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Investigating the Relationship between Metacognition, Motivation, Self-Regulation strategy usage, and Physical Activity Participation

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Investigating the Relationship between Metacognition, Motivation, Self-Regulation Strategy usage, and Physical Activity Participation
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Abstract

Title: Investigating the Relationship between Metacognition, Motivation, Self-Regulation Strategy use, and Physical Activity Participation

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There are numerous benefits associated with physical activity. Unfortunately, few people participate in enough daily activity to reap the rewards. Health professionals have explored ways to promote adherence to physical activity and healthy behavior. Evidence shows self-regulation to be a determinant of physical activity. This study investigated the relationship between self-regulation strategy usage and levels of physical activity participation. Additionally, the study examined how motivation (through the perspective of Self-Determination theory) impacts physical activity. Six behavior regulation styles correspond to the degree of motivation (from low to high) on the Self-Determination continuum. A comparison of behavior regulation styles to physical activity levels was performed to better understand how motivation drives the decision to be physically active. Participants were students (at least 18 years old) enrolled at a private university in Florida. Self-report questionnaires

were used to measure the variables in this study: self-regulation strategy usage, behavior regulation style, and physical activity participation.

When analyzed, self-regulation strategy usage was related to physical activity. Those who participated in strenuous physical activity used more self-regulation strategies than those who participated in only non-strenuous activity. Compared to non-strenuous activities, participation in strenuous activities may result in better health benefits.

High levels of physical activity were seen among highly self-determined (autonomous) behavior regulation styles. Self-regulation strategies were used more by those within the higher autonomous behavior regulation styles. This information may guide research on how to promote activity based on an individual's level of motivation.

GPAs were compared to physical activity and self-regulation. Some studies have shown academic achievement (e.g., GPA or math scores) to be related to physical activity. In this study, the GPA levels did not appear to be associated with physical activity. There was not enough evidence to show GPA impacted usage of self-regulation strategies. Freshman class and graduates had higher levels of physical activity. Freshmen living on campus may part of the reason for higher activity compared to other undergraduate students. These findings suggest having an environment favorable for activity (and less driving) provides more opportunities to reach healthy levels of physical activity.

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Chapter I

Introduction

Background

Decades of research has established the importance of physical activity. Health experts recognize the connection between physical activity and overall health. Regular physical activity can lead to numerous health benefits, such as improved cognitive function and mental health, better quality of sleep, decreased risk of cardiovascular diseases, reduction in body fat, and maintenance of body weight (American Heart Association, n.d). Physical inactivity is a major contributor to some chronic, non-communicable diseases including obesity, high blood pressure, and diabetes (USHHS, 2018; President's Council on Sports, Fitness, & Nutrition, 2012; Cadmus-Bertram et al., 2015; Bauman et al., 2012). Physically active adults have shown increased longevity and a reduced risk of developing some common cancers, including breast, colon, kidney, and lung (Arem et al., 2015; Lee & Paffenbarger, 2000; Guthold et al., 2018).

Participation in regular physical activity benefits areas of "brain health" such as cognition (often measured as executive function, processing speed, and memory). Positive relationships have been discovered between physical activity and academic performance (Nelson & Gordon-Larson, 2006; McPherson et al., 2018; Pilcher et al., 2017; Weston et al., 2020). Other advantages to participation in long-term, consistent

activity are decreased feelings of anxiety and a reduced risk of depression and dementia (USHHS, 2018; ACSM, 2018; AHA, n.d.; WHO, 2018; Guthold et al., 2018).

Despite the many benefits associated with regular physical activity, less than half of the adults in the United States meet the minimum guidelines for general health and well-being. On a global scale, some studies estimate at least 23% to 27.5% of adults are not meeting physical activity recommendations (WHO, 2018; Guthold et al., 2018). Drop-out rates from physical activity programs are common and well documented. Some studies on exercise adherence have estimated over half of participants that begin an exercise program will stop within six months (Schmidt et al., 2000; Wilson & Brookfield, 2009; Linke et al., 2011).

Health professionals and researchers have tried to identify ways to promote adoption of healthy behaviors throughout a lifetime. What motivates someone to make healthy behavior changes depends on a variety of factors which vary greatly by individual. The factors that influence a health behavior change in one person may not be the same for someone else (Schuz et al., 2014; Duncan et al., 2010; Luque-Casado et al., 2021). Gaining knowledge about health and having intentions to become physically active are "rarely sufficient for changing behavior, and further motivational support is often needed for people to implement their intentions" (Conroy et al., 2014). To encourage better health and longevity, examining factors that influence physical activity can guide the development of strategies and interventions to encourage individuals to achieve healthy behavior change. (Korinek et al., 2018; Bauman et al., 2012; Nam et al., 2012).

Metacognition and Cognition

Metacognition has been defined simply as "thinking about thinking" or a person being aware of his or her thinking (Flavell, 1979; Ennis, 2016). Within education, metacognition has been referred to as "higher order thinking which involves active control over the cognitive processes engaged in learning" (Livingston, 2003; Wittrock, 1986). Metacognition is beneficial to education as it has been associated with successful learning and increased academic achievement. Additionally, metacognition plays a role in self-regulated learning which can be used to influence adherence to health behavior. (Chatzipanteli et al., 2016; Schraw et al., 2006; Craig et al., 2020).

The terms "metacognition" and "cognition" have been used interchangeably over the years, which can lead to confusion when discussing these concepts (Dinsmore, 2008; Livingston, 2003; Tomporowski et al., 2015). Schraw (2001) notes "cognition and metacognition differ in that cognitive skills are necessary to perform a task, while metacognition is necessary to understand how the task was performed." Flavell explained that "cognitive strategies are invoked to *make* cognitive progress, metacognitive strategies to *monitor* it" (Flavell, 1979). Cognitive skills tend to be more domain specific and used to develop strategies and abilities required within a certain subject. Metacognitive skills acquired are domain general; they can be used more broadly to develop processes and can be transferred to different learning environments (Schraw & Moshman, 1995; Schraw, 2001). It is important for health educators and learners to understand the differences between cognition and

metacognition strategies to encourage self-regulated learning (Schraw et al., 2006; Stadler et al., 2009; Anderson et al., 2006).

Self-Regulation

Self-regulation has been described as "personal regulation of goal-directed behavior or performance" made possible by "goal setting, reinforcements, self-monitoring, corrective self-reactions, performance self-guidance." Additionally, self-regulation involves preparing ways to overcome barriers and reach personal goals (Umstattd et al, 2009; Bandura, 1998). Students who use self-regulation skills tend to be more efficient learners and report a higher degree of academic satisfaction (Zimmerman & Schunk, 1989).

Self-regulation is a predictor of physical activity in adolescents and adults. Strategies involved with self-regulation (i.e., goal-setting and monitoring) have been associated with reaching health-related goals (Umstattd et al, 2009; Cadmus-Bertram et al., 2015; Miragall et al., 2018; Rhodes & Pfaeffli, 2010; Watanabe, et al., 2017). Self-management of one's health behaviors can lead to good health. As Bandura noted, "quality of health is heavily influenced by lifestyle habits" (Bandura, 2005). Those who control their health behaviors may enjoy the benefits of living longer, healthier lives.

Health behavior change has been examined within different theoretical frameworks, including self-regulation and cognitive theories (Bandura, 1998; Schuz, 2014). For example, Social Cognitive Theory (SCT) assumes people are in control of their own actions, and it helps them understand how to monitor and regulate their thinking (cognition) processes to help them reach their goals (Bandura, 2005). This

involves someone using their abilities to control their own cognition and to reflect on which strategies helped them achieve their goals. Many of these components can be used to set fitness goals, monitor and regulate health behaviors, and evaluate progress made towards health-related outcomes, including physical activity participation.

Cognitive strategies and behavior change techniques incorporated into health interventions have helped identify which factors influence health behavior change (McPherson et al., 2018). However, the relationship between domain-specific metacognitive and self-regulation strategy usage on physical activity has not been adequately explored (Leno, 2019; Tomporowski et al., 2015; Conroy et al., 2014; Umstattd et al., 2009).

Motivation

Motivation has been referred to as "the process whereby goal-directed activities are instigated and sustained" (Cook & Artino, 2016). At a basic level, motivation is the push to move, and it is a fundamental part of self-regulation processes. From a health perspective, motivational forces are what prompt the cognitive processes that lead to learning, performing, and regulating new health behaviors (Ryan & Deci, 2000; Cook & Artino, 2016; Solmon, 2003; Roberts, 1992). Motivation is a key factor in maintaining healthy behaviors, such as healthy eating and daily physical activity. Therefore, understanding the reasons behind someone's motivation (the motivational forces that drive action) may help us find better ways to regulate consistent, healthy activity levels (Ryan & Deci, 2000).

Self-determination and Regulation of Exercise Behavior

Because there are variety of factors which influence human behavior, different motivational theories attempt to explain the underlying forces that motivate humans to act (Bandura, 1998; Cook & Artino, 2016). For instance, Self-determination theory (SDT) suggests there are different types of motivation. Humans naturally have the need to use their own will and seek out activities they are interested in. Autonomy, relatedness, and competence are considered basic psychological needs in SDT. Fulfilment of these needs are linked to well-being and can play an important part in creating an environment to promote regulation of health behaviors (Ryan & Deci, 2000).

The reason to act can be for "reasons external to the self" (external motivation). Actions can also be based on more personal interests and values (internal motivation). High levels of achievement can "occur when we are motivated by an intrinsic interest" in the activity (Ryan & Deci, 2000; Cook & Artino, 2016). Within the framework of SDT, motivation lies along a continuum and reflects to what degree one is self-determined (or autonomous) about a behavior. Behaviors become more autonomous (or self-determined) as an individual internalizes the value of the behaviors and becomes part of their identity (Cook & Artino, 2016; Ryan & Deci, 2000). The types of motivation (from least to most autonomous) are amotivation, extrinsic motivation, and intrinsic motivation. Intrinsic motivation and highly autonomous types of extrinsic motivation are positively correlated with exercise behaviors (Duncan et al., 2010; Teixeira et al, 2012). People who are regularly active tend to identify as an exerciser; it is part of who they are. Assessing exercise

motivation allows us to recognize how people are driven to participate in physical activities. Understanding how one regulates behavior can provide direction for development of strategies that encourage physical activity, especially for those who are not sufficiently active (Duncan et al., 2010; Chatzisarantis & Hagger, 2009).

Of the three types of motivation, amotivation is the lowest level on the self-determination continuum. Amotivation has been described as a "state of lacking the intention to act" (Ryan & Deci, 2000). In the middle of the continuum lies extrinsic motivation. Behavior that is extrinsically motivated is prompted through external forces, such as rewards or punishments. At the far right of the continuum is the highest level of self-determination: intrinsic motivation. Those who are intrinsically motivated are highly autonomous and will perform an activity for the sake of personal enjoyment or satisfaction (Ryan & Deci, 2000; Cook & Artino, 2016).

Each of the motivation types correspond to six behavior regulation styles ranging from non-regulation (amotivated) to intrinsic regulation (intrinsic motivation). In regards to physical activity, most people fall within some gradient of extrinsic motivation. Extrinsic motivation has four different regulatory styles: external, introjected, identified, and integrated (Duncan et al., 2010; Ryan & Deci, 2000).

The least-autonomous of the extrinsically motivated behaviors are called *externally regulated.* Actions that are externally regulated are performed based on external pressures such as earning a benefit or avoiding punishment. *Introjected regulation* is next type within extrinsic motivation. Actions are performed to satisfy self-esteem or to avoid guilt or anxiety. While these behaviors are somewhat internalized, they are partially driven by external forces. *Identified regulation* is the

next regulatory type. Reaching an outcome (by performing the action) is important and valued on a personal level. *Integrated regulation* is the most-autonomous regulatory type within extrinsic motivation. Behaviors that are integrated occur when one personally identifies with them (Ryan & Deci, 2000; Cook & Artino, 2016).

