2013

PHYSICAL ACTIVITY RELAPSE PREVENTION IN MIDDLE SCHOOL STUDENTS: USING MEDIATION ANALYSIS

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BY

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

IN

PSYCHOLOGY

UNIVERSITY OF RHODE ISLAND

2013

MASTER OF ARTS
IN
PSYCHOLOGY

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UNIVERSITY OF RHODE ISLAND
2013

ABSTRACT

Currently, very little is known about the mechanisms involved in effective behavior change interventions. In order to determine which mechanisms of the model produced the behavior change, longitudinal mediation structural equation models are necessary. The current study aims to determine the processes that underlie behavior change mechanisms of a Transtheoretical Model (TTM) computer based physical activity intervention study administered to middle school students (N = 4,151) in the state of Rhode Island.

This study examined a subset of students (N = 534) who reported as physically active at baseline. For this study, the independent variables consist of behavioral processes; mediating variables consist of Pros, Cons and Self-efficacy, and the dependent variable measuring physical activity levels. Several longitudinal meditational models are used to determine which of the mechanisms of the TTM model produced a significant role in maintaining physical activity levels within this population of students.

The purpose of study one is to develop single longitudinal mediation models composed of all variations of the five independent variables (i.e., counterconditioning, dramatic relief, reinforcement management, stimulus control, self-reevaluation) and each of the three mediating variables (i.e., Pros, Cons, Self-efficacy), in combination with the dependent variable, physical activity. These models are necessary in order to determine which combinations of variables are making a significant impact on physical activity maintenance levels over time. The mediator Pros, was the best

construct over time in combination with the independent variables, counterconditioning and stimulus control in the model.

The purpose of study two is to develop three way longitudinal mediation models composed of each of the five independent variables (i.e., counterconditioning, dramatic relief, reinforcement management, stimulus control, self-reevaluation) with all three of the mediator variables (i.e., Pros, Cons, Self-efficacy) with the dependent variable, physical activity. These models are necessary in order to determine if all three of the mediators presented together with an independent variable invokes a positive outcome in physical activity.

The purpose of study three is to examine the psychometric properties of the TTM in this middle school population of exercise maintainers. More specifically, group differences between race (White = 87%), ethnicity (Hispanics = 12%) and gender (Females = 43%) were examined within a three year longitudinal model. For this single longitudinal mediation model, Self-efficacy was as an IV, stimulus control the mediator and physical activity level was the dependent variable. This study is an investigative study to determine if the structure of the model is different among the groups, or Factorially Invariant, if the models are the same for each of the subgroups. Although good fit was determined for gender, none of the models were able to hold parametrically in the invariance test. This provides evidence for the conclusion for the groups to be treated the same within the model, as the groups do not differ.

Overall, one of the three mediators, Pros, demonstrated relevance to the physical activity intervention when administered to middle school students beginning the study as maintainers. Although two of the five processes of change, counter

conditioning and stimulus control were more relevant to the model, not enough evidence is provided to delete the other three, reinforcement management, dramatic relief, and self-reevaluation, from the physical activity intervention. There was no evidence that providing cons in the model is beneficial to maintenance of physical activity. Therefore, future interventions may benefit from not including cons in TTM interventions created for middle school physical activity maintainers.

It is important to note that future studies such as ones created to examine how these results compare to different populations as well as studies designed to examine additional positive health behaviors are necessary.

ACKNOWLEDGMENTS

I would like to thank my advisor, Dr. Wayne Velicer and my committee members Dr. Colleen Redding and Dr. Bryan Blissmer for all of their help and assistance throughout the process of writing my thesis. I would also like to thank my sister, Stephanie Nefas for assisting in the creation of the figures.

PREFACE

This thesis is formatted as an overall study which incorporates three manuscripts.

Manuscript format is in use.

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OVERVIEW OF STUDIES

Physical activity is an important health benefit for individuals of all ages. Unfortunately, according to the Center of Disease Control and Prevention, only twenty percent of the adult population meet the national guidelines of physical activity, composed of both muscle strength and aerobic exercise (Centers for Disease Control and Prevention, 2013). It has been suggested that a large decrease in physical activity occurs in middle school, whereas from sixth to eighth grade there is a decline in students maintaining their physical activity levels (Kimm et al., 2000). In addition, minority students reported not meeting the national recommendations more often than nonminority students (Agazzi et al., 2010).

In an effort to increase and/or maintain physical activity levels, computer based interventions have been developed. These interventions, such as ones based on the Transtheoretical Model (TTM) of behavior change, has produced positive results (Krebs et al., 2010; Spencer et al., 2006; Mauriello et al., 2007).

The TTM, a model of intentional behavior change, has served as a basis for a large number of computer based interventions, producing significant positive changes in many diverse populations (Krebs et al., 2010, Mauriello et al., 2007, Prochaska et al., 2001; Prochaska et al., 2004; Prochaska & Velicer, 2004; Velicer et al., 1999), including the adolescent school community (Mauriello et al., 2006). The goal of the model is to assist individuals in the development or aid in the continuation of positive health behaviors, which is also referred to the maintenance stage of the model.

Currently, very little is known about the mechanisms involved in effective behavior change interventions. For example, even though a positive behavioral

outcome is produced from an intervention, often times the conclusion of the positive outcome is credited to the intervention as a whole. In order to determine which mechanisms of the model produced the behavior change, longitudinal mediation structural equation models are necessary. Mediation analysis allows for practical identification of both effective and ineffective mechanisms because it determines which variables within the models are significant predictors both cross-sectionally and over time (Mackinnon, Fairchild & Fritz, 2007). This longitudinal component within the model further allows for the determination of which mechanisms invoke change over time. Once significant mechanisms are determined from these models, interventions can be tailored to be more efficient by increasing the emphasis on mechanisms which are effective and decreasing or deleting mechanisms that are not effective.

The current study aims to determine the processes that underlie behavior change mechanisms of a TTM tailored computer based physical activity intervention study administered to middle school students (N = 4,151) in the state of Rhode Island. The data consists of students who entered the study as sixth grade physical activity maintainers (N = 534) and concluded the intervention in their eighth grade year. In addition, the dataset contains all of the critical measures of the TTM. For this study, the independent variables consist of behavioral processes; mediating variables consist of Pros, Cons and Self-efficacy, and the dependent variable measuring physical activity levels. Several longitudinal meditational models are used to determine which of the mechanisms of the TTM model produced a significant role in maintaining physical activity levels within this population of students.

The purpose of study one is to develop single longitudinal mediation models composed of all variations of the five independent variables (i.e., counterconditioning, dramatic relief, reinforcement management, stimulus control, self-reevaluation) and each of the three mediating variables (i.e., Pros, Cons, Self-efficacy), in combination with the dependent variable, physical activity. These models are necessary in order to determine which combinations of variables are making a significant impact on physical activity maintenance levels over time.

The purpose of study two is to develop three way longitudinal mediation models composed of each of the five independent variables (i.e., counterconditioning, dramatic relief, reinforcement management, stimulus control, self-reevaluation) with all three of the mediator variables (i.e., Pros, Cons, Self-efficacy) with the dependent variable, physical activity. These models are necessary in order to determine if all three of the mediators presented together with an independent variable invokes a positive outcome of maintaining or increasing physical activity.

The purpose of study three is to examine the psychometric properties of the TTM in this middle school population of exercise maintainers. More specifically, group differences between race (White = 87%), ethnicity (Hispanics = 12%) and gender (Females = 43%) were examined within a three year longitudinal model. For this single longitudinal mediation model, Self-efficacy was as an IV, stimulus control the mediator and physical activity level was the dependent variable. This study is an investigative study to determine if the structure of the model is different among the groups, or factorially invariant, if the models are the same for each of the subgroups. This will allow for disparities between the groups within the model to be determined.

Once significant mechanisms are determined from these models, modification of the intervention can produce benefits such as increased efficacy, more efficient individual tailoring, increased cost efficiency, and greater ease of dissemination. Also, group differences, if any, will be determined. In addition, findings from this study can be used to improve TTM interventions for integrating and maintaining exercise into a daily lifestyle of all groups, a behavior strongly linked to improvement of individuals' overall quality of life, as well as reducing individuals' risk to chronic diseases.

Study 1. ***Physical Activity Relapse Prevention in Middle School Students: Using Mediation Analysis***

Study 2. ***Physical Activity Relapse Prevention in Middle School Students: Using Three Way Mediation Analysis***

Study 3..***Physical Activity Relapse Prevention Group Differences: Using Invariance Testing***

Study 1

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Physical Activity Relapse Prevention in Middle School Students:

Using Single Mediation Models

ABSTRACT

The purpose of this study is to determine the processes that underlie behavior change mechanisms in middle school students who began the study (6^{th} grade) as individuals who were adherent for six months or longer to regular physical activity. Mediation models were created, incorporating three time points (e.g., 6^{th}, 7^{th}, and 8^{th} grade) of data using constructs assessed within a physical activity intervention based on the Transtheoretical Model (TTM) of behavior change. These models were used to determine which mechanisms of the TTM are necessary as well as unnecessary for maintaining middle school students' physical activity levels. The mediator Pros was the best construct over time in combination with the independent variables (IV), counterconditioning (CC) and stimulus control (SC) in the models. Future studies should include different populations to determine the generalizability of these effects within the TTM for a wider range of physical activity maintainers. Results provide insight so that TTM based interventions may be tailored to be more cost and time efficient when developed for this group of exercise maintainers.

Keywords: Transtheoretical Model of Behavior Change, physical activity, mediation, longitudinal model, adolescents

Physical Activity Relapse Prevention in Middle School Students: Using Mediation Analysis

Despite the overwhelming amount of health benefits individuals in all age groups acquire from participating in regular physical activity, most people are not meeting the national recommended criteria (Center for Disease Control and Prevention, 2012). This deficiency has led to various efforts geared toward increasing physical activity levels, whereas not enough attention has been placed on helping individuals maintain positive exercise habits. For example, a large decrease in physical activity maintenance occurs during middle school, whereas by the eighth grade many students do not maintain their exercise habits as they had in sixth grade (Kimm et al., 2000).

According to the Transtheoretical Model (TTM) of behavior change (e.g., processes of change, decisional balance, self-efficacy) mechanisms of behavior change are hypothesized to differ depending on the stage (e.g., maintenance, contemplation)an individual is categorized in. The application of the TTM to exercise behavior has been reviewed and found to be promising (Spencer et al., 2006), although specific mechanisms within the model have not been analyzed for effectiveness. The proposed research aims to use successive longitudinal mediation models over three years to determine which mechanisms of the TTM are necessary as well as unnecessary, in the maintenance stage, for maintaining middle school student's physical activity levels.

The use of meditational analysis allows for practical identification of both effective and ineffective mechanisms within interventions because it shows which

variables within the models are significant predictors both cross-sectionally and over time (Mackinnon, Fairchild & Fritz, 2007). In addition, adding a longitudinal component, or multiple time points, within the model allows for the determination of which mechanisms invoke change over time. Ultimately, once significant mechanisms of longitudinal change are determined, modification of the intervention can produce benefits such as increased efficacy, more efficient individual tailoring, increased cost efficiency, and greater ease of dissemination.

Physical Activity in Middle School Students

Adolescents acquire many benefits associated with physical activity such as better health, growth and development, both physically and mentally (Center for Disease Control and Prevention, 2012). These benefits support the importance of incorporating physical activity into adolescent's daily routine. The United States Department of Health and Human Services national recommendations state that children aged six to seventeen should participate in at least 60 minutes or more of physical activity on a daily basis. In addition, adolescents are spending most of their time participating in sedentary behaviors (i.e., watching television, using a computer) (Zabinski et al., 2007). This increase of sedentary behavior has in turn resulted in a decrease of physical activity among this age group. For example, one study found that adolescents who watch television for more than two hours a day have lower levels of physical and psychosocial health (Tremblay et al., 2011).

Although there are clear benefits of regular participation in physical activity, many adolescents are not meeting national recommendations. For example, the 2007 National Youth Risk Behavior Survey (NYRBS) (Eaton et al., 2008), funded by the

Center of Disease Control and Prevention, assessed many health risk behaviors which develop in adolescents during the course of middle school, including physical activity. Physical activity was measured through a question, based on previous national recommendations, asking students if they were active for at least 60 minutes five of seven days out of the week. For the state of Rhode Island (N=2,382), a little over half of students,55.1%, reported meeting this criterion (Eaton et al., 2008). In addition, minority students reported not meeting the national recommendations more often than nonminority students (Agazzi et al., 2010).

Surveys such as the NYRBS emphasize the importance of developing and implementing interventions geared toward increasing physical activity. It has been suggested that awareness of benefits and recommendations of physical activity are important to instill in children and adolescents and can raise participation (Bauman et al., 2008, Driskell et al., 2007). One way to do this is through interactive computer-based physical activity interventions which are ideal for adolescents as they tend to welcome technology (Mauriello et al., 2007). In addition, models such as the TTM are being used to change behaviors since they do not overwhelm participants with too much information (Driskell et al., 2007).

Most importantly, maintaining and incorporating regular physical activity into a daily routine over time is the desired outcome of these interventions. This is crucial because most individuals who start integrating physical activity into their daily routine drop out or relapse, whereas they stop participating in physical activity or participate below national recommendations. This pattern of drop out or relapse was also apparent in the NYRBS in the assessment of adolescents. An overall pattern of

physical activity attrition was reported from sixth grade (78.2%), to seventh (74.1%)and to the eighth grade (73.7%) (Eaton et al., 2008). More specifically, within the group of students who met the activity criterion in sixth grade, there was a steady decline in physical activity throughout the next two years. Interventions geared toward preventing drop out and relapse are an important focus as most adolescents have good physical activity habits, and tend to lose them throughout their years in junior high school. Focusing on these individuals is crucial to incorporating physical activity habits throughout life.

The Transthoretical Model of Behavior Change

The TTM, a model of intentional behavior change, has served as the basis for a large number of computer-based interventions that have produced significant changes in behaviors for many different populations (Krebs et al., 2010, Mauriello et al., 2007, 2010,Prochaska et al., 2001; Prochaska et al., 2004; Prochaska & Velicer, 2004; Velicer et al., 1999, 2013), will be utilized. In addition to behavior change, these interventions have been found to be accepted within the adolescent school community (Mauriello et al., 2006). The central organizing construct of the model is stages of change. The stages of change categorize individuals into five stages of 'readiness' to change (e.g., precontemplation, contemplation, preparation, action, and maintenance). These stages have been well described (Haas & Nigg, 2009; Leslie et al., 2003) and validated. Each stage is determined by the level of intention and behavior corresponding to how ready an individual feels to change their physical activity behaviors. For example, a person who does not think about the behavior at all would likely be in the first, precontemplation stage, whereas a person who continues to

engage in the behavior as a normal routine would likely be in the fifth stage, the maintenance stage.

Within each stage of change an individual participates in certain covert and overt activities in order to progress to the next stage. These processes are referred to the ten processes of behavior change (Prochaska & DiClemente, 1983;Prochaska et al., 1988). Five of the processes (e.g., consciousness raising, dramatic relief, environmental reevaluation, social liberation, self-liberation) are labeled as experiential and are necessary for an individual to engage in when progressing through the early stages of change. The other five processes (e.g., stimulus control, helping relationships, counter conditioning, reinforcement management, self-reevaluation) are labeled as behavioral processes and are engaged in during the later stages when a person is changing or has changed their behavior. For a person in the maintenance stage who is maintaining their behavior, the five behavioral processes would be the main focus.

In addition, when an individual transitions through stages, other constructs are measured throughout the behavior change process. These are labeled as decisional balance, pros and cons, as well as self-efficacy. For example, for an individual within the maintenance stage group for exercise behavior, an individuals' positive beliefs about physical activity, referred to as 'Pros', are expected to be rated highly. On the contrary, the 'Cons', negative beliefs about physical activity are expected to be rated lower (Prochaska et al., 1994). The 'Self Efficacy' construct, or the situational temptation measure (DiClemente, 1981, Velicer et al., 1990), represents how confident an individual is to participate in exercise behaviors despite any barriers. For

individuals in the maintenance stage, a person would feel confident about their behavior despite barriers. Within this study, Pros, Cons and Self Efficacy constructs will be used as the mediator variables. These mechanisms, mediator variables, within the TTM are hypothesized to differ depending on stage of an individual, as it has been suggested that interventions aimed at increasing physical activity should be geared toward raising awareness of personal activity and should also be stage matched (Ronda, Assema, & Brug, 2001).

Specifically, interventions applying the TTM to increase physical activity have produced positive results (Krebs et al., 2010; Spencer et al., 2006;Mauriello et al., 2007, 2010; Velicer et al., 2013), and implementing these interventions using both computers and print versions have been effective by providing individually tailored feedback (Marcus et al., 2007; Marcus et al., 1998). Although constructs have been confirmed to be measured equivalently between adult sex, age and ethnicity groups, the stability of constructs have not been measured through longitudinal analyses (Paxton et al., 2008). In addition, it has been suggested that interventions which provide interactive feedback should be evaluated so that mechanisms within interventions can be more refined (Norman et al., 2007). Previous studies have focused on the efficacy of the intervention as a whole, whereas the mechanisms within the intervention for stages (i.e., maintenance), have not been examined separately. In addition, specific interactions of processes and the role of mediators have not been tested.

Longitudinal Mediation Design

Even though the determinants of behavior change are very complex, temporal relationships are best understood by examining a behavior over time. In addition to setting up a foundation for determining a causal relationship, longitudinal designs offer other advantages such as the ability to separate aging effects from cohort effects and offer more powerful designs as well as more information about individual change (Hedeker & Gibbons, 2006). Utilizing a meditation analysis design with longitudinal data allows for additional advantages: (1) Identifying the temporal precedence of X, M, and Y, (2) identifying changes within individuals and cross-sectional relations, and (3) the data allow for alternative explanations for cross-sectional mediated effects (MacKinnon, 2008).

When interventions, such as ones created from the TTM, are produced, it is important to understand what actually changes behavior while taking into consideration individual differences. Mediators, or variables that transmit the effect of an independent variable on a dependent variable, often give insight on how a process or mechanisms within an intervention affect behavior change (Mackinnon, Fairchild & Fritz, 2007). Mediation analysis, which was initiated by an influential Baron and Kenny (1986) paper, has now been modified to represent an ideal approach to identifying mechanisms of behavior change. The findings of meditational studies can be used to determine which theoretical mechanisms of an intervention produced the greatest amount of behavior change (Napolitano et al., 2008). In addition to determining mediation with cross-sectional data, the use of meditational analyses over time can identify both effective and ineffective mechanisms within interventions

(Mackinnon, Fairchild, & Fritz, 2007; Baron & Kenny, 1986). Examining the effects of longitudinal data allows for more rigorous conclusions of causality involving mechanisms within an intervention on a behavior (Cole & Maxwell, 2003).

Literature reviews such as Lewis et al. (2002) have determined that physical activity mediator-intervention studies are needed to determine if theory based interventions are effective. This is especially important because physical activity interventions have now become more time consuming and less cost efficient (Glasgow et al., 2006). Mediators such as self-efficacy derived from Bandura's Social Cognitive Theory have been effectively used as mediators of physical activity within adolescent girls (Lubans & Sylva, 2009). Mediation studies such as this one suggest that within the TTM, mediators such as self-efficacy, pros and cons, are important to examine. In order to determine which of these potential mediators from a TTM based intervention have the largest impact on physical activity, a series of secondary data analyses will be performed using longitudinal meditational models.

