</td>
<td>-0.74-1.59</td>
</tr>
<tr>
<td>Explicit attitude</td>
<td>34.79</td>
<td>(4.56)</td>
<td>18-40</td>
</tr>
<tr>
<td>HFHRV (ms²)</td>
<td>1449.24</td>
<td>(1550.46)</td>
<td>32.4-7372.2</td>
</tr>
<tr>
<td>Effortful control (Composite score)</td>
<td>-0.01</td>
<td>(0.94)</td>
<td>-2.30-2.68</td>
</tr>
<tr>
<td>Effortful control subscales (ATQ)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Inhibitory control</td>
<td>4.45</td>
<td>(0.84)</td>
<td>2.64-6.82</td>
</tr>
<tr>
<td>Attentional control</td>
<td>3.94</td>
<td>(0.87)</td>
<td>1.92-6.17</td>
</tr>
<tr>
<td>Activation control</td>
<td>4.84</td>
<td>(0.85)</td>
<td>2.17-7.00</td>
</tr>
<tr>
<td>State self-control (SSCCS)</td>
<td>100.52</td>
<td>(23.35)</td>
<td>23-157</td>
</tr>
<tr>
<td>Depressive symptoms (CESD)</td>
<td>13.80</td>
<td>(10.24)</td>
<td>0-47</td>
</tr>
</tbody>
</table>
Table 3

Descriptive statistics for physical activity variables

<table>
<thead>
<tr>
<th>Activity type</th>
<th>Minutes/week M(SD)</th>
<th>MET minutes/week M(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking</td>
<td>813.77(594.05)</td>
<td>2695.34(1960.38)</td>
</tr>
<tr>
<td>Moderate activity</td>
<td>319.91(494.11)</td>
<td>1267.56(2019.07)</td>
</tr>
<tr>
<td>Vigorous activity</td>
<td>256.85(324.00)</td>
<td>2054.79(2592.04)</td>
</tr>
<tr>
<td>MVPA activity</td>
<td>577.10(688.50)</td>
<td>3325.07(3863.30)</td>
</tr>
<tr>
<td>Leisure activity</td>
<td>360.19(368.84)</td>
<td>2125.73(2165.79)</td>
</tr>
<tr>
<td>Total activity</td>
<td>1394.76(1076.63)</td>
<td>6023.34(4910.94)</td>
</tr>
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</table>
Table 4

Correlations (r) between primary variables

<table>
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<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
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<tbody>
<tr>
<td>1. Implicit attitude</td>
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<td>2. Explicit attitude</td>
<td>.06</td>
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<tr>
<td>3. \lnHF-HRV</td>
<td>&lt;.01</td>
<td>.05</td>
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<tr>
<td>4. Effortful control</td>
<td>.03</td>
<td>.09</td>
<td>.09</td>
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<tr>
<td>5. Inhibitory control</td>
<td>.12</td>
<td>.10</td>
<td>.07</td>
<td>.77*</td>
<td>--</td>
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<tr>
<td>6. Attentional control</td>
<td>-.02</td>
<td>.12</td>
<td>&lt;.01</td>
<td>.77*</td>
<td>.58*</td>
<td>--</td>
<td></td>
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<tr>
<td>7. Activation control</td>
<td>.04</td>
<td>.03</td>
<td>.13</td>
<td>.80*</td>
<td>.48*</td>
<td>.48*</td>
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<td>8. SSCCS</td>
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<td>.62*</td>
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<td>.57*</td>
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<tr>
<td>9. BMI</td>
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<td>.03</td>
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<tr>
<td>10. Total MET mins/week</td>
<td>.02</td>
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<td>&lt;.01</td>
<td>.02</td>
<td>-.07</td>
<td>.02</td>
<td>.12</td>
<td>-.10</td>
<td>.07</td>
<td>--</td>
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<td>.01</td>
<td>.06</td>
<td>-.03</td>
<td>.04</td>
<td>.15</td>
<td>-.09</td>
<td>.06</td>
<td>.93*</td>
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<td>.12</td>
<td>.22</td>
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<td>.64*</td>
<td>.67*</td>
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<td>13. Depressive symptoms</td>
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<td>-.08</td>
<td>-.34*</td>
<td>-.26*</td>
<td>-.35*</td>
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<td>.06</td>
<td>.01</td>
<td>.12</td>
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* p < .05  
‡ p < .1
Table 5