Integrated and intrinsic motivation are similar as the behaviors are "engaged in willingly" and are fully self-determined, or autonomous (Ryan & Deci, 2000; Duncan et al., 2010). However, actions performed due to intrinsic motivation are done for the "inherent enjoyment" of the activity instead of for the purpose of reaching other (external) outcomes. When predicting health behaviors, the more autonomous regulation styles (identified and intrinsic) tend to be important in promoting adherence to physical activity (Teixeira et al., 2012; Duncan et al., 2010; Cook & Artino, 2016; Ryan & Deci, 2000).

Statement of the Problem

Although the importance of participating in daily physical activity has been established, very few people participate in the minimum recommended levels of activity to achieve health benefits. Health behavior changes are dependent on various factors. By recognizing which factors influence physical activity, health and fitness plans can be personalized to encourage healthy living and regularly adapted to promote adherence to physical activity. Ultimately, being able to successfully encourage healthy physical activity levels among more individuals may also contribute to a healthier society (USHHS, 2018; Riebe et al., 2018; Bauman et al., 2012; Ennis, 2017).

Health professionals have discovered strategies associated with successful promotion of health behaviors. This includes setting reachable activity goals; recognizing barriers and planning ways to overcome them; staying active throughout the day; and reminding individuals of the importance of regular activity (Bauman et al., 2012; Ennis, 2017). However, motivation is an important factor in driving health behavior and continuing with the behavior long term (Ryan & Deci, 2000; Duncan et al., 2010). Continued research on this topic helps us better understand the types of motivation that contribute to participation in physical activity.

Purpose of the Study

The purpose of this study was to investigate the relationship between self-regulation strategies and motivation on physical activity participation levels. Specifically, this research was to explore if types of motivation and usage of self-regulation processes impact participation in physical activity. Self-regulation strategy usage was measured to see if it impacted physical activity.

The decision to engage in a behavior, such as physical activity, can be prompted by different factors. While one person can be motivated to act based on personal reasons, another person may be influenced to act based on achievement of more external goals. Types of motivation (and corresponding behavior regulation styles) were examined to see if there was any impact on physical activity participation.

Research Questions

Based on previous discussion, it was expected that using self-regulation strategies would be positively associated with physical activity participation levels. In other words, as self-regulated strategy usage increased, physical activity participation

levels increased. To investigate the relationship between levels of motivation and physical activity participation, behavior regulation styles were compared to physical activity levels. The following research questions and hypotheses for this study are:

Research question 1. Do behavior regulation styles relate to physical activity participation?

H_1: Behavior regulation styles are related with physical activity participation.

Research question 2. Does self-regulation strategy usage relate to physical activity participation?

H_2: Self-regulation strategy usage is related with physical activity participation.

Research question 3. Do behavior regulation styles relate to self-regulation strategy usage?

H_3: Behavior regulation styles are related to self-regulation strategy usage.

Research question 4. Does self-regulation strategy usage differ between groups who are strenuously active and groups who are not strenuously active?

H_4: Self-regulation strategy usage differs between strenuous and non-strenuous groups.

Limitations

Self-report instrumentation was used to measure independent and dependent variables for this study. A limitation of using self-report tools as measurement is that participants may not accurately answer questionnaire items. There may be a tendency for participants to respond in a certain pattern (answer "yes" for all items), no matter the question content. Misremembering details can lead to incorrect estimates and invalid responses on self-report questionnaires. For example, a participant cannot remember how much they jogged during the week, so they overestimated how often they were physically activity. Although measuring variables with a survey can be efficient, if questions require participants to select from a list of provided answers, it may not accurately represent someone's viewpoint on the subject. A lack of clarity may cause one to misinterpret the questions and provide a less than accurate response. Response bias may limit the reliability and validity of the questionnaires used in this study.

Another limitation of this study has to do with the range of age for participants. Because most participants were between 20 and 29 years old, it may be difficult to generalize findings from this study to other populations (especially outside of this age bracket). In addition, the participants who volunteered for this study were from a student population attending a private university in Florida. The main campus is located near beaches and experiences warm weather most of the year. This could have a huge impact on an individual's activity levels. As there are more opportunities to be outdoors in pleasant climates over the fall and winter months, the physical activity

levels reported could be overall higher than individuals living in colder or harsher climates.

Delimitations

Participants for this dissertation study were selected from an accessible population of college students. A campus-based, online forum was used for recruitment of participants 18 years of age and older. In the full study, only student participants were recruited. This allowed for academic achievement to be examined and compared to levels of weekly physical activity. Studies with participants from a student population can contribute to research on physical activity promotion for young adults.

The surveys used in this study consisted of closed-ended and Likert-scale questions. These types of questions limit answer choices, but this can encourage more people to finish all responses which aids in completing research projects in a timely manner. The electronic-only access to the questions (via Qualtrics system) facilitated fast scoring of the surveys which helped the researcher gather and analyze the data more efficiently compared to hand-written responses.

Definition of Key Terms

Key terms and phrases used in this study are defined in this section.

Amotivation: a lack of motivation. The state of lacking intent to act (Ryan & Deci, 2000; Cook & Artino, 2016).

Exercise: physical activity that is planned and structured towards achieving certain fitness components or performance objectives. All exercise is physical activity, but not all physical activity is exercise (Caspersen et al., 1985; ACSM, 2018). Sometimes the terms are used interchangeably in research.

External regulation: a level of extrinsic motivation that is low autonomy and where "behaviors are performed to satisfy an external demand of reward contingency" (Ryan & Deci, 2000).

Extrinsic motivation: motivation that prompts actions by external forces, such as rewards or punishments (Cook & Artino, 2016).

Identified regulation: a level of extrinsic motivation that is somewhat autonomous; actions are performed because one consciously values the goal; the behavior is "personally important" (Ryan & Deci, 2000).

Integrated regulation: a level of extrinsic motivation that is the most autonomous; actions are performed because they are in alignment with a person's needs and values (Ryan & Deci, 2000; Cook & Artino, 2016).

Intrinsic motivation: an action prompted by personal interests and performed for the enjoyment of the task (Cook & Artino, 2016).

Intrinsic regulation: behaviors are "engaged in willingly" and are fully autonomous. Actions are performed for the personal, "inherent enjoyment" of the activity (Ryan & Deci, 2000).

Introjected regulation: a level of extrinsic motivation that is partly autonomous; behaviors are performed to avoid anxiety and guilt, improve self-esteem (Ryan & Deci, 2000).

Knowledge of cognition: a component of metacognition that refers to what individuals know about their own cognitive processes which can be used to control their learning (Schraw & Moshman, 1995; Ozturk, 2017).

Metacognition: "an individual's knowledge about and control over their cognitive processes" (Wittrock, 1986).

Motivation: processes by which goal-directed activities are initiated and continued in order to achieve the goal.

Physical Activity: "any bodily movement produced by skeletal muscles that requires energy expenditure." (Caspersen et al., 1985; WHO, 2020; ACSM, 2018). In addition to exercise and sports, leisure-time, transportation, occupational, and household activities are considered physical activity.

Regulation of cognition: a component of metacognition that refers to strategies and processes used by a person to plan, evaluate, and control their learning in order to reach a goal (Schraw & Moshman, 1995; Ozturk, 2017).

Self-Determination theory (SDT): a theoretical framework to explain motivation of human behavior. Innate psychological and social needs of a person are at the core of this theory. SDT "differentiates types of motivation along a continuum

from controlled to autonomous." (Ryan & Deci, 2017). Fulfilment of basic psychological needs (autonomy, competency, and relatedness) is regarded as crucial for motivation of human behavior. Application of this theory can be made to health behaviors such as physical activity.

Self-Regulation: "personal regulation of goal-directed behavior or performance" made possible through "goal setting, reinforcements, self-monitoring, corrective self-reactions, and performance self-guidance" to overcome barriers and reach personal goals (Umstattd et al, 2009; Bandura, 1998).

Chapter II

Literature Review

Introduction

The following chapter is divided into several sections. The first section is a discussion of the importance of physical activity to attain various health and wellness benefits. The next section addresses the problem of lack of physical activity participation. The third section identifies ways by which physical activity has been promoted along with suggestions to improve those efforts. The role of motivation and self-regulation in this study is discussed. This chapter closes with an overview of how previous research applies to this study.

The Importance of Physical Activity

Participation in regular physical activity offers many benefits for different aspects of health. The *Physical Activity Guidelines* (2018) published by the U.S. Department of Health and Human Services (USHHS) summarized some of the health benefits gained through regular, moderate-to-strenuous physical activity for people of different ages.

> Some benefits of physical activity can be achieved immediately, such as reduced feelings of anxiety, reduced blood pressure, and improvements in sleep, some aspects of cognitive function, and insulin sensitivity. Other benefits, such as increased cardiorespiratory fitness, increased muscular

> strength, decreases in depressive symptoms, and sustained reduction in blood pressure, require a few weeks or months of participation in physical activity. Physical activity can also slow or delay the progression of chronic diseases, such as hypertension and type 2 diabetes. Benefits persist with continued physical activity (p 39).

Participation in physical activity has also been associated with decreased risk for stroke, weight gain, and heart disease. Performing moderate activity can help reduce systemic inflammation and improve immune response. Regular physical activity has positive effects on emotional well-being, quality of sleep, and brain function. (USHHS, 2018; Pescatello, 2018; da Silveira, 2021; Nieman, 2020). While there is limited information on the relationship between physical activity and COVID-19, data gathered during the pandemic showed physical inactivity and obesity to be risk factors for increased rates of hospitalization, severe infection, and death after COVID-19 diagnosis (da Silveria et al., 2021; Nieman, 2020; Sallis et al., 2021). Because of the link between overall health and regular physical activity, health organizations have established guidelines for different populations.

For general health benefits, the World Health Organization (WHO) global recommendations on physical activity for adults is 150 to 300 minutes of moderately intense activity; 75 to 150 minutes of vigorous activity; or a combination of moderate- and vigorous-intense activity accumulated over a week. For adolescents, the activity recommendation is at least 60 minutes of moderate to vigorous activity every day (WHO, 2020).

In a similar set of guidelines, the Centers for Disease Control (CDC) and American Heart Association (AHA) have recommended that healthy adults accumulate at least 150 minutes of moderate-intense aerobic activity or 75 minutes of vigorous activity (or a combination of each) every week. Adults age 65 years and older are encouraged to be as active as possible throughout the day (if chronic conditions prevent reaching 150 minutes of moderate-intense activity per week). For children and adolescents, it is suggested to reach a minimum of 60 minutes of moderate activity every day (USHHS, 2018; AHA, n.d.; ACSM, 2018; Strong et al., 2005). Reducing sedentary time and increasing "incidental physical activity" (e.g., taking short walks and using stairs instead of an elevator) throughout the day can help individuals rectify the adverse effects of too much inactivity (WHO, 2018; CDC, 2022).

Physical health

Evidence shows when one participates in regular activity, it can prevent (or even treat) some diseases that negatively impact health. Health benefits include reduced risk of cardiovascular diseases (stroke, high blood pressure) and improvements to muscle and bone health (USHHS, 2018; ACSM, 2018; Erickson et al., 2019).

Obesity. Research has shown that lack of regular physical activity is associated with obesity. Obesity can put one at risk for a number of health consequences and is a leading cause of death in the United States and around the world. Obesity has been linked to systemic inflammation in the body which can negatively impact the immune system. Along with caloric intake, physical activity has

been shown to be an important factor in weight management (i.e., to either lose or maintain body weight) (USHHS, 2018; ACSM, 2018).

Immunity. The effectiveness of the body's immune system may be boosted by participating in consistent, moderate-intense physical activity. An enhanced immune response not only protects one from diseases, but can reduce the risk (and severity) of viral infection and respiratory infections, such as pneumonia, colds, and influenza. (Nieman, 2020; Nieman & Wentzl, 2019; da Silveira et al., 2020).