Overview of Current Study

Currently, very little is known about the mechanisms involved in effective behavior change interventions. In many cases, the final behavior is measured without knowing the process of how the change was invoked, leading researchers to conclude that their intervention as a whole lead to the behavior change. Although this may be the case, often times it is unknown if certain mechanisms of the intervention were more or less beneficial in regard to the actual change in behavior. Critical constructs necessary for behavior change are hypothesized and incorporated into interventions and are typically never measured. Significant constructs are important because once

they are determined; interventions can be tailored to be more efficient by increasing the emphasis on mechanisms which are effective and deleting mechanisms which are not effective. In order for these constructs to be identified as significant, the use of longitudinal mediation analysis is necessary to investigate effects of intervention components over time.

The use of meditational analysis further allows for practical identification of both effective and ineffective constructs within interventions because it shows which variables invoke change in the final behavior. An individual also utilizes decisional balance, Pros and Cons, as well as Self-Efficacy as they change their behavior. The decisional balance scale consists of questions that an individual has to weigh the Pros and Cons of for a specific behavior (Velicer et al., 1985). For individuals within the maintenance stage group for physical activity, individuals who exercise regularly, Pros are expected to be high and the Cons are expected to be low (Hall & Rossi, 2008; Prochaska et al., 1994). The Self-Efficacy variable measure (DiClemente, 1981, Velicer et al., 1990) represents how confident an individual is to participate in physical activity despite barriers. Within this study, the Pros, Cons and Self-Efficacy constructs will be defined as the mediating variables, since they are necessary to produce change or the continued behavior of physical activity.

The dataset used in this study includes important variables that allow for the analysis of the effects of a TTM based intervention over a three year period. The group analyzed in this study consists of individuals who began the intervention with sufficient physical activity patterns based on daily recommendations, or sixth graders who were categorized in the maintenance stage group within the TTM model.

Variables based on the TTM model, measured at each of the three different time points, will be analyzed using multiple meditational models in order to determine which of the processes of change have the largest impact on physical activity. These models are used to determine which of the five behavioral processes assessed for the maintenance group during baseline assessment, in combination with the mediating variables (e.g., Pros, Cons, Self Efficacy), will be most influential on behavior continuation. Results can provide a good test of the physical activity intervention mechanisms based on the TTM and can provide guidance to refine existing TTM based interventions due to the unique size and longitudinal nature of the data set.

Next to applying the TTM to tobacco use, the TTM has been most widely applied to exercise behavior. According to a review of one hundred and fifty studies using the TTM with physical activity, the model has been successfully applied to various populations (Spencer et al., 2006). It is expected that the TTM will be a good representation for the physical activity of middle school aged participants within this study.

Overall, results from this study provide evidence for which TTM mechanisms are necessary, as well as unnecessary, within this physical activity intervention. This is important so that physical activity interventions which utilize the constructs of the TTM can be better tailored to provide the optimal or best feedback in order to maintain an individual's physical activity level. In addition, these findings can be used to improve interventions for integrating and maintaining exercise into a daily lifestyle, a behavior strongly linked to improvement of individuals' overall quality of life, as well as reducing individuals' risks for development of chronic diseases.

Method

The proposed dataset contains all the critical measures from the TTM necessary for these proposed analyses. In addition, this dataset is unique because it is longitudinal in nature containing three different time points; baseline, approximately 12 months, and approximately 24 months. Also, this dataset is unique because it includes all of the necessary variables with very few missing values, and includes a large number of participants which ensures adequate power for the analyses. The nature of this large, longitudinal dataset allows for examination of change across a general adolescent population as well as differences within subgroups (MacKinnon, 2008).

The proposed project is a secondary data analysis consisting of multiple longitudinal mediation analyses. The basic model will be the one proposed in figure 1. All latent variables, variables within circles in the figure, will be composed of measured items, shown in boxes in the figure. The independent latent variable will be created from each of the five processes (e.g., stimulus control, helping relationships, counter conditioning, reinforcement management, self-liberation), three items each, measured during time one among students who were in the maintenance stage. The three different mediator variables or M will be the Pros and Cons, each are latent variables created from four items, and Self-Efficacy is a latent variable made up of six items. The physical activity variable will be the dependent measure, also known as the Y. This latent variable is created from two physical activity items. This dependent latent variable measuring physical activity will be used in all of the models.

Time one will consist of 6th grade middle school students who began the intervention in the maintenance stage, time two will consist of their 7th grade data, and time three will contain their 8th grade data. All time points (i.e., T1, T2, T3) are approximately one year apart. Time 2 and time 3 include the mediator variable and the physical activity variable. The independent variable, or the five processes, will only be included at time one due to individuals changing stage and not being asked the same process questions throughout the study.

The B's or beta weights will be examined for significance between pathways. The five independent variables are used in time one, the three mediators and the physical activity variables are used at all three times. In total, there are a total of fifteen models containing this structure within this study.

Participants

Of the total N=4,151 6th grade middle school participants in the twenty schools within this study (Velicer et al., 2013) , only participants from the ten schools that were randomly selected to receive the physical activity intervention and were categorized in the maintenance stage of change at baseline (N=993) were included in these analyses. Of those nine hundred and ninety three, only participants who had complete three year data (6th, 7th and 8th grade timepoints) were used for this study (N= 534). Participants' mean age at time one was eleven years (SD = .43).Demographic variables in this study include gender (Females= 42.7%) and ethnicity (2% American Indian/Alaskan Native, 3% Asian/Pacific Islander, 2% Black/Not Hispanic, 11% Hispanic, 68% White/Not Hispanic, 2% Other, and 11% Combination, and 1% Unknown).

The staging algorithm for physical activity maintenance has been confirmed and validated (Hellsten et al., 2008; Mauriello et al., 2010; Velicer et al., 2013). Participants in maintenance reported participating in 60 minutes or more of physical activity at least five days a week. All participants in the analyses were maintainers at time point one. At time point two, 73% of participants remained in the maintenance stage whereas 6.7% moved back to the action stage, 13.1% were in the preparation stage, 5.4% were contemplators, and 1.7% regressed to the precontemplation stage. At time point three, 66.7% of participants were still in the maintenance stage whereas 11.2% were in the action stage, 13.3% were in the preparation stage, 5.8% were contemplators, and 3.0% were in the precontemplation stage. This pattern of physical activity decline or relapse within the study sample is expected and consistent with previous studies (e.g., Kimm et al., 2000).

Measures

The independent variables in the model are the five behavioral processes of change: Counterconditioning (CC), Dramatic Relief (DR), Reinforcement Management (RM), Stimulus Control (SC), and Self Reevaluation (SR). These processes are relevant for individuals in the maintenance stage, such as those included in this study. The processes of change measured latent variables that facilitate change. Different processes of change are thought to be engaged in at different stages of change.

The mediating variables, also known as the mediators, in the model are the decisional balance, pros and cons, and self-efficacy (Velicer et al., 1996). Mediators explain the dependent variable without changing the relationship between the

independent variable and the dependent variable. The impact of the independent variable on the dependent variable would not be possible without the mediator variable. One of the goals of this analysis is to determine the significance and impact of these proposed mediators.

The dependent variable used in the analysis will be composed of two items. This variable will incorporate physical activity measures that an individual is in control of. This is consistent with analyzing physical activity that the individual chooses to participate in, compared to mandatory participation (i.e., physical education classes). It is important to note that the dependent measure is not dependent on stage due to possible changes in stage between time 1 and times 2 and 3. Therefore the model measures model based predictors of physical activity over time.

All item details for the independent items, the mediator items and the dependent items are presented in Table 1.

Statistical Analyses

Because this model is theory driven, latent variable structural equation modeling (SEM) will be utilized. More specifically, the model is an autoregressive mediation structural equation model. Mediation is an important aspect of the model due to its' unique ability to offer the most comprehensive investigation of the mechanism of change available. Causal inferences that can be determined from this series of mediation analyses will aid in the process of determining which mediating variables combined with independent variables are the most effective in the exercise intervention.

In order to produce results multiple single meditational models are utilized. Mediation models were produced with each of the five processes combined with cons, pros and self-efficacy as mediators and physical activity as the dependent variable. This process will create fifteen different individual models which are examined for significance of fit, effect size, and compared for similarities and differences between each of the models.

Results

Initial background analyses were conducted. Skewness and kurtosis was assessed using West, Finch, and Curran (1995) criteria of >2 and >7 respectively. Next, multivariate kurtosis was determined by EQS (Bentler, 2007). Some of the variables were skewed and kurtotic although this was expected from some of the questions asked for this group of physical activity maintainers. Since this was expected, transformations to the variables were not made, instead robust maximum likelihood estimates were used which take into account the nonnormality of the data when calculating chi-squared and fit indices (Tabachnick & Fidell, 2007). Percentages, means, standard deviations for study variables and scale scores, as well as the correlation matrix are shown in Tables 2-4.

Structural Equation Modeling

Each of the models included latent variables made up of three items for every independent variable [i.e., Counterconditioning (CC), Dramatic Relief (DR), Reinforcement Management (RM), Stimulus Control (SC), and Self Reevaluation (SR)]. Mediating latent variables, including pros and cons, were created using four items each and the latent variable for self-efficacy was created using six items. Lastly,

the dependent latent variable, incorporated in all the models, was created using two items.

The significance test used for the models created in the statistical software, EQS, was the chi-squared statistic. The chi-squared test determines if the model can reproduce the population covariance matrix, "fitting" the data used in the model (Hu & Bentler, 1995). The chi-squared goodness-of-fit index was significant in all of the models, indicating a poor fit; however, this value is misleading due to the large sample size. Kenny (2010) advises that the chi-squared statistic is almost always significant in models when the sample size is greater than 200, and in this study the sample size is 534. Because all of the models are statistically significant, Chi-squared statistics will not be reported.

It is important to determine model fit when assessing the significance of the models. Values for the Comparative Fit Index (CFI), Normed Fit Index (NFI), and the Nonnormed Fit Index (NNFI) are provided. All of the indices provide a measure of fit with values ranging from 0 to 1. Greater values indicate a better fit. For example, a strong fit can also be concluded for models with a Comparative Fit Index (CFI) greater than .90 and a really great fit with a CFI above .95 (Bentler, 1992).

Residuals can also be used to determine a good fit. One residual, Root Mean Square Error of Approximation (RMSEA) is used most often and is less influenced by sample size (Steiger & Lind, 1980). The smaller values of RMSEA are ideal and values less than .05 indicate a very good fit (Hu & Bentler, 1999). Also, confidence intervals for RMSEA can be examined. When examining the RMSEA confidence interval, the lower value should be near zero, not lower than .05, and the upper value

should not be much larger. Kenny (2010) also notes that the confidence interval informs the researcher of how precise the RMSEA value is, and a smaller confidence interval is ideal.

All of the models are presented in Figures. The numbers within the figures, or the direct effects, represent standardized solutions produced by EQS. These standardized solutions are obtained by dividing the beta coefficient by the standard deviation of that beta coefficient, resulting in beta weights typically found in regression (Bentler, 2006)**.** Indirect effects are represented by the arrows within the figures. Open arrows represent significant paths, at the .05 level, and solid arrows represent nonsignificant paths.

Since mediation is the main focus of the analyses, the results will reflect the paths of interest. More specifically, meditational change over time, or the path from the independent variable at time one, the mediator variable at time two, and the physical activity variable at time three will be examined.

Other paths, such as the paths from one factor to another across time points (i.e., T1, T2, T3) indicate the reliability of a measure over time when significant (i.e., open arrows). The arrows from items (i.e., boxes) to the latent variables (i.e., circles) indicate the significance of an item creating the latent measure.

Mediation models evaluating the role of Cons in physical activity

A series of five models were first conducted, including each of the independent variables in combination with the mediator, Cons, and the dependent variable, physical activity. The model's fit indices are presented in Table 5. All of the models produced good values, whereas the fit indices were above .90 and the RMSEA was

below .05, providing evidence that the processes in combination with Cons as a mediator predicted physical activity at all three time points within this group of maintainers.

None of the Cons models in combination with each of the five processes [i.e., counterconditioning (CC), dramatic relief (DR), reinforcement management (RM), stimulus control (SC), self-reevaluation (SR)] provided evidence for significance over time. Specifically, the paths from each of the IV's (TI) to cons (T2) and then from cons (T2) to physical activity (T3) did not provide evidence for longitudinal meditational relationships. These models are presented in Figures 2-6.

Mediation models evaluating the role of Pros in physical activity

A series of five models were conducted including each of the independent variables in combination with the mediator, Pros, and the dependent variable, physical activity. Overall the models provided an excellent fit, presented in Table 5, whereas the fit indices were above .90 and the RMSEA was below .05. These values provide evidence that the processes in combination with Pros as a mediator predicted physical activity at all three time points within this group of maintainers.

Three of the Pros models in combination with each of the processes [i.e., dramatic relief (DR), reinforcement management (RM), self-reevaluation (SR)] did not provide evidence for significance over time. Specifically, the paths from each of the IV's (TI) to pros (T2) and then from pros (T2) to physical activity (T3) did not provide evidence for longitudinal meditational relationships. Although not fully supported, both RM and SR models provided partial significance. These models are presented in Figures 7-9.

Two of the Pros models in combination with the processes, counterconditioning (CC) and stimulus control (SC), did provide evidence for longitudinal meditational relationships. Specifically, the paths from each of the IV's (T1) to Pros (T2) and then from Pros (T2) to physical activity (T3) were significant. These models are presented in figures 10 and 11.

Mediation models evaluating the role of Self-Efficacy in physical activity

A series of five models were conducted, including each of the independent variables in combination with the mediator, Self-efficacy, and the dependent variable, physical activity. Overall the models provided an excellent fit, presented in Table 5, whereas the fit indices were above .90 and the RMSEA was below .05. These values provide evidence that the processes in combination with Self-efficacy as a mediator predicted physical activity at all three time points within this group of maintainers.

None of the Self-Efficacy models in combination with each of the five processes [i.e., counterconditioning (CC), dramatic relief (DR), reinforcement management (RM), stimulus control (SC), self-reevaluation (SR)] provided evidence for significance over time. Specifically, the paths from each of the IV's (TI) to self-efficacy (T2) and then from self-efficacy (T2) to physical activity (T3) did not provide evidence for longitudinal meditational relationships. The models are presented in Figures 12-16.

Discussion

The purpose of this study was to examine longitudinal predictors of physical activity maintenance in middle school students. Mechanisms within the TTM were tested in order to determine which processes and mediators were more beneficial, or

which mechanisms best prevented exercise relapse over time for this group of Rhode Island middle school students. Mediation models testing each of the mediators, Cons, Pros, and Self-efficacy were performed. These models (Figures 2-16) show visual representations of the specific contributions (i.e., significant paths, standardized solutions) of each of these mechanisms. All of the single mediator models provided good fit indices and residuals, showing significant reliability of measures over time.

Cons models

The Cons models provided evidence that none of the processes in combination with Cons resulted in physical activity over time. This is consistent with Cons decreasing importance in the maintenance stage with acquisition of healthy behaviors such as physical activity (Prochaska et al., 1994). Ultimately, this provides evidence that including Cons in a physical activity intervention does not lead to better maintenance of physical activity within adolescents.

Pros models

For healthy behaviors such as physical activity, Pros tend to increase and remain important for individuals in the maintenance stage (Prochaska et al., 1994). Within this study for the Pros models, both counterconditioning, substituting healthy ways of thinking for unhealthy ones, and stimulus control, using reminders which encourage healthy behaviors, provided significant mediation paths.

Although it was expected that maintainers value the Pros, the type of relationship produced was not expected. There were significant negative relationships in both of the models between Pros at time two and physical activity at time three. As the Pros increased, the level of physical activity decreased. This may be due to a

possible ceiling effect, or as the Pros raise consciousness, they play a role in behavior change initiation and then it levels off due to the lack of continuing benefits.

Self-Efficacy models

For the Self-efficacy models, or models which measured how confident individuals were about maintaining regular physical activity, there were no significant mediation paths over time in combination with the five processes of change. Although not significant, there were negative relationships between Self-efficacy (T2) and physical activity (T3) for all of the processes of change. Overall, these results provide evidence that including Self-efficacy in physical activity interventions given to middle school aged exercise maintainers is not necessarily beneficial over time.

Limitations and Future Directions

Although this is a critical time when participation in physical activity declines, further research should be conducted in order to determine if there is a similar pattern within different populations of physical activity maintainers. In addition to using samples from other States, participants who report being at different stages at baseline (i.e, Precontemplators, Contemplators), can be examined to further investigate which mechanisms of the TTM are important/necessary for each stage of the behavior change process. Furthermore, the inclusion of all three mediators within the models would provide more details of which processes are significant over time.

The results for this population can be used to strengthen existing interventions as well as aid in developing new interventions for maintaining physical activity and preventing drop-out rates. This would allow an emphasis on the most relevant processes of change, counter conditioning and stimulus control, in combination with

Pros within individuals who maintain regular physical activity. Maintaining exercise, and reducing drop-out rates, will contribute to a healthier lifestyle. Ultimately, providing encouragement to regularly participate in physical activity will reduce chronic diseases which can reduce health care costs and, most importantly, improve an individual's quality and quantity of life.