Results of hierarchical multiple regression for analysis of Hypothesis 1

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<tr>
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<td>t</td>
<td>p</td>
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<td>R²</td>
<td>b</td>
<td>t</td>
<td>p</td>
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<td></td>
<td>R²</td>
<td>b</td>
<td>t</td>
<td>p</td>
</tr>
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Note: \( b \) represents unstandardized regression coefficients
Table 6

*Results of hierarchical multiple regression for analysis of Hypothesis 2*

<table>
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<tr>
<th>Predictor</th>
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<th>MVPA MET mins/week</th>
<th></th>
<th>LTPA MET mins/week</th>
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</thead>
<tbody>
<tr>
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<td>$R^2$</td>
<td>$b$</td>
<td>$t$</td>
<td>$p$</td>
<td>$R^2$</td>
<td>$b$</td>
</tr>
<tr>
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<td><strong>Step 2</strong></td>
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Note: $b$ represents unstandardized regression coefficients
Table 7

Results of hierarchical multiple regression for analysis of Hypothesis 3

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Total MET mins/week</th>
<th>MVPA MET mins/week</th>
<th>LTPA MET mins/week</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>$R^2$</td>
<td>$b$</td>
<td>$t$</td>
</tr>
<tr>
<td>Step 1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Implicit attitudes</td>
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Note: $b$ represents unstandardized regression coefficients.
Table 8

Results of multiple regressions for post-hoc analyses of EC subscales

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<th>$t$</th>
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<td>.100</td>
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<td>.609</td>
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<td><strong>Activation control Model</strong></td>
<td>.062</td>
<td></td>
<td></td>
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<td>Explicit attitudes</td>
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<td>Activation control (Act)</td>
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<td><strong>Inhibitory control Model</strong></td>
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<td>Implicit attitudes</td>
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<td>208.55</td>
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<td>.645</td>
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<tr>
<td>Impulsivity (Imp)</td>
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<td>Implicit attitudes x Imp</td>
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<td>-228.126</td>
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Note: $b$ represents unstandardized regression coefficients; P/LD and Impulsivity scales come from the Effortful Control Scale; Attentional, Activation, and Inhibitory control subscales come from the ATQ
Appendix B: Figures
Figure 1. Graph of leisure PA METs by implicit attitude score and EC. The interaction between implicit attitudes and EC was nonsignificant. However, a marginally significant main effect of EC on implicit attitudes emerged ($b = 339.54, t = 1.89, p = .061$) and the effect of implicit attitudes on LTPA was in the expected direction ($b = 280.30, t = 1.51, p = .133$)
Appendix C: Self-report measures
DEMOGRAPHIC INFORMATION

Instructions: Please answer the following questions about yourself.

1.) What is your sex?  □ Male  □ Female  □ Other  □ Prefer not to disclose

2.) What is your age? ______

3.) Which one of the following groups do you think best represents your race?
   □ White
   □ Black or African American
   □ Asian
   □ Hispanic or Latino
   □ Native Hawaiian/Pacific Islander
   □ Native American
   □ Other: _______________________
   □ Don’t know/Not sure

4.) What is your ethnicity?  □ Hispanic/Latino/Latina  □ Non-Hispanic/Latino/Latina

5.) What is your academic year?
   □ Freshman
   □ Sophomore
   □ Junior
   □ Senior
   □ Graduate/professional student
   □ Other: _______________________

6.) What is your current living arrangement?
   □ On campus  □ Off campus

7.) What is your height? __________

8.) What is your weight? __________
INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (IPAQ)

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous and moderate activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

**PART 1: JOB-RELATED PHYSICAL ACTIVITY**

The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3.