Da Silveira (2020) explains how immune response may be related to physical activity. When participating in moderate activity, there is an increase in the body's "immune surveillance" which guards against pathogens. There is a release of anti-inflammatory cytokines, and the circulation of lymphocytes increases. During moderate activity, there is a decrease in stress hormones and inflammatory responses which provides "a reduction in the systemic inflammatory process" and therefore helps protect one from infection. However, when one participates in more intense training sessions (i.e., athletes), an immunosuppression response is more likely and may cause one to be more prone to infections (da Silveira et al., 2020; Gleeson et al., 2011).

Brain health (cognition)

Research has found components of cognition (at times referred to as brain processes) to be positively associated with physical activity (Dinsmore et al., 2008; Livingston, 2003; Kohl & Cook, 2013). Cognitive functions including executive control and memory can improve with limited amounts of physical activity (20 to 30 minutes). Better accuracy and improved attention to a specific cognitive task has been

noted after participating in physical activity for about 30 minutes (Ellemberg & St Louis-Deschenes, 2010; Tomporowski et al., 2015; Ennis, 2017; Strong, 2005).

Studies on older adults have discovered cognitive control can be improved with physical activity. There is enhanced information processing ability and better task performance among those who are physically active (Gomez-Pinilla & Hillman, 2013). These changes may be attributed to improvements in brain structure (Colcombe & Kramer, 2003; Lipošek et al., 2019; Tomporowski et al., 2008). As we age, the hippocampus size decreases which can result in diminished memory and a decline in efficient cognition. However, there is evidence that regular physical activity may slow the hippocampus from aging while improving other cognitive abilities (i.e., attention and executive control) (Gomez-Pinilla & Hillman, 2013; USHHS, 2018). An increased supply of blood to the brain may promote new growth of neurons within the hippocampus which can enhance cognitive performance (American Psychological Association, 2020; Di Liegro et al., 2019; Gomez-Pinilla & Hillman, 2013). Newer research suggests white and grey matter within the brain may be impacted by physical activity which can enhance "cognitive processes like thinking and memory, attention span, and perception" (American Psychological Association, 2020).

Academic Achievement

Positive relationships have been seen between physical activity and components of academic performance (McNaughton & Gabbard, 1993; Singh et al., 2012; Lipošek et al., 2019). Evidence suggests participation in physical activity can enhance health and cognitive functions (Di Liegro et al., 2019), and the improvements to academic achievement may be due to cognitive changes associated with physical

activity (Tomporowski et al., 2008; Gomez-Pinilla & Hillman, 2013; Singh et al., 2012). Memory and executive control, which are foundational for learning and academic success, have been found to be related to physical activity (Kohl & Cook, 2013). Research suggests math achievement and reading performance are impacted the most by physical activity (Coe et al., 2006; Nelson & Gordon, 2006; Singh et al., 2012; Kohl & Cook, 2013).

Although it is well established that health and well-being can have an impact on learning, it should be noted there are various inter-related factors which can influence academic performance, including intellectual abilities, socioeconomic status, and learning environment (Basch, 2011; USHHS, 2018; Ennis, 2017). However, participation in regular physical activity can lead to physically and mentally healthier students. Healthy students are better learners (Basch, 2011; Strong, 2005; Ennis, 2017; Di Liegro et al., 2019). In this study, there was a comparison of the differences between GPA levels and physical activity participation (including the intensity of the activity). The results of this will be discussed in later chapters.

Health Care

In addition to physical and mental health benefits, regular physical activity may help keep health care costs low. Lack of physical activity can be expensive. The CDC has estimated costs of healthcare associated with "inadequate physical activity" to be $117 billion annually. A 2016 study on the economic impact of physical activity showed that adults who participated in at least 30 minutes of moderate or vigorous physical activity, five days a week had lower healthcare costs and resource utilization than those who were not as active (USHHS, 2018; Valero-Elizondo et al., 2016).

In 2013, due to physical inactivity, it was estimated that $54 billion (international dollars) was spent on health care globally with an extra $14 billion "attributable to lost productivity" (WHO, 2013). As physical inactivity increases, the costs increase. If this trend continues, it will negatively impact the "health system, the environment, economic development, community well-being, and quality of life" (WHO, 2018).

Lack of Physical Activity

Participation in physical activity has been associated with various health benefits. Although numerous, positive outcomes from regular physical activity have been documented, many do not meet the minimum daily activity levels suggested by health experts (Pauline, 2013; USHHS, 2018; Pescatello, 2018; CDC, 2022). Around the globe, based on 2016 data, WHO noted about 28% of adults (18 years and older) were not meeting the recommendations for physical activity. Overall, levels of insufficient activity were estimated to be stable at 27.5% (WHO, 2018).

Data collected by the CDC within the United States from 2017 through 2020 revealed the overall prevalence of physical inactivity to be 25.3%. Differences in physical inactivity prevalence varied by region. States in the West had the lowest frequency of inactivity (21%) followed by the Northeast (24.7%) and Midwest (25.2%). The highest prevalence of inactivity was found in the South (27.5%) (CDC, 2022).

Research suggests lower levels of physical activity tend to correspond to higher gross national product for a country. A study from Guthold and team (2018) on global physical activity trends investigated data from 168 countries (between 2001 and

2016). By 2016, the percentage of those insufficiently active in high-income countries was twice as high (36.8%) as those in low-income countries (16.2%) (WHO, 2018; Guthold et al., 2018). There was little change to the prevalence of inactivity from 2001 to 2016 in low-income countries (16% to 16.2%); but there was an average 6% increase in high-income countries over the same time (from 31.6% to 36.8%). An increase in sedentary behaviors at work (seated or technology-type jobs) along with use of more passive types of transportation (taking a taxi to work instead of walking) can explain some of the differences in overall inactivity levels between high-income and low-income countries.

Contrary to previous findings regarding adults (Guthold et al., 2018), the same research team later discovered no differences between the prevalence of inactivity and the country income level for adolescents. The lowest prevalence of "insufficient" activity was found in male adolescents from higher-income countries. However, this was not the case with female adolescents. Regardless of income group, and consistent with previous findings, almost all countries analyzed showed girls to be less active than boys (Guthold et al., 2020; Mielke et al., 2018; Bryan & Solmon, 2012). Understanding these differences may be helpful for promoting physical activity plans for individuals (Bryan & Solmon, 2012; Bauman, 2009).

Physical activity can improve health and reduce the risk of developing chronic disorders and other negative health conditions. Brain health and academic achievement (especially in math and reading) have been linked to physical activity. The next section discusses physical activity promotion and ways health educators have encouraged activity through health interventions.

Physical Activity Promotion

Health and Physical Education

A major goal within the physical education (PE) setting is promotion of physical activity. High quality PE programs allow students to be more physically active during the day and can encourage students to develop and use self-regulation skills, such as self-assessment, planning, goal-setting, and self-monitoring (Ennis, 2017). Self-regulation skills help students learn more information with less effort and report higher levels of academic satisfaction (Zimmerman & Schunk, 1989). In addition to building motor-learning skills, PE students can benefit by developing problem-solving skills as they learn to overcome obstacles that interfere with reaching physical activity goals (Le Masurier & Corbin, 2006; Ennis, 2017; Theodosiou & Papaioannou, 2006; Craike et al., 2018).

Health experts recommend children and adolescents participate in at least 60 minutes of physical activity every day for good health. Regular physical activity is known to reduce the risk of chronic diseases (such as obesity), improve the immune system, and promote overall good health (USHHS, 2020; Strong et al., 2005), but so few people are active enough to gain health benefits. A review published in the Lancet Child & Adolescent Health (2020) analyzed surveys for 1.6 million adolescents (ages 11-17 years old) from 146 countries. Approximately 81% of adolescents were not meeting recommended guidelines for physical activity (Guthold et al., 2020). Within the United States, the most recent *Dietary Guidelines* released in 2020 estimates 41% of children and adolescents in are overweight or obese (USHHS, 2020).

Some health educators have suggested learning sports and motor skills in PE helps students develop cognitive skills (self-monitoring and evaluating) which can transfer over to self-regulation of physical activity goals. Others recommend implementation of a knowledge-based curricula to teach cognitive strategies that encourage physical activity (Ennis, 2017; Theodosiou & Papaioannou, 2006; Beni, 2017). This suggests re-evaluating different approaches as to how physical education is traditionally presented to students.

Much of the educational research on cognition focused on student academic performance across subject areas, such as math and science. Within the setting of health and PE, there has been more emphasis on development of cognition skills for motor learning and physical performance (e.g., learning skills and processes needed to complete a golf swing) (Solmon, 2016; Chatzipanteli & Digelidis, 2011).

Silverman (2011) revealed four recurring factors of PE curriculum that can negatively impact student attitude about PE. They are (1) repetitive content; (2) lack of learning; (3) lack of relevance; and (4) competitive environment (Silverman, 2011; Beni et al., 2017). Very often traditional PE programs in the United States focus on sport-based curriculums which do not contribute to a motivational climate for all students. Individuals who are inactive/unfit, do not feel competent in a skill/activity, or do not like sports or competition may feel more engaged when they can select from different activities (Beni et al., 2017). Offering a variety of activities increases the chance of someone finding activities they enjoy and want to participate in. This also allows the student to take control of their own learning and may result in a more meaningful experience. Considering the needs of more students is beneficial in

encouraging people to become more physically active over a lifetime (Beni et al., 2017; Bryan & Solmon, 2012; Ennis, 2017).

A consistent link has been found between personal relevance and meaningful PE experiences. Researchers have noted (Jewett et al., 2017) students must consider activity "to be meaningful if they are to adopt an active lifestyle" (Kretchmar, 2000b; Silverman, 2011; Beni et al., 2017). Emphasizing "value of task" can lead to more meaningful experiences in PE. Out of 50 reviewed articles on what influences "meaningful experiences" for young people in PE and sports settings, main themes were discovered that influence meaningful experiences. They include social interaction, challenge, fun, motor competence, and personally relevant learning. Promotion of physical activity may be improved (at least in the youth setting) by stressing less of a traditional sports-performance approach to PE (Beni et al., 2017).

Beni et al (2017) suggested educators and coaches help students recognize *why* they are doing an activity (i.e., find the purpose and value) to instill personal relevance, as well as *how* the activity "applies to their lives beyond the classroom" (Beni et al., 2017; Ennis, 2017). This is important as "personal meaningfulness derived from experiences that are satisfying, challenging, social, or simply fun is likely to lead individuals to commit to a physically active lifestyle" (Beni et al., 2017; Solmon, 2003).

When promoting physical activity in a PE class setting, research (Bryan & Solmon, 2012) noted when a learning climate is more "task" or "mastery-oriented" it may be more inclusive of all students (compared to a "performance-oriented" environment). Task-oriented PE classes focus on students participating in an activity

to improve abilities and master the task at hand; it has been associated with "high levels of effort, persistence in learning, group cohesion, enjoyment, and other positive variables" (Cuevas et al., 2012; Bryan & Solmon, 2012).

The addition of task-oriented activities can help build a student's confidence through repeated successes which can nurture positive attitudes about their ability to participate in physical activity. Meaningful and positive experiences in PE may play a role in encouraging involvement from more students and influencing people to adopt a more active lifestyle (Cuevas et al., 2012; Bryan & Solmon, 2012; Jewett et al., 1995).

Behavior Change Techniques

Numerous factors are involved with behavior change. Different theories have been used as a framework to guide development of interventions to encourage health-related behavior changes. Investigations focused through the lens of previously established theory, such as the transtheoretical model, may offer explanation about a person's willingness to start a change in health behavior. Yet the factors that prompted an initial change of behavior may not accurately predict adherence to the behavior (Bandura, 1998; Cook & Artino, 2016; Schuz, 2014).