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Table 1. Questions used for Study Variables

	Variable	Question	Range
Processes	CC01	When you were tempted to skip it, you told yourself that you'd do a physical activity for at least a little while.	1-5
	CC02	When you didn't want to do a physical activity, you reminded yourself of your goal to get or stay in shape.	1-5
	CC03	You thought of physical activity as fun, rather than a burden.	1-5
	DR01	You were inspired by people who are more physically active than you.	1-5
	DR02	It upset you to hear that people your age aren't getting enough physical activity.	1-5
	DR03	You were inspired by stories about people who got into shape or improved their fitness.	1-5
	RM01	You found that you enjoyed physical activity.	1-5
	RM02	You realized that one of the benefits you got from physical activity was that it improved your mood.	1-5
	RM03	You congratulated yourself for being physically active.	1-5
	SC01	You spent time with friends who are physically active.	1-5
	SC02	You joined a team or gym, or signed up for a class so you had a regular time for physical activity.	1-5
	SC03	You wore sneakers or brought extra clothes with you so you could do a physical activity.	1-5
	SR01	Getting enough physical activity made you feel more confident.	1-5
	SR02	You saw yourself as a healthier person because you got enough physical activity.	1-5
	SR03	You liked seeing yourself as someone who takes care of his or her body.	1-5
Mediators	Next are some thoughts and feelings people might have about doing 60 minutes or more of physical activity on at least 5 days of the week. Please tell us how important each one is in your decision about whether or not to do 60 minutes or more of physical activity on at least 5 days of the week.		
	CON1	Others might feel guilty if they weren't doing that much physical activity.	1-5
	CON2	I'd have to buy sneakers or work-out clothes.	1-5
	CON3	I might be embarrassed to do a physical activity in front of others.	1-5
	CON4	It would take too much energy.	1-5
	PRO1	I'd be in a better mood.	1-5
	PRO2	I'd feel better about myself.	1-5
	PRO3	I'd stay in shape.	1-5
	PRO4	I'd have more energy.	1-5
	Next are some situations that might make it hard to do 60 minutes or more of physical activity on at least 5 days of the week. Please tell us how confident you are that you could do 60 minutes or more of physical activity on at least 5 days of the week.		
	SELF1	You were on a break from school?	1-5
	SELF2	You were busy?	1-5
	SELF3	You didn't feel like exercising?	1-5
	SELF4	The weather was bad?	1-5
	SELF5	You just wanted to chill?	1-5
	SELF6	You had to exercise alone?	1-5
Physical Activity	DAY60MIN	In a typical week, how many days do you do 60 minutes or more of physical activity?	0-7
	TYPDAY	On a typical day, how much physical activity do you get?	0-12

Table 2.
Percentages, Means, and SD's for Study Variables

Variable		%	Mean (SD)			Range
		T1	T1	T2	T3	
Gender	Female	42.7				
Ethnicity	American					
	Indian	2				
	Asian	3				
	Black	2				
	Hispanic	11				
	White	68				
	Other	2				
	Combination	11				
	Unknown	1				
Age	10	2				
	11	79				
	12	18				
	13	1				
Counterconditioning 1			3.60 (1.32)			1-5
Counterconditioning 2			3.89 (1.17)			1-5
Counterconditioning 3			4.52 (0.85)			1-5
Dramatic Relief 1			3.19 (1.26)			1-5
Dramatic Relief 2			2.98 (1.28)			1-5
Dramatic Relief 3			3.33 (1.30)			1-5
Reinforcement 1			4.67 (0.67)			1-5
Reinforcement 2			4.04 (1.10)			1-5
Reinforcement 3			3.90 (1.19)			1-5
Stimulus Control 1			4.45 (0.82)			1-5
Stimulus Control 2			3.65 (1.41)			1-5
Stimulus Control 3			3.76 (1.27)			1-5
Self-Reevaluation 1			4.43 (0.81)			1-5
Self-Reevaluation 2			4.35 (0.90)			1-5
Self-Reevaluation 3			4.30 (0.92)			1-5
Con 1			2.47 (1.32)	2.16 (1.27)	1.96 (1.27)	1-5
Con 2			2.00 (1.27)	1.90 (1.26)	1.71 (1.16)	1-5
Con 3			1.64 (1.06)	1.69 (1.09)	1.58 (0.99)	1-5
Con 4			1.75 (1.05)	1.71 (1.04)	1.55 (1.01)	1-5
Pro 1			4.18 (1.00)	4.07 (0.98)	4.33 (0.98)	1-5
Pro 2			4.48 (0.93)	4.39 (0.96)	4.48 (0.95)	1-5
Pro 3			4.73 (0.60)	4.62 (0.73)	4.69 (0.77)	1-5
Pro 4			4.47 (0.79)	4.37 (0.87)	4.42 (1.00)	1-5
Self-Efficacy 1			4.28 (0.96)	4.27 (0.95)	3.30 (1.15)	1-5
Self-Efficacy 2			3.32 (1.11)	3.40 (1.27)	3.55 (1.25)	1-5
Self-Efficacy 3			3.34 (1.27)	3.38 (1.20)	3.97 (1.20)	1-5
Self-Efficacy 4			3.63 (1.24)	4.27 (1.04)	3.35 (1.24)	1-5
Self-Efficacy 5			3.43 (1.25)	3.57 (1.28)	3.70 (1.30)	1-5
Self-Efficacy 6			3.98 (1.25)	3.57 (1.29)	4.10 (1.17)	1-5
How many days 60 min			6.08 (0.86)	5.65 (1.47)	5.52 (1.60)	0-7
How many min per day			2.89 (2.43)	2.96 (2.55)	3.02 (2.62)	0-12*

Note. T1 = Baseline, T2 = Approximately 1 year, T3 = Approximately 2 years
*Range for "How many min a day" is measured in 30 min increments

Table 3. Correlation Matrix

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
1.T1Counterconditioning	-																
2.T1Dramatic Relief	.52*	-															
3.T1Reinforcement Management	.54*	..50*	-														
4.T1Stimulus Control	.41*	.47*	.50*	-													
5.T1Self-Reevaluation	.55*	.52*	.72*	.50*	-												
6.T1Cons	.05	.22*	.02	.08	.04	-											
7.T1Pros	.40*	.42*	.53*	.34*	.57*	.10*	-										
8.T1Self-Efficacy	.35*	.29*	.41*	.36*	.41*	.02	.29*	-									
9.T1Pysical Activity	.04	.00	.15*	.10*	.15*	.03	.03	.10*	-								
10.T2Cons	.07	.16*	.04	.00	-.02	.54*	.06	.04	.03	-							
11.T2Pros	.32*	.28*	.33*	.30*	.33*	.03	.40*	.24*	-.05	.06	-						
12.T2Self-Efficacy	.24*	.16*	.28*	.26*	.25*	-.02	.12*	.51*	.12*	-.01	.35*	-					
13.T2Physical Activity	.11*	.03	.10*	.15*	.10*	.01	-.01	.14*	.38*	.04	.20*	.25*	-				
14.T3Cons	-.02	.00	-.06	-.03	-.08	.34*	-.04	-.01	-.02	.40*	-.07	-.03	.03	-			
15.T3Pros	.20*	.15*	.22*	.17*	.26*	-.12*	.22*	.13*	-.04	-.13*	.42*	.19*	.07	-.06	-		
16.T3Self-Efficacy	.11*	.07	.16*	.19*	.21*	-.07	.10*	.35*	.14*	-.09*	.17*	.48*	.22*	-.03	.42*	-	
17.T3Physical Activity	.01	-.02	.06	.09*	.00	.02	-.07	-.09	.29*	.07	.12*	.20*	.53*	.05	.22*	.29*	-

T1=Time one, T2=Time two, T3=Time three
*Significant at the .05 level

Table 4.
Percentages, Means, and SD's for Scale Scores

Variable	Mean (SD)			Range
	T1	T2	T3	
Counterconditioning	12.00 (2.43)			1-5
Dramatic Relief	9.50 (2.87)			1-5
Reinforcement Management	12.61 (2.26)			1-5
Stimulus Control	11.85 (2.55)			1-5
Self-Reevaluation	13.08 (2.17)			1-5
Cons	7.86 (3.23)	7.46 (3.36)	6.80 (3.34)	1-5
Pros	17.87 (2.61)	17.45 (2.86)	17.92 (3.28)	1-5
Self-Efficacy	22.07 (5.07)	21.87 (5.15)	22.56 (5.87)	1-5
Physical Activity	8.97 (2.78)	8.61 (3.22)	8.54 (3.42)	0-12

Note. T1 = Baseline, T2 = Approximately 1 year, T3 = Approximately 2 years

Table 5. Fit Indices by Mediator Variable

I. Fit Indices for CON Mediator Models

Model	ML ROBUST				
	NFI	NNFI	CFI	RMSEA	RMSEA 90%
CON and CC	.869	.935	.952	.030	(.021,.038)
CON and DR	.859	.914	.936	.036	(.028,.043)
CON and RM	.865	.925	.944	.033	(.025,.041)
CON and SC	.865	.927	.945	.032	(.024,.040)
CON and SR	.872	.926	.945	.034	(.027,.042)

II. Fit Indices for PRO Mediator Models

Model	ML ROBUST				
	NFI	NNFI	CFI	RMSEA	RMSEA 90%
PRO and CC	.914	.972	.979	.023	(.012,.032)
PRO and DR	.911	.964	.973	.027	(.018,.035)
PRO and RM	.911	.965	.974	.026	(.017,.035)
PRO and SC	.912	.968	.976	.025	(.015,.033)
PRO and SR	.911	.961	.971	.028	(.019,.036)

III. Fit Indices for SELF Mediator Models

Model	ML ROBUST				
	NFI	NNFI	CFI	RMSEA	RMSEA 90%
SELF and CC	.898	.951	.960	.033	(.027,.039)
SELF and DR	.903	.955	.964	.032	(.026,.038)
SELF and RM	.905	.959	.967	.030	(.024,.036)
SELF and SC	.907	.962	.969	.029	(.023,.035)
SELF and SR	.904	.954	.963	.033	(.027,.039)

