# A Prospective Test of Predictors of Physical Activity in Freshman College Women Using a Path Analytic Method

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**Abstract**

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Physical activity levels decrease dramatically from childhood to adulthood, and only a minority of adult Americans meets the minimum recommendations for regular exercise. It therefore appears important to intervene with young people to encourage them to continue leading an active lifestyle rather than settling into a sedentary lifestyle common among adults. The first step towards encouraging such activity is to understand the reasons that some individuals adopt an active lifestyle while others do not. The present study examined young adult women entering their first year of college and evaluated the ability of a number of individual psychological variables to predict exercise behavior over several months. The variables explored included those comprising the Theory of Planned Behavior, past exercise behavior patterns, personality characteristics, physical self-efficacy, and change in emotional affect after a single bout of moderate exercise.

The participants in this study were asked to walk on a treadmill for 10 minutes (for the purpose of measuring affective change with physical activity), self-report their physical activity over three days, complete a number of questionnaires, and, two to five months later, again self-report their recent exercise behavior. Path analysis was used to evaluate the predictive value of these variables for current and future exercise behavior. Eighty-two women provided data at time 1 and 53 provided data longitudinally. Results indicated that, cross-sectionally, intention and past exercise behavior predicted current exercise behavior most strongly. Longitudinally, in part due to low statistical power, many of these relationships diminished and only current exercise behavior and affect change after walking were independent predictors in the confirmatory model; an exploratory model suggested that personality and intention could also be a significant direct independent predictor of behavior. These differential cross-sectional and longitudinal findings suggest that the women may have been less tuned into internal predilections early in their freshman year, but that these predispositions became more influential later. Past behavior predicted later behavior as expected, but over a limited time span. These findings raise intriguing questions about the changing nature of the early college experience and an individual's changing awareness of environmental versus internal cues for behavior.

# CHAPTER 1. INTRODUCTION

Leisure time physical activity (or "exercise") is promoted by health sciences researchers as an essential component of a healthy lifestyle, particularly for those individuals who live otherwise sedentary lives. Numerous controlled trials and longitudinal observational studies have found a strong inverse relationship between physical activity levels and all-cause mortality, cardiovascular disease, and diabetes (Blair et al., 1996; Hardman, 1999). Because of such findings, promotion of an active lifestyle has become a priority among public health officials. However, despite the emphasis on the benefits of exercise through public health promotions, news stories and the proliferation of fitness centers, Americans are not increasing their levels of exercise; if anything, Americans are becoming more sedentary and more obese. Research suggests that a minority of Americans exercise enough to meet minimum fitness criteria (Macera et al., 2001). The types of occupations held in Western civilization, which are increasingly more service oriented and less industrial/agricultural, can account for some decreases in physical activity, as can increased computer and television use (Prentice & Jebb, 1995).

Why some people exercise and others do not is a continuing matter for study. There may be a genetic predisposition for or against habitual physical activity (Bouchard & Tremblay, 1990; Perusse, Tremblay, Leblanc, & Bouchard, 1989) as well as cultural or familial transmission (Perusse et al., 1989). Some individuals may enjoy the feeling of exercise, while others find it unpleasant. People who are of normal weight may find it easier to move during exercise than some obese individuals who may find it uncomfortable due to their excess weight (Ball, Crawford, & Owen, 2000). Obese individuals may also experience embarrassment exposing their body in exercise clothing (Lyons & Miller, 1999). The question remains as to whether this aversion to exercise develops from the obesity, or might be a predisposing factor to obesity, the classic "chicken and egg" conundrum.

Developing a better understanding of why people exercise and what motivates them to engage (or not) in this health-enhancing activity can help in tailoring exercise programs and regimens on an individual level, which in turn may lead to enhanced participation and adherence. In turn, better exercise adherence may lead to better health outcomes and weight control. There are many different individual factors that lead to performing any given behavior, and numerous theoretical models have been developed. However, the different models (such as the Theory of Planned Behavior discussed herein) have often accounted for only a small (but significant) percentage of observed variance in exercise behavior. Meanwhile, numerous psychological variables have been explored in clinical studies from an atheoretical standpoint, and some of these variables have also demonstrated significant predictive value. Therefore, it appears that the reasons for exercise activity are multidimensional and vary at the individual level, and the best-fit model has not yet been identified. The present study seeks to evaluate a number of individual attributes, attitudes, and reactions to exercise, both theoretically and empirically based, and how these interrelate to predict exercise behavior.

This paper first reviews the reasons that exercise is important, by outlining its effects on health and weight control; general exercise recommendations are also outlined.

Next, a variety of individual differences regarding exercise are explored, including affective response, past exercise behavior, personality contributions, and the components of the Theory of Planned Behavior, upon which the present investigation is based. The available evidence is used to critique existing theories and propose modifications. Third, the purposes of the present study, as related to the theories and constructs, are outlined and hypotheses are presented. The methodologies employed and results obtained are then summarized, followed by a discussion of the findings from a practical perspective.

## The Effect of Physical Activity on Health

Numerous clinical trials have determined that physical activity can benefit people in numerous physiological and psychological ways. Perhaps most importantly, level of physical exercise is an independent predictor of all-cause mortality, such that people (regardless of age or gender) who are moderately or vigorously active have a lower all-cause premature mortality risk, independent of many other covariates including adiposity (see Katzmarzyk, Janssen, & Ardern, 2003 for a full review).

Exercise benefits many systems of the body. For example, both aerobic exercise and strength training have been found in meta-analyses to reduce the loss of regional bone (Kelley, 1998b) and increase hip bone density (Kelley, 1998a) in women at risk for osteoporosis. A randomized controlled trial of 112 adults with hypertension found that rigorous exercise for six months significantly lowered resting blood pressure compared to a wait list control (Blumenthal et al., 2000). Similarly, cardiorespiratory fitness, as measured by $VO_2$max, has been inversely associated with both systolic and diastolic blood pressure in both men and women (Wareham et al., 2000). On the flip side, a twenty-year longitudinal cohort study of female nurses determined that physical *inactivity* was a significant independent predictor of coronary heart disease, over and above relative weight (Li et al., 2006).

A meta-analysis reported that, in people who are overweight or obese, institution of aerobic exercise for at least eight weeks resulted in an 11% decrease in triglyceride levels when compared to a no-exercise control group, independent of changes in body composition (Kelley, Kelley, & Tran, 2005). Another meta-analysis found statistically significant decreases (relative to the control group) in total cholesterol (-2%), low-density lipoproteins (-3%), and triglycerides (-5%), and an increase in high-density lipoproteins (HDL) (+3%) among women of all sizes after at least eight weeks of aerobic exercise as part of randomized controlled trials (Kelley, Kelley, & Tran, 2004).

Physical exercise is not a panacea for all ills; many of the physiological benefits demonstrated have been small. Regional bone loss improvements in postmenopausal women were smaller than those afforded by hormone replacement and/or calcium intake (Kelley, 1998b). Aerobic exercise has not been found to have any substantial effect on high-density lipoprotein (HDL) levels or low-density lipoprotein levels (LDL) in the absence of other lifestyle changes (Kelley et al., 2005). Exercise for six months did not lower blood pressure or insulin levels as much as did exercise plus a behavioral weight loss plan in adults with hypertension (Blumenthal et al., 2000). Physical activity also does not appear to have a clinically significant effect on blood pressure in individuals who do not already have high blood pressure (Kelley, 1999; Kelley & Sharpe Kelley, 2001). Therefore, although it is clear that physical activity can have a positive impact on health, it is also clear that exercise must be performed in combination with other healthy lifestyle practices, and that if a person's physiological parameters are already within normal ranges, there is no guarantee of further improvement.

The psychological benefits of exercise have been explored less fully than have the physiological effects, but the results thus far are even more pronounced and rapid than the results for physiological health. A meta-analysis was published in 2005 that evaluated the results from 14 randomized controlled trials on the effect of exercise on individuals diagnosed with depression. Of nine studies reporting the Beck Depression Inventory as an outcome measure, in which exercise was the only intervention, there was a mean relative decrease of 7.3 points among exercisers compared to no-exercise control groups. Four studies compared exercise alone to cognitive therapy alone, and found no statistically significant differences in effect sizes – both treatment approaches resulted in decreased depression levels. One study compared exercise to antidepressant therapy, and also found no statistically significant differences (Lawlor & Hopker, 2001). These findings suggest that exercise does have a short-term beneficial impact on depression levels relative to other treatment options.

For the elderly specifically, a growing population for whom physical and psychological health is of great concern, a meta-analysis in 2000 reported a statistically significant effect of exercise on mood; however, heterogeneity among studies limited interpretability. It appeared that a number of moderating variables impacted the effect size; physical activity was effective only if practiced for 45 minutes or more per day and if compared to a no-treatment or motivational comparison group, but no more effective than a yoga/flexibility group. Interestingly, lower intensity exercise had a significantly greater effect on mood than moderate or intense exercise. Both cardiovascular and resistance training were beneficial (Arent, Landers, & Etnier, 2000).

Psychological benefits from exercise in a general population with no mental illness are unclear. Some studies have suggested improvements in mood, while others have found little or no effect of exercise on mood. Studies on this topic have generally had small sample sizes and have been cross-sectional in nature, reporting that people who exercise regularly report better mood than those who do not exercise regularly. However, such studies are confounded by design, such that it is impossible to determine the precise temporal or causative relationship between mood and exercise (U.S. Department of Health and Human Services, 1996).

Exercise may also reap certain cognitive benefits. One meta-analysis found that, in longitudinal, randomized controlled trials, both acute and chronic exercise had a small but significant positive impact on cognitive performance. This impact was greatest in people aged 18-30 and 46-60 (Etnier et al., 1997). However, limitations in the quality of the body of research in this area prevented firm conclusions about the benefits of exercise on cognitive ability.

## Physical Activity and Obesity

### *Obesity Epidemic*

The majority of Americans are overweight or obese. Overweight is generally defined as having a body mass index (BMI) of 25-29.9, while obese is defined as having a BMI of 30 or higher. (Body mass index is calculated by dividing weight in kg by height in meters, squared.) In the National Health and Nutrition Examination Survey (NHANES) of 1999-2002, 34.7% of adults aged 20 years and older were overweight (but not obese), 30.4% were obese, and 4.9% were extremely obese (BMI 40+) (Hedley et al., 2004). These rates are an increase from the NHANES survey of 1988-94, in which 33% of adults were overweight (a 5% increase), and 23% were obese (a 32% increase) (Centers for Disease Control and Prevention, 2004a). These trends, suggesting a greater increase in severe obesity compared to overweight, are supported by other population-based studies (Sturm, 2003).

The most recent data from NHANES indicates that 16 percent of children and adolescents aged 12 to 19 are overweight, defined as at-or-above the 95%ile for the sex-specific BMI-for-age growth chart (Hedley et al., 2004). This is a 45% increase from the 11% estimate obtained in 1988-94 and a 220% increase from 5% in 1976-80 by the same research project (CDC, 2004b); hence, obesity rates are increasing at a much higher rate among adolescents than they are among adults.

The CDC reported in 1995 that 13.9% of college women aged 18-24 were overweight or obese, while 17.2% of college men were overweight or obese, defined in this study as BMI≥27.8 for men and ≥27.3 for women (CDC, 1997). However, these rates are more than 10 years old and may be outdated.

*College Weight Gain*

There is a certain amount of debate as to whether students tend to gain weight during their first year at college. The so-called “Freshman 15,” referring to the 15 pounds that college freshmen are said to gain, presumably occur because young adults living away from home for the first time have not yet learned how to regulate their own energy intake and/or activity patterns in a healthy manner; this phenomenon, in combination with unlimited access to cafeterias that often serve starchy, high-fat food, as well as unregulated access to "junk" food such as snacks and pizzas, may lead to weight gain (Levitsky, Halbmaier, & Mrdjenovic, 2004).

However, research documenting the existence of the Freshmen 15 has been scant, and the results from the small literature base have yielded mixed and contradictory findings. The existing literature has estimated that Freshman weight gain may range from 2.5 to 8.8 lbs (Anderson, Shapiro, & Lundgren, 2003; Cooley & Toray, 2001; Hovell, Mewborn, Randle, & Fowler-Johnson, 1985; Levitsky et al., 2004; Megel, Wade, Hawkins, & Norton, 1994), and perhaps that most of the weight gain occurs during the first semester (Anderson et al., 2003). Thus the existing evidence suggests that it is not so much the "Freshman 15" as the "Freshman 5," which is still substantially more than a healthy or average amount of weight gain in one year. However, weight change has varied widely among the students sampled in the five available studies, with a substantial minority of students losing weight during the measurement period (Aaron et al., 1993; Levitsky et al., 2004). Still, there is an apparent instability of eating control during this period of change for young adults (Levitsky et al., 2004) that warrants further attention to determine the causal factors and develop effective interventions that might preclude the initiation of unhealthy eating and lifestyle practices. The reasons for wanting to prevent such obesity-related lifestyle practices are outlined next.

*Obesity-Related Health Risks*

Researchers have found that in both men and women (who were initially free of disease), the risk of developing diabetes, gallstones, hypertension, and heart disease increased over 10 years with severity of overweight. Interestingly, when the BMI cutoffs were repartitioned so that normal weight was defined as BMI 18.5-21.9, women and men with BMI 22-24.9 showed an increased relative risk to develop at least one of the aforementioned health problems (Field et al., 2001). Obesity also predicts mortality among older Americans (Calle, Thun, Petrelli, Rodriguez, & Heath, 1999).

Moderate weight loss can decrease risks of obesity-related diseases. A systematic review of obesity treatments evaluating only randomized controlled trials (RCTs) concluded that a weight loss of 10 kg was associated with a mean decrease in total cholesterol of 0.25 mmol/l and a mean decrease in diastolic blood pressure of 3.6 mmHg (Avenell et al., 2004). At least three studies have found that modest weight loss through nutritional intervention can decrease (Langford et al., 1985), eliminate (Stamler et al., 1987), or prevent (Whelton et al., 1998) the need for anti-hypertensive medication in individuals with hypertension. Other studies have found a variety of similar benefits resulting from modest weight loss, and are too numerous to review here (see de Leiva, 1998; Mertens & Van Gaal, 2000; and Van Gaal, Wauters, & De Leeuw, 1997 for reviews).

This section has demonstrated that obesity is associated with a number of serious health concerns. Evidence has already been presented documenting the direct association between physical activity and health. However, physical activity may also indirectly impact health through its relationship with body weight, discussed in the next section.

## Exercise as a Predictor of Weight Change

Numerous interventional studies have evaluated the impact of a physical activity component on weight loss maintenance during or after a structured diet (e.g., Jakicic, Wing, & Winters-Hart, 2002; Jeffery, Wing, Sherwood, & Tate, 2003), a detailed review of which is beyond the scope of the present report. Briefly, studies have consistently found that, in people who have recently lost weight, high physical activity is associated with less weight regain (see Fogelholm & Kukkonen-Harjula, 2000 for a systematic review).

More pertinent to the present effort, a number of observational studies have also evaluated physical activity as a predictor variable for weight change in adults who were not on a study-sponsored weight loss program. Fogelholm and Kukkonen-Harjula (2002) have conducted a thorough systematic review of such research published between 1980 and 2000, and their efforts are not duplicated here. Inclusion criteria for their review required that the study report some measure of physical activity and change in weight, include no intervention regarding weight loss or physical activity, and have a follow-up duration of at least 2 years. (The choice of 2 year minimum follow-up time, according to the authors, was arbitrary.)

Using these criteria, Fogelholm and Kukkonen-Harjula included 16 prospective, longitudinal observational studies. Studies reported physical activity either at baseline, at follow-up, and/or change in physical activity over time. Most studies adjusted for age, smoking status, and baseline BMI. There were mixed findings from those that reported physical activity at baseline: four reported an inverse relationship between physical activity and weight change (such that more physical activity led to less change in weight), one found this inverse relationship for men but not women, while two found no association (over 4 and 10 years, respectively), and two found a positive relationship (over a 2 year follow-up). On the other hand, when physical activity was measured at follow-up, it was more consistently found to have an inverse relationship with weight change, such that higher physical activity predicted less weight gain (Fogelholm & Kukkonen-Harjula, 2000).

When change in physical activity was measured over the length of the study, 7 of 11 studies found that increased physical activity was associated with less weight gain, while 3 found no association, and one found a positive association (Fogelholm & Kukkonen-Harjula, 2000). This systematic review did not report how changes in muscle mass that accompany vigorous physical activity might have affected change in weight over time in the different studies. Hence, the majority of evidence suggests that physical activity does predict weight change over time, and most of that evidence suggests that more physical activity is associated with less weight gain. However, this “vote counting” method of determining the prevailing evidence is a potentially flawed approach because it equally weights small and large studies and can lead to erroneous conclusions (Hedges & Olkin, 1980). No meta-analysis on this topic was identified in the published literature.

To summarize, exercise has been found in controlled trials to directly impact physiological and psychological functioning, and has been indirectly inferred through longitudinal observational studies to contribute to weight control over time (which in turn can prevent health problems). The question remains as to what amount of physical activity is required to reap these benefits.

## Current Exercise Recommendations

Because of the clear health benefits associated with regular physical activity, the CDC and other government health agencies periodically re-evaluate the scientific evidence on physical activity and compile recommendations for exercise. The current recommendations for physical activity by the CDC are as follows:

"Adults should strive to meet either of the following physical activity recommendations.

- Adults should engage in moderate-intensity physical activities for at least 30 minutes on 5 or more days of the week.
  - Centers for Disease Control and Prevention/American College of Sports Medicine

**OR**

- Adults should engage in vigorous-intensity physical activity 3 or more days per week for 20 or more minutes per occasion
  – *Healthy People 2010"* (Centers for Disease Control and Prevention, 2005)

Moderate-intensity activity is that which results in some increase in breathing or heart rate and burns 3.5 to 7 kcals per minute or 3-6 metabolic equivalents (METs). (METs are defined as the number of calories consumed by an organism per minute in an activity relative to their basal metabolic rate). Vigorous activity is defined as any activity that is intense enough to represent a substantial challenge to an individual as manifested by a large increase in breathing and/or heart rate. This includes activities that burn 7 or more kcal per minute or more than 6 METs (CDC, undated website).