Investigations into what leads to behavior change has allowed us to identify factors or behavior change techniques (BCTs) which have the greatest impact on health behavior change. (Conroy et al., 2014; Abraham & Michie, 2008). Reviews on effective health BCTs revealed "feedback" on behavior and "demonstration" of behavior resulted in successful physical activity interventions, especially within short-term interventions. BCTs such as goal-setting and self-monitoring have been

associated with both initial change and maintenance of the behavior (Howlett et al., 2019; Samdal et al., 2017; Mercer et al., 2016; Olander, et al., 2013).

No theoretical framework completely explains or predicts what influences someone to become (or stay) physically active (Cook & Artino, 2016; Bauman et al., 2012). However, applying perspectives from different theories may offer explanation as to why individuals make (and maintain) health behavior changes. With this knowledge, we may be able to successfully design effective, physical activity interventions for individuals (Cook & Artino, 2016; Solmon, 2003; Egli et al., 2011; Markland & Ingledew, 1997).

Physical Activity Interventions

Physical activity interventions are a way to offer health knowledge and introduce strategies that encourage someone to be more active. The Merriam-Webster dictionary defined strategy as, "the art of devising or employing plans or stratagems toward a goal." Pressley explained that strategies are used to accomplish a purpose and are "operations over and above the processes that are a natural consequence of doing a task" (Pressley et al., 1987). Cognitive strategies are used to make progress toward a specific task or goal, and they can include an assortment of tactics used by educators and students to improve and self-regulate learning. (Olander et al, 2013; Umstad et al., 2009; Wood & Neal, 2016; French et al., 2014).

Physical activity interventions have been shown to have a positive effect on increasing activity levels. This can help health experts determine which factors or strategies are effective in achieving a desired health behavior change (Cadmus-Bertram et al., 2015; Adams et al., 2017; Duncan et al., 2014; Hartman et al., 2016;

Miragall et al., 2018; Wood & Neal, 2016; French et al., 2014). Samdal and his team (2017) discovered most interventions combined several strategies (or BCTs) as part of the treatment to investigate any relationship to physical activity levels. In a 2019 meta-analysis, researchers found an average of 8.4 different BCTs (such as "goal/action planning," and "prompt/cues") found across 26 physical activity interventions. The results showed goal-setting (walk 5 days a week) and self-monitoring of a behavior (log in workout into journal) to be "associated with better intervention effects" (Howlett et al., 2019; Samdal, et al., 2017; McEwan et al., 2016).

Health interventions have been delivered through different formats. Some interventions have been presented through guided, group settings with follow-ups by a health professional or coach (offered in a university/school-based or community-based setting). Other studies opted for a more individual-led approach which may be important for long-term adherence to a behavior. (Samdal, et al., 2017; Cadmus-Betram et al., 2015; Hartman, et al., 2016; Howlett et al., 2019). To illustrate: During an 8-week activity intervention, a person checks-in at a gym 4 days a week to workout. They record and reflect on their weekly progress. At the end of the 8 weeks, they submit their notes to researchers and have their progress measured.

Technological advancements have paved the way for "eHealth" (electronic health) and "mHealth" (mobile health). Electronic tools for self-monitoring, such as spreadsheets and pedometers, have been successful in helping participants keep track of activity goals. Wearable activity trackers and smartphones can use apps to record a person's activity, provide feedback, and generate notifications about a behavior in real time (Mercer et al., 2016; Reeder & David, 2016). Additional information based on

quantitative data from activity trackers may help to better personalize physical activity interventions (Howlett et al., 2019; Hickey & Freedson, 2016).

Compared to studies on static goal-setting, adaptive goals used in physical activity interventions have led to increased levels of physical activity in adults. An adaptive approach allows the person's intervention to be revised, based on the level of progress made towards a goal (Korinek et al., 2018; Adams et al., 2017). For example, as incremental goals are met (e.g., 5,000 steps/day achieved for 2 weeks), components of the intervention can be updated to newer, more advanced goals (e.g., new goal is set at 10,000 steps/day).

As this section noted, there have been different approaches used by health professionals to encourage people to be more active every day. In addition to health education and self-monitoring of health goals, setting adaptive goals through health interventions have been successful in promoting physical activity. Individuals can use wearable devices (e.g., health apps for smartphones or Fitbits) to track and receive feedback about their activity throughout the day. This technology can make it easier to self-monitor and self-regulate health goals.

The upcoming sections discuss how metacognition, self-regulation, and motivation are involved with physical activity. In addition, components of metacognition, self-regulation strategies, and types of motivation are presented. How these variables apply to this dissertation study are also discussed.

Metacognition

Metacognition can be described as a person's awareness of their own knowledge and an understanding of their own thought processes. Wittrock defined

metacognition as “an individual’s knowledge about and control over their cognitive processes” (Wittrock, 1986). When someone uses metacognition, they not only use cognitive processes to learn, but they also know when, how, and why to use a specific strategy for the situation. For example, based on previous knowledge, learners can plan goals, create learning strategies, monitor and reflect on progress, self-evaluate results, and appropriately revise strategies when needed to help reach goals. (Meichenbaum, 1985; Solmon, 2016; Livingston, 2003).

The terms metacognition and cognition have been used interchangeably throughout educational research. For instance, a 2015 review of the literature discovered only a few studies on children’s metacognition had noted clear differences between executive function and metacognition. (Tomporowski et al., 2015; Dinsmore et al., 2008). However, researchers have outlined distinctions between cognition and metacognition. According to Schraw et al. (2006), “Cognition includes skills necessary to encode, memorize, and recall information. Metacognition includes skills that enable learners to understand and monitor their cognitive processes” Schraw et al., 2006).

Metacognition is different from cognition in that it is more domain-general in terms of knowledge and regulatory skills. Learners use cognition skills to perform a task whereas metacognition is needed to understand and monitor how the task is performed (Schraw et al., 2006). Pressley noted that when learners know little about a subject area, they may be able to understand better by using analogies from subjects they do understand. Cognitive skills can be used for learning a certain task or developing mastery of subject matter (i.e., steps to solve a quadratic equation), but

they may not be as useful outside of a specific area (Pressley et al., 1987). Whether the learner's strategy is cognitive or metacognitive depends on the context of how it is being used (Schraw, 2001; Schraw et al., 2006).

Metacognitive strategies are used to monitor and reflect on progress, and to make sure the goal is achieved, or the task is done correctly (Flavell, 1979; Schraw et al., 2006). The distinction between cognitive strategies (averaging one's test scores) and metacognitive strategies (evaluating if the answer is correct) is important to recognize in order to encourage self-regulation of learning and other goals. (Schraw et al., 2006).

Because of the generality of metacognition, strategies can be used across a variety of learning situations and subjects (i.e., math, reading, physical education, science) to control one's learning and other performance outcomes (Schraw, 2001). Some evidence shows the greater someone's metacognitive abilities are, the more successful they tend to be at their learning endeavors (Pressley et al., 1987; Livingston, 2003). However, the influence of activity-related metacognitive strategies on physical activity levels has not been adequately studied (Leno, 2019).

Metacognition has been divided into two components: knowledge of cognition and regulation of cognition. Knowledge of cognition generally refers to what individuals know about their own cognitive processes which can be used to control their learning. Regulation of cognition includes the strategies used by a person to plan, evaluate, and control their learning to reach a goal (Schraw & Moshman, 1995; Ozturk, 2007). Cognition researchers including Schraw (2001) have noted that skills related to knowledge of cognition often supports behavior regulation. Although made

up of individual strategies, the knowledge and regulation skills someone uses to control their cognition are interconnected (Schraw, 2001; Livingston, 2003).

Knowledge of cognition

Flavell (1979) categorized metacognition knowledge into three variables: person, task, and strategy. Modern researchers refer to the knowledge of cognition categories as declarative, procedural, and conditional. In simple terms: Knowing *about* things is declarative knowledge; Knowing *how* to do things is procedural knowledge; Knowing *when* and *why* to use certain strategies to efficiently (and correctly) complete a task or goal is conditional knowledge. To better understand how these different parts interact, Livingston uses the example. "I know that I (declarative) have difficulty with word problems (procedural), so I will answer the computational problems first and save the word problems for last (conditional)" (Schraw, 2001; Flavell, 1979; Livingston, 2003).

Declarative knowledge. This knowledge tends to be descriptive in nature. Declarative knowledge consists of knowing about things, facts, processes, and other basic information related to a certain environment or subject area. Knowing that something is the case (i.e., "+" means add) is declarative knowledge. In the metacognitive sense, declarative knowledge is what someone knows about their own general cognitive processes for learning, as well as their strengths and weaknesses. This includes individuals knowing their limitations of their own memory or what influences their learning (Flavell, 1979; Livingston, 2003; Schraw, 2001).

Successful learners tend to have knowledge about their own cognitive processes related to memory; and they are able to apply previous knowledge to new

learning experiences (Schraw & Moshman, 1995; Pressley et al.,1987). Some have noted that declarative knowledge is an interconnected part of procedural knowledge in that it provides the starting point for building and mastering skills. For example, knowing "+" means "to add" is the first step needed to advance a person's skills and master the ability to perform addition (ten Berge & van Hezewijk, 1999).

Procedural knowledge. Knowledge that involves a person's understanding of a task and what cognitive demands the task will put upon them is procedural knowledge. Studies have shown those who measured high on use of procedural-knowledge skills perform those skills more automatically and can better sequence learning strategies when it comes to situations requiring problem solving (Schraw & Moshman, 1995). It can be thought of as *how* to perform or make application of a skill (Ozturk, 2017).

Conditional knowledge. Knowledge which refers to knowing cognitive and metacognitive strategies and having the ability to know *when* to utilize the appropriate strategy to complete the task is conditional knowledge. The knowledge of when and where to apply strategies involve an overlap and interaction of declarative and procedural knowledge (Livingston, 2003; Flavell, 1979). Flavell (1987) also noted goals or objectives set by the learner will determine the types of strategies used. For example, if the task is to perform addition on a list of numbers, the strategy would be cognitive. To evaluate if the given answer is correct or incorrect would involve metacognitive strategies.

Regulation of cognition

A learner's use of cognitive strategies to control their learning environment is referred to regulation of cognition. Metacognitive regulation has generally been divided into the categories: plan, monitor, evaluate and revise. These strategies allow one to actively develop a course of action, monitor the progress, and assess the advancement towards their goals. Based on progress, strategies may need to be revised by the learner to make sure goals have been reached properly (Schraw, 2001; Flavell, 1979).

Plan. Deciding what needs to done and selecting suitable strategies to regulate behavior and reach goals is the process of planning. The planning process tends to be continuous in nature; as objectives are met (or not met), a different set of actions may be required to reach the desired outcomes (Schraw & Moshman, 1995). For instance: if someone wants to be more physically active, they can set a specific goal of walking 30 minutes a day and schedule the activity into their calendar or organizer (McEwan et al., 2016; Wilson & Brookfield, 2009).