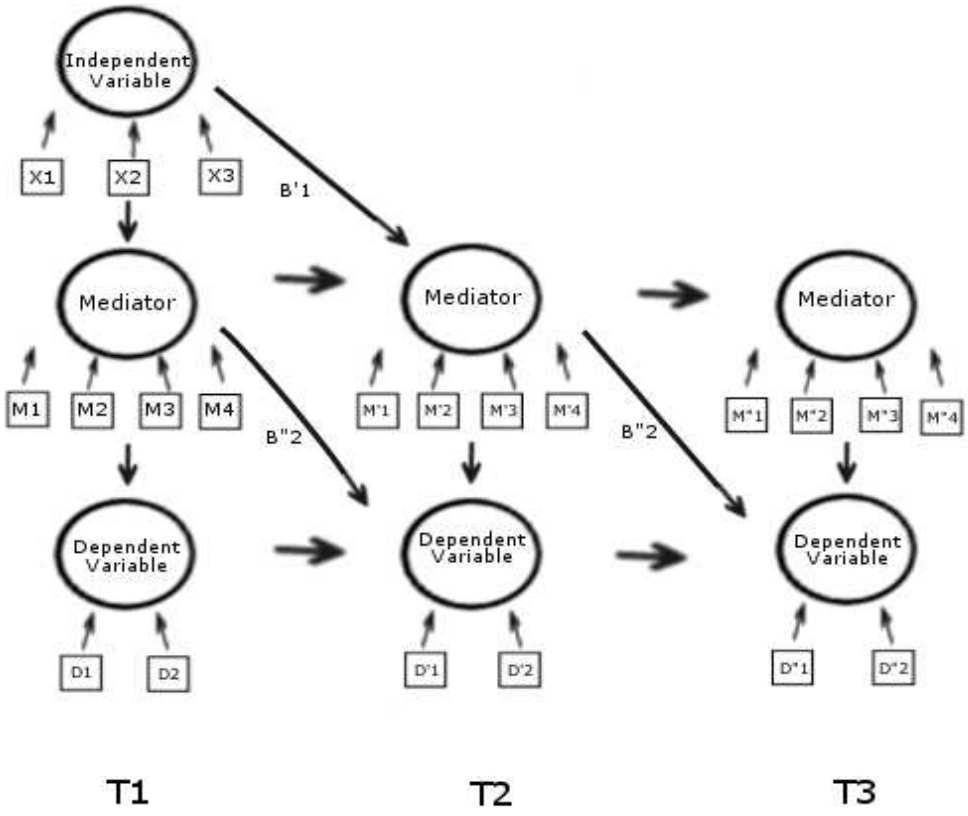

Figure 1. Basic Three Wave Mediation Model

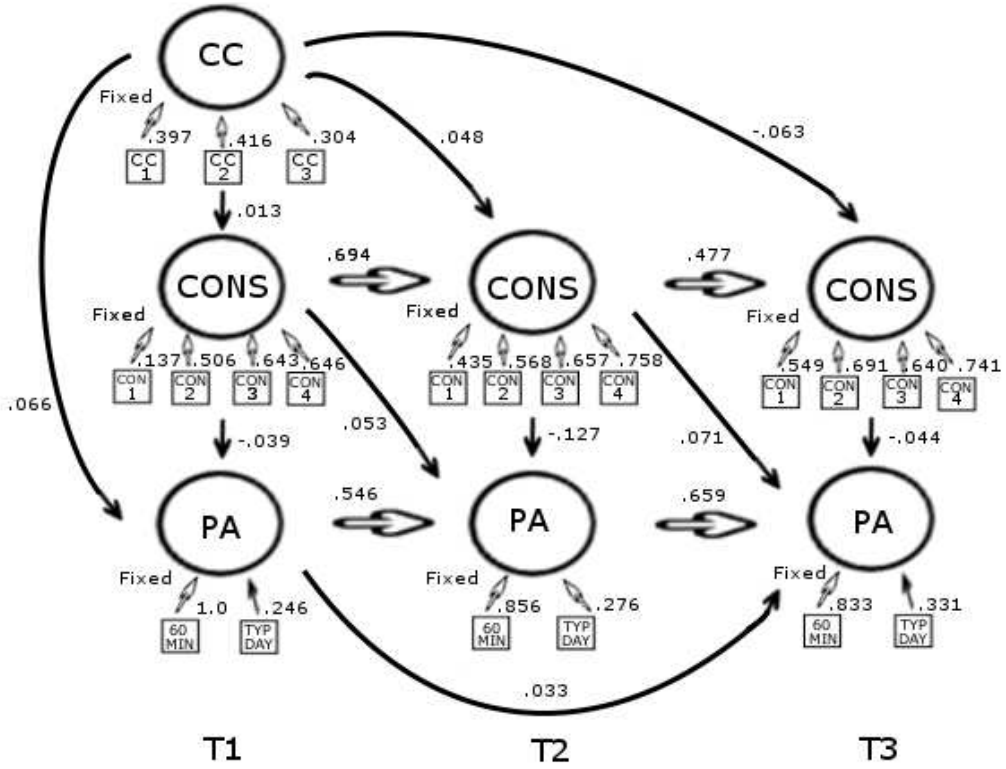

Figure 2. CON with Counterconditioning (CC) Model

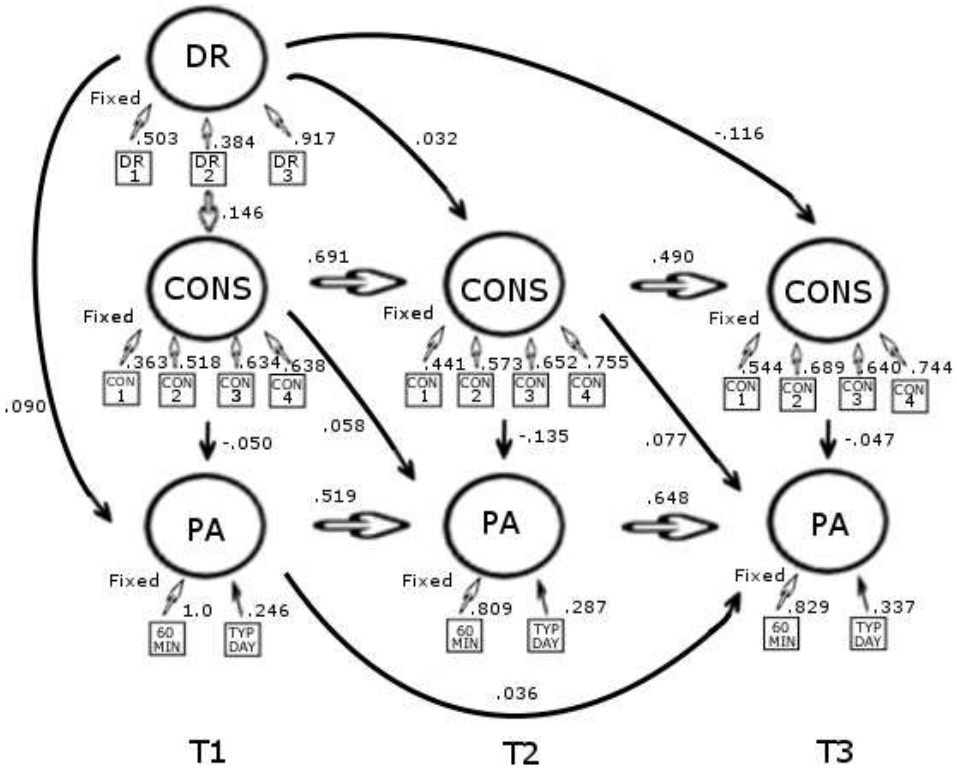

Figure 3. CON with Dramatic Relief (DR) Model

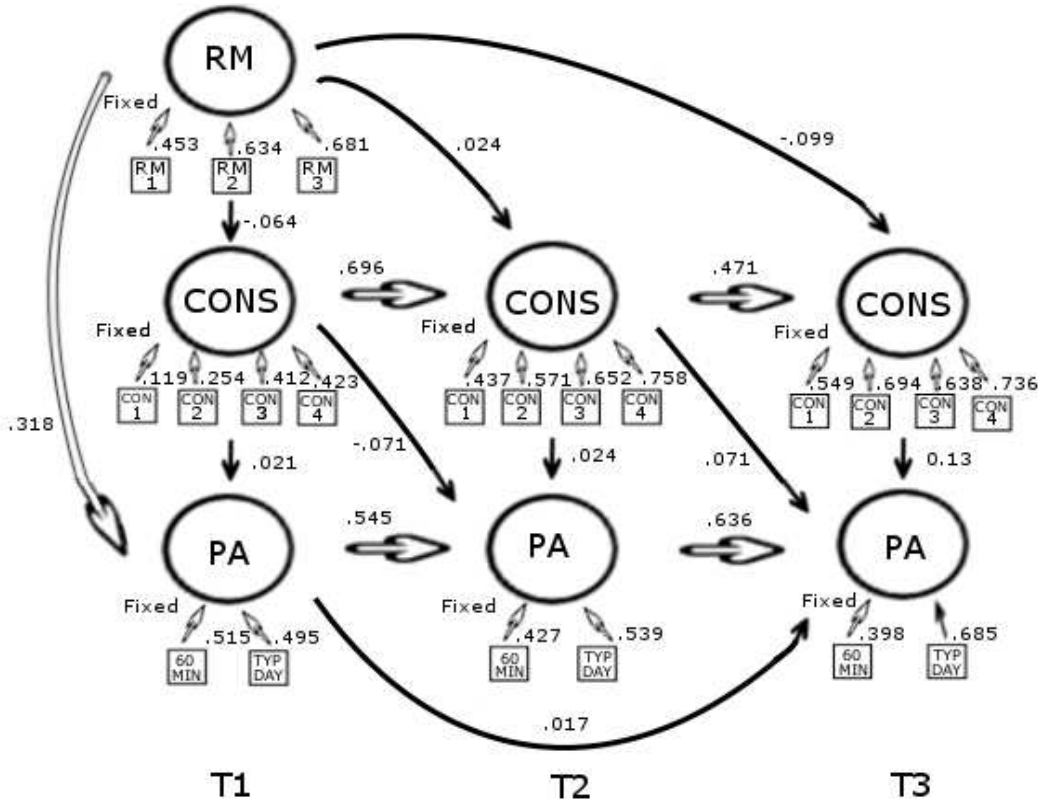

Figure 4. CON with Reinforcement Management (RM) Model

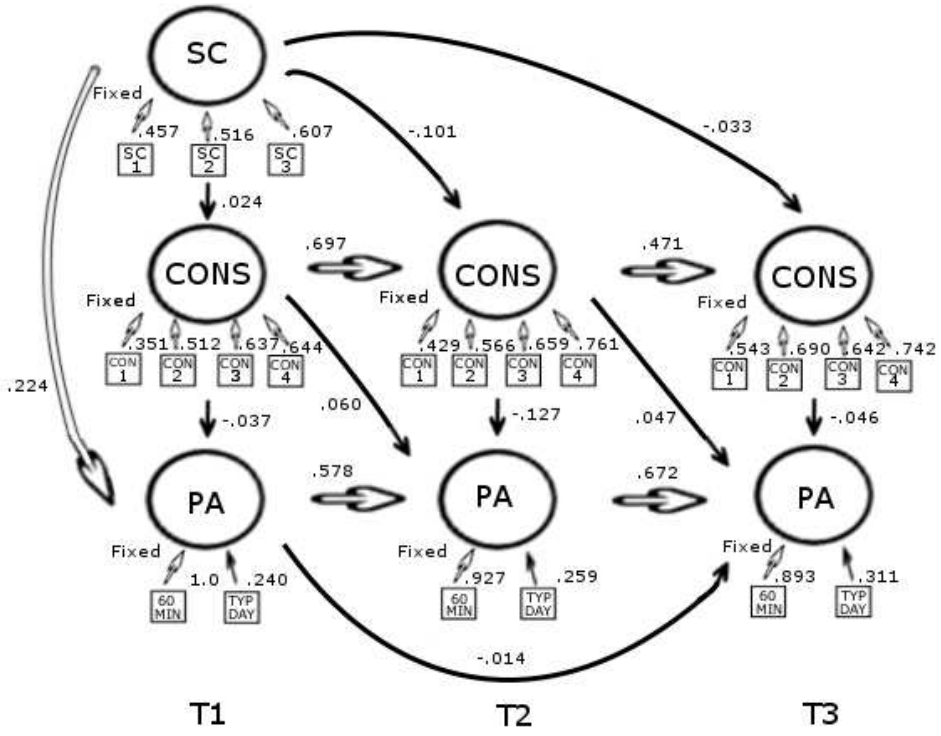

Figure 5. CON with Stimulus Control (SC) Model

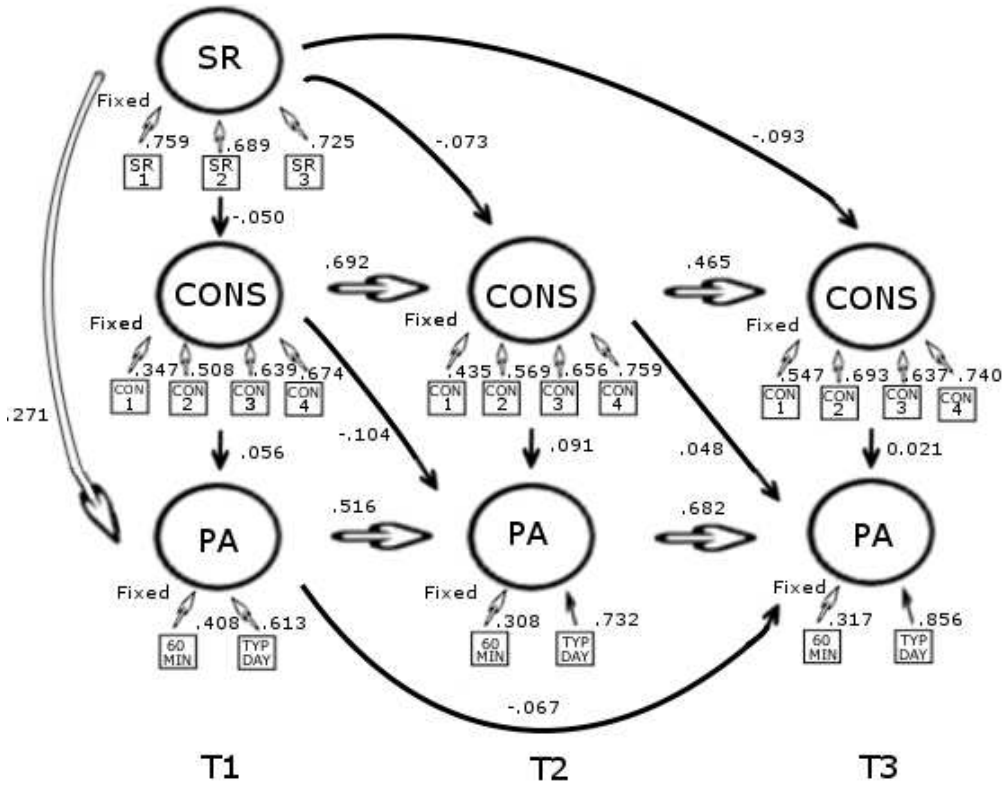

Figure 6. CON with Self-Reevaluation (SR) Model

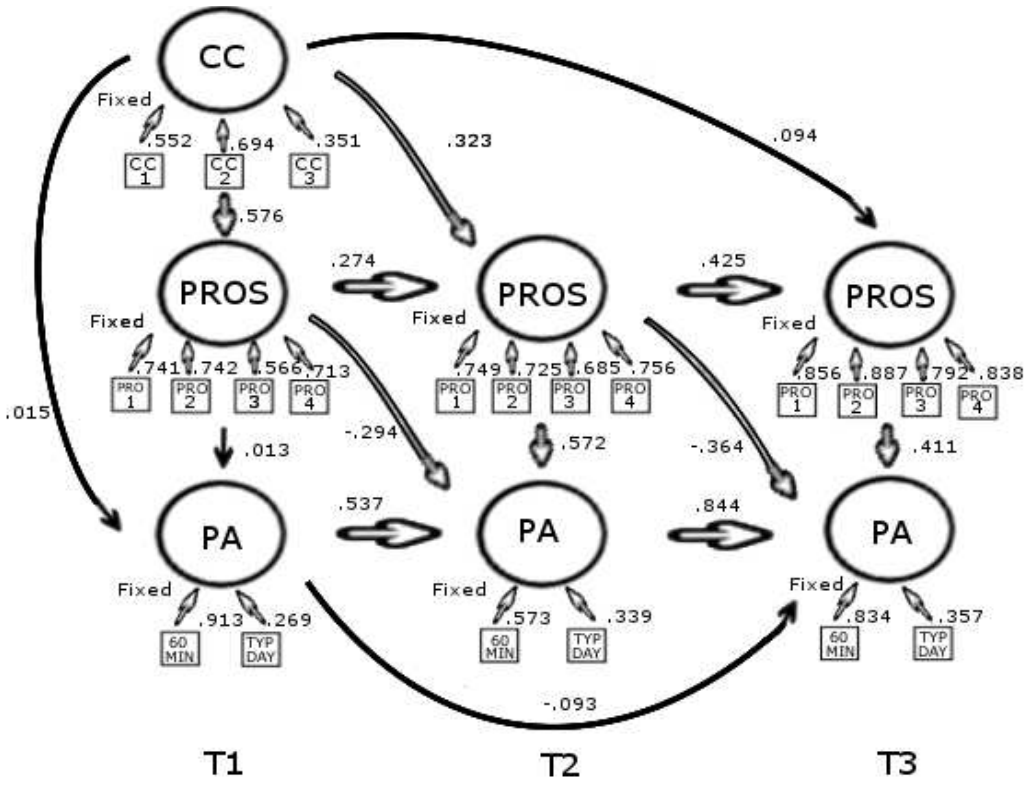

Figure 7. PROS with Counterconditioning (CC) model

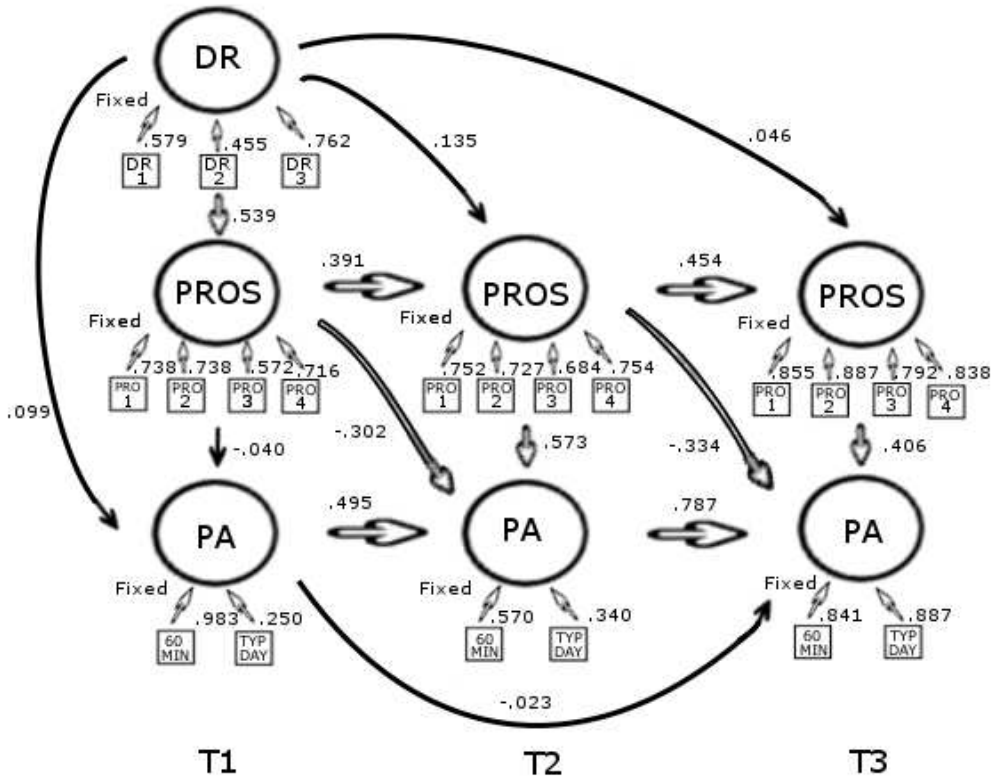

Figure 8. PROS with Dramatic Relief (DR) model

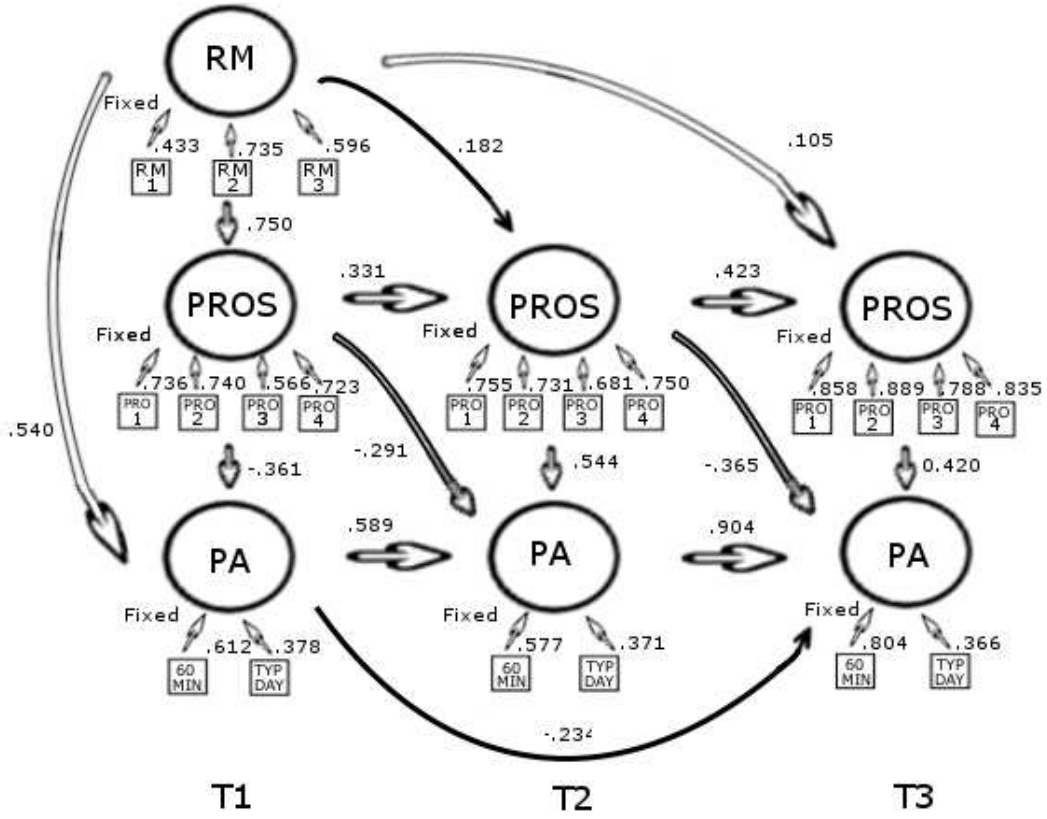

Figure 9. PROS with Reinforcement Management (RM) model

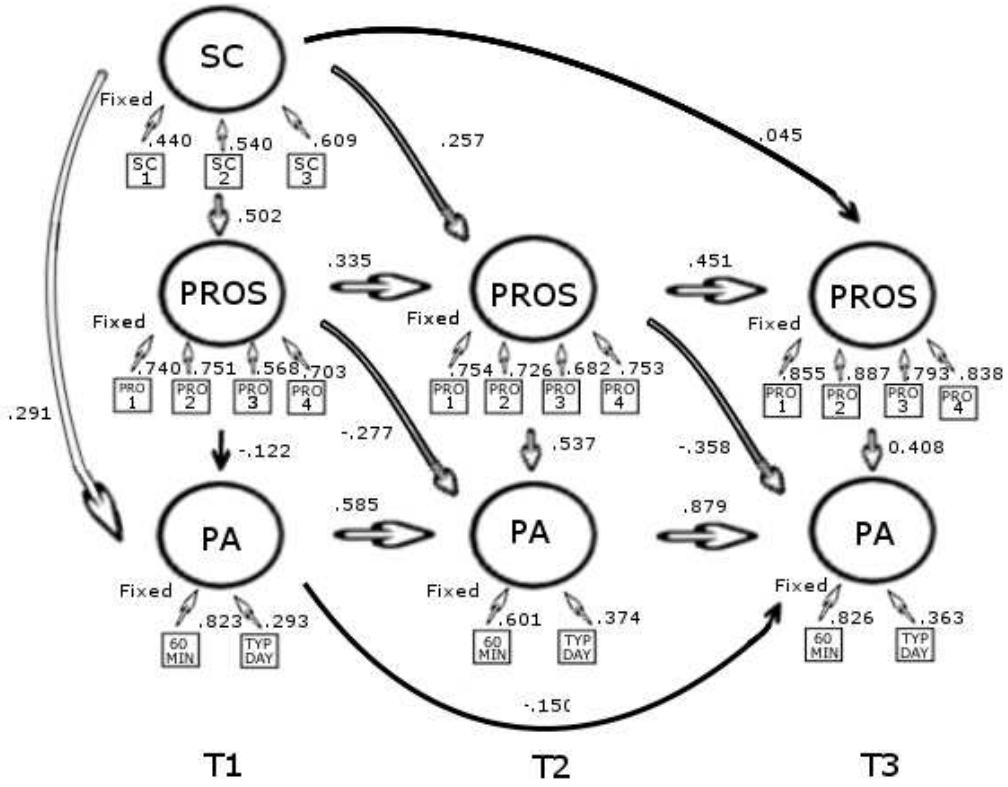

Figure 10. PROS with Stimulus Control (SC) model

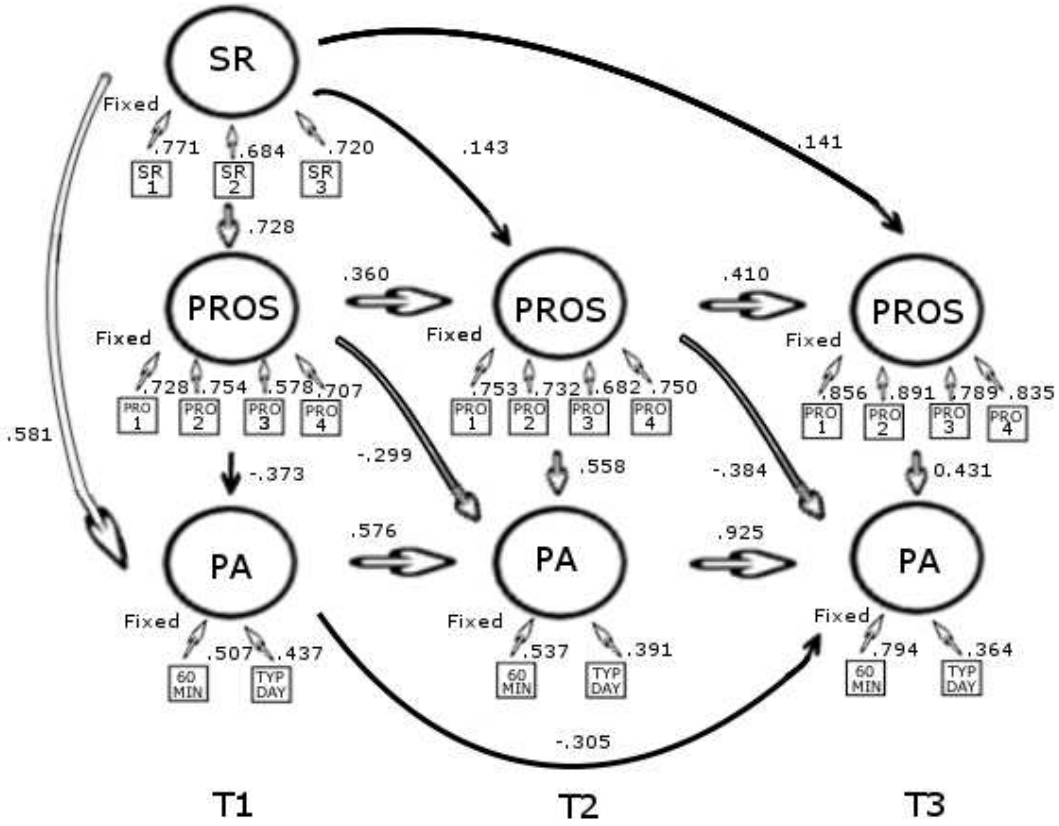

Figure 11. PROS with Self Reevaluation (SR) model

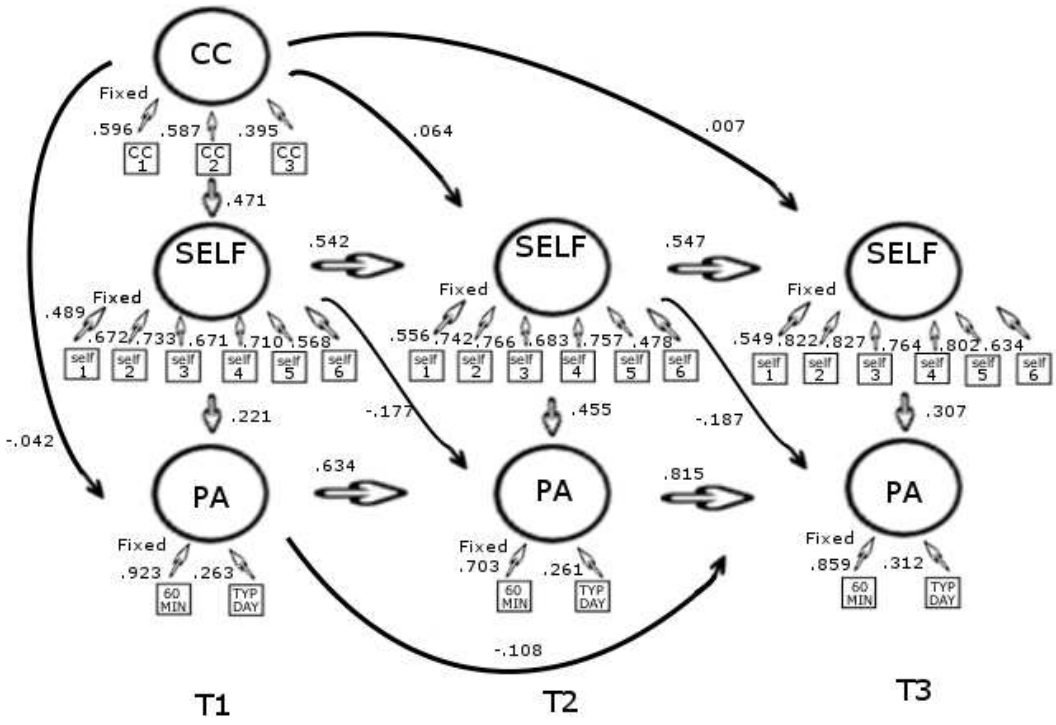

Figure 12. Self-Efficacy with Counterconditioning (CC) model

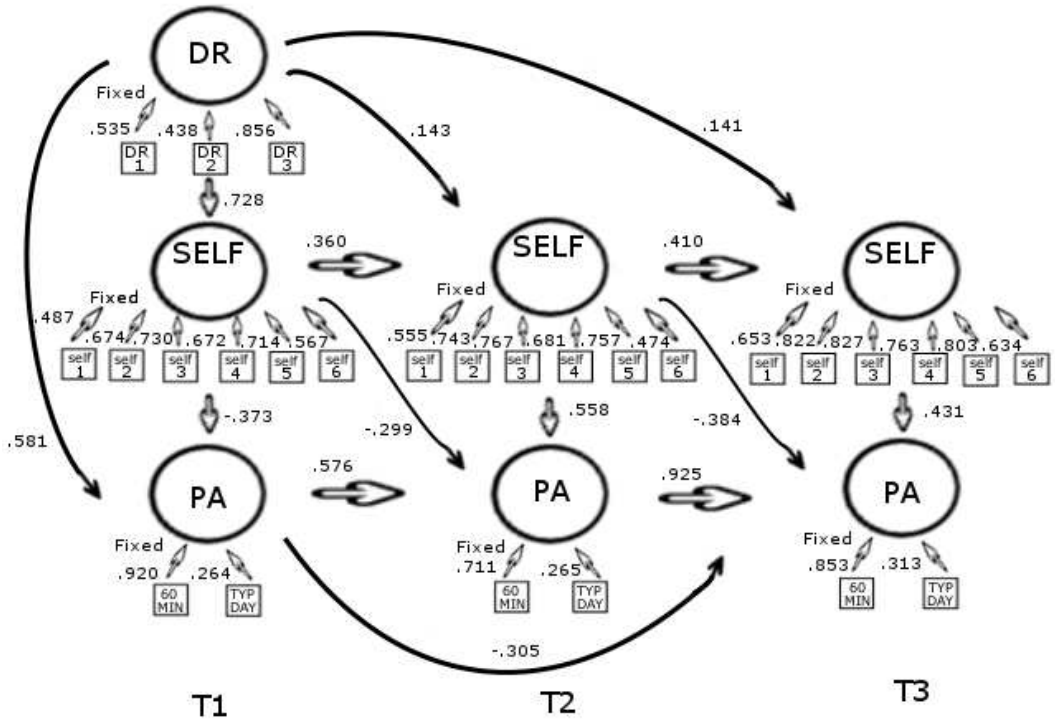

Figure 13. Self-Efficacy with Dramatic Relief (DR) model

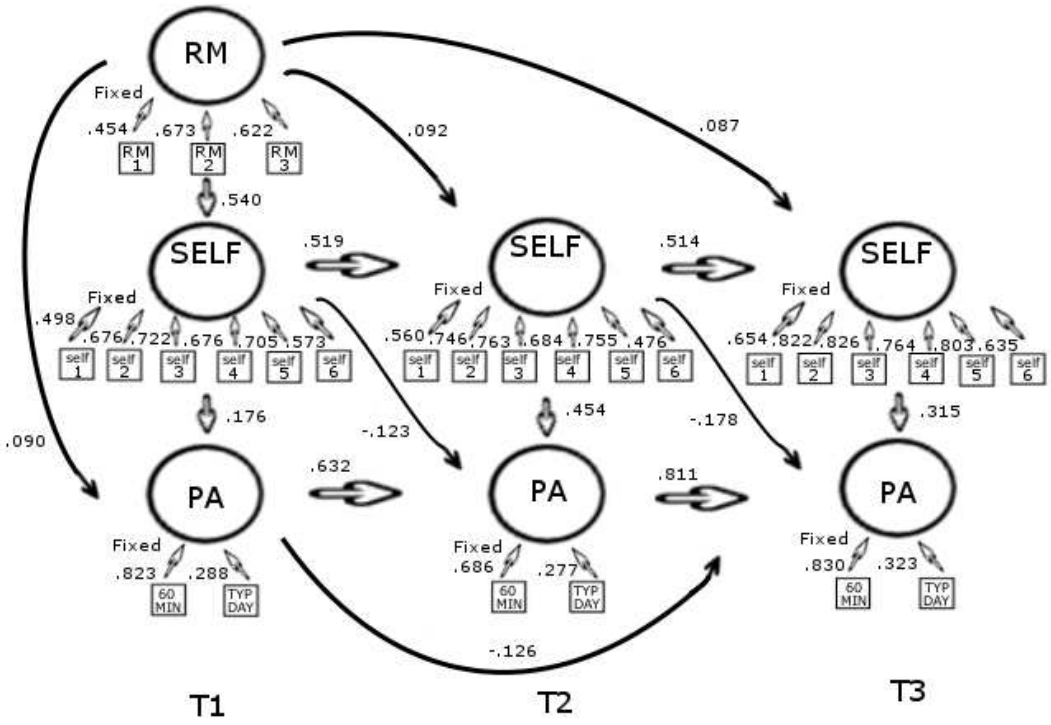

Figure 14. Self-Efficacy with Reinforcement Management (RM) model

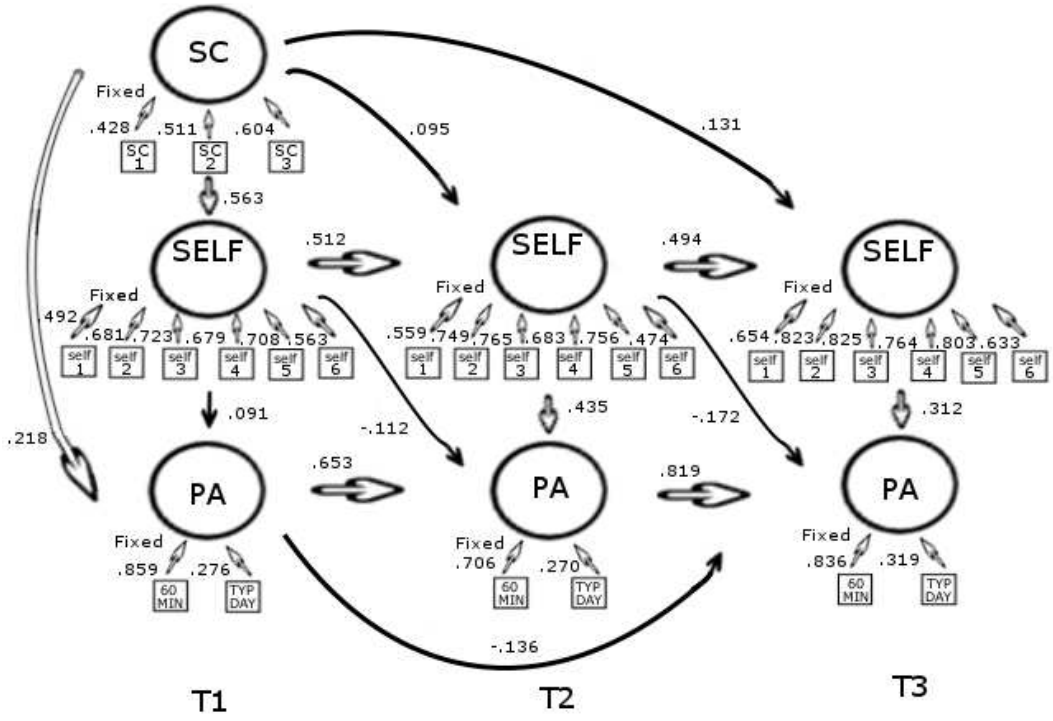

Figure 15. Self-Efficacy with Stimulus Control (SC) model

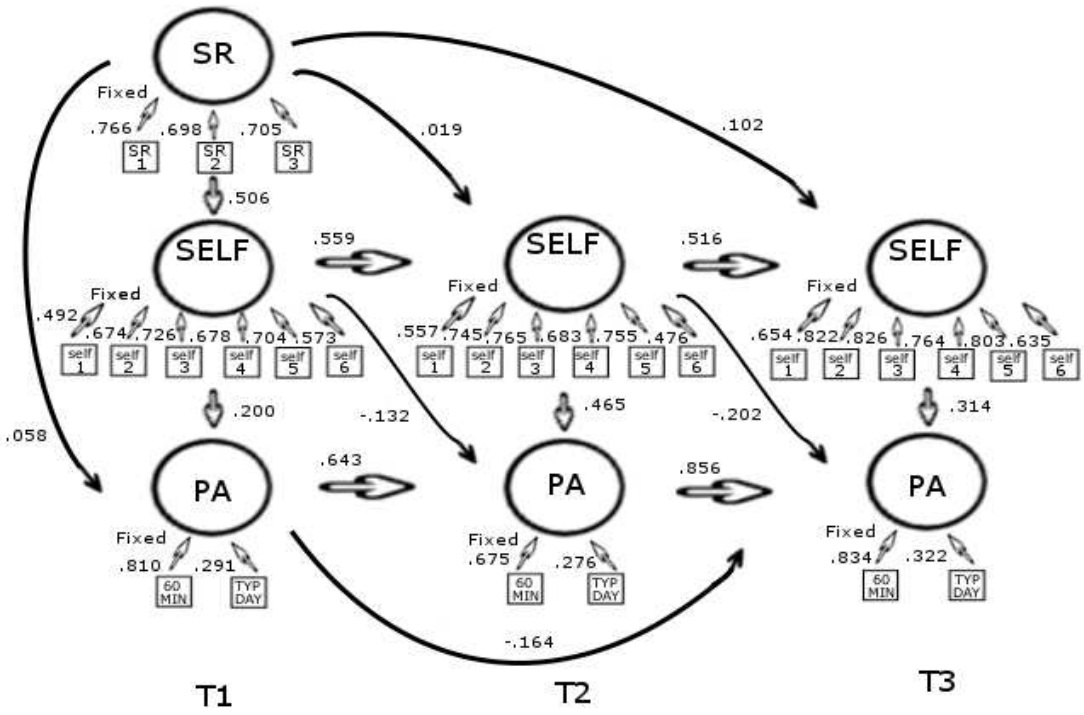

Figure 16. Self-Efficacy with Self-Reevaluation (SR) model

Study 2.

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Physical Activity Relapse Prevention in Middle School Students: Using Three Way Mediation Models

ABSTRACT

The purpose of this study is to determine the processes that underlie behavior change mechanisms in middle school students who began the study (6^{th} grade) as individuals who were adherent for six months or longer to regular physical activity. Mediation models were created, incorporating three time points (e.g., 6^{th}, 7^{th}, and 8^{th} grade) of data using constructs assessed within a physical activity intervention based on the Transtheoretical Model (TTM) of behavior change. These models were used to determine which mechanisms of the TTM are necessary as well as unnecessary for maintaining middle school students' physical activity levels. The mediator Pros provided partial mediation, and the mediator Self-efficacy provided full meditational paths in combination with all of the processes of change. Future studies should include different populations to determine the generalizability of these effects within the TTM for physical activity maintainers. Results provide insight so that TTM based interventions may be tailored to be more cost and time efficient when developed for this group of exercise maintainers.

Keywords: Transtheoretical Model of Behavior Change, physical activity, mediation, longitudinal model, adolescents

Physical Activity Relapse Prevention in Middle School Students: Using Three Way Mediation Models

Despite the overwhelming amount of health benefits individuals in all age groups acquire from participating in regular physical activity, most people are not meeting the national recommended criteria (Center for Disease Control and Prevention, 2012). This deficiency has led to various efforts geared toward increasing physical activity levels, whereas not enough attention has been placed on helping individuals maintain positive exercise habits. For example, a large decrease in physical activity maintenance occurs during middle school, whereas by the eighth grade many students do not maintain their exercise habits as they had in sixth grade (Kimm et al., 2000).

According to the Transtheoretical Model of Behavior Change (TTM) (e.g., processes of change, decisional balance, self-efficacy) mechanisms of behavior change are hypothesized to differ depending on the stage (e.g., maintenance, contemplation) an individual is categorized in. The application of the TTM to exercise behavior has been reviewed and found to be promising (Spencer et al., 2006), although specific mechanisms within the model have not been analyzed for effectiveness. The proposed research aims to use successive longitudinal mediation models over three years to determine which mechanisms of the TTM are necessary as well as unnecessary, in the maintenance stage, for maintaining middle school student's physical activity levels.

The use of meditational analysis allows for practical identification of both effective and ineffective mechanisms within interventions because it shows which

variables within the models are significant predictors both cross-sectionally and over time (Mackinnon, Fairchild & Fritz, 2007). In addition, adding a longitudinal component, or multiple time points, within the model allows for the determination of which mechanisms invoke change over time. Ultimately, once significant mechanisms of longitudinal change are determined, modification of the intervention can produce benefits such as increased efficacy, more efficient individual tailoring, increased cost efficiency, and greater ease of dissemination.

Physical Activity in Middle School Students

Adolescents acquire many benefits associated with physical activity such as better health, growth and development, both physically and mentally (Center for Disease Control and Prevention, 2012). These benefits support the importance of incorporating physical activity into adolescent's daily routine. The United States Department of Health and Human Services national recommendations state that children aged six to seventeen should participate in at least 60 minutes or more of physical activity on a daily basis. In addition, adolescents are spending most of their time participating in sedentary behaviors (i.e., watching television, using a computer) (Zabinski et al., 2007). This increase of sedentary behavior has in turn resulted in a decrease of physical activity among this age group. For example, one study found that adolescents who watch television for more than two hours a day have lower levels of physical and psychosocial health (Tremblay et al., 2011).

Although there are clear benefits of regular participation in physical activity, many adolescents are not meeting national recommendations. For example, the 2007 National Youth Risk Behavior Survey (NYRBS) (Eaton et al., 2008), funded by the

Center of Disease Control and Prevention, assessed many health risk behaviors which develop in adolescents during the course of middle school, including physical activity. Physical activity was measured through a question, based on previous national recommendations, asking students if they were active for at least 60 minutes five of seven days out of the week. For the state of Rhode Island (N=2,382), a little over half of students, 55.1%, reported meeting this criterion (Eaton et al., 2008). In addition, minority students reported not meeting the national recommendations more often than nonminority students (Agazzi et al., 2010).

Surveys such as the NYRBS emphasize the importance of developing and implementing interventions geared toward increasing physical activity. It has been suggested that awareness of benefits and recommendations of physical activity are important to instill in children and adolescents and can raise participation (Bauman et al., 2008, Driskell et al., 2007). One way to do this is through interactive computer-based physical activity interventions which are ideal for adolescents as they tend to welcome technology (Mauriello et al., 2007). In addition, models such as the TTM are being used to change behaviors since they do not overwhelm participants with too much information (Driskell et al., 2007).