A recent study estimated that just 41% of Americans meet or exceed recommended physical activity levels (Macera et al., 2001). These findings suggest that approximately 59% of the population is at increased risk for physical and psychological conditions, including obesity, which might be prevented (in part) by an active lifestyle. Children are generally more active than adults, in a time of life when running and playing is normal behavior. However, our lives become increasingly sedentary as we grow up (Gordon-Larsen, Nelson, & Popkin, 2004; Telama & Yang, 2000 Sep; van Mechelen, Twisk, Post, Snel, & Kemper, 2000), although at a more steep decline for boys than for girls after the age of 12 (Telama & Yang, 2000; van Mechelen et al., 2000). These findings suggest that early intervention in adolescence may be critical to maintain healthy levels of physical activity in boys, but the timing of such intervention is more flexible in girls. Only 37.6% of college students nationwide participate in activities that meet the criteria for regular vigorous activity, while 19.5% meet the criteria for participating in regular moderate physical activity. Male students (43.7%) are significantly more likely than female students (33.0%) to report vigorous physical activity (CDC, 1997). These statistics suggest better activity levels than those for adults reported above, but not by a large margin, suggesting that a sedentary lifestyle is already becoming established during the college years. Because activity levels are higher among college students than adults, but are expected to decrease by the time they graduate, it becomes crucial, first, to learn more about what causes physical activity to decrease over the college years, and second, to find ways to intervene and prevent the decrease in activity.

Exercise adherence rates are also low amongst those who initiate an exercise regimen. It is estimated that, on average, 50% of individuals starting an exercise program will drop out within six months (Dishman, 1988). Lack of time is the most commonly reported reason for discontinuing or not following through on planned exercise (Godin, Shephard, & Colantonio, 1986; Sport and Recreation New Zealand, 2003; Steinhardt & Dishman, 1989), although among college students, "low motivation" is the most cited reason (Steinhardt & Dishman, 1989). Therefore, a number of hurdles prevent widespread adoption and maintenance of regular exercise by the population, but it also seems critical that some steps be taken by late adolescence to help institute regular physical activity. It is of critical importance, therefore, to develop a greater understanding of the underpinnings of young adults' participation (or lack thereof) in physical activity, in order to be able to develop effective physical activity interventions that will foster adherence for the rest of their lives.

Having presented data illustrating the importance of exercise and the low rates of regular exercise among young adults, the primary goal of the present research was to develop a model for predicting exercise behavior among college students. The present research focused on individual psychological differences that may contribute to a decision to exercise or not. First, the theoretical background for the present research is reviewed.

## Individual Factors that Influence Exercise Activity

This section reviews current theoretical and empirical research into the individual differences that may contribute to exercise activity, particularly the Theory of Planned Behavior that serves as the starting point for this research. An area that has not been well explored is how affective response to exercise may influence future exercise behavior, and the existing research in this area will be reviewed. Numerous other areas, such as genetics and social support, which are likely to impact exercise behavior greatly, are not addressed herein. The theoretical model for the present study is presented graphically in Figure 1.

### *Affect as a Predictor of Repeated Exercise*

As reviewed earlier, repetitive, long-term physical activity can have a beneficial impact on both physiological health and general mood states, resulting in improved mood in individuals suffering from depression and in the elderly, and possibly improving cognitive performance; effect of exercise on average, healthy individuals has been limited by poor study design and findings have been contradictory. However, separate research has also explored the immediate impact of a single bout of exercise on affect. Affect is defined as a feeling state expressed during a specified moment in time (different from mood, which is a longer-standing inner emotional status) (Serby, 2003). The primary concern for the present study is affect resulting from a single bout of moderate walking. Studies have yielded mixed findings as to whether a single bout of walking can produce a change in affect. In particular, tradition has held that exercise must exceed 60-70% $VO_2max$ and last longer than 20 minutes in order to improve certain emotional states (Ekkekakis, Hall, VanLanduyt, & Petruzzello, 2000).

Contrary to this, however, more recent studies have suggested that general affect could be improved by a single, short duration (10 minute) walk (Ekkekakis et al., 2000; Saklofske, Blomme, & Kelly, 1992; Treasure & Newbery, 1998; Thayer, 1989 as cited in Ekkekakis et al., 2000). For example, Ekkekakis et al. (2000) asked 52 student volunteers to either walk at a self-selected pace for 10 minutes or to read an article for 10 minutes, and compared pre- and post-test self-evaluation of affect. They found that walking was associated with significant shifts towards more activated, pleasant affect (as measured by the Feeling State Questionnaire), while there were no significant changes in the affect of those in the reading group. There was no impact of activity on a measure of anxiety. After 10 minutes of rest, the affective gains began to reverse themselves. In a second study by the same authors, similar observations were made for volunteers asked to walk on a treadmill in a controlled environment or to read a magazine for 10 minutes, such that feeling state was improved by walking and remained constant for the readers. Hence, this finding suggests that extensive, vigorous exercise is not necessary for a brief improvement in affect; in fact, other research has suggested that vigorous activity that crosses the upper anaerobic threshold results in a brief change towards negative affect during exercise that is not found for aerobic or sub-aerobic exercise (Hall, Ekkekakis, & Petruzzello, 2002).

However, affective response to a single bout of mild to moderate exercise may vary widely from individual to individual. A single bout of exercise may result in positive or negative affect (Van Landuyt, Ekkekakis, Hall, & Petruzzello, 2000), depending on an individual's preferences for the activity (Parfitt & Gledhill, 2004) and mental status at the time of exercise performance (O'Halloran, Murphy, & Webster, 2005; Parfitt, Rose, & Markland, 2000). Hence, factors other than the exercise itself may correlate with the affective response to the activity. An individual who experiences a feeling of positive affect during and just after exercise is receiving an immediate positive reinforcement for engaging in that activity. Therefore, it has been argued that affective response may be related to whether a behavior such as exercise will be repeated (or "adhered to")

(Dishman, 1982; Ekkekakis, 2001; Norman & Smith, 1995; Rejeski, 1992). Numerous studies have demonstrated that long-term activity generally improves mood, while other studies reviewed here have suggested that a single bout of exercise leads to improved affect. However, no studies could be identified in the literature to link the two areas of research. Hence, it is unknown whether individuals who experience a strong positive affective response to a single bout of mild-moderate exercise are those who might exercise more repeatedly as a result of this positive reinforcement. The present study will evaluate this proposition correlationally in the context of the multidimensional model being studied.

*The Theory of Planned Behavior (TpB): A social-cognitive model*

Ajzen (1991) postulated that behavior is a function of social and cognitive processes and is largely under conscious control. He suggested that intentions are the primary determinants of behavior, and these intentions are impacted by perceived behavioral control, subjective norms, and attitudes towards the behavior. These constructs form his model for the Theory of Planned Behavior, which is described below.

- *Intention*. In the TpB model, a construct known as "intention" is the driving force behind action. Intention is assumed to capture the motivation to act, in that level of intention will reflect a person's willingness to try and amount of effort they will expend to perform a behavior (Ajzen, 1991). If an individual does not have the intention, or motivation, to exercise, he simply will not exercise. Intention is impacted by three different factors: subjective norms, attitudes towards the behavior, and perceived behavioral control.

- *Subjective norms* stem from normative beliefs of the behavior and can come from a number of sources: whether the individual's culture values exercise and promotes exercise; whether the individual's friends or family exercise; and how the individual thinks his social circle will react to his exercising. Some individuals may value social input more highly than others, and therefore, this component may be weighted highly or not at all. However, regarding health behaviors, subjective norms have generally demonstrated little predictive value for intentions beyond the effects of attitude and perceived behavioral control (Armitage & Conner, 1999; Hagger, Chatzisarantis, & Biddle, 2002).

- *Attitudes* towards physical activity will have an impact on intention, such that an individual who believes that exercise is a valuable health benefit will be much more likely to plan to exercise than a person who believes that exercise has no value.

- *Perceived behavioral control* (PBC) was added to the TpB specifically so that the model would be applicable to behaviors that are both completely volitional and others that are only semi-volitional. PBC refers to people's perceptions of their ability to perform a given behavior despite the presence of other factors that might interfere with the performance of the behavior. PBC affects action both indirectly through intention, and directly on action alongside of intention (Ajzen, 2006).

*Application of TpB to Exercise*

TpB has been investigated extensively as it applies to exercise behavior. McAuley and Courneya (1993) summarized the existing research, consisting of about 14 studies (evaluating the TpB and its predecessor, the Theory of Reasoned Action). They found that intention predicted between 10% and 67% of variance in exercise behavior, suggesting wide variation in measurement methods and populations under consideration. Attitudes predicted intention better than did subjective norms. Perceived behavioral control contributed predictive value similar to attitudes. The amount of variance in intention explained by attitude, subjective norms, and PBC in these models ranged from 24% to 66% (McAuley & Courneya, 1993).

Hagger, Chatzisarantis, and Biddle (2002) also conducted a meta-analytic review of TpB research on predicting exercise behavior, as well as the additional components of self-efficacy and past exercise behavior (discussed later in this document). They employed a path analytic approach to evaluate the relationships among the variables. Their analysis indicated (as did that of McCauley and Courneya) that attitude and PBC were the best predictors of intention. The inclusion of PBC in the model (which was a variable not included in the original Theory of Reasoned Action) attenuated the effect of attitude on intention. The TpB model accounted for 44.5% of the variation in intention to exercise. The direct path between PBC and action was also explored in the model, and it significantly improved the model fit, with PBC accounting for 15% of variation in behavior. Overall, the TpB accounted for 22.4% of variation in behavior (Hagger, Chatzisarantis, & Biddle, 2002).

Armitage (2005) used regression models to evaluate whether TpB predicted actual participation in physical activity and used survival analysis to determine how TpB predicted maintenance of such activity over 12 weeks. Participants were members of a private fitness club who completed self-report measures on exercise attitudes, social norms, perceived behavioral control, intention, and self-reported exercise behavior. Actual gym attendance was monitored weekly (Armitage, 2005).

Results indicated that the TpB model predicted 49% of the variance in intention to exercise. Subjective norm and PBC were both independent predictors. Actual behavior was predicted by a model including behavioral intention and perceived behavioral control, accounting for 22% of observed variance. Only perceived behavioral control was a significant independent predictor of behavior. Survival analysis indicated that stable exercise habits developed within 5 weeks of gym attendance and that perceived behavioral control predicted time to exercise lapse. Exercise adherence in turn affected later perceived behavioral control; that is, people with good adherence experienced enhanced PBC (Armitage, 2005).

On average, the TpB has shown moderate predictive success in the area of exercise, although predicting intentions has been more successful than predicting actual exercise behavior.

*Critiques of TpB as a Theory for Exercise Behavior*

TpB has received certain criticisms. First, researchers have observed that the TpB lacks temporal stability; that is, the TpB demonstrates predictive value for voluntary behaviors only over short periods of time because intentions, attitudes and perceived control change over time (Ajzen, 2002). Such a finding is particularly true of exercise activity (Courneya & McAuley, 1993; Norman & Smith, 1995). Therefore, a complete and predictive model for long-term exercise behavior may need a component reflecting temporal stability over time, as healthy exercise behavior is that which is performed repeatedly and frequently over the lifespan; it is this repetitive behavior which is of interest to exercise researchers.

As a result of such criticisms, some researchers have attempted to improve upon the TpB, as it applies to exercise, by adding additional, more stable components, such as personality, to the model (Ingledew, Markland, & Sheppard, 2004; Rhodes, Courneya, & Jones, 2004; Rhodes, Courneya, & Jones, 2005), since personality is considered to be the most enduring and stable aspect of an individual. Others have recommended the addition of a “habit” measure, particularly to account for repetitive behaviors like exercise (Triandis, 1977). Self-efficacy has also been proposed by a number of researchers. These additional components are considered further here and in the proposed research.

### *Personality*

Although the level of exercise activity varies over time, some researchers have proposed that inclination towards exercise and exercise intensity may be an enduring personality trait that remains stable over time, perhaps related to Eysenck’s extroversion/introversion construct (Ekkekakis, Hall, & Petruzzello, 2005; Ingledew et al., 2004) and the Five Factor model derived from it (Saucier & Ostendorf, 1999). Under Eysenck’s theory, extroverts would be expected to be sensations seekers and, therefore, be more tolerant of the discomforts of exercise; introverts would be sensation avoiders who would be less likely to tolerate high intensity exercise (Ekkekakis et al., 2005).

Although support for a relationship between a specific personality construct and exercise has been mixed (Ekkekakis et al., 2005), the general concept that personality and other intrinsic factors may play a role in exercise activity, intention, and motivation has been widely researched (e.g., Hausenblas & Giacobbi, 2004; Ingledew et al., 2004; Lochbaum & Lutz, 2005; Rhodes et al., 2005). While Ajzen (1998) supports the idea that personality is implicated in human behavior, he argues that its influence is mediated by more immediate factors (Ajzen, 1991), such as intention. Therefore, according to Azjen, personality would not add any predictive value beyond that offered by TpB.

Within the five-factor model of personality, certain constructs may be more applicable to exercise than others. One construct that has garnered considerable attention is the activity sub-trait of extraversion. This sub-trait represents a predisposition towards being busy and fast paced (Rhodes et al., 2004). After controlling for the TpB model, the activity trait was found in three studies to be the only important independent personality influence on exercise behavior (Rhodes, Courneya, & Jones, 2002; Rhodes & Courneya, 2003b; Rhodes et al., 2004), adding significant (though small, circa 4%) independent predictive value beyond the components of TpB (contrary to Ajzen's assertion). However, another study by the same authors implicated the industriousness-ambition subtrait of the conscientiousness trait as a moderator between intention and behavior (accounting for 3% of the variance observed in exercise behavior) (Rhodes et al., 2005), suggesting that those higher in industriousness are more likely to carry through on their intention to exercise. This study also found that the activity trait acted as a moderator between PBC and intention to exercise, whereby high levels of activity led to a stronger effect of PBC on intention (Rhodes et al., 2005). Therefore, the precise personality style(s) affecting exercise behavior are not yet clear, nor are the precise mechanisms by which they act. Nevertheless, some aspect(s) of personality do appear to correlate significantly (albeit, not substantially) with exercise behavior. Therefore, activity and industriousness will be considered in the present model.

There may be an indirect relationship between personality and exercise behavior through its relationship with affect (discussed earlier). It is conceivable that individuals with certain personality types will respond more favorably (i.e., with more positive affect) to the experience of exercise. For example, it has long been hypothesized that extroverts (who tend to be sensations seekers) would respond more positively to the sensations of rigorous exercise than would introverts (Ekkekakis et al., 2005). However, research in this area has been scant, and the few studies that have been conducted have either conducted flawed or incomplete statistical analysis to make such a determination (Lochbaum & Lutz, 2005), or evaluated only arousal rather than positive vs. negative affect (Saklofske et al., 1992). These inter-relationships are explored further in the present study within the structure of a path analysis relating this selection of variables to each other and to exercise behavior over time.

### *Past Exercise Behavior*

Numerous studies have observed that past behavior predicts future behavior (see Ouellette & Wood, 1998 and Rhodes & Courneya, 2003a for reviews). However, the precise mechanism through which this occurs is a matter of intense debate. Some researchers have termed this relationship to be an indication of “habit.” “Habit” is a term that can be defined in a number of different ways. In his Theory of Interpersonal Behavior, Triandis defined habit based solely on the frequency of occurrence of the behavior in the individual's past (Triandis, 1977). Others have defined it as the mindless, automatic performance of a behavior that requires little conscious thought to be put into action, and is instead cued by environmental stimuli (Aarts, Paulussen, & Schaalma, 1997). In the case of exercise, habit may be relevant when a person has been physically active repeatedly in the past with good results, with repetitive behavior resulting from positive or negative reinforcement. Those who are sedentary and have not exercised repeatedly, or those who have tried exercise once and disliked it, will not be influenced by habit. Hence, individual differences in influence of habit are expected.

Ajzen (2002) argued that although the evidence has suggested that past behavior predicts future behavior and attenuates the relationship between intention and behavior, it does not necessarily indicate the presence of an automatic, mindless "habit" process. Instead, the relationship between past and future behavior may be mediated by an unknown construct or may simply indicate a stability of behavior over time when intentions or attitudes are weak (otherwise, the relationship between past behavior and current behavior would be mediated by intention and attitude). The past behavior may also trigger established intentions more quickly and in a less deliberate way than do attitudes and norms (Ajzen, 2002). Oullette and Wood (1998) posit a compromise between Ajzen and the behaviorists: in the case of high frequency behaviors, automatic habitual behavior patterns may form. (If a person exercises every day, they may not have to consciously decide to do it.) However, in low-frequency situations where habituation is unlikely to occur, the relationship between past behavior and future behavior is mediated by intention. (If a person exercises once a week, they will still require conscious intention to do it.) To sum, it appears that there is considerable debate over how to explain the empirical findings that past behavior predicts current and future behavior beyond the TpB. Therefore, it may be premature to label such findings as an indication of an automatic, mindless "habit" process.

In a meta-analytic path analysis examining the predictive value of TpB, self-efficacy and past exercise behavior on current exercise behavior, Hagger et al. (2002) amalgamated 25 empirical studies that included all of these relevant components. As hypothesized, past behavior was a significant predictor of behavior and intention, independent of the predictive value of the TpB components or self-efficacy. More interesting were the attenuation effects exerted by past behavior on the model, which significantly reduced the relationship between intention and behavior, attitude and behavior, and self-efficacy and behavior. Therefore, shared variance among these variables may best be accounted for by the past exercise behavior measurement. However, this analysis was correlational in nature and therefore true causality cannot be determined. This model accounted for the greatest amount of variance in intentions (60.2%) and behavior (46.7%) compared to TpB alone or TpB with self-efficacy (discussed later).

Norman and Smith (1995) tested the model of TpB and past physical activity in a group of undergraduate college students who completed a TpB questionnaire about current and future planned exercise activity on two different occasions, six months apart. A hierarchical regression analysis indicated that 41% of the variance in exercise activity at time 2 was accounted for by intention and perceived behavioral control. When prior exercise activity (at time 1) was added, the predictive ability of the model increased to 54%.

Hagger, Chatzisarantis, and Biddle (2001) evaluated the addition of both self-efficacy and past behavior to the TpB in predicting intention to be physically active among adolescents in Great Britain. They proposed that if self-efficacy and past exercise behavior contributed significantly to a model of intention to be physically active, then the addition of these components would reduce the predictive value of the TpB components (subjective norms, attitudes, PBC). They found that the TpB, by itself, accounted for a significant proportion of variation observed in intention to be physically active (normed fit index = 0.97). Of the TpB components, subjective norm contributed no predictive value to the model, while attitude and PBC were significant predictors (accounting for 48.2% of the variance in intention). The addition of previous exercise behavior to the model resulted in an unstable model, and its addition did not change the predictive value of the other components, although past behavior was significantly correlated with the other components in the model. The authors suggest that, among adolescents, exercise habits are not well formed enough to contribute in a consistent manner to the model, as has been demonstrated in models of adults.