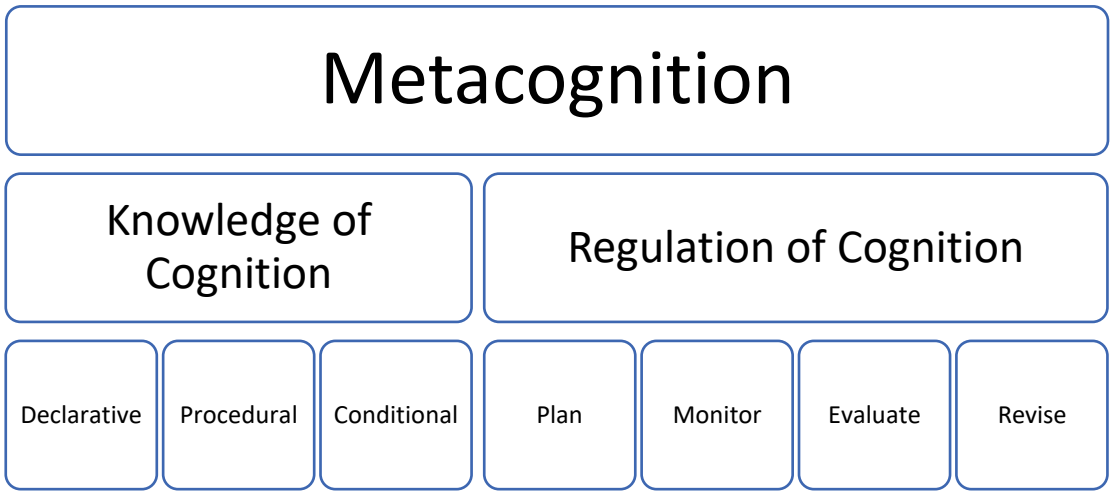
Monitor. The active observation of a performance to regulate strategies in order to reach specific goals or performance objectives is monitoring. Based on progress, monitoring can allow individuals to continue, change, or leave out strategies being used to accomplish a goal. Another benefit to monitoring is that it can lead to improvement of strategy knowledge. Active monitoring has been found to improve children's understanding of how to use strategies properly and distinguish between which strategies are beneficial and those that are not (Pressley et al., 1995).

Evaluate. A component of regulation where the learner reviews progress made towards previously set goals or objectives is evaluation. Considering the effectiveness of cognitive strategy use is also part of evaluation. Some researchers feel planning, monitoring, and evaluation is not always a conscious process to all learners. Evaluation may be more of an automatic process among adults and other experienced, successful learners (Schraw et al., 2006).

Revise. After monitoring and evaluating the progress on goals or objectives, along with considering perceived benefits of strategies used, goals or strategies may need to be revised (Schraw & Moshman, 1995). More realistic goals may be needed based on performance advancement. For example, if someone has practiced enough volleyball serves, they may want to revise goals so they can advance to jumping to "spike" a ball over the net during play (Anderson, 1997). Figure 2.1 outlines the components of metacognition previously discussed.

Figure 2.1

Elements of Metacognition



Note. Adapted from Schraw, 2001.

To investigate if using metacognitive strategies contributed to engagement in physical activity, a comparison of metacognitive and self-regulation strategies to physical activity participation was conducted in the preliminary study. To examine metacognitive strategies, activity-related strategy usage was measured to see if there was high strategy usage among physically active participants. Planning strategies included: "I set specific goals before I begin exercising" and "I organize my time to best accomplish my exercise goals." Findings from the pilot study will be discussed in later chapters. Self-regulation is discussed in the next section, as well as how it applies to this dissertation study.

Self-Regulation

Self-regulation has been described as a process "whereby learners personally activate and sustain cognitions, affects, and behaviors that are systematically oriented toward the attainment of personal goals (Zimmerman & Schunk, 1989). Self-

regulation has been established as a determinant of physical activity and has been used successfully for health behavior change. Specifically, self-monitoring and goal-setting strategies usage is highly associated with physical activity participation (Umstattd et al., 2009; Samdal et al., 2017).

In a 2010 review, self-regulated change was found to be a key factor in health interventions that resulted in changes to physical activity (Rhodes & Pfaeffli, 2010). In a 16-week study on the effects of self-monitoring strategy use on physical activity, participants experienced an average increase of 63 minutes per week in moderate-intense activity when compared to baseline measures (Cadmus-Bertram et al., 2015). Another study with a sample of sedentary college students increased their daily physical activity by setting personalized physical activity goals (Miragall et al., 2018). Based on cross-sectional studies, Watanabe and team (2017) later noted a stronger correlation between self-regulation and physical activity when compared to self-efficacy and outcome expectations. (Rhodes & Pfaeffli, 2010; Watanabe, et al., 2017).

Consistent participation in physical activity requires development of habits through behavioral changes. Cognitive involvement is required to decide to become regularly active long term. In other words, there are thought processes involved to make the decision to become physically active and to maintain the behavior throughout life (Ennis, 2017). These processes can be achieved through development and use of self-regulatory skills. According to self-regulation theory, individuals must be actively involved (self-directed) when managing their behavior (Schraw & Moshman, 1995; Ormrod, 2012). A knowledge of how and when to use self-regulation strategies, such as planning, monitoring, and evaluating progress, are also crucial for

someone wanting to regulate their own health behavior (Livingston, 2003; Bandura, 1998).

Planning. Educational researchers have suggested students be taught goal-setting and planning strategies as part of health or PE. Health experts and educators can help others successfully reach healthy outcomes by providing guidance on setting manageable, personalized goals (McEwan et al., 2016; Wilson & Brookfield, 2009). After setting attainable objectives of value, one must set benchmarks for progress to achieve those objectives. Appropriate goal selection is based on the person's needs, desired outcomes, and abilities of the person. Planning includes selecting appropriate strategies (based on the previously set goals) to help regulate actions and reach performance goals. Examples of planning include: setting aside time to walk every day or scheduling weekly activity goals to calendar to reach a more long-term goal of weight loss (Schraw & Moshman, 1995; McEwan et al., 2016).

An individual's past successes and failures can influence goal setting and therefore can impact health behavior change. This highlights the importance of realistic goal-setting along with planning and establishing standards of measure for achieving those goals. As someone accomplishes a certain goal or performance level, they may look for more of a challenge and set goals progressively higher to improve their performance (Ormrod, 2012).

Self-monitoring. Gathering information and monitoring progress towards achieving one's own goals is self-monitoring. This has also been referred to as self-observation. Self-observation involves a real-time look at current behavior and behavior change over time, with an emphasis on what supported (or did not support)

achievement of goals (Schraw & Moshman, 1995; Ormrod, 2012). Various styles of wearable activity trackers can monitor and give instant feedback about different areas of an individual's health (steps per day; heart rate; calories burned). The convenience of mHealth can serve as an advantage for the purposes of self-monitoring health goals (Lyons et al., 2014; Lobelo et al., 2016; Hartman et al., 2016).

Self-evaluation. The process which involves judgement of one's behavior based upon standards of measure set by an individual is self-evaluation. The judgement process allows a person to determine how valuable the performance of the behavior will be for them; whether the behavior is viewed as positive or negative; and if the result was due to personal or external factors (Bandura, 1998). Based on an individual's assessment of their progress, along with achievements or barriers encountered, their reaction (or self-response) may be to reinforce the behavior to continue the desired outcomes (through self-reward, such as praise).

Self-evaluation can highlight a need to realign strategies to achieve the anticipated results (Ormrod, 2012). For example, attention to relapse prevention (e.g., better time management) may be needed if goals are not being reached consistently (Ormrod, 2012; Bandura 1998). Reflecting on what has been accomplished allows individuals to understand what changes or gradual improvements need to be made to continue progress towards their goals (Ormrod, 2012).

The process of self-regulation takes place through acquisition of various cognitive constructs and has a positive effect on influencing health behavior change (Zimmerman & Schunk, 1989). Educators have been encouraged to teach students strategies to encourage processes "associated with self-regulated learning." This can

play an important role in promoting physical activity by increasing one's ability to set goals based on standards and desired outcomes; encouraging self-observation and reflection on performance; and self-evaluation of pre-set standards and goals (Anderson, 1997; Schraw, 2006).

Bandura noted knowledge, desire, and intent were not enough to prompt behavior change if a person could not self-regulate their behavior and "exercise influence over their own motivation" (Bandura, 1998). Someone who has cognitive skills, but lacks motivation to use the skills, is not as likely to reach the same level of achievement as someone who is motivated (Zimmerman & Schunk, 1989; Livingston, 2003; Schraw et al., 2006). Beliefs and attitudes are associated with motivation and can influence one's development and use of cognitive skills. These factors can determine whether someone decides to participate in physical activity (Schraw et al., 2006; Livingston, 2003; Chatzipanteli et al., 2016).

Promotion of physical activity is a major goal in physical education, and it is important to investigate motivational factors that encourage engagement in activity throughout a lifetime (Bryan & Solmon, 2012; Guthold et al., 2019; Bauman et al., 2012). As Solmon suggested: "Motivation is creating an environment that encourages students to make decisions to engage in learning activities actively and with effort, and that includes fostering positive attitudes about class and eliciting cognitions that will produce achievement" (Solmon, 2003). Cognitive strategies, BCTs, and other contributing factors of physical activity have been studied within the areas of health, sports psychology, and physical education. Successful physical activity interventions have been shown to provide ways for self-monitoring and other self-regulation

strategies to the participant (McEwan et al., 2016; Hartman et al., 2016; Cadmus-Bertram et al., 2015). However, more research is needed to investigate how self-regulation strategies and motivation are associated with an individual's physical activity participation levels.

Motivation

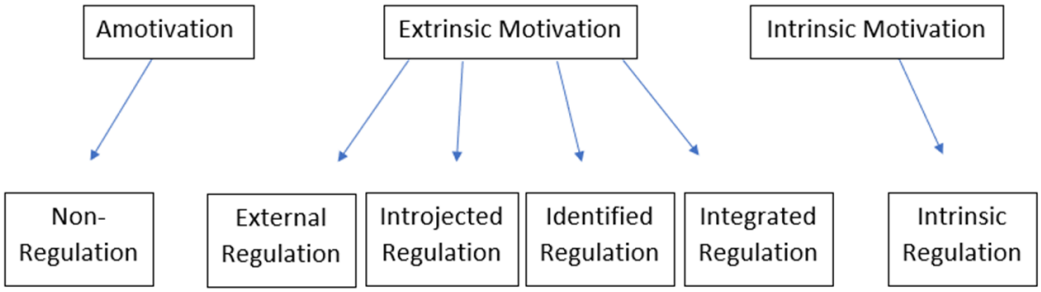
Motivation can be defined as "the need or reason for doing something" (Cambridge, n.d.). Motivation is considered an underlying component in cognitive processes. The decision to engage is a first step that leads to other cognitive processes which can lead to continued learning (Roberts, 1992; Solmon, 2003). Motivated individuals will decide to put forth effort, challenge themselves, and push through barriers to achieve goals or objectives (Ryan & Deci, 2000). If someone is not motivated to perform a certain task or activity, one can find ways to avoid being engaged with that behavior (Solmon, 2003). For the full study, Self-Determination theory (SDT) was used to investigate motivation as it relates to physical activity.

Self-Determination

When discussing motivation within the framework of Self-Determination, reasons for behavior can be "external to self" (externally motivated) or based more on personal interest and values (internally motivated). Motivation lies on a continuum reflecting the degree to which a behavior is self-determined (autonomous). For each type of motivation (i.e., amotivation, external, and intrinsic), there are corresponding behavior regulation styles. See figure 2.2 for the Self-Determination continuum.

Figure 2.2

Self-Determination continuum: Motivation types and Behavior Regulation styles



Note. Adapted from Ryan & Deci, 2003.

Amotivation is the lowest type of motivation on the self-determination continuum and corresponds to the non-regulation style. Intrinsic motivation is the highest on the continuum and corresponds with the intrinsic regulation style. Extrinsic motivation is between amotivation and intrinsic motivation and corresponds to external regulation, introjected regulation, identified regulation, and integrated regulation styles (Ryan & Deci, 2000).

Behaviors become more autonomous as one internalizes the value of the behavior and it becomes part of their identity. Those who are more intrinsically motivated on the self-determination continuum tend to adhere long-term to a behavior (e.g., physical activity); high levels of achievement can be reached "when we are motivated by an intrinsic interest." (Ryan & Deci, 2000; Cook & Artino, 2016). In addition to self-regulation strategies, the full study measured motivation and how it contributed to physical activity.

Summary

Researchers have investigated reasons as to why some people are physically active and others are not. Various factors are known to influence participation in physical activity. The pilot study explored the use of metacognitive strategies and self-regulation strategies (within the domain of physical activity) and how those strategies related to physical activity participation. Findings from the preliminary study resulted in changes to the variables measured in the full dissertation study.