Most importantly, maintaining and incorporating regular physical activity into a daily routine over time is the desired outcome of these interventions. This is crucial because most individuals who start integrating physical activity into their daily routine drop out or relapse, whereas they stop participating in physical activity or participate below national recommendations. This pattern of drop out or relapse was also apparent in the NYRBS in the assessment of adolescents. An overall pattern of

physical activity attrition was reported from sixth grade (78.2%), to seventh (74.1%) and to the eighth grade (73.7%) (Eaton et al., 2008). More specifically, within the group of students who met the activity criterion in sixth grade, there was a steady decline in physical activity throughout the next two years. Interventions geared toward preventing drop out and relapse are an important focus as most adolescents have good physical activity habits, and tend to lose them throughout their years in junior high school. Focusing on these individuals is crucial to incorporating physical activity habits throughout life.

The Transthoretical Model of Behavior Change

The TTM, a model of intentional behavior change, has served as the basis for a large number of computer-based interventions that have produced significant changes in behaviors for many different populations (Krebs et al., 2010, Mauriello et al., 2007, 2010,Prochaska et al., 2001; Prochaska et al., 2004; Prochaska & Velicer, 2004; Velicer et al., 1999, 2013), will be utilized. In addition to behavior change, these interventions have been found to be accepted within the adolescent school community (Mauriello et al., 2006). The central organizing construct of the model is stages of change. The stages of change categorize individuals into five stages of 'readiness' to change (e.g., precontemplation, contemplation, preparation, action, and maintenance). These stages have been well described (Haas & Nigg, 2009; Leslie et al., 2003) and validated. Each stage is determined by the level of intention and behavior corresponding to how ready an individual feels to change their physical activity behaviors. For example, a person who does not think about the behavior at all would likely be in the first, precontemplation stage, whereas a person who continues to

engage in the behavior as a normal routine would likely be in the fifth stage, the maintenance stage.

Within each stage of change an individual participates in certain covert and overt activities in order to progress to the next stage. These processes are referred to the ten processes of behavior change (Prochaska & DiClemente , 1983;Prochaska et al., 1988). Five of the processes (e.g., consciousness raising, dramatic relief, environmental reevaluation, social liberation, self-liberation) are labeled as experiential and are necessary for an individual to engage in when progressing through the early stages of change. The other five processes (e.g., stimulus control, helping relationships, counter conditioning, reinforcement management, self-reevaluation) are labeled as behavioral processes and are engaged in during the later stages when a person is changing or has changed their behavior. For a person in the maintenance stage who is maintaining their behavior, the five behavioral processes would be the main focus.

In addition, when an individual transitions through stages, other constructs are measured throughout the behavior change process. These are labeled as decisional balance, pros and cons, as well as self-efficacy. For example, for an individual within the maintenance stage group for exercise behavior, an individuals' positive beliefs about physical activity, referred to as 'Pros', are expected to be rated highly. On the contrary, the 'Cons', negative beliefs about physical activity are expected to be rated lower (Prochaska et al., 1994; Hall & Rossi, 2008). The 'Self Efficacy' construct, or the situational temptation measure (DiClemente, 1981, Velicer et al., 1990), represents how confident an individual is to participate in exercise behaviors despite any barriers.

For individuals in the maintenance stage, a person would feel confident about their behavior despite barriers. Within this study, Pros, Cons and Self Efficacy constructs will be used as the mediator variables. These mechanisms, mediator variables, within the TTM are hypothesized to differ depending on stage of an individual, as it has been suggested that interventions aimed at increasing physical activity should be geared toward raising awareness of personal activity and should also be stage matched (Ronda, Assema, &Brug, 2001).

Specifically, interventions applying the TTM to increase physical activity have produced positive results (Krebs et al., 2010; Spencer et al., 2006; Mauriello et al., 2007, 2010; Velicer et al., 2013), and implementing these interventions using both computers and print versions have been effective by providing individually tailored feedback (Marcus et al., 2007; Marcus et al., 1998). Although constructs have been confirmed to be measured equivalently between adult sex, age and ethnicity groups, the stability of constructs have not been measured through longitudinal analyses (Paxton et al., 2008). In addition, it has been suggested that interventions which provide interactive feedback should be evaluated so that mechanisms within interventions can be more refined (Norman et al., 2007). Previous studies have focused on the intervention as a whole, whereas the mechanisms within the intervention for stages (i.e., maintenance), have not been examined separately. In addition, specific interactions of processes and the role of mediators have not been tested.

Longitudinal Mediation Design

Even though the determinants of behavior change are very complex, temporal relationships are best understood by examining a behavior over time. In addition to setting up a foundation for determining a causal relationship, longitudinal designs offer other advantages such as the ability to separate aging effects from cohort effects and offer more powerful designs as well as more information about individual change (Hedeker& Gibbons, 2006). Utilizing a meditation analysis design with longitudinal data allows for additional advantages: (1) Identifying the temporal precedence of X, M, and Y, (2) identifying changes within individuals and cross-sectional relations, and (3) the data allow for alternative explanations of cross-sectional mediated effects (MacKinnon, 2008).

When interventions, such as ones created from the TTM, are produced, it is important to understand what actually changes behavior while taking into consideration individual differences. Mediators, or variables that transmit the effect of an independent variable on a dependent variable, often give insight on how a process or mechanisms within an intervention affect behavior change (Mackinnon, Fairchild & Fritz, 2007). Mediation analysis, which was initiated by an influential Baron and Kenny (1986) paper, has now been modified to represent an ideal approach to identifying mechanisms of behavior change. The findings of meditational studies can be used to determine which theoretical mechanisms of an intervention produced the greatest amount of behavior change (Napolitano et al., 2008). In addition to determining mediation with cross-sectional data, the use of meditational analyses over time can identify both effective and ineffective mechanisms within interventions

(Mackinnon, Fairchild, & Fritz, 2007; Baron & Kenny, 1986). Examining the effects of longitudinal data allows for more rigorous conclusions of causality involving mechanisms within an intervention on a behavior (Cole & Maxwell, 2003).