Based on the available data, it appears warranted to explore the influence of past behavior on intentions to exercise and on exercise behavior over time. The present sample of freshman women will be interesting to examine in this regard, as their lives are in a state of flux; therefore, it would appear that the influence of past behavior would have to be very strong to exert an independent predictive effect. Whether past exercise behavior is a "habit" or not is beyond the scope of the present research.

### *Self Efficacy*

Physical self-efficacy is the feeling as to whether one feels that one's body has the capability of being active and strong; it reflects the feeling of control and empowerment one has over one's own body. Because the psychological research community has acknowledged the important role of self-efficacy in many areas of living, including physical activity (Ryckman, Robbins, Thornton, & Cantrell, 1982; Sherwood & Jeffery, 2000), it has been argued that self-efficacy should be included in any model of exercise behavior. According to Bandura's social cognitive theory (SCT), one's physical self-efficacy influences interpretations of bodily sensations during challenging tasks like moderate-to-vigorous exercise (Bandura, 1986 as cited in Robbins, Pis, Pender, & Kazanis, 2004). Therefore, people high in physical self-efficacy might be expected to express greater enjoyment and positive affect when exercising, a concept supported by published data (Bandura, 1986; Robbins et al., 2004).

The distinction between perceived behavioral control (in the TpB model) and self-efficacy is a matter of continuing debate. In some publications, Ajzen has essentially equated PBC and self-efficacy, as a person's judgment about their ability to perform a given action (Ajzen, 1991); in others, however, he distinguished between external and internal perceptions of control as distinguishing between PBC and self-efficacy (Ajzen & Timko, 1986). Others have also contended that the two measures are different, suggesting also that PBC refers to a perception of being able to overcome external barriers and difficult situations in order to complete a behavior (Armitage & Conner, 1999), and self-efficacy to one's own feeling of innate ability. Others have modeled self-efficacy as the ability to overcome barriers (Hagger et al., 2001). Armitage and Conner (1999) used principal components analysis to demonstrate that items measuring behavioral control loaded onto two factors, which could be described as a personal control factor versus a belief in ability factor. The former factor was labeled by the authors as PBC and the latter as self-efficacy. These items and labels will be used in the present research.

Self-efficacy has been found to be an independent predictor of vigorous and moderate exercise activity among Caucasian and African-American girls when considered in the context of TpB. In particular, Motl et al., 2002 found that although there was high correlation between the measures of PBC and self-efficacy ($r=0.67$), only self-efficacy predicted moderate physical activity, while both measures predicted vigorous activity. However, the operationalization of self-efficacy and PBC in this study were the precise opposite of those recommended by Ajzen and Timko (1985), as well as Armitage and Conner (1999), who both recommended that TpB be conceptualized as perception of one's own abilities to overcome barriers, versus self-efficacy, which is supposed to reflect only internal aspects of control (Ajzen & Timko, 1986; Armitage & Conner, 1999). Therefore, if the constructs were relabeled (in the manner to be used in the present study), we might then find that PBC predicts moderate exercise while self-efficacy does not.

As described earlier, Hagger, Chatzisarantis, and Biddle (2001) evaluated the addition of both self-efficacy and habit to the TpB in predicting intention to be physically active among adolescents in Great Britain. Addition of a self-efficacy measure increased the predictive value of the TpB model from 44.2% to 66.4% and decreased the predictive value of PBC to almost nothing. Partial correlation analysis suggested that PBC correlated with questions about external challenges (bad weather, doing homework, other hobbies), while self-efficacy correlated independently with all of the above factors plus going out with friends and perceived competence. Hence the findings suggested that PBC was related to barriers alone, while self-efficacy was also characterized by more internal, competence related beliefs (Hagger et al., 2001), similar to the distinction made by Armitage and Conner.

A meta-analytic path analysis by Hagger et al. (2002) has shown that self-efficacy contributes independent predictive value for exercise intention and behavior in the TpB model when results were amalgamated across 12 studies. The attitude-intention relationship, initially significant, was attenuated by the presence of self-efficacy in the model. The model accounted for 50.3% of the variance in intention and 29.1% of the variance in exercise behavior.

The relationship between self-efficacy and exercise (or any) activity is complex because not only does self-efficacy predict exercise activity, exercise activity has also been found, in turn, to predict physical self-efficacy (McAuley & Blissmer, 2000). The evidence above suggests self-efficacy predicts exercise behavior very strongly. On the other side, for example, among previously sedentary adults who instituted a new exercise program, physical self-efficacy increased over the five month program (McAuley, Bane, & Mihalko, 1995). This reciprocal determinism suggests that individuals who engage in exercise regularly should have higher physical self-efficacy than those who are sedentary.

It is particularly important to note that Bandura stated that an individual has to have experienced the behavior in order to evaluate his or her self-efficacy regarding the behavior (Bandura, 1977 as cited in Treasure & Newbery, 1998). Therefore, those who have always been sedentary and who have never engaged in regular physical activity cannot evaluate their own exercise self-efficacy, a point that must be considered in any study on this topic.

Self-efficacy may also influence exercise behavior in a more indirect way, through its relationship with affect, also to be explored in the present model. Affect may be influenced by one's sense of physical self-efficacy, such that a higher sense of SE will lead to more positive affect during exercise (Robbins et al., 2004), or vice versa. Therefore, it is possible that one of these variables may mediate the other, and their interrelationship as it relates to predicting exercise will be explored in the present model.

### *Summary of Individual Influences on Exercise*

The sections above provided an overview of the relationship between exercise and affect, and affect's potential role as a positive reinforcer for repeated exercise behavior. The application of the Theory of Planned Behavior to exercise and its potential limitations as a predictive model were also explored; generally, the TpB has been shown to have moderate predictive value for short-term exercise behavior. Additional constructs have been proposed to supplement and modify the TpB in order to improve the predictive ability for exercise behavior. Personality and past exercise behavior patterns may provide temporally stable predictive value for exercise behaviors over time. Evidence regarding the contribution of popular personality constructs to predicting exercise behavior has been mixed, but findings have been intriguing enough for further exploration. A preponderance of evidence on past exercise behavior (or “habit”) has suggested that it is correlated with future exercise behavior; whether or not this constitutes a mindless, automated behavior is uncertain, but the effects of past behavior may attenuate certain aspects of the TpB model, and therefore it is important to include. Self-efficacy, when distinguished from PBC, has shown substantial independent predictive value for both intention to exercise and exercise behavior itself. These four constructs, added to the TpB model simultaneously (which was not encountered in the published literature), may improve its ability to predict exercise behavior. The inter-relationship of these variables will be evaluated in a path analysis to predict near-term (proximal) and long-term (distal) exercise behavior in freshman women, as well as change in exercise patterns over time.

Although most of these factors appear to temporally precede exercise behavior in existing models, some of them result from exercise experiences that people have already had; e.g., habit is defined by repeated exercise behavior, and as outlined above, self-efficacy changes occur after exercise experience and colors attitudes towards future exercise opportunities. These constructs may interact with affective response to exercise in influencing whether an individual engages in future or repeated exercise behavior; however, such relationships have not been adequately explored in the literature. These potential relationships will be explored in the present model.

## Purpose of Present Research

Based on the above research summary, the overall relationship among all variables proposed (past exercise behavior, the personality constructs of activity and industriousness, self-efficacy, components of the TpB, and affective response to exercise) are evaluated as they relate to the outcomes of proximal exercise behavior at time 1 (occurring soon after predictor variable measurement) and distal exercise behavior at time 2 (occurring two to five months later). The predictive contribution of each variable was determined independent of other variables in the model through the use of path analysis.

The population of interest for the present study was that of freshman women. This population is particularly interesting to study because the transition from the externally-structured environment of high school to the more self-structured atmosphere in college may lead to changes in physical activity levels based on individual attitudes and inclinations. One study found that one-third of students who were active at the end of high school became insufficiently active by the beginning of college; overall 66% reported adequate levels of vigorous activity in high school, while just 44% did so in college (Bray & Born, 2004). Therefore, the start of college appears to be a turning point towards less physical activity for many young adults. This population therefore may be the most needful of intervention to maintain adequate levels of activity. Other research suggests that men are more likely to report more vigorous activity in college than do women (CDC, 1997). Hence, the most critical subpopulation in need of intervention may be young adult college women, but the reasons as to why they may become less active are unclear. Therefore, the present study evaluates individual predictors of leisure-time activity levels of freshman women. Figure 1 shows the overall predictive model considered.

The following research questions are posed:

1. Positive affect after any single instance of exercise behavior may encourage further instances of the behavior. Therefore, the present study evaluates the independent predictive value of affect after a single bout of exercise for leisure-time exercise behavior one week and four months later in freshman women.

2. Past exercise behavior has been found to predict future leisure-time exercise behavior independent of other variables in most studies. This study seeks to evaluate the relative predictive merit of past behavior for exercise one week and four months later as it interacts with affect, personality, self-efficacy, and the components of the TpB model.

3. Two personality constructs have been found to lend predictive power for exercise behavior– the Activity and Industriousness subscales of the Five Factor Model. Existing research has yielded conflicting results as to which of these two constructs is an independent predictor, and how much predictive value they offer. This research evaluates whether the personality constructs of Activity and Industriousness will provide independent predictive power for leisure-time exercise behavior over time or whether they will be mediated by other components of the present model.

4. The relationship between self-efficacy and exercise is complex. This model explores whether self-efficacy predicts intention to exercise and exercise behavior itself independent of affect, personality, past exercise behavior and

the TpB model, and whether physical self-efficacy increases after a single bout of exercise.

5. The existing literature on the application of the TpB to exercise behavior has yielded a widely varying ability to predict exercise behavior. This study will determine how well the TpB predicts both proximal and distal leisure-time exercise behavior among freshman women.

6. The relative influence of perceived behavioral control and self-efficacy on intentions and behavior is unclear due to the disparity between definitions of the two terms and how researchers have operationalized the concepts (Ajzen & Timko, 1986; Armitage & Conner, 1999). In the present study, PBC and self-efficacy will be operationalized to match the factors calculated by Armitage and Conner (1999), and their independent predictive value of intention and leisure-time exercise behavior will be evaluated.

7. The present study will examine the combined predictive value of the above-mentioned variables in a cross-sectional analysis of leisure-time exercise behavior (within a week of variable measurement) and in a longitudinal analysis of leisure-time exercise behavior four months after variable measurement, the latter of which has not been encountered in the published literature. It may be that many of the predictor variables are temporally unstable, and these dual outcome variables allow us to determine the degree of temporal stability, both in the predictor variables and in exercise activity over time.

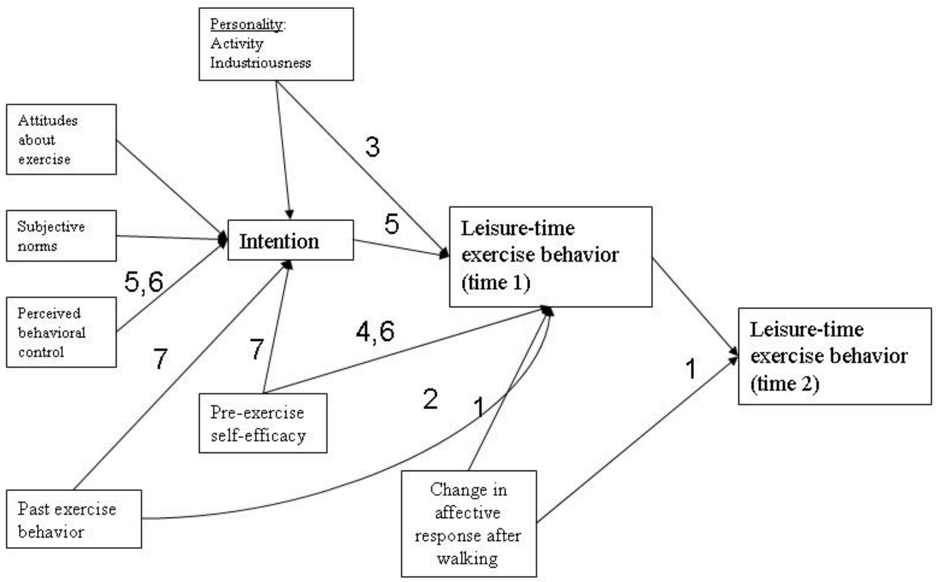


**Figure 1. Theoretical predictive model of exercise behavior in the present study**

## Hypotheses

The precise hypotheses examined in the present model are dependent on which variables are included in the model (based on statistical power). As a result, not all of the hypotheses outlined here are necessarily evaluated, but they are presented in prioritized order.

1. Change in affect after exercise will predict exercise behavior one week and four months later, such that individuals with more positive affect after exercise will report more exercise behavior.

2. Past exercise behavior will independently predict both intention to exercise and exercise behavior directly, and, when analyzed with the TpB, will reduce the predictive value of perceived behavioral control and PA attitudes for intention to exercise.

3. The personality constructs of Industriousness and Activity will independently predict intention to exercise. When analyzed with the TpB predictor variables, its predictive value for intention to exercise will be partially diminished. Self-efficacy will correlate positively with past exercise behavior and change in affect after a single bout of walking.

4. When analyzed with the TpB, self-efficacy will be a better predictor of intention to exercise than will perceived behavioral control.

5. The Theory of Planned Behavior will show significantly better predictive value for proximal exercise behavior (self-reported within 2 weeks) than for distal exercise behavior 4 months later.

6. Both perceived behavioral control for exercise and exercise self-efficacy will predict both intention to exercise and proximal exercise behavior directly.

# CHAPTER 2. METHODS

## Participants

Participants were women, aged 18 to 21 years, starting their freshman year at large urban university in Philadelphia, PA.

## Recruitment

Participants were recruited through on-campus solicitations in early October, 2006 and February, 2007, by two means:

1. Mail and e-mail solicitation. All freshman women received a letter or e-mail inviting them to participate in a research study and the recipients were instructed to visit a website set up by the investigators. The website led interested individuals through a series of questions to determine their physical eligibility to participate in the present study (Physical Activity Readiness Questionnaire, or PAR-Q, see Appendix **A**). If they indicated that they were in good health (by answering "no" to all questions on the PAR-Q), they were then instructed to go to another website where they were able to schedule a time to come into the athletic center to sign the informed consent and undergo a treadmill test. Individuals who answered "yes" to any of the PAR-Q health questions were routed to a webpage that indicated that they needed written physician permission to participate in the study. (No individuals expressed interest in obtaining physician permission during the present study.)

   As noted earlier, participants for this study were recruited in conjunction with a weight control study being conducted by the same research group. This weight control study focused on women with high scores on a dietary restraint scale. Because the intervention arm of this other study included recommendations for becoming more active, participants in the present study who were simultaneously participants in the intervention arm of this weight control study were excluded from analysis. Additionally, because individuals who score high in dietary restraint and who want to learn strategies for weight control may represent a particular subpopulation of young women (since these tend to be individuals at high risk for weight gain), a maximum of 50% of the sample for the present study were permitted to be those individuals also participating in the control group of the weight control study.

2. In-person recruitment at freshman classes: Professors of large freshman classes were contacted for permission to recruit for five minutes at the end or beginning of a class. We recruited in two large Introductory Psychology classes, a nutrition class, and three math classes. A member of the research team made the in-class announcement, providing a basic description of the study and compensation details (see below). Interested individuals were directed to the study website to learn more.

*Inclusion Criteria*

Freshmen women who were age 18-21 years were recruited.

*Exclusion Criteria*

Individuals who answered “yes” to any question on the PAR-Q (Appendix A) were advised that participation in the study may not be advisable and that they required written physician permission before participating. Individuals who could not walk briskly on a treadmill for 10 minutes were also excluded.

## Procedures

### *Time 1*

Each individual was scheduled for a 25 minute appointment at the campus Athletic Center. Appointments were scheduled for the morning to maximize the possibility that the participant had neither exercised nor eaten yet that day, and they were asked not to do so; however, no confirmation was obtained during their testing session. They were also asked to wear comfortable workout clothing and sneakers.

Upon arrival, participants filled out a paper copy of the PAR-Q again to ensure eligibility, and were then consented. They were then weighed to the nearest 0.1 pound (without shoes) on a digital scale that was used for all participants, and the participant was asked her height without shoes. The participant then filled out a questionnaire on affect (Exercise Induced Feeling Inventory, or EFI) (see Appendix E) before getting on a treadmill. The participant was instructed to choose a “brisk but comfortable” speed that she felt she could walk consistently for 10 minutes. There was no incline of the treadmill.

After dismounting the treadmill, participants completed another EFI (Gauvin & Rejeski, 1993). The questionnaire was structured slightly differently in the pre-test and post-test versions to avoid common method variance (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). They were then provided with a pedometer to wear for three days (scheduled to be two weekdays and one weekend day), and the pedometer was calibrated by having the participant walk for 30 steps, then adjusting the pedometer settings as necessary. The pedometer was then taped shut so that the user's activity levels would not be influenced by the readout. Participants were provided with an instruction sheet that included a reminder about which days they were scheduled to wear their pedometer.

Just before their scheduled pedometer wearing days, participants received an email that reminded them to wear their pedometer, and provided instructions on how to complete a series of on-line questionnaires. This website is a secure survey administration portal, which collects and stores survey data. This initial set of questionnaires to be completed included the following:

- Paffenbarger Physical Activity Questionnaire (1 year version)
- Personality Inventory (measuring activity and industriousness subtraits)
- Theory of Planned Behavior Questionnaire
- Physical Self-Efficacy Questionnaire

Participants were emailed on a daily basis to remind them to continue wearing the pedometer. After the three day pedometer measurement period ended, the participant was emailed a web link to a physical activity questionnaire survey about the previous three days. The physical activity questionnaire was a self-report inventory (the International Physical Activity Questionnaire, or IPAQ, long form) (see Appendix D ). Having the participant wear the pedometer and complete the IPAQ questionnaire for the same three days allows comparison of the two different measures of physical activity patterns and levels. The participants also filled out a brief questionnaire about their compliance with wearing the pedometer at all times and about activities that might not have been detected by the pedometer, such as swimming (during which a pedometer cannot be worn) and bicycling (activity that pedometers tend to underestimate). After completing these questionnaires, the participant was then able to schedule an appointment to return the pedometer and be compensated for their participation ($10 or 4 extra credit points for an Introductory Psychology class).

Time 1 measurements occurred in October/November 2006 (Wave 1) and February, 2007 (Wave 2).