Because motivation is key for an individual to start (and adhere to) a health behavior change, investigating someone's drive to perform physical activity can be beneficial for developing effective, personalized interventions to promote activity. The full study measured levels of exercise motivation and self-regulation strategy usage to examine how each factor related to physical activity participation. On the SDT continuum, the level of motivation (amotivation, extrinsic, and intrinsic) corresponds to different styles of behavior regulation. This study compared the behavior regulation styles to physical activity to see if these factors were related.

In the next chapter, details of the preliminary pilot study are discussed including instrumentation, variables, participants, study methods, and outcomes. Following this, specifics about the full study are outlined to include the instruments used, the variables measured, participant details, study design and procedures, and findings.

Chapter III

Methods

Introduction

This chapter describes the research design, procedures, and target population used for this study. A description of instrumentation used in the preliminary pilot study is provided. The independent and dependent variables are identified, and methods were discussed. Based on findings from the pilot study, the revisions applied to the full study are explained. Chapter 3 concludes with a description of the full dissertation study and research questions.

Preliminary Pilot Study

Three self-report questionnaires were completed by participants to measure the variables in the pilot study. Metacognitive strategy usage and self-regulation strategy usage were compared to levels of physical activity participation (accumulated per week). Activity-specific strategy usage was measured to evaluate the impact on physical activity. Likert scales were used to measure the level of self-regulation strategy usage and the level of metacognitive strategy usage (independent variables). Physical activity participation (dependent variable) was measured with a fill-in-the-blank questionnaire. This questionnaire calculated the intensity and amount of physical activity accumulated during a normal week. Details about the instruments and procedures used in this study are provided in the upcoming sections.

Instrumentation

Metacognition: Knowledge of cognition and Regulation of Cognition. The Metacognition Awareness Inventory in Exercise (MAI-E) was used to measure two independent variables: knowledge of cognition (KC) and regulation of cognition (RC). The MAI-E consisted of 20 True/False statements. KC represented by eight items and RC represented by 12 items. The original Metacognition Awareness Inventory (MAI) has been used in metacognition research and was comprised of items related to a learner's general metacognitive activity (Schraw & Dennison, 1994). Based on the original version, the MAI-E reworded items to measure exercise-specific metacognition strategy usage. To calculate the KC score, responses for knowledge of cognition items were summed. Responses for regulation of cognition items were summed and resulted in the RC score (Leno, 2019).

There are eight subcategories on the questionnaire that can be scored and averaged to calculate a metacognition score: declarative knowledge, procedural knowledge, conditional knowledge, planning, information management strategies, comprehension monitoring, debugging/problem-solving strategies, and evaluation. Evidence suggests the MAI is more effective at assessing KC and RC scores separately compared to an overall metacognition score (Harrison & Vallin, 2017; Schraw & Dennison, 1994). For the purposes of this study, the KC and RC scores were calculated separately to compare with physical activity participation.

Researchers Harrison and Vallin (2017) discovered, based on confirmatory factor analysis, a subset of 19 items from the MAI was an overall good model fit on the 622 college students included in the study sample (chi-square = 352.80, df = 151, p

< .001, CFI = .959, TLI = .954, RMSE = .046). For verification, data from another study of 317 college students also showed adequate model fit (RMSE = .069, CFI = .943 and TLI = .935). The multidimensional random coefficients multinomial logit model showed reliability estimates for knowledge and regulation to be .80 and .84, respectively (Harrison & Vallin, 2017).

For the purposes of this study, one item ("I use the organizational structure of the text to help me learn.") was removed from this subset of 19 items because it did not apply to this research. Two additional items from the original version were added for this investigation: items #1 and #45 (see Appendix A) (MAI-E: Leno, 2019). Item #1 ("I ask myself periodically if I am meeting my exercise goals") was added to represent the subcategory of "planning." Item #45 ("I organize my time to best accomplish my exercise goals") was added to represent the subcategory of "comprehension monitoring" (see Appendix B). This was the researcher's attempt to provide better balance among the instrument's subcategories. The strategies presented on the MAI-E representing Knowledge of Cognition and Regulation of Cognition are listed on Table 3.1 and Table 3.2.

Table 3.1

Knowledge of Cognition (KC) strategies listed by subcategory

Knowledge of Cognition Category	Strategy
Declarative	I know what kind of exercises are important to perform. I know how fitness experts expect me to exercise. I have control over how well I exercise. I am a good judge of how well I understand exercising.
Procedural	I am aware of exercise strategies I use when I exercise. I find myself using helpful strategies for exercise automatically.
Conditional	I can motivate myself to exercise when I need to. I know when each exercise strategy I use will be most effective.

Note. Strategies listed were from the Metacognitive Awareness Inventory in Exercise (MAI-E).

Table 3.2

Regulation of Cognition (RC) strategies listed by subcategory

Regulation of Cognition Category	Strategy
Planning	I think about what is best for me to learn before I begin exercising.
	I set specific goals before I begin exercising.
	I organize my time to best accomplish my exercise goals.
Information Management Strategies	I try to translate new exercise information into my own words.
	I ask myself if exercises I am performing are related to exercises I already know.
Comprehension Monitoring	I ask myself periodically if I am meeting my exercise goals.
	I periodically review my exercise to help me understand important relationships
Debugging/ Problem-solving Strategies	I change exercise strategies when I fail to understand.
	I re-evaluate how I perform exercises when I get confused.
	I stop and go back over new exercises that are not clear.
Evaluation	After I finish, I summarize what I have exercised.
	Once I finish, I ask myself if I exercised as much as I could have.

Note. Strategies listed were from the Metacognitive Awareness Inventory in Exercise (MAI-E).

Self-Regulation of Physical Activity. The Physical Activity Self-Regulation scale (PASR-12) was used to measure usage of self-regulation strategies related to physical activity. Responses for the 12 items were on a Likert-type scale from 1 to 5, with 1 = "Not typical of me" and 5 = "Very typical of me." For this study, the responses were summed and provided the SelfRegPA score (one of the independent variables).

Based on research from Umstattd et al (2009), the PASR-12 was modified from the original 43-item version (Petosa, 1993) to measure six types of self-regulation strategies: self-monitoring, goal-setting, eliciting goal support, reinforcement, time management, and relapse prevention (Umstattd et al., 2009). See Appendix C. When given to a sample of 460 adults, the PASR-12 was found to be a valid measurement of self-regulation for physical activity. Confirmatory factor analysis showed an excellent fit with the data (chi-square = 70.75, df = 39, p = .001, RMSEA = 0.04, NNFI = 0.98, CFI = 0.99). A sample of 177 in a 12-month intervention showed the PASR-12 to have internal consistency along the subscales (α = 0.79 to 0.94; Umstattd et al., 2009).

The PASR-12 can calculate six subcategory scores or a single, overall self-regulation strategy score (by summing the six subcategory scores). For this pilot study, the PASR-12 was used to compute an overall score (lowest score = 12; highest score = 60). Higher SelfRegPA scores reflected higher levels of self-regulation strategy usage. See Table 3.3 for PASR-12 items listed by self-regulation strategy.

Table 3.3

Self-Regulation strategies listed by subcategory

Self-Regulation Category	Strategy
Self-monitoring	I mentally keep track of my PA. I mentally note specific things that helped me be active.
Goal-Setting	I set short-term goals for how often I am active. I set exercise goals that focus on my health.
Eliciting Social Support	I ask someone for exercise advice or demonstration. I ask an exercise expert or health professional for exercise advice or demonstration.
Reinforcements	After exercise, I focus on how good I feel. I remind myself of exercise health benefits.
Time Management	I mentally schedule specific times for PA. I rearrange my schedule to ensure I have time for exercise.
Relapse Prevention	I purposely plan ways to exercise when on trips away from home. I purposely plan ways to exercise in bad weather.

Note. Strategies listed were from the Physical Activity Self-Regulation scale.

Physical Activity. Physical activity participation was measured using the Godin-Shephard Leisure Time Physical Activity Questionnaire (LTPAQ). The LTPAQ calculated the PA score, the dependent variable for this study. Participants were asked about their normal physical activity participation accumulated throughout the week, including the intensity of activity. Levels of intensity were categorized as *strenuous/vigorous* ("heart beats rapidly"); *moderate* ("not exhausting"); and *mild* ("minimal effort"). Examples of activities for each intensity level were provided for the participants. Running and vigorous swimming were given as examples of

strenuous activities. Fast walking and tennis were considered moderate activities. Yoga and easy walking were examples of mild activities (Godin & Shephard, 1985).

The amount of physical activity was calculated as units by estimating how often one participates in physical activity. The units for each of the three intensity levels were then multiplied by the appropriate Metabolic Equivalent of Task (MET) value. Strenuous activities were 9 METs; moderate activities were 5 METs; Mild activities were 3 METs. The PA score was calculated as: (units $_{strenuous}$ x 9) + (units $_{moderate}$ x 5) + (units $_{mild}$ x 3). This resulted in an estimate of overall physical activity for a typical week (Godin and Shephard, 1985). The PA score was the dependent variable in this study.

PA scores of 13 and less are considered sedentary/inactive; scores 14 – 23 are considered somewhat/moderately active; scores 24 and higher are considered active (Godin and Shephard, 1985; Godin, 2011). Higher PA scores reflected higher degrees of physical activity participation. The LTPAQ can be found in Appendix D and the scoring sheet in Appendix E. In a sample of 306 participants, the LTPAQ was found to have high test-retest reliability (r = .74). There was 69% accuracy in classification of individuals as "fit" or "unfit" (Godin & Shephard, 1985; ACSM, 1997). The LTPAQ was used in this study as an established tool that provides a valid, convenient measurement for self-reported physical activity participation (Godin, 2011; Jacobs et al., 1993; Miller & Freedson, 1994; ACSM, 1997).

The instrumentation for the pilot study is listed in Table 3.4. This table lists instruments used to measure the independent and dependent variables, the types of questions presented, and the total number of questions found on each survey.

Table 3.4

Instrumentation for the pilot study

Instrument	Number of Questions	Variable	IV or DV	Question Type
Metacognition Awareness Inventory Exercise version (MAI-E)	8	Knowledge of Cognition (KC score)	IV	True/False
	12	Regulation of Cognition (RC score)	IV	True/False
Physical Activity Self-Regulation Scale (PASR-12)	12	Self-Regulation for Physical Activity (Self-Reg PA score)	IV	Likert Scale (1 to 5)
Godin-Shephard Leisure-Time Physical Activity Questionnaire (LTPAQ)	3	Physical Activity participation (PA score)	DV	Questionnaire (numeric fill-in-blank)

Note. Instruments adapted to present electronically to the participants via Qualtrics.

Participants

The target population for the pilot study included adults 18 years of age or older. Participants were selected from an accessible adult population from a private university in the southeastern region of the United States. An advertisement for volunteers was sent through the university's online community forum. Required sample size was 99 based on a priori analysis through GPower with err prob = 0.5, effect size = 0.15, power = 0.9. There were 106 participants (including students,

faculty, and staff members) who completed all sections of the questionnaires and were included in the analysis performed through JMP 15.

Variables

Dependent variable. The dependent variable for this study was physical activity participation (PA score). The PA score was calculated by way of the Godin-Shephard Leisure Time Physical Activity questionnaire (LTPAQ). The PA score was based on an estimate of physical activity participation in a normal week to include the frequency (amount) and intensity. When compared to more objective measures, the LTPAQ has been found to be a reliable, valid instrument to measure physical activity (Jacobs et al., 1993; Miller & Freedson, 1994; Godin & Shephard, 1985).

Independent variables. The first independent variable, the knowledge of cognition (KC score), was a measure of the participants' own knowledge about activity ("I know what kind of exercises are important to perform.") and knowledge of how, when, and why to use strategies that regulated physical activity participation ("I can motivate myself to exercise when I need to."). The second independent variable, the regulation of cognition (RC score), measured strategy usage involved with planning, evaluating, and controlling behavior related to physical activity goals ("I set specific goals before I begin exercising," or "I ask myself periodically if I am meeting my exercise goals").