1. Do you currently have a job or do any unpaid work outside your home?
   - □ Yes
   - □ No →  \*Skip to PART 2: TRANSPORTATION*  

   The next questions are about all the physical activity you did in the last 7 days as part of your paid or unpaid work. This does not include traveling to and from work.

2. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, heavy construction, or climbing up stairs as part of your work? Think about only those physical activities that you did for at least 10 minutes at a time.

   _____ days per week
   - □ No vigorous job-related physical activity →  \*Skip to question 4*
3. How much time did you usually spend on one of those days doing **vigorous** physical activities as **part of your work**?

   ____ hours per day
   ____ minutes per day

4. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads as **part of your work**? Please do not include walking.

   ____ days per week

   □ No moderate job-related physical activity →  
   **Skip to question 6**

5. How much time did you usually spend on one of those days doing **moderate** physical activities as **part of your work**?

   ____ hours per day
   ____ minutes per day

6. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time as **part of your work**? Please do not count any walking you did to travel to or from work.

   ____ days per week

   □ No job-related walking →  
   **Skip to PART 2: TRANSPORTATION**

7. How much time did you usually spend on one of those days **walking** as part of your work?

   ____ hours per day
   ____ minutes per day

**PART 2: TRANSPORTATION PHYSICAL ACTIVITY**

These questions are about how you traveled from place to place, including to places like work, stores, movies, and so on.

8. During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car, or tram?

   ____ days per week
9. How much time did you usually spend on one of those days traveling in a train, bus, car, tram, or other kind of motor vehicle?

______ hours per day
______ minutes per day

Now think only about the bicycling and walking you might have done to travel to and from work, to do errands, or to go from place to place.

10. During the last 7 days, on how many days did you bicycle for at least 10 minutes at a time to go from place to place?

______ days per week

☐ No bicycling from place to place → 

11. How much time did you usually spend on one of those days to bicycle from place to place?

______ hours per day
______ minutes per day

12. During the last 7 days, on how many days did you walk for at least 10 minutes at a time to go from place to place?

______ days per week

☐ No walking from place to place → 

13. How much time did you usually spend on one of those days walking from place to place?

______ hours per day
______ minutes per day

PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY

This section is about some of the physical activities you might have done in the last 7 days in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.
14. Think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, chopping wood, shoveling snow, or digging in the garden or yard?

_____ days per week

☐ No vigorous activity in garden or yard → Skip to question 16

15. How much time did you usually spend on one of those days doing vigorous physical activities in the garden or yard?

_____ hours per day

_____ minutes per day

16. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate activities like carrying light loads, sweeping, washing windows, and raking in the garden or yard?

_____ days per week

☐ No moderate activity in garden or yard → Skip to question 18

17. How much time did you usually spend on one of those days doing moderate physical activities in the garden or yard?

_____ hours per day

_____ minutes per day

18. Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate activities like carrying light loads, washing windows, scrubbing floors and sweeping inside your home?

_____ days per week

☐ No moderate activity inside home → Skip to PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY

19. How much time did you usually spend on one of those days doing moderate physical activities inside your home?

_____ hours per day

_____ minutes per day

PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY
This section is about all the physical activities that you did in the last 7 days solely for leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the last 7 days, on how many days did you walk for at least 10 minutes at a time in your leisure time?

_____ days per week

☐ No walking in leisure time → Skip to question 22

21. How much time did you usually spend on one of those days walking in your leisure time?

_____ hours per day

_____ minutes per day

22. Think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do vigorous physical activities like aerobics, running, fast bicycling, or fast swimming in your leisure time?

_____ days per week

☐ No vigorous activity in leisure time → Skip to question 24

23. How much time did you usually spend on one of those days doing vigorous physical activities in your leisure time?

_____ hours per day

_____ minutes per day

24. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis in your leisure time?