### *Time 2*

Follow-up occurred in April, 2007, in order to match weather conditions with Wave 1, Time 1 (October), which is important in a study of physical activity levels as people's activity levels often change with the weather (Stetson et al., 2005). (Matching weather conditions during follow-up for Wave 2 participants was not possible). Participants were emailed a web link to complete the IPAQ (7 day version) one more time and, upon completion, schedule an appointment to receive compensation for their continued participation. At this time, participants were paid another $15 for their participation and were officially entered into the three $25 drawings for completing all aspects of the study.

## Measures

### *Physical Activity Readiness Questionnaire*

All participants were screened to ensure they were physically capable of safely performing the 10 minute treadmill test. A modified version of the Physical Activity Readiness Questionnaire (PAR-Q) was used (Shephard, 1988; Thomas, Reading, &

Shephard, 1992) (see Appendix **A**). The PAR-Q was designed by the British Columbia Ministry of Health to encourage individuals to adopt exercise by providing them with an easy-to-self-administer questionnaire about the relative safety of undertaking an exercise program. The PAR-Q has been widely adopted in many formats, and the present format is one of many variations. It was adapted for the present study for use with college women, by including a question on eating disorders, and was specifically designed to serve as a self-screening questionnaire.

*Past Exercise Behavior*

Past exercise behavior was assessed using the Paffenbarger Physical Activity Questionnaire (PPAQ) (see Appendix B), modified from (Paffenbarger, Wing, & Hyde, 1978). This self-report questionnaire asks the respondent to report her general activity levels on a weekly basis over the previous year for specific activities, and then converts the responses into the average number of METs per week. This questionnaire is advantageous for use in research because it is relatively brief and can be self-administered. However, as is common with self-report measures that rely on memory over a long period of time, the findings on validity and reliability have been mixed. Test-retest reliability correlation coefficients have ranged from 0.23 to 0.73, depending on the time span and the specific question being evaluated. Validity assessment has been done by comparing the PPAQ to other measures of activity. The strongest finding was reported when comparing the PPAQ to directly-measured $VO_2max$ (r=0.29-0.60). Results have been quite mixed when comparing the PPAQ to other activity questionnaires (which may themselves be of questionable validity). When compared to accelerometer readings, correlations have been quite low for the “blocks walked” and “stairs climbed” questions, but barely acceptable for the sports questions (r=0.33). (However, accelerometers provide user feedback, which may alter activity patterns.) Therefore, the PPAQ may have limited validity and reliability, but this is typical of a self-report questionnaire dependent on memory over a one-year period (Sallis & Saelens, 2000).

The PPAQ was completed at Time 1 and included instructions to encompass the one-year period before coming to college.

*Self-Efficacy*

An individual who experiences self-efficacy in some areas of life may not necessarily also experience it in other areas (McAuley et al., 1995), which renders it important to use a behavior-specific scale, if available. The Physical Self-Efficacy Scale (PSES) (see Appendix C) comprises two subscales: a Perceived Physical Ability (PPA) subscale of 10 items, and a 12-item Physical Self-Presentation Confidence (PSPC) subscale (Ryckman et al., 1982). The authors of this scale found the test-retest reliability to be satisfactory (r=0.85, p<0.001) among college students. Construct and discriminant validity were assessed by comparing the PSES with other personality tests, some similar in concept to the PSES and some testing quite different constructs. Findings indicated that the PSES correlated strongly with the other inventories that tested similar concepts, and less so with other inventories that tested separate and distinct concepts, thus demonstrating validity. Another study evaluated predictive validity and found that the PSES was able to predict participation in sports and performance in a sports contest more so than a comparison physical self-concept scale (Ryckman et al., 1982). Self-efficacy, as measured by the PSES, will serve as a predictor of physical activity in the present statistical model. The PSES was completed at Time 1, before and after the treadmill test.

The items in the PPA subscale appeared more relevant to the present study than those contained in the PSPC subscale, as the former address issues of physical ability, while the later deal with self-consciousness about body image and physical prowess. Therefore, the PPA subscale was used in the present model.

However, the PPA, as it was originally conceived, may not be completely relevant to a college aged female population. Motl and Conroy (2000) evaluated the factor structure of the PSES using confirmatory factor analysis in a college-aged sample of men and women. They found that most items on the PPA-subscale were loaded on the factor appropriately, but two items did not load adequately: "My speed has gotten me out of some tight spots," and "I can't run fast." Therefore, the PPA was scored for the present study excluding those two items.

*Current Physical Activity*

Current physical activity was evaluated using both subjective measures (questionnaire data) and objective measures (pedometer readings).

*International Physical Activity Questionnaire (IPAQ)*

The IPAQ was designed to obtain (in both research and surveillance studies) comparable estimates of physical activity internationally (Sjostrom, Ainsworth, Bauman, Bull, Craig, & Sallis, 2006 ). Both a short-form and a long-form version have been developed, in both telephone administration and self-administration formats, and have been translated into several languages. The IPAQ was originally developed in English, and for validation purposes, has been translated and back-translated through several languages. This questionnaire inquires about physical activity, both leisure and work related, over the previous 7 days. Typical IPAQ correlations were about 0.80 for reliability and 0.30 for validity, which is as good as most other physical activity self-report inventories (Sallis & Saelens, 2000). Because one study found that the short-form IPAQ consistently underestimated physical activity levels compared to the long-form IPAQ (Hallal & Victora, 2004), the long-form version was used in the present study (see Appendix D) (Sjostrom, Ainsworth, Bauman, Bull, Craig, & Sallis, 2006).

This questionnaire was modified to inquire about the previous 3 days at Time 1, rather than the previous 7 days, in order to correlate findings with the three-day pedometer readings. However, the 7-day version was used at Time 2 because participants varied as to when they completed the questionnaire at follow-up, so the full 7 days was necessary to ensure equal numbers of weekdays and weekend days for each participant. Additionally, questions relating to "work" were modified to include "school" also, to reflect the university population being sampled. However, for the primary analysis, only questions in Part 4 ("Leisure-Time Activity") of the IPAQ were analyzed, as the present study is more concerned with the individual factors that lead a person to choose to be physically active in their free time.

*Pedometer Readings*

Published laboratory tests were reviewed to identify the most accurate pedometer model (that includes a 7-day memory) for use in the present study. The Omron HJ-105 was tested in one laboratory trial (Crouter, Schneider, Karabulut, & Bassett, 2003), and was found to have good accuracy except at very slow speeds, during which it was observed to overestimate the number of steps by an average of 10%. However, this type of error at slow speeds was common among pedometers, and many pedometers showed substantially higher error rates. The Omron model includes a calibration switch that can be adjusted to ensure more accurate readings based on an individuals stride length. Hence, the Omron HJ-105 (Omron Healthcare, Inc, Bannockburn, Illinois). was considered a favorable model with the features needed, and was used in the present study.

Pedometer readings were obtained only at Time 1. This provides a more objective assessment of an individual's daily physical activity, without the bias inherent in self-report measures. However, pedometers themselves can provide biased measurements because a person may feel motivated to be more physically active if provided with feedback on number of steps taken. Therefore, the pedometers were taped shut and the participants were instructed not to open the lid, in order to reduce feedback. Pedometers can also be inaccurate because they cannot be worn when swimming and they do not provide accurate measurements when bicycling. The pedometer output is viewed as a general estimate of overall physical activity rather than an accurate estimate of leisure-time exercise activity, since it is not only worn while exercising but worn throughout the day.

### *Affect After Exercise*

Recent research has established that affect may be improved after a single bout of light to moderate walking (Ekkekakis et al., 2000). The Exercise Induced Feeling Inventory (EFI), used in the present study (Gauvin & Rejeski, 1993), comprises 12 questions (see Appendix E) that assess four different areas of exercise-induced affect and arousal: positive engagement, revitalization, tranquility, and physical exhaustion. In validation testing, the questionnaire was given to two different groups of college students, and was found to have adequate internal consistency on all four factors

(Cronbach's $\alpha$ = 0.72-0.91). Concurrent and discriminant validity were determined by comparing the EFI to two other established and validated measures of affective states that have been used often in exercise studies: the Positive Affect Negative Affect Schedule (PANAS) and the Activation Deactivation Adjective Checklist (AD-ACL). Hypotheses were made before analysis as to which subscales or factors of the different measures should correlate. Results indicated that four out of the six anticipated correlations were present and statistically significant. The tranquility factor of the EFI did not correlate significantly with the NA subscale of the PANAS, which is supposed to reflect a state of calmness and serenity; this finding was unexpected, suggesting that the tranquility scale may not be reflecting calmness (although one of the three questions in this factor asks specifically about calmness). Therefore, the concurrent validity of three of the four scales appeared good, and the validity of tranquility was uncertain (Gauvin & Rejeski, 1993).

Construct validity has been previously tested by comparing scores on the EFI before and after exercise, as well as in a social setting versus an isolated lab setting. The results indicated that positive engagement was higher in a social setting than a lab setting; revitalization and tranquility were higher after exercise than before; and exhaustion was lower after exercise than when anticipating exercise. These results suggest that the EFI is sensitive to changes in feeling states that occur with exercise, and thus demonstrates adequate construct validity (Gauvin & Rejeski, 1993). However, some of the correlation between pre- and post-exercise scores in the EFI may have been the result of common methods variance (Podsakoff et al., 2003). Therefore, in the present study, the post-exercise EFI structure has been modified slightly to attempt to avoid this systematic bias, by rewording the questions slightly and changing the layout of the questionnaire (see Appendix E).

The precise subscale of EFI to be used was determined upon initial data exploration, based on which subscale best correlated with the physical activity outcome measures; previous data on such a relationship was not identified, and this particular aspect of the present examination must be considered exploratory due to its *post hoc* nature.

### *Theory of Planned Behavior Measures*

The questionnaire measuring the various aspects of the Theory of Planned Behavior (TpB) was derived from a number of different sources. The primary source was a monograph written by the originating theorist of the TpB detailing how to construct a TpB questionnaire and providing specific examples that, conveniently, used exercise as a model (Ajzen, 2002). Perceived behavioral control questions were designed to reflect one's perception of one's own ability to overcome external obstacles, and were adapted from (Motl et al., 2000). The subjective norm measure comprised two questions asking about influence of the "most important people in my life" on behavior (Ajzen, 2002). Attitude questions were also adapted also from Ajzen, 2002. See Appendix F for the full questionnaire.

The Theory of Planned Behavior questionnaire was completed at Time 1.

### *Personality Traits*

Two specific personality constructs were tested in the present study: the activity subtrait and the industriousness subtrait of the Five Factor Model of personality. Both have been found in previous studies to provide significant predictive value for intention to exercise or for exercise behavior itself, either alone or by moderating other variables (Rhodes et al., 2004). The questionnaire used to measure the activity subtrait was an 8-item scale taken from Rhodes et al. (2004), which included self-evaluation on four positive and four negative traits related to activity. The authors of this study demonstrated that the internal validity of the questionnaire was $\alpha = 0.78$, and another study reported $\alpha = 0.79$ for the same 8-item scale (Saucier & Ostendorf, 1999).

Industriousness was measured using seven adjective sets from Saucier and Ostendorf (1999), adopting the same question structure as used for the activity subtrait by Rhodes et al. (2004) and Rhodes et al., 2005. Both Saucier and Ostendorf (1999) and Rhodes et al. (2005) reported adequate internal validity for this scale ($\alpha = 0.73$ and 0.71, respectively). The full 15-item questionnaire for both the activity and industriousness subtraits is shown in Appendix G.

The Personality Questionnaire was completed at Time 1.

## Statistical Analyses

### *Data Analysis*

The relationships among the variables of interest were modeled via path analysis, using AMOS software (SPSS, Inc.).  Path analysis uses statistics that are similar to those for multiple regression. However, unlike multiple regression, path analysis allows variables to serve both as predictor (or "exogenous") variables and as outcome (or "endogenous") variables simultaneously (if necessary), rather than requiring separate analyses. (In the present case, this is important for the evaluation of intention to exercise, which both predicts exercise behavior and is predicted by other variables in the model.) It therefore allows one to determine not just the relationship between any given predictor variable and the outcome measure (as in multiple regression), but also the relationships among the predictor variables. Although path analysis allows one to hypothesize about parameter relationships, the calculation method is like that of regression analysis, in that although the model may be statistically significant and the solution unique, it does not preclude the existence of other unknown models that might fit the data as well or better than the calculated values.

Some practitioners of path analysis also use structural equation modeling (SEM) techniques in order to evaluate the overall model fit. However, in order to reliably estimate model fit, structural equation modeling usually requires certain parameters in the model to be "fixed," in order to have the degrees of freedom necessary for reliable model fit indices. Fixed parameters are variables or variable relationships within the model that are set to a particular value. For example, a regression coefficient between two variables (such as between intention to exercise and exercise activity) may be set to a particular value, based on evidence from past research or perhaps on a theory being tested. Evaluating overall fit also requires large numbers of data points, because it relies on a chi-square statistic that is heavily influenced by sample size (Bentler & Yuan, 1999) as cited in (Mooijaart & van Montfort, 2004). In the present case, because of the small sample size, and because the model being tested was novel and not conducive to containing fixed parameters based on prior theory, overall model fit is not assessed.

Continuous demographics data are presented in the form of mean ± standard deviation (S.D.); categorical data is presented in the form of percentages. Completers versus dropouts are compared using t-tests for continuous data and chi-square or Fisher's exact (depending on number of categories) for discrete data. Univariate correlations among variables are evaluated using the Pearson's *r* statistic.

### *Power Analysis*

Traditional power analysis software does not address the complexities of path analysis or SEM. However, because path analysis is similar to multiple linear regression, the power estimates for multiple regression may be used. Statisticians have recommended that no fewer than 15 participants be included per predictor variable in the model (Statistical Support, 2002). Kline (1998) recommends for SEM at least 10 cases per parameter, and preferably 20; he warns that analysis should absolutely not be done with fewer than 5 cases per parameter. Therefore, based on the 82 participants who fully participated in the present study (see Results section), only five of the proposed variables are evaluated in the present model, which, with the addition of two error terms in the model, constitutes seven total variables, just over 11 participants per variable. The variables chosen for analysis were the following:

1. Change in affect after exercise;
2. Past exercise behavior;
3. Personality: The personality characteristic evaluated in the present model was Activity (see Results section for more details);

4. Intention to exercise (from the TpB model); and

5. Exercise self-efficacy.

The classic TpB model is also explored as an alternative to this model.

For the longitudinal analysis, another variable is added to the model (follow-up exercise behavior) and the number of participants who completed the follow-up questionnaire decreased from 82 to 53. Therefore, statistical power is severely compromised (eight cases per variable) and results must be interpreted with extreme caution.

The classic TpB model will also be explored as an alternative to this model.

*Model Structure*

Two models were analyzed:

MODEL 1: A cross-sectional analysis of predictors of exercise behavior at time 1 is shown in Figure 2. The path analytic model depicting this analysis is shown below with the final five variables.

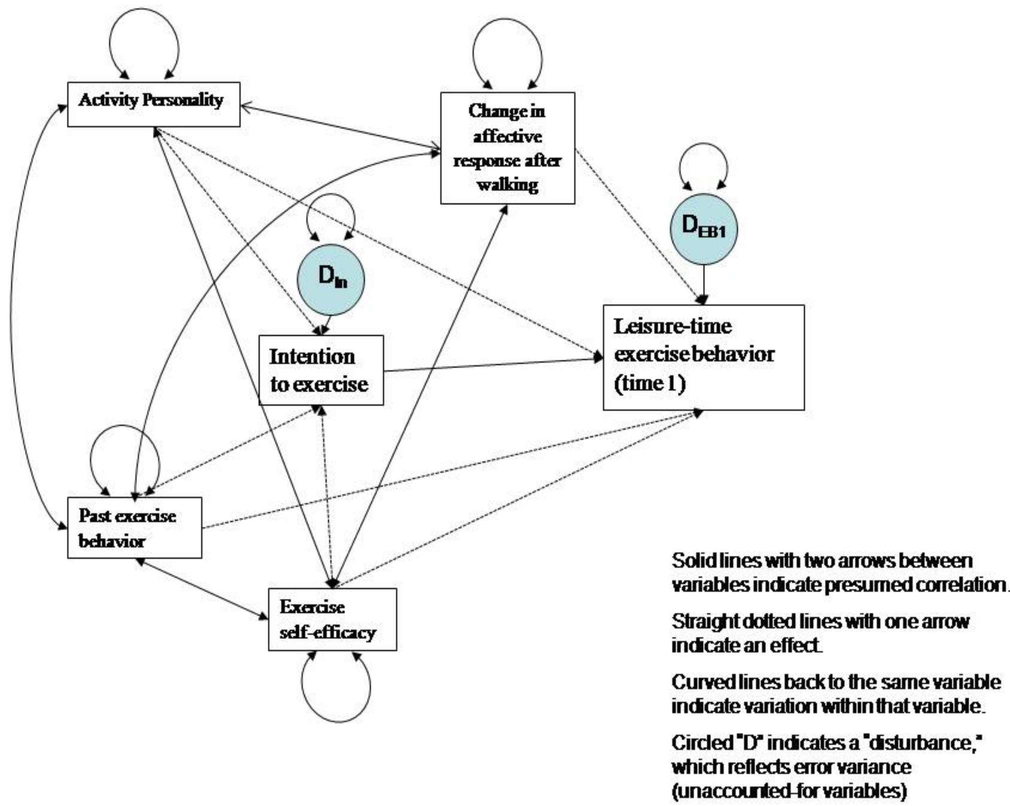


**Figure 2. A cross-sectional model of predictors of exercise behavior at time 1**

MODEL 2: A longitudinal analysis of predictors of exercise behavior at time 2 is shown in Figure 3. The path analytic model depicting this analysis is shown below. Exercise behavior at time 1 is included as a predictor variable in this model.