Researchers have recognized two components of metacognition: knowledge of cognition and regulation of cognition. Although made up of individual strategies, the knowledge skills and regulation skills someone uses to control their cognition are interconnected. Skills related to knowledge of cognition often support behavior

regulation (Schraw, 1998). The activity-specific strategy usage was measured through self-report questionnaire, the Metacognitive Awareness Inventory in Exercise (MAI-E).

The third independent variable for this study was self-regulation of physical activity (SelfRegPA score). The SelfRegPA score was a measure of how often one used self-regulation strategies related to physical activity. Self-regulation has been recognized as a determinant of physical activity (McAuley et al., 2011; Buckley et al., 2014). Self-regulation strategies (i.e., goal-setting and self-monitoring) associated with physical activity participation have been successful when included in interventions to promote activity (Howlett et al., 2019; Anderson et al., 2006; Olson & McAuley, 2015). The PASR-12 was used to measure the SelfRegPA score for this study.

Design and Procedures

Multiple regression was used to analyze responses and to explore the relationship between 3 IVs and 1 DV. The dependent variable, the PA score, was regressed against three independent variables: KC score, RC score, and SelfRegPA score. Linear regression for 3 IVs was used to find the best fitting model. A discussion on the included and eliminated variables is included in the following section.

Data Collection. An application was submitted to the Institutional Review Board (IRB) at Florida Institute of Technology. This study was deemed to be of minimal risk to the participants and exempt from 45 CFR46 federal regulations (see Appendix F, IRB # 21-018).

The collection of surveys for the pilot study were delivered electronically through Qualtrics system during the spring 2021 semester (January 2021 to March

2021), starting in February 12, 2021. Because the surveys were delivered electronically (and accessible through computer or smartphone) this allowed participants the flexibility to complete the questionnaires at their convenience.

An informed consent screen was presented to participants before the survey was made accessible. Before proceeding to the survey, participants read and agreed to the informed consent by clicking the "Agree and Confirm" checkbox. After completing informed consent, the questions were presented. Participants were presented with demographic questions and three self-report questionnaires one at a time in the following order: MAI-E, PASR-12, and the Godin-Shephard LTPAQ.

Descriptive statistics

GPA and Physical Activity. Out of 81 students, those with the lowest GPA scores (2.0 to 2.9) had the highest percentage of physical inactivity (based on measures from the Godin-Shephard LTPAQ). Over half (55%) of the students with GPA scores of 2.0 to 2.9 reported being physically inactive. Students with higher GPA scores (3.0 to 4.0) reported lower levels of physical inactivity. Nearly 36% of students with a GPA between 3.0 to 3.9 reported being physically inactive; only 20% of students with a 4.0 GPA reported being physically inactive. Previous research has showed physical activity to be positively associated with measures of academic success (Tomporowski et al, 2015). Although the number of student participants in this pilot study was small, the findings were consistent with previous research. Lower grades were associated with lower levels of physical activity; higher grades were associated with higher levels of physical activity.

GPA and Strenuous Activity. Students with higher GPAs not only reported higher levels of physical activity, but they were also more likely to participate in "strenuous" activity when compared to students with lower GPAs. Nearly 70% of those with GPAs of 3.0 to 3.9 and 57% of those with a 4.0 GPA participated in strenuous-intense physical activity in an average week. However, only 36% of students with GPAs of 2.0 to 2.9 participated in strenuous-intense physical activity in a typical week. The intensity of physical activity is important to note when considering health benefits. Moderate activity can result in various health benefits, such as weight loss, improvements in BMI, cardiovascular endurance, and cholesterol levels (Schmidt et al., 2001; Glazer et al., 2013; Young & Haskell, 2018).

When compared to mild and moderate intensity, strenuous activity may result in more health and wellness benefits. As the *Physical Activity Guidelines* (2018) explains, high levels of "moderate-to-vigorous physical activity appear to remove the excess risk of all-cause mortality" associated with high levels of sedentary time. Reducing sedentary time only reduces some risk of all-cause mortality.

Inferential statistics

Because regression analysis was used to investigate the relationship between different variables, the assumptions of regression were checked and are presented next. After this, each model used in the data analyses for this pilot study are listed and discussed.

Linearity. To check the relationship between the DV (PA score) and the three IVs, the assumption of linearity was checked based on inspection of x and y scatterplot and plot of residuals by predicted y (Appendix J). Residual analysis plot showed residual by predicted values to be somewhat gathered around the fit line. However, the points on the plot made a slight fan shape instead of being randomly situated around the horizontal line. Based on this, there did not appear to be a linear relationship between the DV and the three IVs. After graphing each of the three IVs independently with the DV, the fit line on the scatterplots showed gaps for two IVs, KC and RC. The third IV, SelfRegPA, also did not appear to have a linear relationship with PA score (DV) based on scatterplot.

Normality. To check if error terms (residuals) are normally distributed, a normal quantile plot (Q-Q plot) was performed. After running with all IVs (KC, RC,

and SelfRegPA) the Q-Q plot did not show a normal distribution as it strayed from the center line (Appendix J).

Independence of residuals. There was no autocorrelation seen based on Durbin-Watson test = 2.18 (<2.5, implying within normal range for no autocorrelation). This suggests independence of residuals (no relationship between the residuals) in regards to physical activity (PA score).

Constant variance (homoscedasticity) of residuals. On Models 1 and 2, fan-shaped on residual by predicted plots suggested heteroskedastic nature of these two models. Model 3 showed less fan-shaped plot with more clustering to center than previous models. The residual variance around the regression line is assumed to be approximately the same. However, this does not seem to be the case with the IVs in these models.

Collinearity. Based on multivariate correlation matrix (<0.8), there was no collinearity noted across three models. Based on variance inflation factor (VIF), there was no evidence of multicollinearity (KC VIF = 1.3; RC VIF = 1.54; Self-Reg PA = 1.48). This result suggests the IVs within each model did not overlap (or explain the same variance of the DV).

The following section outlines which variables were analyzed and any statistical significance found in the three models. Tables with parameter estimates for each model are also presented.

Model 1. To examine the relationship between strategy usage and physical activity participation, the DV (PA score) was regressed on three IVs (KC score, RC score, and SelfRegPA score). This model was shown to be overall statistically

significant (R^2 = 0.18, $F(3, 102) = 9.35$, p = 0.0001). An overall R^2 of 0.18 suggests these three variables explained 18% of the variance in the PA score. Although the overall model showed significance, the KC score did not significantly predict the PA score (B = 0.69, p = 0.731). Therefore, this variable was removed from the next regression analysis model. The RC score did significantly predict PA score (B = -2.94, p = 0.0487) and showed a negative correlation to the PA score. The SelfRegPA score significantly predicted PA score (B = 2.54, $p < 0.0001$). The RC score and SelfRegPA scores were used in the next regression analysis.

Research question 1: Does knowledge of cognition strategy usage correlate with physical activity participation levels?

The model did not fulfil linear assumption when checked, and it does not appear to have a linear relationship between the IVs and the DV. This model showed knowledge of cognition strategy usage to not be statistically significant; this leads to accepting the null hypothesis. See Table 3.5 for parameter estimates in Model 1.

Table 3.5

Parameter Estimates for each variable in Model 1

Variable	*B*	*SE*	*df*	*t*	*p*
Knowledge of Cognition (KC score)	0.692	2.010	3	0.34	0.731
Regulation of Cognition (RC score)	-2.948	1.475	3	-2.00	0.048
Self-Regulation (SelfRegPA score)	2.546	0.509	3	5.00	<.0001

Note. N = 106.

Model 2. After the KC score was removed from the model, the PA score was then regressed on two IVs (RC score and SelfRegPA score) to see the relationship between strategy usage and physical activity participation. Overall, this regression model was shown to be statistically significant ($R^2 = 0.21$, $F(2, 103) = 14.09$, $p = 0.0001$). This indicates regulation of cognition and self-regulation strategies usage for physical activity explained 21% of the variation in the PA score. As in Model 1, the RC score significantly predicted PA score ($B = -2.8$, $p = 0.0489$) and showed a negative correlation to the PA score. The SelfRegPA score significantly predicted the PA score ($B = 2.58$, $p < 0.0001$). See Table 3.6 for parameter estimates for Model 2.

Research question 2: Does regulation of cognition strategy usage correlate with physical activity participation levels?

This model showed regulation of cognition strategy usage was correlated with physical activity participation. However, this should be interpreted with caution as this model did not show a linear relationship between the two IVs and the DV; this leads to the acceptance of the null hypothesis.

Table 3.6

Parameter Estimates for each variable in Model 2

Variable	*B*	*SE*	*df*	*t*	*p*
Regulation of Cognition (RC score)	-2.800	1.405	2	-1.99	0.048
Self-Regulation (SelfRegPA score)	2.584	0.049	2	5.22	<.0001

Note. N = 106.

Model 3. For the last regression model, the RC score was removed from the model, and the PA score was then regressed on the SelfRegPA score. Overall, this model was shown to be statistically significant ($R^2 = 0.18$, $F(1, 104) = 23.53$, $p < 0.0001$) with a positive correlation to the PA score ($B = 2.05$, $p < 0.0001$). This indicates that self-regulation strategies used for physical activity explained 18% of the variation in physical activity participation. This low percentage suggests there are other factors that may be better related to physical activity engagement.

Research question 3: Does self-regulation strategy usage correlate with physical activity participation levels?

The findings show a correlation between self-regulation strategy usage and physical activity. However, the linear assumption of regression was not met with this model which can lead to incorrect results. Linear regression may not be a good fit with this model. This leads to acceptance of the null hypothesis.

Table 3.7

Parameter Estimates for each variable in Model 3

Variable	*B*	*SE*	*df*	*t*	*p*
SelfRegPA score	2.05	0.042	1	4.85	<.0001

Note. N = 106.

Self-Regulation and Strenuous activity. A *t*-test was performed to see if there were differences in the SelfRegPA scores between those who participated in strenuous activity and those who did not participate in strenuous activity. The independent variable represented intensity of physical activity on two levels: (1) Strenuous and (2) Not Strenuous. The dependent variable, SelfRegPA score, measured the degree to which participants used self-regulation strategies with a range of 1 – Never (low level of use) to 5 – Very Often (high level of use).

Because assumption of homogeneity of variance was not met, a Welch's test was performed and found to be statistically significant ($t(1) = 4.07$, $p < .0001$). Comparison of the means showed the 64 participants in the strenuous activity group ($M = 41.58$, $SD = 8.61$) had a higher average SelfRegPA score than the 42 participants in the non-strenuous activity group ($M = 35.48$, $SD = 6.77$); a difference in mean of 6.10. This indicates those who participated in strenuous physical activity used self-regulation strategies more than those who did not participate in strenuous activity. See Table 3.8 for means and standard deviations listed for each level. Figures can be found in Appendix J.

Research Question 4: Does self-regulation strategy usage differ between groups who are strenuously active and groups who are not strenuously active?

There were differences between the strenuous and non-strenuous activity groups; this finding leads to a rejection of the null hypothesis. Those who performed strenuous-intense physical activity used more self-regulation strategies than those who performed only non-strenuous activity. These findings warrant further investigation into which strategies better regulate the intensity of physical activity.

Table 3.8

Self-Regulation (SelfRegPA) scores by Strenuous and Non-strenuous physical activity

Physical Activity intensity	*n*	*M*	*SD*
Strenuous	64	41.58	8.6
Non-strenuous	42	35.48	6.77

Note. SelfRegPA scores (overall): N = 106. *M* = 39; *SD* = 8.45.

Lessons learned from Pilot Study

Based on the analysis of the preliminary pilot study on metacognition and self-regulation strategies, there was need to investigate other factors that contribute to the regulation of physical activity participation. According to social cognitive theory, learning can take place but may not result in a change in behavior. Although knowledge about health benefits can be acquired, it may not be enough to prompt health behavior changes, such as physical activity participation (Bandura, 1998; Ormrod, 2012).