_____ days per week

☐ No moderate activity in leisure time → Skip to PART 5: TIME SPENT SITTING

25. How much time did you usually spend on one of those days doing moderate physical activities in your leisure time?

_____ hours per day

_____ minutes per day
PART 5: TIME SPENT SITTING

The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the last 7 days, how much time did you usually spend sitting on a weekday?
   _____ hours per day
   _____ minutes per day

27. During the last 7 days, how much time did you usually spend sitting on a weekend day?
   _____ hours per day
   _____ minutes per day

Was your physical activity level this week similar to a typical week?
   _____ Yes
   _____ No, I am typically more active than I was this week
   _____ No, I am typically less active than I was this week

This is the end of the questionnaire, thank you for participating.
**EXPLICIT ATTITUDES SCALE**

Please indicate to what extent you believe the following:

**For me to participate in regular physical exercise is:**

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<th>2</th>
<th>3</th>
<th>4</th>
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<td>Enjoyable</td>
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<td></td>
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<td>Foolish</td>
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</table>

1: Important, 2: Enjoyable, 3: Satisfying, 4: Unhealthy, 5: Harmful, 6: Interesting, 7: Unpleasant, 8: Foolish,
EFFORTFUL CONTROL SCALE OF ADULT TEMPERAMENT QUESTIONNAIRE

Directions: On the following pages you will find a series of statements that individuals can use to describe themselves. There are no correct or incorrect responses. All people are unique and different, and it is these differences which we are trying to learn about. Please read each statement carefully and give your best estimate of how well it describes you. Circle the appropriate number below to indicate how well a given statement describes you.

Circle #: if the statement is:
1 extremely untrue of you
2 quite untrue of you
3 slightly untrue of you
4 neither true nor false of you
5 slightly true of you
6 quite true of you
7 extremely true of you

If one of the statements does not apply to you (for example, if it involves driving a car and you don’t drive), then circle “X” (not applicable). Check to make sure that you have answered every item.

**Attentional Shifting from Punishment**
24. When I am sad about something, it is hard for me to keep my attention focused on a task. (R)
25. When I am anxious about the outcome of something, I have a hard time keeping my attention focused on a task. (R)
26. It is very hard for me to focus my attention when I am distressed. (R)

**Attentional Shifting from Reward**
27. When I am happy and excited about an upcoming event, I have a hard time focusing my attention on tasks that require concentration. (R)
28. When I am especially happy, I sometimes have a hard time concentrating on tasks that require me to keep track of several things at once. (R)
29. When I hear good news, my ability to concentrate on taking care of my responsibilities goes out the window. (R)

**Attentional Focusing**
30. When I am trying to focus my attention, I am easily distracted. (R)
31. When trying to focus my attention on something, I have difficulty blocking out distracting thoughts. (R)
32. When trying to study something, I have difficulty tuning out background noise and concentrating. (R)
Attentional Shifting

33. When interrupted or distracted, I usually can easily shift my attention back to whatever I was doing before.

34. I am usually pretty good at keeping track of several things that are happening around me.

35. It’s often hard for me to alternate between two different tasks. (R)
**EFFORTFUL CONTROL SCALE**

[Note: Items on the Persistence/Low-Distractibility scale are highlighted in grey.]

Directions: Below are a number of sentences a person might use to describe themselves. Read each sentence; then circle the appropriate number next to each sentence to show how much this sentence describes you. **Indicate how much each sentence describes how you are most of the time.**