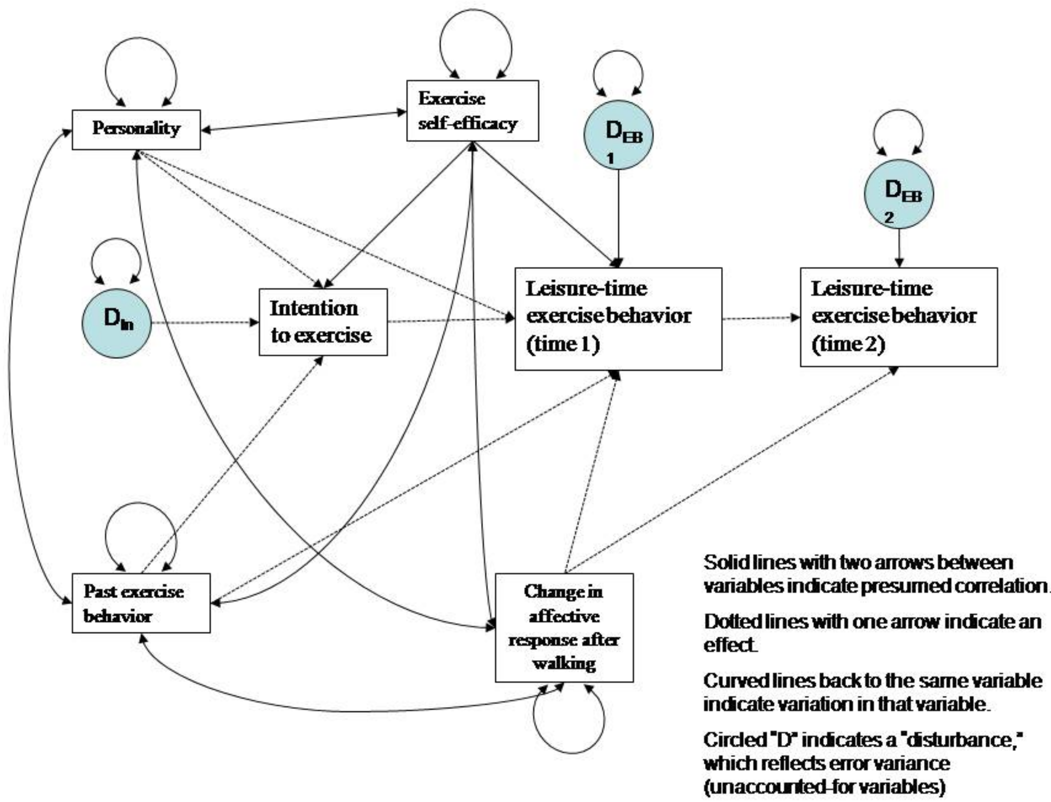


**Figure 3. A longitudinal model of predictors of exercise behavior**

*Data Considerations*

Most of the data in the present study come from self-report questionnaires. Therefore, there may be a substantial amount of error in the measurement of the constructs being examined. All variables in the present study are continuous in nature, which is a requirement of the planned path analysis. In an ideal situation, a confirmatory factor analysis of each questionnaire would be performed to ensure that the predictors represent their intended construct for the population we are testing (Anderson & Gerbing, 1988). However, the number of participants required for such analyses is prohibitively large.

Data from the physical activity questionnaires were found to be non-normally distributed. Both the Paffenbarger and IPAQ questionnaire response distributions demonstrated a skewed-right distribution, due to the large number of participants who participated in very little physical activity in their leisure time and a very small number of participants who exercised a lot. These variables were transformed into a normally distributed distribution using a square root function for the Paffenbarger and follow-up IPAQ, and a double square-root function for the Time 1 IPAQ, in order to adjust the values into more reliably analyzable bounds (Wuensch, 2007).

Although most participants wore and returned their pedometer as instructed, data from the pedometers were not considered reliable. Many women appeared to wear their pedometer for just part of a day (as evidenced by unusually low numbers of steps), while others wore clothing (e.g., loose pants that hung around the hips) that did not allow the pedometer to read steps accurately. Therefore, pedometer readings are not considered in the present analysis.

Two participants declined to answer one question on the EFI before they walked on the treadmill. In these cases, the overall group mean was used in order to be able to calculate the EFI subscales and use that participant's data.

# CHAPTER 3. RESULTS

Eighty-six women completed the initial treadmill test and all questionnaires; no one requested or required physician approval for participation. One woman's data were excluded from analysis because she demonstrated an apparent limited understanding of the English language in her responses to the questionnaires and to follow-up queries from the investigator. Data from one woman were excluded due to missing data points essential to the analyses. Data from two additional participants were excluded because these participants were also taking part in the intervention arm of a concurrent weight loss study that included a physical activity intervention. Two additional participants were also in this concurrent weight loss study, but did not take part until Spring 2007; hence, their Time 1 data from Fall 2006 were used in the cross-sectional analysis, but their follow-up data, collected in Spring 2007, were not included in the longitudinal analysis. As a result, data from 82 women remained for the cross-sectional analysis. Fifty-three of these women completed the follow-up questionnaires in April, were eligible, and were included in the longitudinal analysis.

An analysis comparing those who did and did not participate in the follow-up questionnaire indicated that there were no differences in weight, BMI, age, or past or present physical activity level. However, there were significant differences in race, such that African-Americans were significantly less likely to follow-up compared to Caucasians and Asians, $\chi^2(4) = 11.75$, $p < 0.05$. There was also a significant difference in follow-up participation depending on when participants had been recruited – Wave 2 recruits were more likely to participate than Wave 1 recruits (Fisher's $p < 0.05$).

However, because the expected frequency in one of the cross-tabular cells examining race was less than the minimum recommendation of 2, the validity of this particular finding is questionable.

Wave 1 and Wave 2 participants did not differ on weight, BMI, chosen walking speed, past, current, or follow-up exercise level, personality, self-efficacy, or affect change after walking. Wave 2 participants were slightly older, which may be the result of being tested 4 to 5 months later, 18.87 ± 0.43 vs 18.63 ± 0.37, $p<0.05$. Wave 2 participants also reported enjoying exercise more than Wave 1 participants (score on Physical Activity Enjoyment Scale: 103.65 ± 8.55 vs 96.37 ± 19.51, $p<0.05$, equal variances not assumed.)

All participants were female, and their average age at the start of the study was 18.7 ± 0.4 years with a mean weight of 62.7 ± 13.1 kg and BMI of 23.1 ± 4.1. Sixty-seven percent of participants classified themselves as Caucasian, 23.2% as Asian, 6.1% as African-American, 1.2% as Latina, and 2.4% as “other.”

Of the 82 participants included in the cross-sectional analysis, most were active in high school according to the Paffenbarger survey: only 11 women (13.8%) reported no physical activity (outside of gym class) during the year prior to arriving at college. Fifteen (18.8%) participated in one physical activity, 27 (33.8%) participated in two, 13 (16.3%) participated in three, while 14 (17.5%) participated in four or more. Based on the categorization of METs into active versus non-active (using CDC cutoff points), 63.4% were regularly active, while 36.6% were not.

During Part 1 of this study, according to the IPAQ, 53.7% of participants met the CDC minimum recommended activity levels, while 46.3% did not. Fisher's exact test revealed no statistically significant difference in activity categorization between those who participated in October, and those who did so in February ($p = 0.29$). At follow-up, in April, activity levels were similar to what they were at baseline: 54.5% were categorized as active, while 45.5% were categorized as not active. However, participants at follow-up reported significantly higher levels of activity (as measured by total METs) than they did at baseline, $t(56) = 2.3$, $p < 0.05$, when prorated for total number of day recorded (3 at baseline versus 7 at follow-up).

The relationship between physical activity at Time 1 and Time 2 differed for those participants recruited in October and in February. For those recruited in October, there was a strong positive correlation between their baseline and follow-up activity levels, $r = 0.55$, $p < 0.001$. However, for those participating in February, the correlation was non-existent, $r = 0.01$, $p = 0.98$. Although part of this lost effect may be due to the substantially smaller number of participants (n=17) recruited in February, it seems unlikely to explain the total absence of relationship.

### *Univariate Analyses*

Relationships among the variables of interest were first explored using bivariate Pearson's correlations. Such an analysis helped determine which of the EFI subscales and which personality measure (Activity versus Industriousness) to use in the present analysis (a choice made necessary by the low number of participants enrolled).

None of the EFI subscales was statistically related to current physical activity level. However, both the positive engagement, $r = 0.29$, $p < 0.05$, and physical exhaustion, $r = -0.31$, $p < 0.05$) subscales were significantly correlated with follow-up physical activity level. Because positive engagement can arguably be described as an affect state more than can physical exhaustion, it was chosen to represent Affect Change in the present models. Positive engagement demonstrated a mean change of +4.2 (S.D.=1.9).

The personality trait to be included was then chosen. The Activity personality trait was significantly correlated with the Industriousness trait, $r = 0.35$, $p < 0.005$, Intention to Exercise, $r = 0.24$, $p < 0.05$, Current Exercise Behavior, $r = 0.25$, $p < 0.05$, and Follow-up Exercise Behavior, $r = 0.33$, $p < 0.05$. Industriousness was not significantly related to Intention to Exercise, $r = 0.02$, $p = 0.83$ nor Current Exercise Behavior, $r = 0.07$, $p = 0.54$, but was significantly correlated with Follow-up Exercise Behavior, $r = 0.28$, $p < 0.05$. Based on these relative findings, Activity was chosen over Industriousness as the most relevant personality characteristic for the present model.

**Table 1. Bivariate Correlations Among Exogenous and Endogenous Variables in Models**

| | Past Activity (total METs) | Affect Change (positive engagement) | Exercise Self-Efficacy | Activity Personality | Intention to Exercise | Current Exercise Behavior |
|---|---|---|---|---|---|---|
| Affect Change (positive engagement) | 0.03 | | | | | |
| Exercise Self-Efficacy | 0.30** | 0.10 | | | | |
| Activity Personality | 0.10 | 0.13 | 0.54** | | | |
| Intention to Exercise | 0.22 | 0.11 | 0.19 | 0.22 | | |
| Current Exercise Behavior | 0.26* | 0.00 | 0.26* | 0.23* | 0.29** | |
| Follow-up Exercise Behavior | 0.17 | 0.29* | 0.29* | 0.34* | 0.27* | 0.48** |

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

## *Cross Sectional Analysis*

The first analysis evaluated the relationships among variables at Time 1 using a path analytic model.

### *Confirmatory Path Analysis*

Figure 2 shows the results of the confirmatory path analysis, displaying the standardized coefficients. Shown are the covariances among exogenous (independent) variables, regression coefficients from exogenous to endogenous (dependent) variables, and the squared multiple correlations of each of the two endogenous variables, indicating the amount of variance accounted for by the observed exogenous variables. In this model, observed variables accounted for 13% of variance in Intention to Exercise and 34% of the variance in current exercise behavior. Significant pathways are indicated with asterisks. Overall, the regression equation associated with prediction of intention was statistically significant, $F(3,81) = 3.77$, $p < 0.05$) and the regression equation associated with prediction of current exercise behavior was also statistically significant, $F(5,81) = 7.82$, $p < 0.001$.

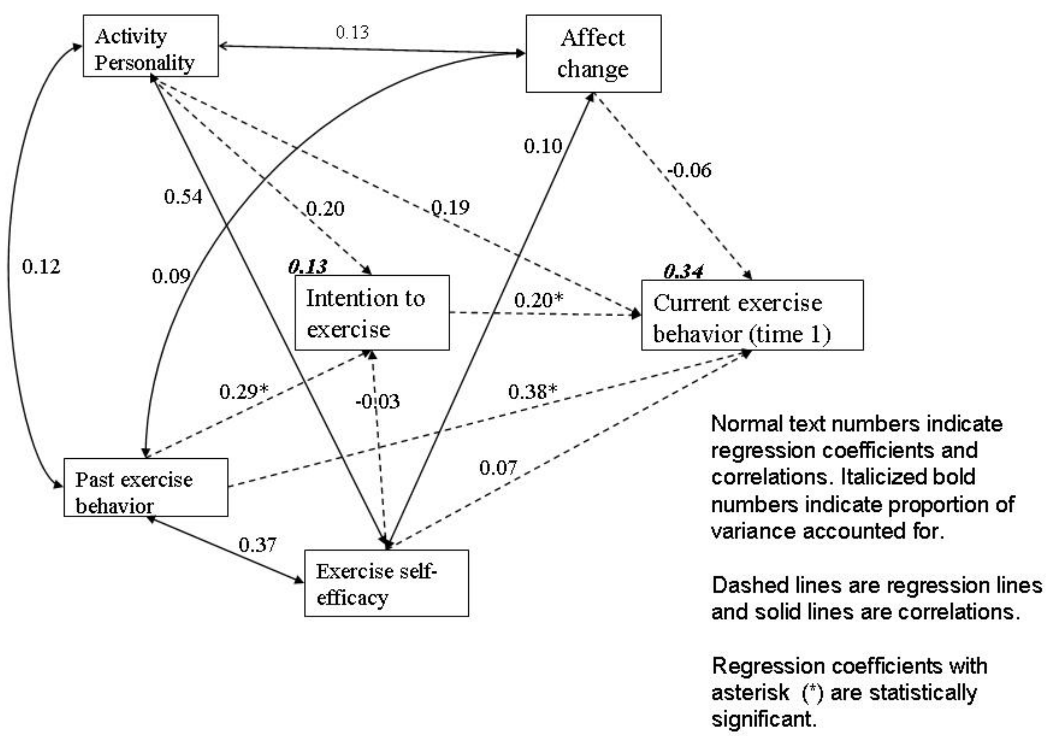


**Figure 4. Cross-Sectional Confirmatory Path Analysis Results Showing Standardized Coefficients**

Table 2 shows the regression weights associating each exogenous and endogenous variable. As predicted, Past Exercise Behavior was a significant predictor of both Intention to Exercise ($p < 0.01$) and Current Exercise Behavior ($p < 0.001$) at Time 1. The Activity personality component, however, did not significantly predict Intention to Exercise as predicted ($p = 0.12$), but a trend was observed towards predicting Current Exercise Behavior ($p = 0.08$), which had not been hypothesized. Also contrary to the hypotheses, Affect Change did not significantly predict Current Exercise Behavior ($p=0.48$), nor did Self-efficacy significantly predict Intention ($p = 0.82$).

**Table 2. Regression Coefficients for Cross-Sectional Classic Path Analysis**

| Predictor Variable | | Outcome Variable | Beta | S.E. | C.R. | p-value |
|---|---|---|---|---|---|---|
| Past Exercise | → | Intention to exercise | .050 | .019 | 2.618 | .009 |
| Activity personality | → | Intention to exercise | .091 | .058 | 1.572 | .116 |
| Physical self-efficacy | → | Intention to exercise | -.018 | .079 | -.230 | .818 |
| Intention to exercise | → | Current exercise behavior (trans) | .119 | .058 | 2.046 | .041 |
| Activity personality | → | Current exercise behavior (trans) | .053 | .031 | 1.729 | .084 |
| Past Exercise | → | Current exercise behavior (trans) | .039 | .010 | 3.724 | <.001 |
| Affect change | → | Current exercise behavior (trans) | -.083 | .117 | -.709 | .478 |
| Physical self-efficacy | → | Current exercise behavior (trans) | .026 | .041 | .642 | .521 |

Covariances among the exogenous variables are shown in Table 3. The general overall findings suggest that there was some limited multicollinearity; however, an evaluation of the tolerance and variance inflation factor (not shown) indicates that this multicollinearity was not profound enough to be considered statistically significant. Of note, however, was Self-efficacy's high covariance with two other exogenous variables

(Activity personality and Past Exercise Behavior), which, in combination with its lack of predictive value, may indicate that Self-efficacy was superfluous to the present model.

**Table 3. Covariances Among Exogenous Variables**

| Predictor Variable | | Outcome Variable | Beta | S.E. | C.R. | p-value |
|---|---|---|---|---|---|---|
| Past Exercise | ←→ | Affect change | 4.276 | 5.158 | .829 | .407 |
| Past Exercise | ←→ | Activity personality | 25.865 | 23.596 | 1.096 | .273 |
| Affect change | ←→ | Activity personality | 2.179 | 1.887 | 1.155 | .248 |
| Activity personality | ←→ | Physical self-efficacy | 32.816 | 7.651 | 4.289 | <.001 |
| Affect change | ←→ | Physical self-efficacy | 1.357 | 1.483 | .915 | .360 |
| Past Exercise | ←→ | Physical self-efficacy | 61.953 | 19.701 | 3.145 | .002 |

*Exploratory Analysis*

Because the results of the confirmatory path analysis appeared weak, with just three out of eight potential pathways providing statistically significant independent predictive value, an exploratory path analysis was conducted. A recommended method of changing one value per step ("model trimming" or "model building") in the exploration was used to evaluate changes in the predictive values of the pathways (Kline, 2005) – in this way, one can observe the impact of each individual variable added or deleted. Appropriate addition or subtraction of variables helps develop more precise estimates of regression parameters that are not confounded by the presence of inappropriate or redundant variables. However, these modifications are exploratory in nature and it is possible that resulting equations may continue to be misspecified.

*Step 1. Delete Self-Efficacy*

Self-efficacy showed no significant predictive value for either Intention to Exercise or Current Exercise Behavior itself, as well has showing high covariance with other exogenous variables, suggesting that its presence in the model was redundant. Therefore, it was deleted from the model. The resulting model showed the same relationships among variables as the baseline model, suggesting that Self-efficacy had truly not been adding any independent information.

*Step 2. Delete Affect Change*

Because the results from the base analysis suggested no predictive value of post-exercise Affect Change (positive engagement subscale of the EFI) for Current Exercise Behavior, this exogenous variable was deleted from the model in the next iteration of the exploratory model. The resultant relationships among other variables in the model demonstrated no substantial changes, and the squared multiple regression coefficients remained the same for both Intention to Exercise (13%) and Current Exercise Behavior (33%).

*Step 3. Replace Self-Efficacy with Perceived Behavioral Control (PBC)*

Perceived behavioral control has been shown in a number of studies to be an essential aspect of the TpB in predicting exercise behavior (Hagger et al., 2002; McAuley & Courneya, 1993). It is considered by some to be similar in concept to self-efficacy (Ajzen, 1991), although this is a matter of considerable debate (Ajzen & Timko, 1986; Armitage & Conner, 1999). Because Self-efficacy was found to be superfluous to the original model, the test here was to see if PBC would be any more influential. It was entered into the model as a predictor of both Intention and of Current Exercise Behavior directly, the latter of which has been shown in past analyses to improve model fit of TPB predicting exercise (Hagger et al., 2002). Indeed, as predicted in the original hypotheses, PBC was a significant independent predictor of Intention to Exercise, $b = 0.24$, $p<0.05$, and Current Exercise Behavior, $b = 0.22$, $p<0.05$), resulting in five total significant predictive paths in the current iteration of the model. The resulting squared multiple correlation for Intention was 18%, $F(3,81) = 5.72$, $p = 0.001$) (an increase of 5% over the original model) and for Current Exercise Behavior, 37%, $F(4,81) = 11.49$, $p < 0.001$, which is slightly better than the original model (34%). The addition of PBC as a direct predictor of Current Exercise Behavior decreased the predictive power of Intention to 14% of variability accounted for (from 20% in the original model).