Literature reviews such as Lewis et al. (2002) have determined that physical activity mediator-intervention studies are needed to determine if theory based interventions are effective. This is especially important because physical activity interventions have now become more time consuming and less cost efficient (Glasgow et al., 2006). Mediators such as self-efficacy derived from Bandura's Social Cognitive Theory have been effectively used as mediators of physical activity within adolescent girls (Lubans & Sylva, 2009). Mediation studies such as this one suggest that within the TTM, mediators such as self-efficacy, pros and cons, are important to examine. In order to determine which of these potential mediators from a TTM based intervention have the largest impact on physical activity, a series of secondary data analyses will be performed using longitudinal meditational models.

Overview of Current Study

Currently, very little is known about the mechanisms involved in effective behavior change interventions. In many cases, the final behavior is measured without knowing the process of how the change was invoked, leading researchers to conclude that their intervention as a whole lead to the behavior change. Although this may be the case, often times it is unknown if certain mechanisms of the intervention were more or less beneficial in regard to the actual change in behavior. Critical constructs necessary for behavior change are hypothesized and incorporated into interventions and are typically never measured. Significant constructs are important because once

they are determined; interventions can be tailored to be more efficient by increasing the emphasis on mechanisms which are effective and deleting mechanisms which are not effective. In order for these constructs to be identified as significant, the use of longitudinal mediation analysis is necessary to investigate effects of intervention components over time.

The use of meditational analysis further allows for practical identification of both effective and ineffective constructs within interventions because it shows which variables invoke change in the final behavior. An individual also utilizes decisional balance, Pros and Cons, as well as Self-Efficacy as they change their behavior. The decisional balance scale consists of questions that an individual has to weigh the Pros and Cons of for a specific behavior (Velicer et al., 1985). For individuals within the maintenance stage group for physical activity, individuals who exercise regularly, Pros are expected to be high and the Cons are expected to be low (Hall & Rossi, 2008; Prochaska et al., 1994). The Self-Efficacy variable or the situational temptation measure (DiClemente, 1981, Velicer et al., 1990), represents how confident an individual is to participate in physical activity despite barriers. Within this study, the Pros, Cons and Self-Efficacy constructs will be defined as the mediating variables, since they are necessary to produce change or the continued behavior of physical activity.

The dataset used in this study includes important variables that allow for the analysis of the effects of a TTM based intervention over a three year period. The group analyzed in this study consists of individuals who began the intervention with sufficient physical activity patterns based on daily recommendations, or sixth graders

who were categorized in the maintenance stage group within the TTM model. Variables based on the TTM model, measured at each of the three different time points, will be analyzed using multiple meditational models in order to determine which of the processes of change have the largest impact on physical activity. These models are used to determine which of the five behavioral processes assessed for the maintenance group during baseline assessment, in combination with the mediating variables (e.g., Pros, Cons, Self Efficacy), will be most influential on behavior continuation. Results can provide a good test of the physical activity intervention mechanisms based on the TTM and can provide guidance to refine existing TTM based interventions due to the unique size and longitudinal nature of the data set.

Other than applying the TTM to tobacco use, the TTM has been most widely applied to exercise behavior. According to a review of one hundred and fifty studies using the TTM with physical activity, the model has been successfully applied to various populations (Spencer et al., 2006). It is expected that the TTM will be a good representation for the physical activity of middle school aged participants within this study.

Overall, results from this study provide evidence for which TTM mechanisms are necessary, as well as unnecessary, within this physical activity intervention. This is important so that physical activity interventions which utilize the constructs of the TTM can be better tailored to provide the optimal or best feedback in order to maintain an individual's physical activity level. In addition, these findings can be used to improve interventions for integrating and maintaining exercise into a daily

lifestyle, a behavior strongly linked to improvement of individuals' overall quality of life, as well as reducing individuals' risks for development of chronic diseases.

Method

The proposed dataset contains all the critical measures from the TTM necessary for these proposed analyses. In addition, this dataset is unique because it is longitudinal in nature containing three different time points; baseline, approximately 12 months, and approximately 24 months. Also, this dataset is unique because it includes all of the necessary variables with very few missing values, and includes a large number of participants which ensures adequate power for the analyses. The nature of this large, longitudinal dataset allows for examination of change across a general adolescent population as well as differences within subgroups (MacKinnon, 2008).

The proposed project is a secondary data analysis consisting of multiple longitudinal mediation analyses. The basic model will be the one proposed in figure 1. All latent variables, variables within circles in the figure, will be composed of measured items, shown in boxes in the figure. The independent latent variable will be created from each of the five processes (e.g., stimulus control, helping relationships, counter conditioning, reinforcement management, self-liberation), three items each, measured during time one among students who were in the maintenance stage. The three different mediator variables or M will be the Pros and Cons, each are latent variables created from four items, and Self-Efficacy is a latent variable made up of six items. The physical activity variable will be the dependent measure, also known as

the Y. This latent variable is created from two physical activity items. This dependent latent variable measuring physical activity will be used in all of the models.

Time one will consist of 6th grade middle school students who began the intervention in the maintenance stage, time two will consist of their 7th grade data, and time three will contain their 8th grade data. All time points (i.e., T1, T2, T3) are approximately one year apart. Time 2 and time 3 include the mediator variable and the physical activity variable. The independent variable, or the five processes, will only be included at time one due to individuals changing stage and not being asked the same process questions throughout the study.

The B's or beta weights will be examined for significance between pathways. The five independent variables are used in time one, the three mediators and the physical activity variables are used at all three times. In total, there are a total of fifteen models containing this structure within this study.

Participants

Of the total N = 4,151 6th grade middle school participants in the twenty schools within this study (Velicer et al., 2013), only participants from the ten schools that were randomly selected to receive the physical activity intervention and were categorized in the maintenance stage of change at baseline (N = 993) were included in these analyses. Of those nine hundred and ninety three, only participants who had complete three year data (6th, 7th and 8th grade timepoints) were used for this study (N = 534). Participants' mean age at time one was eleven years (SD = .43).Demographic variables in this study include gender (Females = 42.7%) and ethnicity (2% American Indian/Alaskan Native, 3% Asian/Pacific Islander, 2%

Black/Not Hispanic, 11% Hispanic, 68% White/Not Hispanic, 2% Other, and 11% Combination, and 1% Unknown).

The staging algorithm for physical activity maintenance has been confirmed and validated (Hellsten et al., 2008; Mauriello et al,. 2010; Velicer et al.,2013). Participants in maintenance reported participating in 60 minutes or more of physical activity at least five days a week. All participants in the analyses were maintainers at time point one. At time point two, 73% of participants remained in the maintenance stage whereas 6.7% moved back to the action stage, 13.1% were in the preparation stage, 5.4% were contemplators, and 1.7% regressed to the precontemplation stage. At time point three, 66.7% of participants were still in the maintenance stage whereas 11.2% were in the action stage, 13.3% were in the preparation stage, 5.8% were contemplators, and 3.0% were in the precontemplation stage. This pattern of physical activity decline or relapse within the study sample is expected and consistent with previous studies (e.g., Kimm et al., 2000).

Measures

The independent variables in the model are the five behavioral processes of change: Counterconditioning (CC), Dramatic Relief (DR), Reinforcement Management (RM), Stimulus Control (SC), and Self Reevaluation (SR). These processes are relevant for individuals in the maintenance stage, such as those included in this study. The processes of change measured latent variables that facilitate change. Different processes of change are thought to be engaged in at different stages of change.

The mediating variables, also known as the mediators, in the model are the decisional balance, pros and cons, and self-efficacy (Velicer et al., 1996). Mediators explain the dependent variable without changing the relationship between the independent variable and the dependent variable. The impact of the independent variable on the dependent variable would not be possible without the mediator variable. One of the goals of this analysis is to determine the significance and impact of these proposed mediators.

The dependent variable used in the analysis will be composed of two items. This variable will incorporate physical activity measures that an individual is in control of. This is consistent with analyzing physical activity that the individual chooses to participate in, compared to mandatory participation (i.e., physical education classes). It is important to note that the dependent measure is not dependent on stage due to possible changes in stage between time 1 and times 2 and 3. Therefore the model measures model based predictors of physical activity over time.

All item details for the independent items, the mediator items and the dependent items are presented in Table 1.

Statistical Analyses

Because this model is theory driven, latent variable structural equation modeling (SEM) will be utilized. More specifically, the model is an autoregressive mediation structural equation model. Mediation is an important aspect of the model due to its' unique ability to offer the most comprehensive investigation of the mechanism of change available. Causal inferences that can be determined from this series of mediation analyses will aid in the process of determining which mediating

variables combined with independent variables are the most effective in the exercise intervention.

In order to produce results multiple single meditational models are utilized. Mediation models were produced with each of the five processes combined with cons, pros and self-efficacy as mediators and physical activity as the dependent variable. This process will create fifteen different individual models which are examined for significance of fit, effect size, and compared for similarities and differences between each of the models.

Results

Initial background analyses were conducted. Skewness and kurtosis was assessed using West, Finch, and Curran (1995) criteria of >2 and >7 respectively. Next, multivariate kurtosis was determined by EQS (Bentler, 2007). Some of the variables were skewed and kurtotic although this was expected from some of the questions asked for this group of physical activity maintainers. Since this was expected, transformations to the variables were not made, instead robust maximum likelihood estimates were used which take into account the nonnormality of the data when calculating chi-squared and fit indices (Tabachnick & Fidell, 2007). Percentages, means, standard deviations for study variables and scale scores, as well as the correlation matrix are shown in Tables 2-4.

Structural Equation Modeling

Each of the models included latent variables made up of three items for every independent variable [i.e., Counterconditioning (CC), Dramatic Relief (DR), Reinforcement Management (RM), Stimulus Control (SC), and Self Reevaluation

(SR)]. Mediating latent variables, including pros and cons, were created using four items each and the latent variable for self-efficacy was created using six items. Lastly, the dependent latent variable, incorporated in all the models, was created using two items.

The significance test used for the models created in the statistical software, EQS, was the chi-squared statistic. The chi-squared test determines if the model can reproduce the population covariance matrix, "fitting" the data used in the model (Hu &Bentler, 1995). The chi-squared goodness-of-fit index was significant in all of the models, indicating a poor fit; however, this value is misleading due to the large sample size. Kenny (2010) advises that the chi-squared statistic is almost always significant in models when the sample size is greater than 200 and in this study the sample size is 534. Because all of the models are statistically significant, Chi-squared statistics will not be reported.

It is important to determine model fit when assessing the significance of the models. Values for the Comparative Fit Index (CFI), Normed Fit Index (NFI), and the Nonnormed Fit Index (NNFI) are provided. All of the indices provide a measure of fit with values ranging from 0 to 1. Greater values indicate a better fit. For example, a strong fit can also be concluded for models with a Comparative Fit Index (CFI) greater than .90 and a really great fit with a CFI above .95 (Bentler, 1992).

Residuals can also be used to determine a good fit. One residual, Root Mean Square Error of Approximation (RMSEA) is used most often and is not influenced by sample size (Steiger& Lind, 1980). The smaller values of RMSEA are ideal and values less than .05 indicate a very good fit (Hu & Bentler, 1999). Also, confidence

intervals for RMSEA can be examined. When examining the RMSEA confidence interval, the lower value should be near zero, not lower than .05, and the upper value should not be much larger. Kenny (2010) also notes that the confidence interval informs the researcher of how precise the RMSEA value is, and a smaller confidence interval is ideal.

All of the models are presented in Figures. The numbers within the figures, or the direct effects, represent standardized solutions produced by EQS. These standardized solutions are obtained by dividing the beta coefficient by the standard deviation of that beta coefficient, resulting in beta weights typically found in regression (Bentler, 2006). Indirect effects are represented by the arrows within the figures. Open arrows represent significant paths, at the .05 level, and solid arrows represent nonsignificant paths.

Since mediation is the main focus of the analyses, the results will reflect the paths of interest. More specifically, meditational change over time, or the path from the independent variable at time one, the mediator variable at time two, and the physical activity variable at time three will be examined.

Other paths, such as the paths from one factor to another across time points (i.e., T1, T2, T3) indicate the reliability of a measure over time when significant (i.e., open arrows). The arrows from items (i.e., boxes) to the latent variables (i.e., circles) indicate the significance of an item creating the latent measure.

Multiple mediator models evaluating the role of Cons, Pros and Self-Efficacy in physical activity

A series of five models were conducted including each of the independent variables in combination with all of the mediators, cons, pros and self-efficacy with the dependent variable, physical activity. The model's fit indices are presented in Table 5.

The models are presented in Figures 2 - 6. To clarify the appearance of these complex models in the figures, the items which make up the latent variables are not shown in the figures but are specified identically to the ones shown in previous figures. Also, the stability paths from each construct to itself over time are specified in the models (as they were previously), but are not shown in the figures.

CONS, PROS and Self-Efficacy (SELF) with Counterconditioning (CC) Model

The CONS, PROS and SELF model in combination with the independent variable counterconditioning produced good values given the complexity of the model (CFI:.888; NFI:.786; NNFI:.875; RMSEA:.040; see Table 5). This provides evidence that all three of the mediators in combination with counterconditioning was a good predictor of physical activity at all three time points within this group of maintainers.

The paths from counterconditioning (T1) to pros (standardized solution = .650, $p < .05$) and self-efficacy (standardized solution = .531, $p < .05$) (T2) were significant, whereas the path from counterconditioning (T1) to cons (T2) was not significant. In addition, the path from self-efficacy (T2) (standardized solution = .532, $p < .05$) to physical activity (T3) was significant and both paths from cons (T2) and pros (T2) to physical activity were not significant. There was not a significant longitudinal

meditational relationship for cons. There was a partial longitudinal meditational relationship for pros. There was a full longitudinal mediational relationship for self-efficacy (see figure 2).

CONS, PROS and Self-Efficacy (SELF) with Dramatic Relief (DR) Model

The CONS, PROS and SELF model in combination with the independent variable dramatic relief produced adequate values given the complexity of the model (CFI:.877; NFI:.779; NNFI:.862; RMSEA:.043; see Table 5). This provided evidence that all three of the mediators in combination with dramatic relief were reasonable predictors of physical activity at all three time points within this group of maintainers.

The paths from dramatic relief (T1) to cons (standardized solution = .177, $p < .05$), pros (standardized solution = .583, $p < .05$) and self-efficacy (standardized solution = .425, $p < .05$) (T2) were significant. In addition, the path from self-efficacy (standardized solution = .239, $p < .05$) (T2) to physical activity (T3) was significant whereas both paths from cons (T2) and pros (T2) to physical activity were not significant. There were only partial longitudinal meditational relationships between cons and physical activity and pros and physical activity. However, there was a full longitudinal mediational relationship for self-efficacy (see Figure 3).

CONS, PROS and Self-Efficacy (SELF) with Reinforcement Management (RM) Model

The CONS, PROS and SELF model in combination with the independent variable dramatic relief produced adequate values given the complexity of the model (CFI:.891; NFI:.790; NNFI:.878; RMSEA:.040; see Table 5). This provided evidence that all three of the mediators in combination with Reinforcement Management were

reasonable predictors of physical activity at all three time points within this group of maintainers.

The paths from reinforcement management (T1) to pros (standardized solution = .605, $p < .05$) and self-efficacy (standardized solution = .464, $p < .05$) (T2) were significant, whereas the path from reinforcement management (T1) to cons (T2) was not significant. In addition, the path from self-efficacy (standardized solution = .239, $p < .05$) (T2) to physical activity (T3) was significant and both paths from cons (T2) to physical activity and pros (T2) to physical activity were not significant. This provides evidence that there was not a significant longitudinal meditational relationship for cons, there was a partial longitudinal meditational relationship for pros and a full longitudinal meditational relationship for self-efficacy (see Figure 4).

CONS, PROS and Self-Efficacy (SELF) with Stimulus Control (SC) Model

The CONS, PROS and SELF model in combination with the independent variable stimulus control produced reasonable values given the complexity of the model (CFI:.894; NFI:.792; NNFI:.882; RMSEA:.039; see Table 5). This provided evidence that all three of the mediators in combination with stimulus control were reasonable predictors of physical activity at all three time points within this group of maintainers.

The paths from stimulus control (T1) to pros (standardized solution = .612, $p < .05$) and self-efficacy (standardized solution = .585, $p < .05$) (T2) were significant, whereas the path from stimulus control (T1) to cons (T2) was not significant. In addition, the path from self-efficacy (standardized solution = .251, $p < .05$) (T2) to physical activity (T3) was significant and neither path from cons (T2) to physical

activity (T3) or pros (T2) to physical activity (T3) was significant. There was not a significant longitudinal meditational relationship for cons. There was a partial longitudinal meditational relationship for pros. There was a full longitudinal meditational relationship for self-efficacy (see Figure 5).

CONS, PROS and Self-Efficacy (SELF) with Self-Reevaluation (SR) Model

The CONS, PROS and SELF model in combination with the independent variable SR produced adequate values given the complexity of the model (CFI:..882; NFI:.786; NNFI:.868; RMSEA:.042; see Table 5). This provided evidence that all three of the mediators in combination with self-reevaluation were reasonable predictors of physical activity at all three time points within this group of maintainers.

The paths from self-reevaluation (T1) to pros (standardized solution = .537, $p < .05$) and self-efficacy (standardized solution = .379, $p < .05$) (T2) were significant, whereas the path from self-reevaluation (T1) to cons (T2) was not significant. In addition, the path from self-efficacy (standardized solution = .238, $p < .05$) (T2) to physical activity (T3) was significant and neither mediational path from cons (T2) to physical activity (T3) or pros (T2) to physical activity (T3) was significant. There was not a significant longitudinal meditational relationship for cons. There was a partial longitudinal meditational relationship for pros and a full longitudinal meditational relationship for self-efficacy (see Figure 6).

Discussion

The purpose of this study was to examine longitudinal predictors of physical activity maintenance in middle school students. Mechanisms within the TTM were tested in order to determine which processes and mediators were more beneficial, or

which mechanisms best prevented exercise relapse over time for this group of Rhode Island middle school students. Mediation models testing all of the mediators, Cons, Pros, and Self-efficacy was performed. These models (Figures 2-6) show visual representations of the specific contributions (i.e., significant paths, standardized solutions) of each of these mechanisms. All of the combined mediator models provided good fit indices and residuals, showing significant reliability of measures over time.

Cons models

Only dramatic relief provided a significant partial meditational path to cons. Overall, the cons within the models provided evidence that none of the processes in combination with cons helped maintain physical activity over time. This is consistent with cons decreasing importance in the maintenance stage with acquisition of healthy behaviors such as physical activity (Prochaska et al., 1994). Ultimately, this provides evidence that including cons in a physical activity intervention does not lead to better maintenance of physical activity within adolescents.

Pros models

For healthy behaviors such as physical activity, pros tend to increase and remain important for individuals in the maintenance stage (Prochaska et al., 1994). Within this study for the pros within the models, both counterconditioning, substituting healthy ways of thinking for unhealthy ones, and stimulus control, using reminders which encourage healthy behaviors, provided partial significant mediation paths. This is consistent with results provided by the single mediation models. In

addition, dramatic relief, reinforcement management and self-reevaluation also provided partial meditational paths to pros.

Self-Efficacy models

For the self-efficacy models, or models which measured how confident individuals were to maintain regular physical activity, there were significant mediation paths over time in combination with all five processes of change. This provides evidence that self-efficacy is an important component within an intervention based on the TTM. Overall, these results provide evidence that including self-efficacy in physical activity interventions given to middle school aged exercise maintainers can be beneficial over time.

Limitations and Future Directions

Although this is a critical time when participation in physical activity declines, further research can be conducted in order to determine if there is a similar pattern within a different population of physical activity maintainers. In addition to using samples from other States and a more diverse range of ages, participants who report being at different stages at baseline (i.e, Precontemplators, Contemplators), can be examined to further investigate which mechanisms of the TTM are important/necessary for each stage of the behavior change process. Furthermore, the inclusion of all three mediators within the models would provide more details of which processes are significant over time.