<table>
<thead>
<tr>
<th></th>
<th>Not at All</th>
<th>Not Much</th>
<th>Some what</th>
<th>Often</th>
<th>Very Much</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I do not complete my homework.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. I am able to resist laughing or smiling when it isn’t appropriate.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. I really dislike it when someone breaks the rules.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. I have difficulty completing assignments on time.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. When I don’t get what I want, it’s hard to enjoy something else.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. Whenever I decide anything I always think about whether it’s right or wrong.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. I have a hard time following instructions.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. I plan and organize my schoolwork very carefully.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. When an activity or task is difficult, I give up.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. I find it easy to concentrate on what I am doing.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. My parent’s ideas of how to do things have always proven best.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. I will move from one task to another without completing any of them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. I can easily stop an activity when told to do so.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14. I usually keep at a task or project until it’s done.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. I wait to be called on before speaking.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>16. Even little things distract me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>17. I like to stop and think things over before I do them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>18. I leave my own projects or tasks unfinished.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>19. I have a hard time concentrating on my work because I’m always thinking about other things.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>20. Once I’m involved in a task, nothing can distract me from it.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>21. I start many things that I don’t finish.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>22. I often get lost in my work.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>23. I can lower my voice when asked to do so.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>24. When I get frustrated with projects or tasks, I quit.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
**CENTER FOR EPIDEMIOLOGIC STUDIES DEPRESSION SCALE (CES-D)**

Please read each statement and then indicate how many days you felt or behaved this way in the past week by filling in the corresponding circle:

<table>
<thead>
<tr>
<th>Statement</th>
<th>less than 1 day</th>
<th>1-2 days</th>
<th>3-4 days</th>
<th>5-7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I was bothered by things that usually don’t bother me.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2. I did not feel like eating; my appetite was poor.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>3. I felt that I could not shake off the blues even with help from my family or friends.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>4. I felt that I was just as good as other people.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>5. I had trouble keeping my mind on what I was doing.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>6. I felt depressed.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>7. I felt that everything I did was an effort.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>8. I felt hopeful about the future.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>9. I thought my life had been a failure.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>10. I felt fearful.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>11. My sleep was restless.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>12. I was happy.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>13. I talked less than usual.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>15. People were unfriendly.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>16. I enjoyed life.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>17. I had crying spells.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>18. I felt sad.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>19. I felt that other people dislike me.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>20. I could not “get going”.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
STATE SELF-CONTROL CAPACITY SCALE

Circle the number corresponding to the one phrase that best represents the extent to which you feel each item is typical of you.

<table>
<thead>
<tr>
<th></th>
<th>Not True</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Very True</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I feel mentally exhausted.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>2.</td>
<td>Right now, it would take a lot of effort for me to concentrate on something.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>3.</td>
<td>I need something pleasant to make me feel better.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>4.</td>
<td>I feel motivated.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>5.</td>
<td>If I were given a difficult task right now, I would give up easily.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>6.</td>
<td>I feel drained.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7.</td>
<td>I have lots of energy.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>8.</td>
<td>I feel worn out.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>9.</td>
<td>If I were tempted by something right now, it would be very difficult to resist.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>10.</td>
<td>I would want to quit any difficult task I was given.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>11.</td>
<td>I feel calm and rational.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>12.</td>
<td>I can’t absorb any information.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>13.</td>
<td>I feel lazy.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>14.</td>
<td>Right now I would find it difficult to plan ahead.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>15.</td>
<td>I feel sharp and focused.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>16.</td>
<td>I want to give up.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>17.</td>
<td>This would be a good time for me to make an important decision.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>18.</td>
<td>I feel like my willpower is gone.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>19.</td>
<td>My mind feels unfocused right now.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>20.</td>
<td>I feel ready to concentrate.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>21.</td>
<td>My mental energy is running low.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>22.</td>
<td>A new challenge would appeal to me right now.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>23.</td>
<td>I wish I could just relax for a while.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>24.</td>
<td>I am having a hard time controlling my urges.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>25.</td>
<td>I feel discouraged.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
Appendix D: Implicit Association Test stimuli
Single-Category Implicit Association Test Words

Physical activity words: run, kick box, walk, sprint, jog, hike, lift weights, bench press, aerobics, squats, dumbbell curls, sit-ups

Pleasant words: caress, freedom, health, love, peace, cheer, friend, heaven, loyal, pleasure

Unpleasant words: abuse, crash, filth, accident, death, grief, poison, stink, sickness, murder