*Step 4. Add Attitude towards Exercise to the model*

The TpB component of Attitude towards Exercise was then added to the model as a predictor of Intention to Exercise. This variable was a statistically significant predictor of Intention, $b = 0.32$, $p < 0.005$, but PBC became non-significant in its presence, $b = 0.14$, $p = 0.17$, and, not surprisingly, there was significant multicollinearity between the two variables ($p=0.001$). This addition to the model increased the explained variability in Intention from 18% to 26%, $F(4,81) = 6.87$, $p < 0.001$, and the variability of Current Exercise Behavior explained remained at 37%. As in the previous model iteration, five paths were significant independent predictors in the present iteration.

*Step 5. The Original TpB Model*

Due to statistical power constraints, the present model did not include all components of the TpB. The TpB has been found in many studies to provide good predictive value for exercise behavior (e.g., Armitage, 2005; Hagger et al., 2002). Therefore, the TpB by itself was evaluated at this point to evaluate whether it fit the data any better than our confirmatory model.

Therefore, Subjective Norms was added to the model, while Affect Change, Activity personality, and Past Exercise were eliminated. All effects were mediated through Intention, except PBC which has been postulated to also predict exercise behavior directly (Ajzen, 2006). The result suggested some improvements and some decrements, with the squared multiple correlation of Intention at 26% of variability explained, $F(3,81) = 8.99$, $p<0.001$, (improved from 13% in our original model) and Current Exercise Behavior at 13%, $F(2,81) = 10.50$, $p < 0.001$), decreased from our original finding of 33% (and decreased from the exploratory finding in Step 4 of 37%). In this model, Attitude towards Exercise and Subjective Norms were significant independent predictors of Intention, while PBC was the only significant predictor of Current Exercise Behavior (Intention was not). Four out of five paths were statistically significant predictors. However, due to the relative amount of variance accounted for, the Step 4 model is concluded to be the superior model for the present study sample (see Figure 5). Compared to the original confirmatory model, it appears that if we had been able to include all TpB components feeding into Intervention, our model's predictive value for Intention would have been much stronger; on the other hand, this finding suggests that additional direct predictors of Current Exercise Behavior, above and beyond TpB, are important.

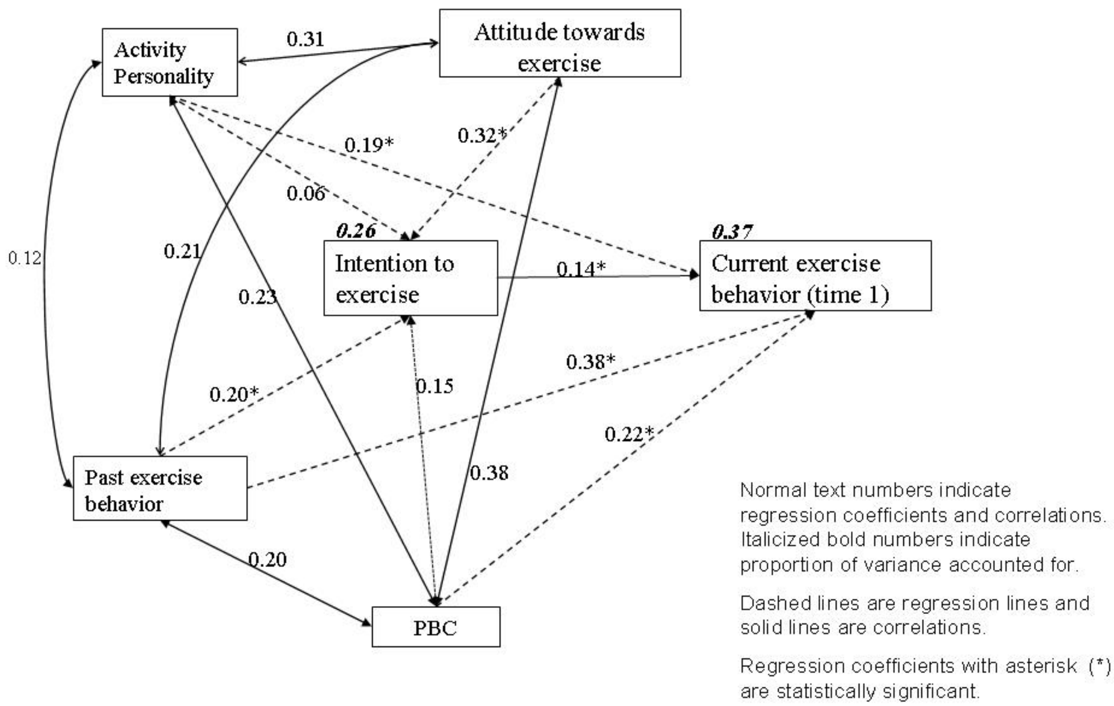


**Figure 5. Cross-Sectional Exploratory Path Analysis Results Showing Standardized Coefficients**

*Longitudinal Analysis*

Much of the longitudinal model is identical to the cross-sectional model; changes in relationships among exogenous variables would only be anticipated to result from the smaller number of participants providing data (53 versus 82). This model has much lower statistical power to detect significant effects, with six exogenous variables (plus error terms), which provides approximately 8 cases per variable, slightly lower than the average lowest number recommended by statistical experts. However, decreasing the number of variables even further than already done would render the model of questionable validity.

*Confirmatory Analysis*

Figure 3 shows the results of the confirmatory longitudinal path analysis, displaying the standardized coefficients. Shown are the covariances among exogenous variables, regression coefficients from exogenous to endogenous variables, and the squared multiple correlations of each of the three endogenous variables, indicating the amount of variance accounted for by the observed exogenous variables. In this model, observed variables accounted for 9% of variance in Intention to Exercise, $F(3,52) = 1.63$, $p = 0.19$, 26% of the variance in Current Exercise Behavior, $F(5,52) = 3.30$, $p < 0.05$, and 26% of Follow-up Exercise Behavior, $F(2,52) = 8.59$, $p = 0.001$, (which includes and controls for the independent contribution of current behavior). In this model, just three out of 10 of the pathways showed statistically significant independent predictive value for one of the endogenous variables, as shown in Figure 3 and in Table 4 (unstandardized coefficients) below. Precise relationships among variables were similar to the cross-sectional analysis (as would be expected), but statistically less robust. As predicted, there was a positive relationship between Past Exercise and Current Exercise Behavior, as well as Current Exercise Behavior and Follow-up Exercise Behavior. The relationship between Past Exercise and Intention to Exercise was a statistical trend, $b = 0.29$, $p = 0.06$. Unexpected was the finding that Intention to Exercise in the next month no longer predicted Current Exercise Behavior, $b = 0.00$, $p = 1.0$.

A new relationship was revealed in this longitudinal model: Affect Change predicted Follow-up Exercise Behavior, $b = 0.29$, $p < 0.05$. Self-efficacy continued to be non-predictive.

Covariances among exogenous variables are shown in Table 5 and are quite similar to the cross-sectional analysis despite the smaller sample size.

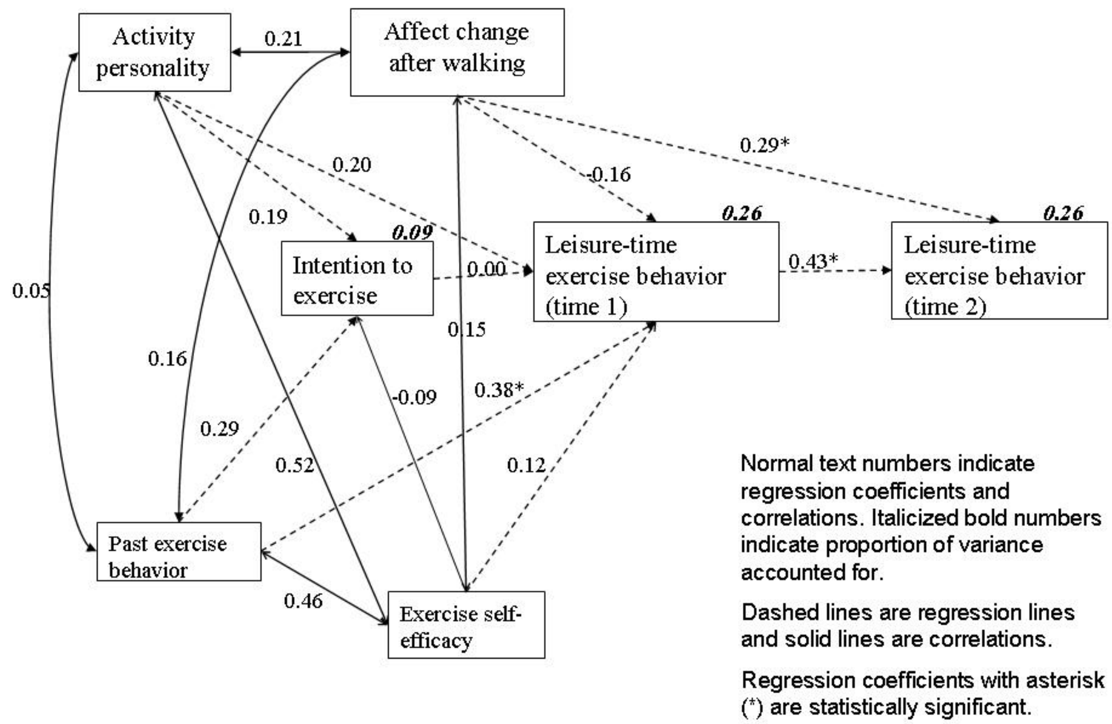


**Figure 6. Longitudinal Path Analysis Results Showing Standardized Coefficients**

**Table 4. Unstandardized Regression Weights among Exogenous and Endogenous Variables: Longitudinal Model**

| Predictor Variable | | Outcome Variable | Beta | S.E. | C.R. | p-value |
|---|---|---|---|---|---|---|
| Past Exercise | → | Intention to exercise | .049 | .027 | 1.863 | .063 |
| Activity personality | → | Intention to exercise | .082 | .068 | 1.195 | .232 |
| Physical self-efficacy | → | Intention to exercise | -.045 | .093 | -.487 | .626 |
| Intention to exercise | → | Current exercise behavior (trans) | -.001 | .074 | -.007 | .995 |
| Activity personality | → | Current exercise behavior (trans) | .051 | .038 | 1.350 | .177 |
| Past Exercise | → | Current exercise behavior (trans) | .038 | .015 | 2.589 | .010 |
| Affect change | → | Current exercise behavior (trans) | -.191 | .145 | -1.320 | .187 |
| Physical self-efficacy | → | Current exercise behavior (trans) | .038 | .050 | .760 | .447 |
| Current exercise behavior (trans) | → | Follow-up exercise behavior (trans) | 3.977 | 1.119 | 3.554 | <.001 |
| Affect change | → | Follow-up exercise behavior (trans) | 3.194 | 1.309 | 2.440 | .015 |

**Table 5. Covariances Among Exogenous Variables**

| Predictor Variable | | Outcome Variable | Beta | S.E. | C.R. | p-value |
|---|---|---|---|---|---|---|
| Past Exercise | ←→ | Affect change | 7.018 | 6.329 | 1.109 | .267 |
| Past Exercise | ←→ | Activity personality | 9.375 | 28.839 | .325 | .745 |
| Affect change | ←→ | Activity personality | 3.868 | 2.574 | 1.503 | .133 |
| Activity personality | ←→ | Physical self-efficacy | 35.901 | 10.820 | 3.318 | <.001 |
| Affect change | ←→ | Physical self-efficacy | 2.200 | 2.107 | 1.044 | .297 |
| Past Exercise | ←→ | Physical self-efficacy | 79.164 | 26.265 | 3.014 | .003 |

*Exploratory Path Analysis*

Because the results of the confirmatory path analysis were very weak, with few exogenous variables providing statistically significant independent predictive value, an exploratory path analysis was conducted, using the same stepwise methodology as in the cross-sectional analysis.

*Step 1. Delete Current Exercise*

In the confirmatory model, it was assumed that Current Exercise Behavior would act as a mediator between most exogenous variables and Follow-up Exercise Behavior. However, because Intention showed no predictive value for Current Exercise Behavior (as opposed to the significant *b*-value of 0.20 in the cross-sectional model), it was clear that such an assumption fell apart in the small sample available for this longitudinal analysis. Therefore, Current Exercise Behavior was deleted to evaluate how well the model worked if exogenous variables were allowed to predict Follow-up Exercise

Behavior directly. In this model modification, predictive value for Follow-up Exercise Behavior improved modestly, from 26% to 31% of variance accounted for, $F(5,52) = 3.99$, $p < 0.005$. Such improvement appeared to stem primarily from the direct path from Intention, $b = 0.30$, $p < 0.05$, and from Activity personality ($b$ =0.25, p=0.08). Interestingly, Past Exercise Behavior showed no predictive value at all for Follow-up Exercise Behavior, $b = 0.00$, $p = 0.99$, nor did Self-efficacy, $b = 0.11$, $p = 0.63$. The predictive value of Affect Change for Follow-up Exercise Behavior decreased but still showed a statistical trend, $b = 0.22$, $p = 0.07$.

Based on these findings, it appeared some modifications of the original confirmatory model were warranted. Current Exercise Behavior was returned to the model (given its significant relationship with Past Exercise Behavior) but Intention was allowed a direct path to Follow-up Exercise Behavior, as was Activity personality. With these revisions, variance of Follow-up Exercise Behavior accounted for was increased from 26% to 40%, $F(6,52) = 5.11$, $p<0.001$. Two additional statistically significant paths were added: Activity personality to Follow-up Exercise Behavior, $b = 0.23$, $p < 0.05$, and Intention to Follow-up Exercise Behavior, $b = 0.28$, $p = 0.05$, for a total of five out of 12 paths providing independent predictive value.

*Step 2. Delete Self-Efficacy*

As in the cross-sectional analysis, Self-efficacy seemed to be a redundant variable in the model. Therefore, it was deleted. The resulting model showed essentially the same squared multiple correlations for Intention (9%), Current Exercise Behavior (25%) and Follow-up Exercise Behavior (40%). These findings suggest that self-efficacy had been superfluous to the model.

In this revision of the model, six out of 10 paths were statistically significant with one additional exogenous variable demonstrating significant independent predictive value: Activity personality was a significant predictor of Current Exercise Behavior, $b = 0.26$, $p < 0.05$. All other regression coefficients remained essentially the same as the previous step.

*Step 3. Add PBC to the Model*

Perceived Behavioral Control was added to the model in place of Self-efficacy. It was modeled to impact all endogenous variables directly. The squared multiple correlations for the endogenous variables showed varying levels of improved prediction: Intention increased from 9% to 11%, $F(3,52) = 1.95$, $p = 0.14$, Current Exercise Behavior from 25% to 31%, $F(5,52) = 4.14$, $p < 0.005$ and Follow-up Exercise Behavior remained essentially the same (40% to 39%), $F(6,52) = 5.10$, $p < 0.001$.

At this step of the exploration process, six out of 12 paths demonstrated significant independent predictive value: added at this stage was PBC for current exercise behavior, $b = 0.24$, $p < 0.05$. However, the predictive value of Activity personality for Current Exercise Behavior decreased to a statistical trend, $b = 0.22$, $p = 0.08$.

This model is shown in Figure 7.

*Step 4. Comparison to TpB Model Predicting Follow-up Exercise Behavior*

As in the cross-sectional analysis, the proposed model was cross-checked against the original TpB model to evaluate its relative robustness. Hence, Attitude towards Exercise and Subjective Norms were added to the model, while Affect Change, Activity personality, and Past Exercise Behavior were deleted. Intention was modeled to impact both Current Exercise Behavior and Follow-up Behavior directly. Accounted-for variance in Intention improved from 11% to 19%, becoming statistically significant, $F(3,52) = 3.88$, $p < 0.05$, but for Current Exercise it decreased from 31% to 11%, $F(2,52) = 3.07$, $p = 0.06$, and for Follow-up Exercise it decreased from 39% to 25%, $F(3,52) = 5.50$, $p < 0.005$. Four out of eight regression paths were statistically significant: Subjective Norms was independently predictive of Intention, $b = 0.29$, $p < 0.05$; PBC was significantly predictive of Current Exercise Behavior, $b = 0.30$, $p < 0.05$; Intention was significantly predictive of Follow-up Exercise Behavior, $b = 0.29$, $p < 0.05$, as was Current Exercise Behavior, $b = 0.38$, $p < 0.005$. These finding suggest that Intention was slightly better predicted by the components of the TpB, but that both Current and Follow-up Exercise Behavior required additional predictive components in this sample.

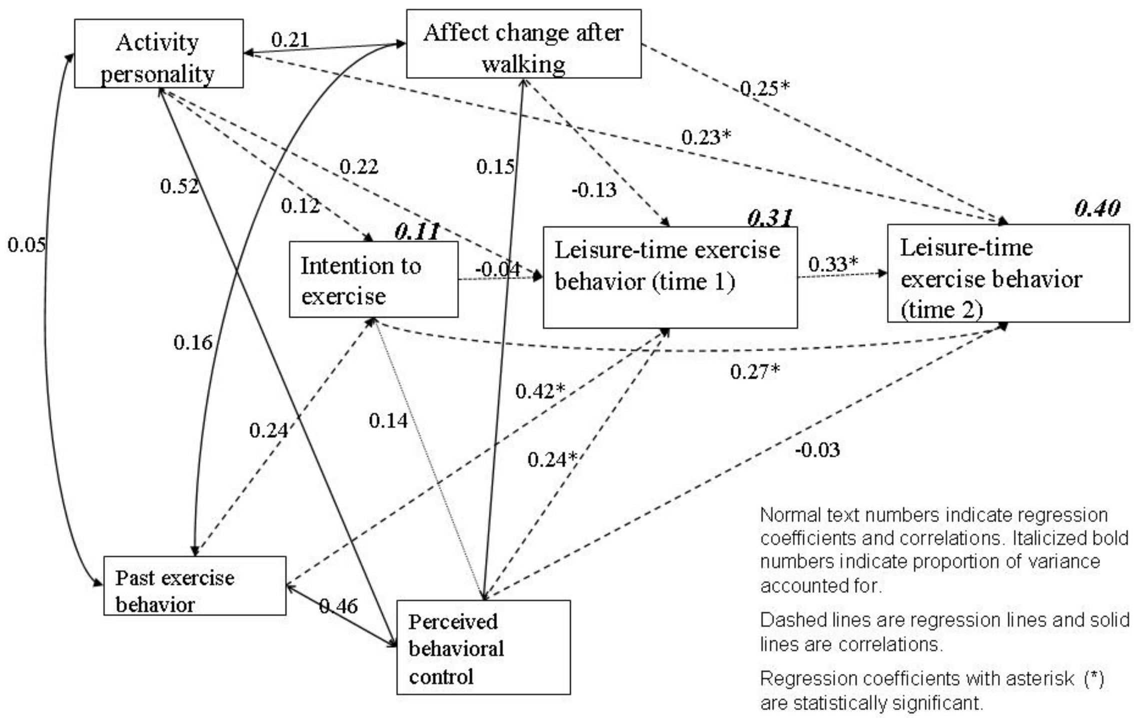


**Figure 7. Longitudinal Exploratory Path Analysis Results Showing Standardized Coefficients**

*Summary of Findings: Hypotheses*

To summarize the findings from this study, the results are summarized according to the original hypotheses proposed.