The results for this population can be used to strengthen existing interventions as well as aid in developing new interventions for maintaining physical activity and preventing drop-out rates. This would allow an emphasis on the most relevant

processes of change, counter conditioning and stimulus control, in combination with pros within individuals who maintain regular physical activity. Maintaining exercise, and reducing drop-out rates, will promote a healthier lifestyle. Ultimately, providing encouragement to regularly participate in physical activity will reduce chronic diseases which can reduce health care costs and, most importantly, improve an individual's quality and quantity of life.

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Table 1. Questions used for Study Variables

	Variable	Question	Range
Processes	CC01	When you were tempted to skip it, you told yourself that you'd do a physical activity for at least a little while.	1-5
	CC02	When you didn't want to do a physical activity, you reminded yourself of your goal to get or stay in shape.	1-5
	CC03	You thought of physical activity as fun, rather than a burden.	1-5
	DR01	You were inspired by people who are more physically active than you.	1-5
	DR02	It upset you to hear that people your age aren't getting enough physical activity.	1-5
	DR03	You were inspired by stories about people who got into shape or improved their fitness.	1-5
	RM01	You found that you enjoyed physical activity.	1-5
	RM02	You realized that one of the benefits you got from physical activity was that it improved your mood.	1-5
	RM03	You congratulated yourself for being physically active.	1-5
	SC01	You spent time with friends who are physically active.	1-5
	SC02	You joined a team or gym, or signed up for a class so you had a regular time for physical activity.	1-5
	SC03	You wore sneakers or brought extra clothes with you so you could do a physical activity.	1-5
	SR01	Getting enough physical activity made you feel more confident.	1-5
	SR02	You saw yourself as a healthier person because you got enough physical activity.	1-5
	SR03	You liked seeing yourself as someone who takes care of his or her	1-5
Mediators	Next are some thoughts and feelings people might have about doing 60 minutes or more of physical activity on at least 5 days of the week. Please tell us how important each one is in your decision about whether or not to do 60 minutes or more of physical activity on at least 5 days of the week.		
	CON1	Others might feel guilty if they weren't doing that much physical activity.	1-5
	CON2	I'd have to buy sneakers or work-out clothes.	1-5
	CON3	I might be embarrassed to do a physical activity in front of others.	1-5
	CON4	It would take too much energy.	1-5
	PRO1	I'd be in a better mood.	1-5
	PRO2	I'd feel better about myself.	1-5
	PRO3	I'd stay in shape.	1-5
	PRO4	I'd have more energy.	1-5
	Next are some situations that might make it hard to do 60 minutes or more of physical activity on at least 5 days of the week. Please tell us how confident you are that you could do 60 minutes or more of physical activity on at least 5 days of the week.		
	SELF1	You were on a break from school?	1-5
	SELF2	You were busy?	1-5
	SELF3	You didn't feel like exercising?	1-5
	SELF4	The weather was bad?	1-5
	SELF5	You just wanted to chill?	1-5
	SELF6	You had to exercise alone?	1-5
Physical Activity	DAY60MIN	In a typical week, how many days do you do 60 minutes or more of physical activity?	0-7
	TYPDAY	On a typical day, how much physical activity do you get?	0-12

Table 2.
Percentages, Means, and SD's for Study Variables

Variable		%	Mean (SD)			Range
		T1	T1	T2	T3	
Gender	Female	42.7				
Ethnicity	American					
	Indian	2				
	Asian	3				
	Black	2				
	Hispanic	11				
	White	68				
	Other	2				
	Combination	11				
	Unknown	1				
Age	10	2				
	11	79				
	12	18				
	13	1				
Counterconditioning 1			3.60 (1.32)			1-5
Counterconditioning 2			3.89 (1.17)			1-5
Counterconditioning 3			4.52 (0.85)			1-5
Dramatic Relief 1			3.19 (1.26)			1-5
Dramatic Relief 2			2.98 (1.28)			1-5
Dramatic Relief 3			3.33 (1.30)			1-5
Reinforcement 1			4.67 (0.67)			1-5
Reinforcement 2			4.04 (1.10)			1-5
Reinforcement 3			3.90 (1.19)			1-5
Stimulus Control 1			4.45 (0.82)			1-5
Stimulus Control 2			3.65 (1.41)			1-5
Stimulus Control 3			3.76 (1.27)			1-5
Self-Reevaluation 1			4.43 (0.81)			1-5
Self-Reevaluation 2			4.35 (0.90)			1-5
Self-Reevaluation 3			4.30 (0.92)			1-5
Con 1			2.47 (1.32)	2.16 (1.27)	1.96 (1.27)	1-5
Con 2			2.00 (1.27)	1.90 (1.26)	1.71 (1.16)	1-5
Con 3			1.64 (1.06)	1.69 (1.09)	1.58 (0.99)	1-5
Con 4			1.75 (1.05)	1.71 (1.04)	1.55 (1.01)	1-5
Pro 1			4.18 (1.00)	4.07 (0.98)	4.33 (0.98)	1-5
Pro 2			4.48 (0.93)	4.39 (0.96)	4.48 (0.95)	1-5
Pro 3			4.73 (0.60)	4.62 (0.73)	4.69 (0.77)	1-5
Pro 4			4.47 (0.79)	4.37 (0.87)	4.42 (1.00)	1-5
Self-Efficacy 1			4.28 (0.96)	4.27 (0.95)	3.30 (1.15)	1-5
Self-Efficacy 2			3.32 (1.11)	3.40 (1.27)	3.55 (1.25)	1-5
Self-Efficacy 3			3.34 (1.27)	3.38 (1.20)	3.97 (1.20)	1-5
Self-Efficacy 4			3.63 (1.24)	4.27 (1.04)	3.35 (1.24)	1-5
Self-Efficacy 5			3.43 (1.25)	3.57 (1.28)	3.70 (1.30)	1-5
Self-Efficacy 6			3.98 (1.25)	3.57 (1.29)	4.10 (1.17)	1-5
How many days 60 min			6.08 (0.86)	5.65 (1.47)	5.52 (1.60)	0-7
How many min per day			2.89 (2.43)	2.96 (2.55)	3.02 (2.62)	0-12*

Note. T1 = Baseline, T2 = Approximately 1 year, T3 = Approximately 2 years
*Range for "How many min a day" is measured in 30 min increments

Table 3. Correlation Matrix

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
1.T1Counterconditioning	-																
2.T1Dramatic Relief	.52*	-															
3.T1Reinforcement Management	.54*	..50*	-														
4.T1Stimulus Control	.41*	.47*	.50*	-													
5.T1Self-Reevaluation	.55*	.52*	.72*	.50*	-												
6.T1Cons	.05	.22*	.02	.08	.04	-											
7.T1Pros	.40*	.42*	.53*	.34*	.57*	.10*	-										
8.T1Self-Efficacy	.35*	.29*	.41*	.36*	.41*	.02	.29*	-									
9.T1Pysical Activity	.04	.00	.15*	.10*	.15*	.03	.03	.10*	-								
10.T2Cons	.07	.16*	.04	.00	-.02	.54*	.06	.04	.03	-							
11.T2Pros	.32*	.28*	.33*	.30*	.33*	.03	.40*	.24*	-.05	.06	-						
12.T2Self-Efficacy	.24*	.16*	.28*	.26*	.25*	-.02	.12*	.51*	.12*	-.01	.35*	-					
13.T2Physical Activity	.11*	.03	.10*	.15*	.10*	.01	-.01	.14*	.38*	.04	.20*	.25*	-				
14.T3Cons	-.02	.00	-.06	-.03	-.08	.34*	-.04	-.01	-.02	.40*	-.07	-.03	.03	-			
15.T3Pros	.20*	.15*	.22*	.17*	.26*	-.12*	.22*	.13*	-.04	-.13*	.42*	.19*	.07	-.06	-		
16.T3Self-Efficacy	.11*	.07	.16*	.19*	.21*	-.07	.10*	.35*	.14*	-.09*	.17*	.48*	.22*	-.03	.42*	-	
17.T3Physical Activity	.01	-.02	.06	.09*	.00	.02	-.07	-.09	.29*	.07	.12*	.20*	.53*	.05	.22*	.29*	-

T1=Time one, T2=Time two, T3=Time three
*Significant at the .05 level

Table 4.
Percentages, Means, and SD's for Scale Scores

Variable	Mean (SD)			Range
	T1	T2	T3	
Counterconditioning	12.00 (2.43)			1-5
Dramatic Relief	9.50 (2.87)			1-5
Reinforcement Management	12.61 (2.26)			1-5
Stimulus Control	11.85 (2.55)			1-5
Self-Reevaluation	13.08 (2.17)			1-5
Cons	7.86 (3.23)	7.46 (3.36)	6.80 (3.34)	1-5
Pros	17.87 (2.61)	17.45 (2.86)	17.92 (3.28)	1-5
Self-Efficacy	22.07 (5.07)	21.87 (5.15)	22.56 (5.87)	1-5
Physical Activity	8.97 (2.78)	8.61 (3.22)	8.54 (3.42)	0-12

Note. T1 = Baseline, T2 = Approximately 1 year, T3 = Approximately 2 years

Table 5.
Fit Indices for CON, PRO and SELF Mediator Models

Model	ML ROBUST				
	NFI	NNFI	CFI	RMSEA	RMSEA 90%
CON, PRO, SELF and CC	.786	.875	.888	.040	(.036,.044)
CON, PRO, SELF and DR	.779	.862	.877	.043	(.039,.046)
CON, PRO, SELF and RM	.790	.878	.891	.040	(.036,.044)
CON, PRO, SELF and SC	.792	.882	.894	.039	(.035,.043)
CON, PRO, SELF and SR	.786	.868	.882	.042	(.038,.046)