1. *Change in affect after exercise will predict exercise behavior one week and four months later, such that individuals with more positive affect after*

*exercise will report more exercise behavior.*

Findings: This hypothesis was only partially supported . Affect Change did not significantly predict Current Exercise Behavior, and in fact was deleted from the cross-sectional model. However, it was a significant independent predictor of Follow-up Exercise Behavior in all iterations of the longitudinal model.

2. *Past exercise behavior will independently predict both intention to exercise and exercise behavior directly, and, when analyzed with the TpB, will reduce the predictive value of perceived behavioral control and attitudes for intention to exercise.*

   Findings: This hypothesis was partially supported. Past Exercise Behavior was a significant independent predictor of Intention to Exercise and Current Exercise Behavior, but not of Follow-up Exercise Behavior. When analyzed in a cross-sectional model that included PBC and Attitude, these variables did not appear to be statistically impacted by the presence of Past Exercise Behavior.

3. *The personality constructs of Industriousness and Activity will independently predict intention to exercise. When analyzed with the TpB predictor variables, its predictive value for intention to exercise will be partially diminished.*

   Findings: Due to statistical limitations, Industriousness was not analyzed in the tested models. Regarding Activity, this hypothesis was not supported by the available data. Activity was not a significant predictor of Intention in either the confirmatory cross-sectional or longitudinal analyses. Unexpectedly, it trended towards prediction of Current Exercise Behavior directly, and when allowed to influence Follow-up Exercise Behavior directly in exploratory analysis, was statistically significant.

When PBC was added to the longitudinal model during exploratory analysis, it diminished Activity's predictive value for Follow-up Exercise Behavior from a statistically significant finding to a statistical trend.

4. *Self-efficacy will correlate positively with past exercise behavior and change in affect after a single bout of walking.*

   Findings: This hypothesis was partially supported. On univariate analysis, Self-efficacy correlated significantly with Past Exercise Behavior but not with Affect Change. Within the context of the confirmatory cross-sectional model, Self-efficacy demonstrated significant multicollinearity with Past Exercise Behavior, but not with Affect Change.

5. *When analyzed with the TpB, self-efficacy will be a better predictor of intention to exercise than will perceived behavioral control.*

   Findings: This hypothesis was not supported by the available data. Self-efficacy demonstrated no independent predictive ability for either Intention or Exercise Behavior directly, and because of high multicollinearity with other exogenous variables, was deleted from both the cross-sectional and longitudinal models during exploratory analysis. Conversely, PBC provided good independent predictive value for Intention.

6. *The Theory of Planned Behavior will show significantly better predictive value for proximal exercise behavior (self-reported within 2 weeks) than for distal exercise behavior 4 months later.*

   Findings: This hypothesis was not supported by the available data. On exploratory cross-sectional analysis, the TpB accounted for just 13% of variance in Current Exercise Behavior. On exploratory longitudinal analysis, it accounted for 11% of Current Exercise Behavior and 25% of Follow-up Exercise Behavior. Therefore, the pattern observed was opposite of that expected.

7. *Both perceived behavioral control for exercise and exercise self-efficacy will predict both intention to exercise and proximal exercise behavior directly.*

   Finding: This hypothesis was supported only for PBC and not for self-efficacy. Self-efficacy, as described under #4, above, contributed no predictive value to any model. PBC was a significant predictor of both Intention to Exercise and Current Exercise Behavior in the exploratory cross-sectional model and for Current Exercise Behavior in the exploratory longitudinal model.

# CHAPTER 4. DISCUSSION

The present study examined some of the individual factors that may impact a young woman's exercise behavior during transition into her college years. The Theory of Planned Behavior served as a starting point to evaluate the relative predictive value of intention, personality, past behavior, and a variable not previously examined -- affective response to mild exercise. Although limited by small sample size, the present study was able to confirm the importance of both intention and past exercise behavior for predicting current leisure-time physical activity in a cross-sectional analysis. Interestingly, although affective response and personality were not significant predictors in the cross-sectional analysis, they were both significant in an exploratory analysis of the longitudinal model; this unexpected discrepancy of findings will be discussed further, below. The significant findings from the longitudinal analysis are particularly important because this type of analysis can distinguish the direction of effect between predictor and dependent measures in a way that a cross-sectional analysis cannot (although a causal relationship, *per se*, cannot be determined from any cohort study); these findings are also particularly notable in the face of a debilitating lack of statistical power.

The Theory of Planned Behavior, evaluated extensively in previous studies, has been found to predict a wide variety of behaviors (e.g., social drinking, eating behaviors, risky sexual behaviors, choice of travel mode) in a wide variety of populations (e.g., African-American high school students, German general populace, outdoor recreationists). Therefore, it was reasonable to assume that the TpB would also provide predictive value in the present sample regarding exercise behavior. Even though the full model (TpB plus additional proposed variables) could not be tested, we were able to demonstrate that, cross-sectionally, intention predicted 20% of the variability in current exercise behavior, a statistically significant finding. Previous studies evaluating the predictive value of TpB plus personality or past exercise behavior for vigorous activity have demonstrated predictive values of intention for exercise behavior ranging from 25% to 82% (Rhodes & Courneya, 2003a; Rhodes et al., 2002; Rhodes & Courneya, 2003b); hence, the present findings were somewhat less robust than anticipated. However, the addition of extra supplementary variables, including both past exercise *and* personality as independent predictors may have led to an understandable decrease in the predictive value of intention compared to previous studies. The present study also differed from past studies in that it attempted to predict any leisure-time activity, not just vigorous activity as in similar prior studies. People may be more likely to intend to practice mild-moderate exercise and then not follow through, leading to a decreased correlation between intention and behavior, and hence decreased predictive value of intention for behavior.

Ajzen has recently acknowledged that intention tends to overestimate the probability of predicting desirable behaviors and underestimate the probability of undesirable ones (Ajzen, No date; Ajzen, Brown, & Carvajal, 2004). Physical activity is certainly a value-laden activity; whether it is a desirable or undesirable activity depends on the individual viewpoint (Grubbs & Carter, 2002; Kamarudin & OmarFauzee, 2007). Either way, this reported imprecision of the TpB would be expected to have a detrimental impact on the predictive value of intention to exercise, and this was certainly true in the present study. One problem seems to be that there is a difference between what we plan to do and what we are actually inclined or able to perform. As tentatively suggested by part of the longitudinal analysis and discussed further below, certain personality types may be more likely than others to actually implement exercise behavior.

This imprecision in intention to predict health behaviors is one reason that applied health psychologists have begun to explore the use of “implementation intentions” in behavior change (McCrae & Costa, 1990; Verplanken & Wood, 2006). In this approach, participants are not just asked what they intend to do, but are also asked to formulate a very specific plan about how they are going to attain their goal. In this way, an individual is forced to think about the realities of their behavioral plan, which may often be rather vague. Implementation intentions may better predict exercise behavior than intentions(Ziegelmann, Luszczynska, Lippke, & Schwarzer, 2007), although findings have not been consistent (Budden & Sagarin, 2007; McCrae & Costa, 1990).

The overall cross-sectional model predicted 34% of the variance in current exercise behavior, with most variance explained by intention and past behavior (both direct and intention-mediated paths). This finding coincides with results from a meta-analysis of Hagger et al. (2002) that also suggested that past exercise provides predictive value over and above the TpB, with only partial mediation through intention. Hence, the present study seems to support the concept that the conscious deliberate process of intending to exercise cannot explain all the variability in actual exercise behavior; instead, a more automatic process that some may term “habit” (Aarts & Dijksterhuis, 2000; Ouellette & Wood, 1998; Verplanken & Orbell, 2003) appears to play a role as well. However, past exercise behavior provided no significant predictive value longitudinally for follow-up exercise behavior. We might hypothesize that the relationship between past and future exercise behavior was completely mediated by current exercise behavior, as current behavior was a significant predictor of follow-up behavior. However, even when current exercise behavior was removed from the model, there was no relationship between past and future behavior. Thus finding suggests a different possibility – that the impact of "habit" on behavior has temporal limitations, and a full year interval may be too long to expect behavioral consistency in this population. Such a finding may not be surprising given the changing environment of these women, which may necessitate the development of new habits (Wood, Tam, & Witt, 2005).

The confirmatory longitudinal model predicted 26% of the variance in follow-up exercise behavior; both paths directly leading to this outcome measure (from Current Exercise Behavior and Affect Change) were statistically significant. However, a number of other paths in the model became much less powerful compared to the cross-sectional analysis, a finding that is perplexing. Lower statistical power may be responsible for some of this decrease in significance level but it would not be responsible for the low beta values ($b$=-0.001) observed between Intention and Current Behavior, instead suggesting that this subset of participants who completed follow-up were different in some way in their baseline behavior patterns from those who did not. However, our baseline comparison of those who completed the follow-up questionnaires to those who did not found few differences.

It was clear from these findings that the confirmatory model was inadequate, and hence exploratory analyses were performed. An optimized exploratory analysis predicted 39% of variability in follow-up exercise behavior, with additional variance explained by

Intention and Activity personality. Contrary to the cross-sectional analysis, these longitudinal findings provide partial support for past research from Rhodes and colleagues (Rhodes et al., 2002; Rhodes & Courneya, 2003b; Rhodes et al., 2004), who found Activity personality to be a significant independent predictor of exercise behavior in a longitudinal analysis over one month. Rhodes and colleagues hypothesized that persons high in Activity personality are the type of people who typically exercise more than they intend because they naturally seek out situations where "the opportunity to be active presents itself" (Rhodes & Courneya, 2003b); therefore, a direct path from Activity personality to Current or Follow-up Exercise Behavior would be expected (in addition to the mediation through intention).

However, a meaningful difference exists between the present study and these prior studies – Rhodes evaluated the prediction of vigorous activity only, whereas the present study evaluated any level of leisure-time exercise behavior. Because the personality of an individual who regularly performs low intensity exercise may be quite different from that of a person who performs high intensity exercise (Ekkekakis et al., 2005), the predictive value of personality may be weakened when exercise is a more generalized measure. However, such a measurement difference does not explain the fact that current exercise was not predicted by Activity personality but follow-up exercise behavior was. Such a finding may instead suggest that there is something unique about the early college life experience that renders it difficult to predict behavior at that time; this concept is further discussed later in this section.

We also suggested earlier that there would be a positive correlation between Activity personality and Affect change, under the supposition that persons high in Activity may be more affected by positive affective change after exercise behavior than persons low in Activity personality. However, both the univariate and multivariate analyses showed no correlation or covariance between Activity personality and Affect change. It is possible that people who score high on the Activity scale (a subscale of Extraversion) are those who require more vigorous exercise to respond affectively – that they may tend to be more "sensation seekers" than people who score lower on that scale (Ekkekakis et al., 2005; Rhodes et al., 2004). If this is true, then no personality difference in affective response to 10 minutes of walking would be expected, and a more rigorous test may be necessary to distinguish affective response by different personality types. Either way, based on the findings of the exploratory longitudinal analysis, people high in Activity personality must have an inherent inclination towards being active, as evidenced by the direct effect observed herein.

This study also evaluated a variable not examined previously in this context – the impact of affect change during a brief bout of exercise. Although the existence of variability in affect change during mild exercise has been observed in cross-sectional studies (e.g., Ekkekakis et al., 2000; Parfitt & Gledhill, 2004; Van Landuyt et al., 2000), its impact on current and future behavior has not. In the present study, Affect change was not found to predict Current exercise behavior significantly – in fact, it showed no relationship at all. However, unexpectedly, Affect change did predict Follow-up exercise behavior, such that those with a greater positive increase in affect at Time 1 showed higher overall leisure-time activity levels at follow-up when controlling for leisure-time activity at baseline. The reasons for these temporally inconsistent findings are unclear, and are particularly perplexing given the decrease in statistical power in the longitudinal analysis. Of note was the fact that three predictor variables in our model (Activity personality, Affect change, and Self-efficacy) had slightly higher correlations with Follow-up exercise behavior than with Current behavior. Such a trend raises intriguing questions about the unique nature of the early college experience that may render behavior difficult to predict. The early months of college are a time of adjustment and stress for many college students (Darling, McWey, Howard, & Olmstead, 2007; Towbes & Cohen, 1996), during which a young woman may be in a state of flux and not acting according to her usual tendencies (Ogden & Mitandabari, 1997); by her second semester, she may be settling back into her more usual behavior pattern. Once she has adjusted to her environment and developed routines that decrease her cognitive load, these findings suggest that she may become more attuned to internal cues, such as natural predilections and affective response. The present findings are not conclusive, and the reasons for them are conjecture, but may warrant further study.

The change in the predictive value of Activity personality over time may also be the result of changing manifestation of this personality trait over time. Personality traits, although presumably fairly stable through the lifespan, may manifest themselves differently depending on environmental demands (Funder & Colvin, 1991). Therefore, a person who is high in Activity and in a novel environment may manifest this by attending a lot of parties, meeting new people, and trying new things. In a more stable environment, perhaps the same person would tend to express this trait through regular exercise behavior. Such a phenomenon might help to explain why Activity did not predict exercise behavior well at the beginning of Freshman year but did so more effectively long-term.

Of note was the distribution of values for the positive engagement (Affect change) subscale of the EFI. Although past studies have suggested that some participants may respond to a bout of exercise in a negative fashion, all the participants in the present study experienced either no change or a positive change in their Positive Engagement score (reflecting happiness and enthusiasm) after 10 minutes of walking; however, the positive change was not associated with higher amounts of Current exercise behavior. One possible reason may be a self-selection bias in this sample, such that individuals more favorably disposed towards exercise and more positively affected by it were willing to participate in the study. This limited distribution in responses may have contributed to the difficulty in identifying a significant predictive relationship with actual exercise behavior. Affect change may also have failed to result in increased exercise behavior at Time 1 for the reasons discussed earlier, namely, an environmental disruption that may have resulted in disregarding internal states in order to attend to an unfamiliar external environment.

Self-efficacy showed no independent relationship with Current or Follow-up exercise behavior in either multivariate analysis, although it showed significant bivariate correlation with both these variables. Such a finding contradicts previous findings, including one study that found that the addition of a self-efficacy measure increased the predictive value of the TpB model from 44.2% to 66.4% (Hagger et al., 2001). It appeared during the present analysis that Self-efficacy, as measured by the Physical Self-

Efficacy Scale (PPA subscale) was redundant with other variables already in the model – in essence, its bivariate correlation with the outcome variables was cancelled out by the influence of some other variable(s) in the model. The likely candidates were Activity personality and/or Past Exercise Behavior, as Self-efficacy demonstrated significant covariance (but not multicollinearity) with these other two variables; the Activity personality questionnaire would seem the most likely culprit, as questions on this survey inquired about being "daring," "active," and "rambunctious," while the PSES inquired about being "agile and graceful," "run[ning] fast," and "strong physique." It seems reasonable that such questions may reflect a similar underlying concept.

The present findings may be the result of the self-efficacy measure employed. The PSES has been criticized recently for not being a true measure of self-efficacy, but rather a measure of physical self-esteem (Hu, McAuley, & Elavsky, 2005). The term “self-efficacy” is used to reflect one’s “confidence in one’s own ability to carry out a behavior” (Armitage & Conner, 1999), whereas self-esteem is the acknowledgement of “good” in oneself relative to others (Hu et al., 2005). The PPA subscale of the PSES has shown convergent validity with physical self-esteem and self-worth measures (Hu et al., 2005). Such a phenomenon would explain the lack of correlation between Perceived behavioral control and Self-efficacy in the present study, which have historically been found to be highly-correlated constructs (Motl et al., 2002), although meant to reflect different aspects of one’s perception of control over one’s own behavior. The PSES has also been criticized for being too global and not task-specific (Bandura, 1997 as cited in Hu et al., 2005). Although the PSES has been used widely as a measure of physical self-efficacy, the above criticisms, as well as the present findings, suggest that perhaps this use of the PSES should be reconsidered.

A number of limitations to the present study are worth noting. First and foremost, the small sample size precluded a full analysis of all variables under consideration. The limitation in the number of variables to be reliably analyzed may have resulted in a model that was overly parsimonious. In particular, the absence of classic components of the TpB model that influence intention (attitude, social norms, and perceived behavioral control) may have led to an overestimation of the predictive value of Past behavior and Activity personality on Intention. Also because of the small size, a simple path analysis was conducted (rather than a full model-fit analysis using structural equation modeling methodology), which is in essence a multiple regression analysis. Findings from such an analysis do not preclude the existence of another model that may be equally or more predictive and appropriate.

Second, the present study relied heavily on self-report measures. Self-report measures are prone to a number of types of reporting bias, including social desirability bias (BoothKewley, Edwards, & Rosenfeld, 1992) and inaccurate recall (Choi & Pak, 2005), the latter of which may have been particularly pronounced when trying to recall physical activity patterns a year earlier using the Paffenbarger questionnaire. Carelessness and intentional false responses leading to inaccuracies have been found to be important self-report biases in questionnaires completed by adolescents (Fan et al., 2006); this phenomenon was observed in the present study also, as investigators were forced to contact several participants to clear up substantial inconsistencies in questionnaire responses (e.g., "How many days exercised: 0 days; Average number of minutes spent exercising on each day: 60"). Two alternatives exist to this self-report methodology: the first is to interview the person face-to-face. There are numerous physical activity questionnaires that use such a format, and it might eliminate most of the error caused by carelessness. However, social desirability bias might increase in this format if the participant is face-to-face with an individual perceived to judge their behavior. The second methodology is to use more direct behavioral observation or more timely reporting. While following an individual around 24 hours a day is neither practical nor ethical, two technologies exist that may provide more of a minute-by-minute evaluation of a person's activity. The first is the tri-axial accelerometer, a pedometer-like technology that improves upon the original by measuring movement on all three planes. Some models can be strapped to a wrist, eliminating the error contributed by positioning on an individual's waistband. However, this technology would be most effectively used to measure overall physical activity, not just leisure-time activity, since it would be difficult to ask participants to wear it only during leisure exercise.

The second methodology is ecological momentary analysis (EMA) (Stone & Shiffman, 1994), alternatively known as experience sampling methods (ESM) (Csikszentmihalyi & Larson, 1984). This methodology was developed 30 years ago to track personal experience and behaviors over time and now commonly uses a handheld computerized device (such as a palmtop computer or cell phone) that alarms periodically to cue the wearer to record the activity of interest at frequent intervals. It is being widely adopted in eating behaviors research (Carels et al., 2001; Carels, Douglass, Cacciapaglia, & O'Brien, 2004) but less so in exercise research thus far. The advantage of this technology is that memory biases can be minimized; the disadvantage is that carelessness is not addressed and may in fact be increased if a participant is in a hurry at the time the alarm rings.

Third, the present study was limited by its observational methodology and the cross-sectional nature of one of its analyses. This study offers no information about whether and how young adult women can be influenced to continue or institute a regular physical activity pattern as they enter college. With the cross-sectional analysis, it is not possible to determine the direction of any effect – as to whether, for example, intention always leads to exercise, or whether exercise leads to intention (or both, as in a circular effect). However, some variables were time sensitive, such as Past exercise behavior, which essentially built in a retrospective longitudinal component. One may also presume that personality variables, such as the Activity variable used in the present analysis, are long-standing constructs (McCrae & Costa, 1990 as cited in Rhodes & Courneya, 2003b) that have been long present in the individual and are not easily changed by a behavior at one point in time. Therefore, the cross-sectionality was only a limitation of part of this initial analysis.

Fourth, the present study only measured affect before and after exercise and did not attempt to measure affect during the exercise experience. Measurement during exercise may be important for understanding how well different individuals cope with such a strong physical sensation, particularly in the midst of vigorous physical activity (Lochbaum, Karoly, & Landers, 2004). Affective response appears to demonstrate a linear pattern during low-level exercise for most people, showing, on average, a slow but steady increase over time (Hardy & Rejeski, 1989; Lochbaum et al., 2004; Parfitt & Eston, 1995). This pattern may not hold true during high-exertion exercise for those individuals who are inactive (Lochbaum et al., 2004), who appear to show a dip in their affect in the midst of such vigorous activity. Such a dip may potentially lead some individuals to discontinue vigorous activity prematurely, suggesting that starting an exercise program initially with lower level exercise may be important for adherence. For the purposes of the present study, which was to evaluate post-exercise reinforcement after just 10 minutes of low level exercise, understanding that many people do experience positive post-exercise affect (or at least a feeling of relief that it is over, as hypothesized by some researchers (Wininger, 2007), showed itself to be a useful piece of information for understanding why some people may adhere to exercise over long-term follow-up.

Finally, the use of just a couple of subcomponents of the Five Factor Model of Personality may present unrealistic predictions about the relationship between personality and behavior. Personality is a complex, multi-dimensional phenomenon, and personality traits may interact with one another to affect behavior patterns (Lochbaum, Bixby, & Wang, 2007). Therefore, the predictive value of Activity may be due not only to that inherent trait but the co-occurrence of other traits that also commonly occur in people who exercise regularly over time. If other personality traits were considered in the model, it is possible that Activity's influence would be different.

Future research is needed that includes adequate sample size for a more thorough analysis of variable inter-relationships and overall model fit. In this way, the true appropriateness of the exact model can be evaluated, rather than just evaluating one of several potentially appropriate models (as is the case when interpreting regression models such as the present one). In order to reach adequate sample size from a single class at university, a larger university may be necessary or else more effective recruitment techniques need to be developed. The present study used multiple recruitment modalities, automated reminders, and provided up to $25 in compensation, so it may be challenging to develop more effective enticements for study participation and completion.

Affective response variation was limited in the present study, which raises questions about the methodology and measures used. An alternative approach may be to test participants with a more rigorous exercise option –it is possible that those who score low on the Activity personality scale may have a more adverse reaction to rigorous exercise than by low level exercise as was tested in the present study. If participants were asked to, for example, run or bicycle vigorously for 10 minutes, two things may emerge: first, a more wide range of affective responses and second, a better distinction of responses based on personality style. It may, however, be more difficult to recruit a wide variety participants for such a potentially unpleasant task.

The basic concepts of the present study could also be explored in different ways. It might be interesting to compare those who self-select to exercise in high school versus those who do not, and how their exercise changes over time. Within this conceptual framework, it would also be interesting to further explore how environmental factors and changes impact exercise behavior maintenance and change over time as a young person transitions to the very different atmosphere of college.

Were the results of the present study replicated in a larger, more robust sample, significant implications would emerge. Such a replication might suggest that, while an early college student's behavior patterns are unstable and attunement to the environment is high, that opportunities for exercise provided in that environment and cued by that environment should be maximized. Because high school activity patterns could not predict activity patterns late in Freshman year, it appears that any student, whether previously active or not, might ultimately become inclined towards such activity if it were made available. Given the changing environment, those who are already active might need environmental enticement to maintain these behaviors. Therefore, universities should strive to maximize physical activity possibilities to Freshman students early in their college career, and perhaps even make a wide variety of such opportunities mandatory aspects of their first year of college.

# CHAPTER 5. CONCLUSIONS

Although the present study was limited by low statistical power, a few patterns emerged that provide interesting fodder for future research. The general trend suggests that intention is an important predictive factor in exercise behavior early in the college experience, along with past exercise behavior. However, as the young woman adjusts to college life and develops stable activity patterns, other inherent constructs, such as personality and affective response to exercise, begin to emerge as important predictors of physical activity. This suggests generally that conscious and deliberate cognitive processes and habits are most important in a novel environment, but once an environment is stabilized, other more ingrained processes may also become important. However, no firm conclusions can be developed from the present small data set; findings are intriguing enough to encourage future researchers to further explore these aspects of behavioral stability in young adulthood and the individual predisposing factors influencing the emergence of adult activity patterns.

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# APPENDIX A. PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (PAR-Q) (MODIFIED)

For most people, physical activity should not pose any problem or hazard. The Par-Q has been designed to identify the small number of adults for whom physical activity might be inappropriate or those who should have medical advice concerning the type of activity most suitable for them.

Common sense is your best guide in answering these questions. Please read them carefully and check YES or NO if it applies to you. If a question is answered with YES, please use the available space to explain your answer and give additional details.

1. Has a doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor? ☐ **YES** ☐ **NO**

2. Do you feel pain in your chest when you do physical activity? ☐ **YES** ☐ **NO**

3. In the past month, have you had chest pain when you were not doing physical activity? ☐ **YES** ☐ **NO**

4. Do you lose your balance because of dizziness or do you ever lose consciousness spontaneously? ☐ **YES** ☐ **NO**

5. Do you have a bone or joint problem that could be made worse by a change in your physical activity? ☐ **YES** ☐ **NO**

6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition? ☐ **YES** ☐ **NO**

7. Have you either a) been recently diagnosed with an eating disorder such as anorexia nervosa or bulimia nervosa OR b) are you currently undergoing treatment for an eating disorder? ☐ **YES** ☐ **NO**

8. Do you have asthma that is induced by walking? ☐ **YES** ☐ **NO**

9. Do you have back pain that is induced by walking or that makes it painful to walk? ☐ **YES** ☐ **NO**

10 Do you know of any other reason why you should not do physical activity? ☐ **YES** ☐ **NO**

Please explain: ________________________________

If you answered NO to all questions above, it gives a general indication that you may participate in fitness evaluation testing. The fact that you answered NO to the above questions, is no guarantee that you will have a normal response to exercise. If you answered Yes to any of the above questions, then you may need written permission from a physician before participating in fitness evaluation testing at the Deskalakis Athletic Center.

# APPENDIX B. PAFFENBARGER PHYSICAL ACTIVITY QUESTIONNAIRE

Please answer the following questions based on your average daily physical activity habits for the past year.

"The past year" means the one year prior to arriving at college.

1. How many stairs did you climb up on an average day during the past year?

   ___________ stairs per day (1 flight or floor=10 stairs)

2. How many city blocks or their equivalent did you walk on an average day during the past year?

________________ blocks per day (12 blocks = 1 mile)

3. List any sports, leisure, or recreational activities you have participated in on a regular basis during the past year. Enter the average number of times per week you took part in these activities and the average duration of these sessions. Include only time you were physically active (that is, actual playing or activity time).

An example is given for an individual who bicycles for 1 hour and 30 minutes, 2 times per week, for 15 weeks out of the year.

**Sport or Times per Time per Episode**

| Recreation | Avg # times per week | Number of weeks practiced over the previous year | Avg # of Hours per session (if ≥ 1 hour) | Avg # of Minutes per session |
|---|---|---|---|---|
| Ex. Bicycling | __2__ | __15__ | __1__ | ___30___ |
| ___________ | _______ | _______ | ______ | ________ |
| ___________ | _______ | _______ | ______ | ________ |
| ___________ | _______ | _______ | ______ | ________ |

# APPENDIX C. PHYSICAL SELF-EFFICACY SCALE

1. I have excellent reflexes

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

2. I am not agile and graceful

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

3. I am rarely embarrassed by my voice.

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

4. My physique is rather strong.

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

5. Sometimes I don't hold up well under stress.

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

6. I can't run fast.

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

7. I have physical defects that sometimes bother me.

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

8. I don't feel in control when I take tests involving physical dexterity.

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

9. I am never intimidated by the thought of a sexual encounter.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

10. People think negative things about me because of my posture.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

11. I am not hesitant about disagreeing with people bigger than me.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

12. I have poor muscle tone.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

13. I take little pride in my ability in sports.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

14. Athletic people usually do not receive more attention than me.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

15. I am sometimes envious of those better looking than myself.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

16. Sometimes my laugh embarrasses me.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

17. I am not concerned with the impression my physique makes on others.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

18. Sometimes I feel uncomfortable shaking hands because my hands are clammy.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

19. My speed has helped me out of some tight spots.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

20. I find that I am not accident prone.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

21. I have a strong grip.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

22. Because of my agility, I have been able to do things that many others could not do.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly agree | Somewhat agree | Agree a little | Disagree a little | Somewhat disagree | Strongly disagree |

# APPENDIX D. INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (MODIFIED)

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 3 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 3 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 of school?

☐ Yes

☐ No ***Skip to PART 2: TRANSPORTATION***

The next questions are about all the physical activity you did in the **last 3 days** as part of your paid or unpaid work. This does not include traveling to and from work.

2. During the **last 3 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**

☐ 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 3 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**

☐ 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 3 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**

☐ 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, school, stores, movies, and so on.

8. During the **last 3 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car, or tram?

_____ days

☐ No traveling in a motor vehicle *Skip to question 10*

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/school, to do errands, or to go from place to place.

10. During the **last 3 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go from place to place?

_____ days

☐ No bicycling from place to place Skip to question 12

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 3 days**, on how many days did you **walk** for at least 10 minutes at a time to go from place to place?

_____ days

☐ No walking from place to place **Skip to PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY**

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 3 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 3 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**

☐ 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 3 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**

☐ 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 3 days**, on how many days did you do **moderate**

activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**?

_____ **days**

☐ 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 3 days** solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the **last 3 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?

_____ **days**

☐ 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 3 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming **in your leisure time**?

_____ **days**

☐ 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 3 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**

☐ 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 3 days**, how much time did you usually spend **sitting** on a **weekday**?

_____ **hours**

_____ **minutes per day**

27. During the **last 3 days**, how much time did you usually spend **sitting** on a **weekend day**?

_____ **hours per day**

_____ **minutes per day**

***PART 6. SLEEP***

How many hours a night would you estimate you slept last night?  _______

How many hours would you estimate you slept the night before last? _______

How many hours would you estimate you slept two nights ago? _______

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

## APPENDIX E. EXERCISE INDUCED FEELING INVENTORY

Part A. Pre-Exercise Version

Instructions: Please use the following scale to indicate the extent to which each word below describes how you feel **at this moment in time**. Record your responses by filling in the appropriate circle next to each word.

| | |
|---|---|
| 0 | Do Not Feel (DNF) |
| 1 | Feel Slightly |
| 2 | Feel Moderately |
| 3 | Feel Strongly |
| 4 | Feel Very Strongly (FVS) |

| DNF | 0 | 1 | 2 | 3 | 4 | FVS |
|---|---|---|---|---|---|---|
| 1. Refreshed | ○ | ○ | ○ | ○ | ○ | |
| 2. Calm | ○ | ○ | ○ | ○ | ○ | |
| 3. Fatigued | ○ | ○ | ○ | ○ | ○ | |
| 4. Enthusiastic | ○ | ○ | ○ | ○ | ○ | |
| 5. Relaxed | ○ | ○ | ○ | ○ | ○ | |
| 6. Energetic | ○ | ○ | ○ | ○ | ○ | |
| 7. Happy | ○ | ○ | ○ | ○ | ○ | |
| 8. Tired | ○ | ○ | ○ | ○ | ○ | |
| 9. Revived | ○ | ○ | ○ | ○ | ○ | |
| 10. Peaceful | ○ | ○ | ○ | ○ | ○ | |
| 11. Worn out | ○ | ○ | ○ | ○ | ○ | |
| 12. Upbeat | ○ | ○ | ○ | ○ | ○ | |

Part B. Exercise Induced Feeling Inventory: Post Exercise Version

Part 1.

How much did you enjoy the exercise you just performed?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| It was no fun at all | | | | | | It was a lot of fun |

Part 2. Instructions: Please use the following scale to indicate the extent to which each word below describes how you feel **at this moment in time**.

1. I feel refreshed

:_____: :_____: :_____: :_____: :_____:
Not at all Very much so

2. I feel calm

:_____: :_____: :_____: :_____: :_____:
Not at all Very much so

3. I feel fatigued

:_____: :_____: :_____: :_____: :_____:
Not at all Very much so

4. I feel enthusiastic

:_____: :_____: :_____: :_____: :_____:
Not at all Very much so

5. I feel relaxed

:_____: :_____: :_____: :_____: :_____:
Not at all Very much so

6. I feel energetic

:_____: :_____: :_____: :_____: :_____:
Not at all Very much so

7. I feel happy

:_____: :_____: :_____: :_____: :_____:
Not at all Very much so

8. I feel tired

:_____: :_____: :_____: :_____: :_____:
Not at all Very much so

9. I feel revived

:_____: :_____: :_____: :_____: :_____:
Not at all Very much so

10. I feel peaceful

:_____: :_____: :_____: :_____: :_____:
Not at all Very much so

11. I feel worn out

:______:   :______:   :______:   :______:   :______:
Not at all   Very much so

12. I feel upbeat

:______:   :______:   :______:   :______:   :______:
Not at all   Very much so

# APPENDIX F. THEORY OF PLANNED BEHAVIOR QUESTIONNAIRE

In this questionnaire, "exercise" indicates participating in leisure-time physical activity moderately for at least 30 minutes or vigorously for at least 20 minutes.

*Attitude*

For me to exercise at least 3 days a week in the next month is
Not at all beneficial :_____:_____:_____:_____:_____:_____:_____: Very beneficial
Pleasant :_____:_____:_____:_____:_____:_____:_____: Unpleasant
Good :_____:_____:_____:_____:_____:_____:_____: Bad
Worthless :_____:_____:_____:_____:_____:_____:_____: Valuable
Enjoyable :_____:_____:_____:_____:_____:_____:_____: Unenjoyable

*Subjective Norms*

Most people who are important to me think that…
I should :_____:_____:_____:_____:_____:_____:_____: I should not
…exercise at least 3 days a week in the next month

Most people who are important to me exercise at least 3 days a week
completely true :_____:_____:_____:_____:_____:_____:_____: completely false

Many people like me exercise at least 3 days a week
extremely unlikely :_____:_____:_____:_____:_____:_____:_____: extremely likely

*Perceived Behavioral Control*

How much personal control do you believe you have over exercising at least 3 days a week in the next month?
no control :_____:_____:_____:_____:_____:_____:_____: complete control

It is entirely up to me whether or not I exercise at least 3 days a week in the forthcoming month
strongly agree :_____:_____:_____:_____:_____:_____:_____: strongly disagree

How much do you feel that whether you exercise at least 3 days a week in the next month is beyond your control?
Not at all :_____:_____:_____:_____:_____:_____:_____: Very much so

*Intention*

I intend to exercise for at least 30 minutes each day in the forthcoming month

extremely unlikely :_____:_____:_____:_____:_____:_____:_____: extremely likely

I will try to exercise for at least 30 minutes each day in the forthcoming month

definitely true :_____:_____:_____:_____:_____:_____:_____: definitely false

I plan to exercise for at least 30 minutes each day in the forthcoming month

strongly disagree :_____:_____:_____:_____:_____:_____:_____: strongly agree

## APPENDIX G. PERSONALITY QUESTIONNAIRE

Generally compared to other college women my age, I consider myself to be:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Active | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |
| Rambunctious | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |
| Daring | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |
| Adventurous | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |
| Ambitious | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |
| Industrious | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |
| Purposeful | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Conscientious | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |
| Unadventurous | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |
| Uncompetitive | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |
| Unenergetic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |
| Aimless | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |
| Negligent | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |
| Lazy | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |
| Unconscientious | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | Extremely inaccurate | | | | | | | | Extremely accurate |

# VITA

## Karyn Andrea Tappe

### EDUCATION

| | | | |
|---|---|---|---|
| **Drexel University, Philadelphia, PA** | PhD | 2008 (expected) | Psychology |
| **The Pennsylvania State University** | M.S. | 1995 | Psychology |
| **Haverford College** | B.A. | 1994 | Psychology |

### TEACHING/TUTORIAL EXPERIENCE

**Graduate Teaching Assistant (September-December 2004)**
*Department of Psychology, Drexel University*

Course: "Honors Introduction to Psychology"

**Graduate Teaching Assistant (Sept-Dec 1994)**
*Department of Psychology, The Pennsylvania State University*

Course: "Advanced Research Methods in Psychology"

### EMPLOYMENT HISTORY

| | | |
|---|---|---|
| **Health Psychology Intern** | VA Connecticut Healthcare System | 2007-09 |
| **Research Assistant** | Drexel University Psychology Department | 2004-07 |
| **Healthcare Research Analyst** | ECRI, Inc. | 1996-2004 |

### PEER REVIEWED PUBLICATIONS

Lowe, M., **Tappe, K.A.**, Annunziato, R.A., Riddell, L.J., Coletta, M.C., Crerand, C.E., Didie, E.R., Ochner, C.N., & McKinney, S. The effect of training in reduced energy density eating and food self-monitoring accuracy on weight loss maintenance: A randomized controlled trial. Revised and resubmitted to *Obesity*, November 2007.

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