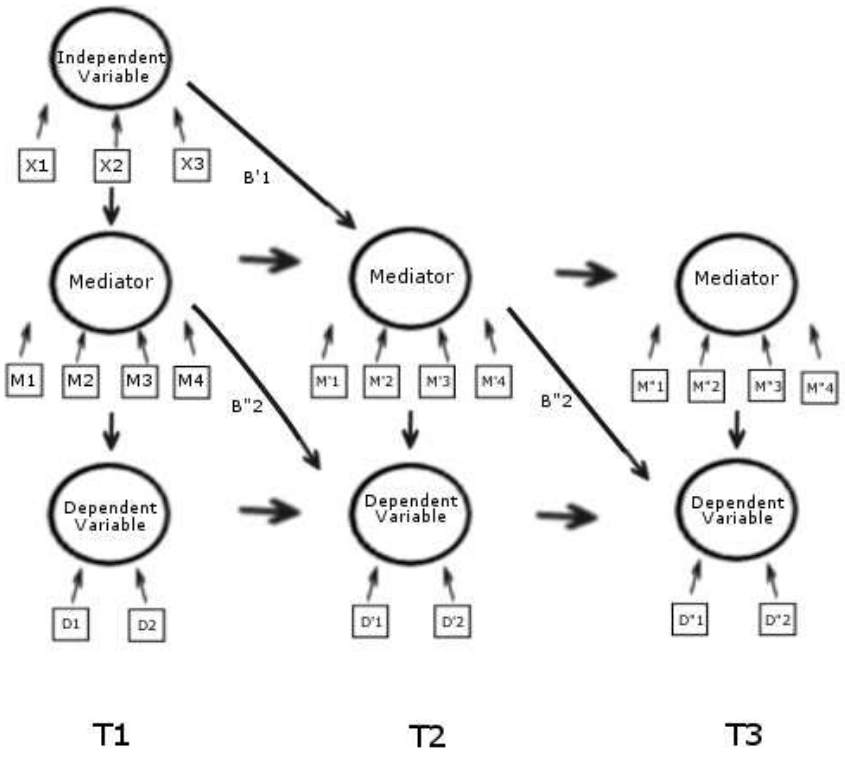

Figure 1.Basic Three Wave Mediation Model

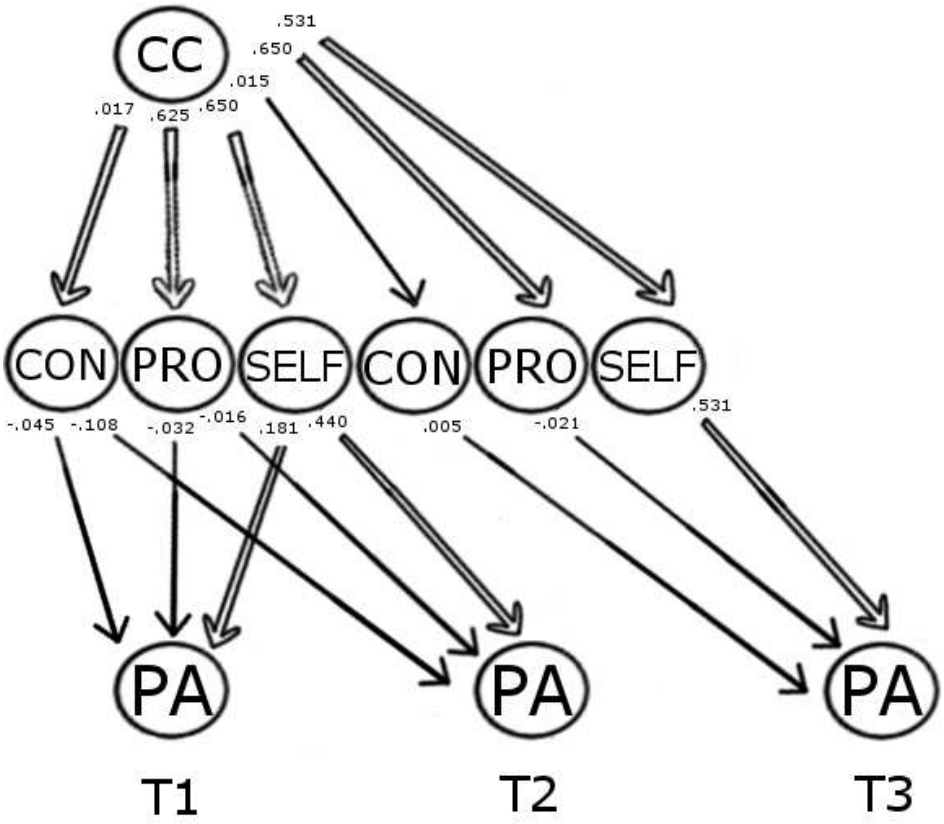

Figure 2.CON, PRO and SELF with Counterconditioning (CC) Model

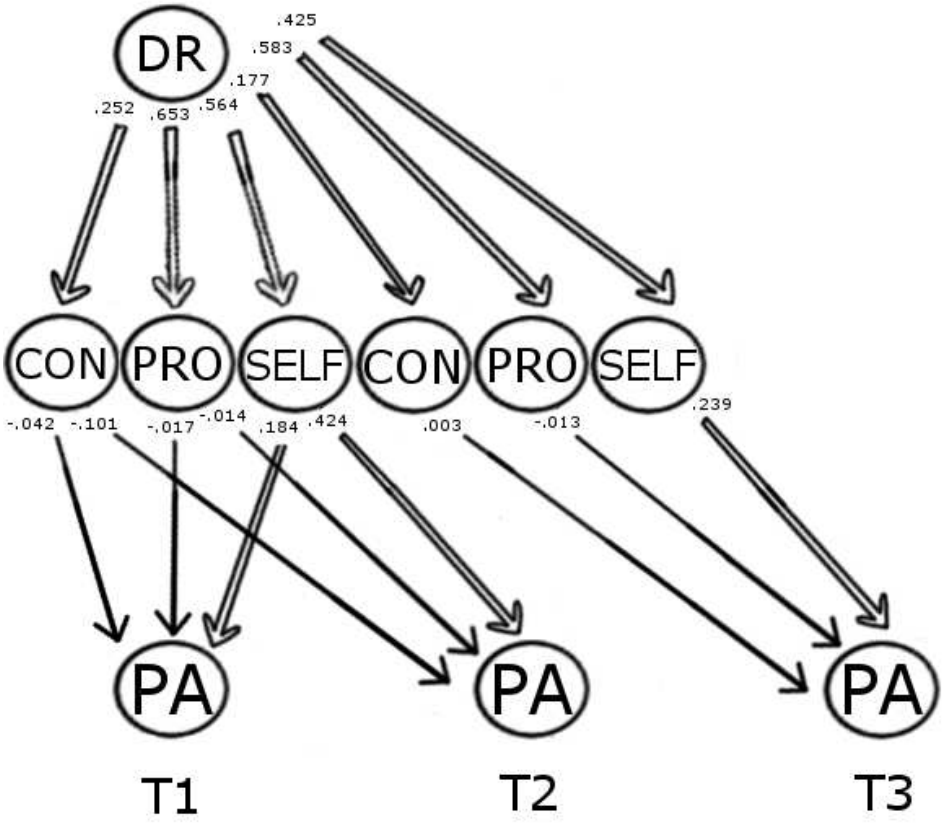

Figure 3. CON, PRO, and SELF with Dramatic Relief (DR) Model

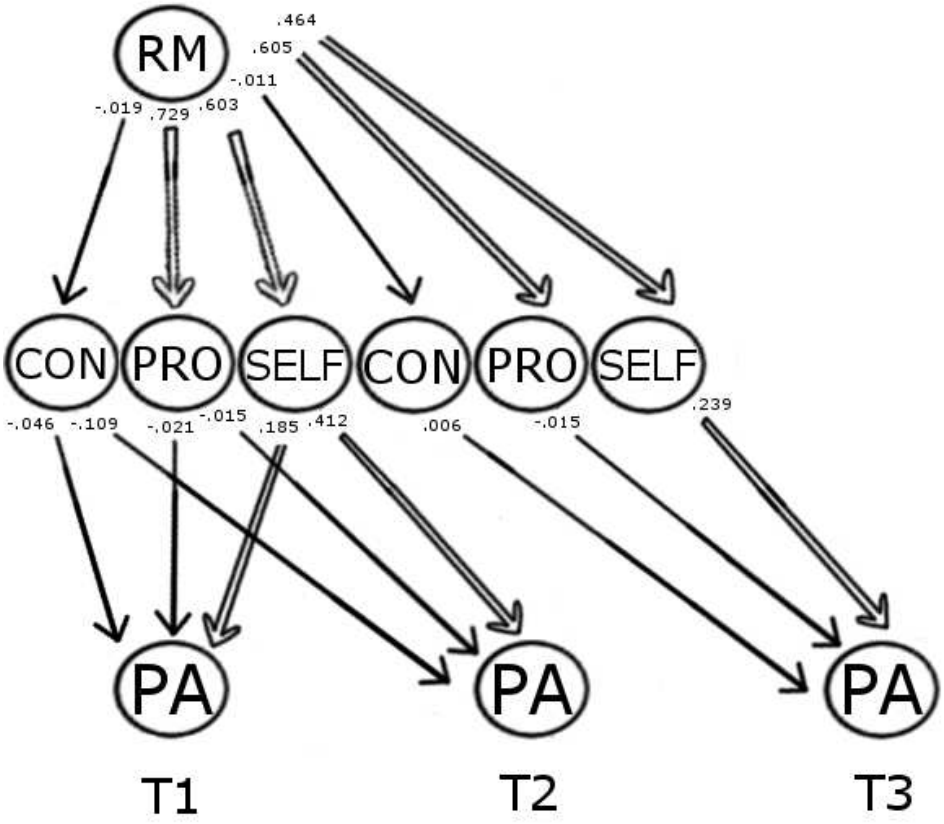

Figure 4. CON, PRO, and SELF with Reinforcement Management (RM) Model

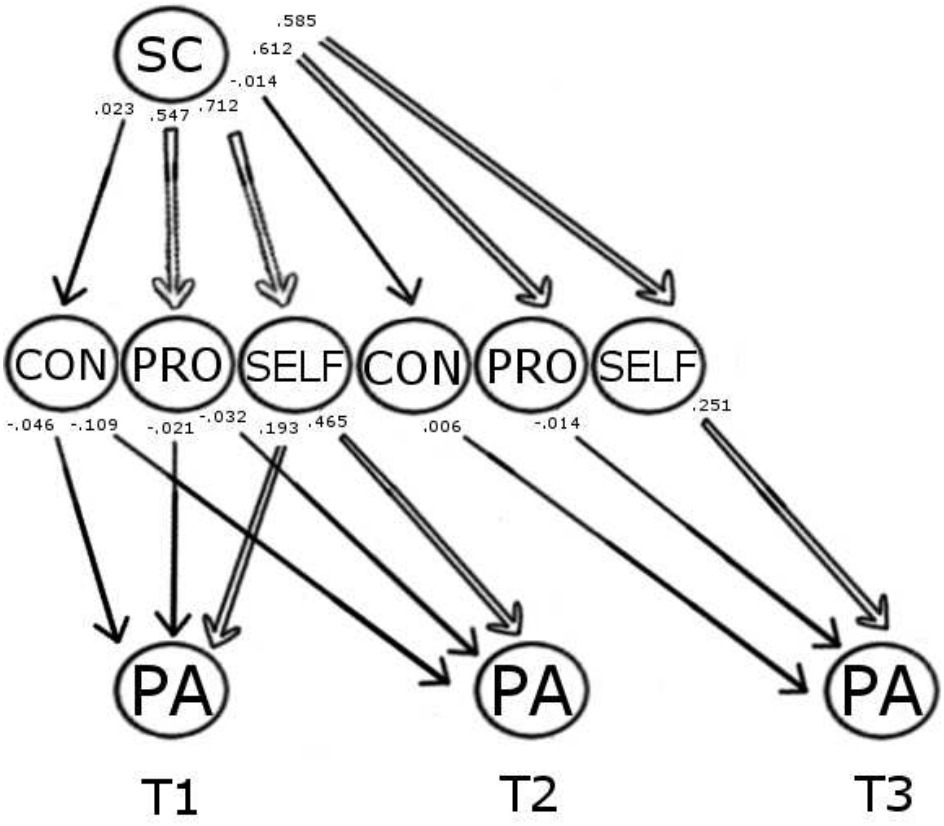

Figure 5. CON, PRO, and SELF with Stimulus Control (SC) Model

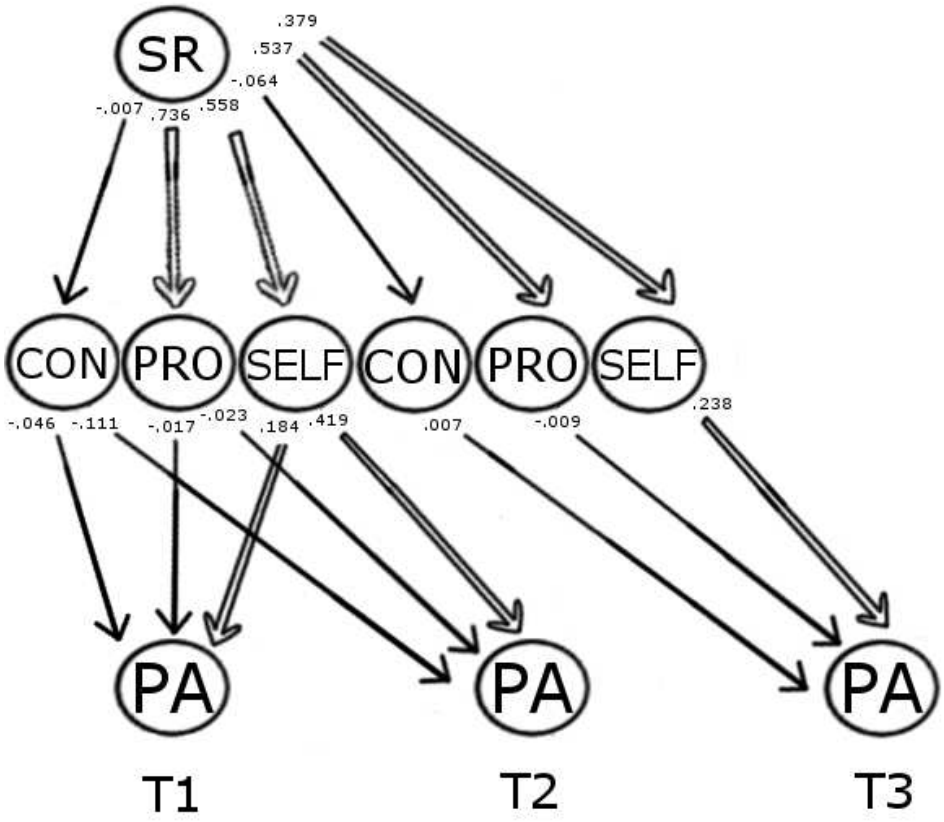

Figure 6. CON, PRO, and SELF with Self-Reevaluation (SR) Model

Study 3.

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Physical Activity Relapse Prevention Group Differences: Using Invariance Testing

Abstract

The current study examined the psychometric properties of a Transtheoretical Model Mediation Model, with self-efficacy (IV), stimulus control (mediator) and physical activity (DV) as variables. The model was confirmed in a previous study with a Rhode Island middle school population of physical activity maintainers. More specifically, subgroup differences between race (White = 86.5%), ethnicity (Hispanics = 11.8%), and gender (Females = 42.7%) subgroups were examined within a three year longitudinal model. Strong factorial invariance provided a good fit for gender (CFI =.938) but not for race or ethnicity. Although gender provided a good fit, none of the models provided ΔCFI values of less than -0.01. This supports the conclusion that the models did not hold parametrically in the invariance test, indicating no measurement invariance. Furthermore, these results do not provide evidence for these groups to be examined separately within the models.

Keywords: Transtheoretical Model of Behavior Change, physical activity, mediation, longitudinal model, adolescents, invariance testing

Physical Activity Relapse Prevention Group Differences: Using Invariance Testing

According to the 2007 National Youth Risk Behavior Survey (NRBS) there were disparities between physical activity levels of different groups of minorities among middle school aged adolescents. Specifically, minorities and females participated in fewer activities compared to both non-minorities and males. Even though an overall decline of physical activity among middle school students was determined, detailed disparities were sufficient for students who were considered to be at risk or, not fulfilling physical activity requirements. Many students answered no to the question, "I participated in at least one hour a day of physical activity in the past seven days". Majority of respondents who answered no were Black 32.1% followed by Hispanic 23.9% and White 20.3%. This disparity is alarming and deserves additional attention.

Gender differences have also been determined by the NRBS. According to the survey, there was a disparity among males and females whereas females participate in less physical activity than males. The survey concluded that females were more concerned more about their weight than their health, and were also using alternative unhealthy weight loss methods such as fasting and laxatives.

Disparities such as these highlight the importance of including additional analyses to determine differences between different groups (i.e., race, ethnicity, gender) so they can be further investigated. Because this study is concerned with students in the maintenance stage group, it is hypothesized that there will be a lower ratio of minority students who participate in physical activity on a regular basis. This

is also thought to be the case for the ratio of males to females in the maintenance stage group.

This study will determine the psychometric properties of a confirmed model; examining differences between race, ethnicity, and gender. More specifically, the study will determine if the structure of the model is different among the groups, or factorially invariant, if the models are the same for each of the subgroups. This will allow for disparities between the groups within the model to be determined.

Method

Participants

This secondary data analysis will consist of only participants in the maintenance stage group who had complete three years of data (N= 534). Demographic variables which will be used in this study include gender (Females= 42.7%) and ethnicity (2% American Indian/Alaskan Native, 3% Asian/Pacific Islander, 2% Black/Not Hispanic, 11% Hispanic, 68% White/Not Hispanic, 2% Other, and 11% Combination, and 1% Unknown). Due to the large variability in numbers of participants between groups, gender will be divided up between males and females, race will be categorized as “white” and “nonwhite”, and ethnicity will be categorized as “Hispanic” and “not Hispanic”. Further details about items are provided in Table 1.

Statistical Analyses

The proposed project is a secondary data analysis using a longitudinal mediation model. The model is presented in figure 1.

All latent variables, variables within circles on the figure, are composed of measured items, shown in boxes in the figure. The independent latent variable was created from the process, stimulus control, with three items. The mediator variable,

Self-Efficacy, is a latent variable made up of six items. Lastly, physical activity, the dependent measure, is composed of two physical activity items.

Time one consists of 6th grade middle school students who began the intervention in the maintenance stage, time two consists of their 7th grade data, and time three contains their 8th grade data. All time points (i.e., T1, T2, T3) are approximately a year apart. Time 2 and time 3 include the mediator variable and the physical activity variable.

Three levels of factorial invariance will be tested in order to determine disparities between groups within the proposed model. The least restrictive, Configural Invariance, will be first conducted. This test will determine the fit of the model without any constraints (i.e., factor, error) (Meredith, 1993). The next method that will be used to test invariance will be Pattern Identity Invariance, in which the free factor loadings will be constrained. Finally, Strong Factorial Invariance will be used to determine how the groups compare when both the factor loadings and the error terms are constrained. If the models have strong fits despite the added groups and constraints, the model will be determined to be psychometrically valid.

Results

EQS 6.1 software (Bentler, 2007) provided results for all of the levels of factorial invariance using structural equation modeling (SEM). Fit indices were determined to be used based on previous studies; Comparitive Fit Index (CFI), Normed Fit Index (NFI), Nonnormed Fit Index (NNFI), and Root Mean Squared Error of Approximation (RMSEA) (i.e., McGee et al., 2012, Babbin et al, 2011, Ward et al., 2004). A strong fit can be concluded for models with a CFI, NFI, or NNFI greater than

.90 and a really great fit with a CFI above .95 (Kline, 2005). Residuals are also be used to determine a good fit, whereas a Root Mean Square Error of Approximation (RMSEA) of less than .05 is ideal(Hu & Bentler, 1999). In addition to these values the difference in the CFI (ΔCFI) between the new and preceding models were calculated. These values indicate whether or not the null hypothesis should be rejected, indicating a value of -0.01 or less (Cheung &Rensyold, 2002). Due to the large sample size (N = 534), greater than the large criteria of 200, the Chi squared is always significant and will not be reported (Kenny, 2010).

Gender

Sample size per subgroup was adequate for males (56.7%) (n = 303) and females (42.7%) (n = 228), with .6% missing data. Strong Factorial Invariance was an adequate fit for gender (CFI:.938; NFI:.836; NNFI:.927; RMSEA:.044; see Table 2).

Race

Sample size per subgroup was largely discrepant for whites (86.5%) (n = 462) and nonwhites (5.3%) (n = 28), with 8.2% missing data. Strong Factorial Invariance did not adequately fit for race (CFI:.868; NFI:.793; NNFI:.868; RMSEA:.062; see Table 2).

Ethnicity

Sample size per subgroup was largely discrepant for Hispanics (11.8%) (n = 63) and non-Hispanics (84.6%) (n = 452), with 3.6% missing data. Strong Factorial

Invariance did not adequately fit for race (CFI:.791; NFI:.578; NNFI:..754; RMSEA:.096; see Table 2).

Discussion

These models testing relapse prevention in middle school students did not demonstrate a high level of factorial invariance. The group that performed the best between the three, with decent fit indices, was gender. Race followed by ethnicity both provided poor fit. In addition, none of the models provided ΔCFI values of less than -0.01, supporting the conclusion that the models did not hold parametrically in the invariance test, indicating no measurement invariance. These results do not provide evidence that these groups can be examined separately within the models.

A major limitation to this study includes the large discrepancy between the sample sizes of tested subgroups. This confirms the previous hypothesis, as there were smaller percentages of minorities in the maintenance stage group. This suggests that results in regard to race and ethnicity should not be fully trusted. In addition, before conclusions can be made concerning race and ethnicity, studies targeting more diverse samples should be conducted.

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Table 1.
Percentages, N, Means, and SD's for Study Variables

Variable		%	N	Mean (SD)			Range
		T1	T1	T1	T2	T3	
Gender	Female	42.7	228				
	Male	56.7	303				
	Missing	.6	3				
Race	White	86.5	462				
	Not White	5.3	28				
	Missing	8.2	44				
Ethnicity	Hispanic	11.8	63				
	Not	84.6	452				
	Missing	3.6	19				
SC01				4.45 (0.82)			1-5
SC02				3.65 (1.41)			1-5
SC03				3.76 (1.27)			1-5
SELF1				4.28 (0.96)	4.27 (0.95)	3.30 (1.15)	1-5
SELF2				3.32 (1.11)	3.40 (1.27)	3.55 (1.25)	1-5
SELF3				3.34 (1.27)	3.38 (1.20)	3.97 (1.20)	1-5
SELF4				3.63 (1.24)	4.27 (1.04)	3.35 (1.24)	1-5
SELF5				3.43 (1.25)	3.57 (1.28)	3.70 (1.30)	1-5
SELF6				3.98 (1.25)	3.57 (1.29)	4.10 (1.17)	1-5
DAY60MI				6.08 (0.86)	5.65 (1.47)	5.52 (1.60)	0-7
TYPDAY				2.89 (2.43)	2.96 (2.55)	3.02 (2.62)	0-

Note. T1 = Baseline, T2 = Approximately 1 year, T3 = Approximately 2 years

Table 2.
Goodness of Fit Statistics for Invariance Models

Model	NFI	NNFI	CFI	ΔCFI	RMSEA
Gender					
Configural Invariance	.856	.943	.954	—	.039
Pattern Identity Invariance	.851	.943	.952	.002	.039
Strong Factorial Invariance	.836	.927	.938	.014	.044
Race					
Configural Invariance	.807	.872	.872	—	.062
Pattern Identity Invariance	.800	.871	.871	.003	.062
Strong Factorial Invariance	.793	.868	.868	.003	.062
Ethnicity					
Configural Invariance	.551	.726	.777	—	.091
Pattern Identity Invariance	.531	.719	.763	.015	.093
Strong Factorial Invariance	.578	.754	.791	.028	.096

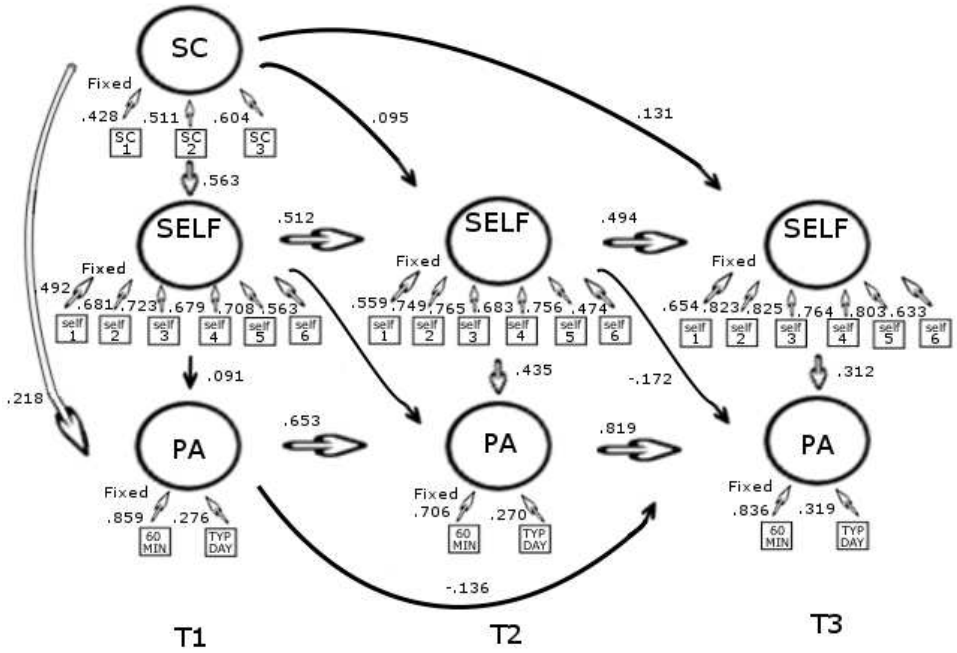

Figure 1.Self Efficacy (SELF) with Stimulus Control (SC) Model

Conclusion of Studies

The purpose of this study was to create longitudinal mediation models in order to determine which of the mechanisms within a computer based TTM intervention invokes positive change in physical activity maintenance behavior within a population of middle school students in the State of Rhode Island.

The total intervention sample (N=4,151; Velicer et al., 2013) was reduced to participants who were in the maintenance group in the beginning of the study and who had complete data at the end of the three year time period. This resulted in a total sample of 534 participants, which included 43% females, and 2% American Indian/Alaskan Native, 3% Asian/Pacific Islander, 2% Black/Not Hispanic, 11% Hispanic, 68% White/Not Hispanic, 2% Other, 11% Combination, and 1% Unknown.

All of the models within the study included latent variables. The IV's (i.e., stimulus control, helping relationships, counter conditioning, reinforcement management, self-liberation) were composed of three items. The mediator variables, Pros and Cons were composed of four items and Self-efficacy was composed of six items. Finally, the dependent variable, physical activity, was composed of two items.

The significance test, chi-square, used for the models was created in the statistical software, EQS. Although the chi square statistic was not assessed to determine fit because of the unreliability of the test due to the large nature of the data set (Kenny, 2010), values were reported for the CFI, NFI, and the NNFI. In addition, residuals, or the RMSEA were examined to indicate fit of the model.

In study one, single longitudinal mediation models (T=15) were developed. All five of the independent variables were used in combination with each of the three

mediators. The same dependent variable, physical activity, was used in all fifteen models. Each of the models provided good fit indices and residuals. The mediator Pros, was the best construct over time in combination with the independent variables, counterconditioning and stimulus control in the model. For healthy behaviors such as physical activity, pros tend to increase and remain important for individuals in the maintenance stage (Proschaska et al., 1994). Further investigation, such as using all three mediators in study two, will help determine the efficacy of the mediators being presented together in the intervention.

In study two, three way mediation models (T=5) were developed. All five of the independent variables were used in combination with all three of the mediators used and the dependent variable, physical activity. Each of these models resulted in good fit indices and residuals. In addition, reliability of measures over time was evident in all of the models. Self-efficacy showed significant mediation over time in all five of the models. Pros showed partial mediation from all IV's at time one to Pros at time two. Cons paths were not significant which was consistent with previous single and dual models. Overall, pros and self-efficacy in combination with counterconditioning and stimulus control provided the best evidence of efficiency in the model for physical activity maintainers.

In study three, the psychometric properties of the TTM were examined in a single mediation model which used Self-efficacy (IV), stimulus control (mediator) and physical activity (DV) as variables. Although good fit was determined for gender, none of the models were able to hold parametrically in the invariance test. This

provides limited evidence for the conclusion for the groups can be treated the same within the model, however, these analyses were very limited by small sample sizes.

Overall, one of the three mediators, Pros, demonstrated relevance to the physical activity intervention when administered to middle school students beginning the study as maintainers. Although two of the five processes of change, counter conditioning and stimulus control were more relevant to the model, not enough evidence is provided to delete the other three, reinforcement management, dramatic relief, and self-reevaluation, from the physical activity intervention. There was no evidence that providing feedback on cons in the model is beneficial to maintenance of physical activity. Therefore, future interventions may benefit from not including cons in TTM interventions created for middle school physical activity maintainers.

It is important to note that future studies such as ones created to examine how these results compare to different populations as well as studies designed to examine additional positive health behaviors are necessary. Ultimately, providing encouragement to physical activity maintainers of all subgroups to continue a positive lifestyle will reduce chronic diseases which can reduce health care costs and, most importantly, improve an individual's quality and quantity of life.

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