In the pilot study, activity-specific knowledge (knowing what type of activity is important) and awareness of when and how to use specific knowledge or strategy (knowing "how fitness experts expect me to exercise") did not appear to be related to physical activity participation. When measured, those with lower KC scores (1 to 3 out of 8) had lower physical activity participation (low PA scores). However, higher KC scores (6 to 8) did not lead to into higher levels of physical activity participation (high PA scores).

Findings showed self-regulation strategy usage was related to physical activity participation. Those who reported higher levels of self-regulation strategy usage for

physical activity (SelfRegPA score) were more likely to participate in strenuous physical activity. Out of those with higher SelfRegPA scores (45 to 60; max = 60), 85% participated in strenuous physical activity. Only 42% of those with lower SelfRegPA scores (18 to 32) participated in strenuous physical activity. This suggests higher self-regulation strategy usage was related to strenuous activity. Finding ways to regulate and maintain behavior change is of concern for health professionals. Intensity of physical activity is important to consider; participation in strenuous physical activity may yield more health benefits for some individuals when compared to low-intense activities (USHSS, 2018).

Based on what was discovered in the pilot study, the KC and RC scores (metacognitive strategy usage) were not measured in the full study. Instead, the full study focused on different types of motivation and the impact on regulation of physical activity. A person needs to be motivated enough to make the decision to engage in a behavior. If there is a lack of motivation to begin with, this would inhibit development and use of metacognitive strategies. Continued research into the decision to participate in physical activity can better inform us about which processes encourage long-term adherence to activity participation (Markland & Ingledew, 1997; Miragall et al, 2017).

The two independent variables for the full study were: 1) behavior regulation style (BehReg) and 2) self-regulation of physical activity (SelfRegPA score). The dependent variable was physical activity participation (PA score). Behavior regulation style reflects the degree of motivation to be physically active (also called exercise motivation). Measurement of a new independent variable required a different survey

to be included: the Behavior Regulations in Exercise Questionnaire-3 (BREQ-3). The instrumentation for the other independent variable and dependent variable (SelfRegPA score and the PA score) was used in the pilot study and remained the same for the full study. Additional information on instrumentation and methods are discussed in upcoming sections.

Full Study

The upcoming section describes the research design, procedures, and participants used in the full study. The instruments used to measure three variables are discussed. The dependent and independent variables are identified and described in detail. The design and procedures for the study are outlined and explained. To close, the research questions and hypotheses for the study are presented.

Instrumentation

Behavior Regulation style and Motivation. The Behavior Regulations in Exercise Questionnaire-3 (BREQ-3) was used to measure the degree of motivation (for physical activity) and behavior regulation style within the framework of Self-Determination Theory (SDT). The BREQ-3 (Appendix G) asks participants about their decision to participate (or not participate) in physical activity. Statements representing each of the behavior regulation styles (BehReg) were presented.

Responses for each statement were scored on a 5-point Likert scale (ranged from "Never true for me" to "Always true for me"), and scores for each regulation style were calculated. The participant was assigned to the BehReg with the highest score: non-regulation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic regulation. The BehReg was one of the two IVs in this study.

The latest version of the questionnaire was used in the full study as it included an integration regulation category that was not found in previous versions (Markland & Toobin, 2004; Wilson et al., 2006). Reliability analysis from 2010 showed the inclusion of integrated regulation to have internal consistency values of .76 to .90

across different behavior regulation styles (Duncan et al., 2010; Wilson et al., 2006). Because highly autonomous regulation styles (identified, integrated, and intrinsic) have been shown to be positively correlated with physical activity participation, a measurement of the integration regulation style was of interest in this study.

Self-Regulation of Physical Activity. The Physical Activity Self-Regulation scale (PASR-12) was used to measure levels of self-regulation strategy usage related to physical activity. The PASR-12 was modified from the original version (Petosa, 1993) to measure usage of six types of self-regulation strategies: self-monitoring, goal-setting, eliciting goal support, reinforcement, time management, and relapse prevention (Umstattd et al., 2009). Statements representing each type of self-regulation strategy were presented, and responses were measured on a 5-point Likert-scale (ranged from "Never" to "Very Often"). Scores for each of the six categories were summed (lowest score = 12; highest score = 60); the final score was used as the SelfRegPA score (IV) in this full study. Higher scores reflect higher levels of self-regulation strategy usage.

For instance, for a goal-setting statement ("I set exercise goals that focus on my health regarding goal-setting"), one would respond on a scale of 1 to 5 (1-Never to 5-Very Often). Because the PASR-12 has been shown to be a valid instrument to measure self-regulation for physical activity, with an internal reliability across subcategories, it was used to measure self-regulation strategy usage (SelfRegPA score) for this full study.

Physical Activity. The Godin-Shephard Leisure Time Physical Activity questionnaire (LTPAQ) measured physical activity participation. The LTPAQ was used to calculate a numeric value of physical activity levels, and it was used in this study to provide the PA score (DV). Participants were asked to provide their physical activity participation levels (accumulated during an average week) by the intensity of activity.

Intensity was categorized as *strenuous/vigorous* ("heart beats rapidly"); *moderate* ("not exhausting"); and *mild* ("minimal effort"). The three intensity levels were multiplied by the appropriate Metabolic Equivalent of Task (MET) value. Strenuous activities were 9 METs; moderate activities were 5 METs; Mild activities were 3 METs. The PA score was calculated as: (units $_{\text{strenuous}}$ x 9) + (units $_{\text{moderate}}$ x 5) + (units $_{\text{mild}}$ x 3). Higher PA scores reflected higher degrees of physical activity participation. PA scores less than 14 are considered sedentary/inactive; PA scores 14 – 23 are considered somewhat/moderately active; PA scores 24 and higher are considered active (Godin and Shephard, 1985; Godin, 2011). The LTPAQ can be found in Appendix D and the LTPAQ scoring sheet in Appendix E.

To summarize, there were three instruments used to measure variables in this study: Behavior Regulations in Exercise Questionnaire-3 (BREQ-3); the Physical Activity Self-Regulation scale (PASR-12); and the Godin-Shephard Leisure Time Physical Activity questionnaire (LTPAQ). A list of the instrumentation for each variable can be found in Table 3.4.

Table 3.9

Instrumentation for the full study

Instrument	Number of Questions	Variable	IV or DV	Question Type
Behavior Regulation in Exercise questionnaire (BREQ-3)	24	Behavior Regulation style (BehReg)	IV	Likert Scale (0 to 4)
Physical Activity Self-Regulation Scale (PASR-12)	12	Self-Regulation for Physical Activity (SelfRegPA score)	IV	Likert Scale (1 to 5)
Godin-Shephard Leisure Time Physical Activity Questionnaire (LTPAQ)	3	Physical Activity participation (PA score)	DV	Questionnaire (numeric fill-in-blank)

Note. Each instrument was adapted to be presented electronically to the participants.

Participants

Participation in this study was limited to students 18 years old and older. Volunteers were recruited from an accessible, adult student population enrolled at a private university in Florida. The required sample size was 107 based on a priori analysis through GPower 3.1, with err prob = 0.05, effect size = 0.15, power = 0.95. There were 189 participants who completed all questionnaires and were included in the analysis performed through JMP 17. After removal of outliers, the number of participants decreased from 189 to 185. A detailed explanation for outlier removal is provided in Chapter 4.

Variables

Dependent variable. The dependent variable for the full study was physical activity participation (PA score). The PA score was calculated based on a participant's estimate of physical activity participation in a normal week. The PA score included the frequency (amount) and intensity of physical activity (Jacobs et al., 1993; Miller & Freedson, 1994; Godin & Shephard, 1985). Higher PA scores reflected higher levels of physical activity participation per week.

Independent variables. For the full study, two independent variables were measured: self-regulation of physical activity (SelfRegPA score) and behavior regulation style (BehReg). The SelfRegPA score was a measure of how often one used self-regulation strategies related to physical activity. Self-regulation has been recognized as a determinant of physical activity (McAuley et al., 2011; Buckley et al., 2014). Goal-setting, self-monitoring, and other self-regulation strategies are associated with physical activity participation, and they have been used successfully in interventions to promote physical activity (Howlett et al., 2019; Anderson et al., 2006; Olson & McAuley, 2015).

The other independent variable, behavior regulation style (BehReg), was a measure of one's degree of motivation for physical activity. Each type of motivation corresponded to different behavior regulation styles. The six behavior regulation styles were: *non-regulation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic regulation* (Ryan & Deci, 2000). When measured, the regulation style with the highest score determined the participant's behavior regulation style.

Design and Procedures

Linear regression, ANOVA, and *t*-test were used to evaluate the relationships between the IVs (SelfRegPA score and BehReg) and DV (the PA score). The PA score was regressed on the SelfRegPA score to see if self-regulation strategy usage was related to physical activity participation. An ANOVA was performed to determine if physical activity participation would be different among behavior regulatory styles. Additionally, a one-way ANOVA was run to investigate if self-regulation strategy usage differed between the behavior regulation styles. A *t*-test was performed to compare self-regulation strategy usage between groups who were strenuously active and non-strenuously active.

Data Collection. Upon approval of the full study from the Institutional Review Board (IRB) at Florida Institute of Technology, the surveys were delivered electronically through the Qualtrics system starting in March 2023 (spring semester). After informed consent was presented to participants, and they selected the "agree and confirm" checkbox, the demographic questions and questionnaires were presented to the participants in the following order: BREQ-3, PASR-12, and the Godin-Shephard LTPAQ.

The following hypotheses and research questions were included in the full study to guide this investigation on how different motivational factors may regulate physical activity:

Research question 1: Do behavior regulation styles relate to physical activity participation?

H_1: Behavior regulation styles are related to physical activity participation.

Research question 2: Does self-regulation strategy usage relate to physical activity participation?

H_2: Self-regulation strategy usage is related to physical activity participation.

Research question 3: Do behavior regulation styles relate to self-regulation strategy usage?

H_3: Behavior regulation styles are related to self-regulation strategy usage.

Research question 4: Does self-regulation strategy usage differ between groups who are strenuously active and groups who are not strenuously active?

H_4: Self-regulation strategy usage differs between strenuous and non-strenuous groups.

Chapter 4

Results

Introduction

This chapter presents the results of the data analysis for the full dissertation study. Linear regression assumptions and the reasoning behind removal of outliers are discussed. Descriptive statistics and results from data analyses are provided. Inferential statistics are grouped by each research question. This section ends with a discussion of the additional analyses performed and the findings.

Preliminary Analysis

Outliers

Visual inspection of scatterplots and histograms revealed four outliers present within the PA score (scores 145 or higher). The remaining PA scores were within the range of 1 to 130. To determine the impact of these outliers, one regression analysis was run with outliers included; and another analysis was run without outliers included. After removing the four outliers, the R^2 improved (from $R^2_{\text{with outliers}} = 0.07$ and $R^2_{\text{no outliers}} = 0.18$). The overall R^2 without outliers increased by 0.11 units (11%). Because of this, four participants were not included in the data analysis for this study. This reduced the sample size from 189 to 185, a decrease of approximately 2%.

Assumptions of Regression

Normality. Checking residuals for normality with a normal quantile plot showed somewhat normal distribution. Histogram shows a slight skewness to the right for the PA score.

Linearity. Based on residual by predicted plot, the assumption of linearity was checked. The spread of the residuals around the line had no distinct shape. However, when looking at a scatterplot of x and y, the points were scattered and did not fall around any discernable line. This indicates assumption of linearity is not met.

Independence of residuals. Durbin-Watson test = 2.18; Scores that are <2.5 imply within normal range indicating no autocorrelation.

Constant variance (homoscedasticity) of residuals. On residual by predicted plot, there was no apparent shape (i.e., fan-shaped) on the plot. This suggests a homoscedastic nature of this model.

Collinearity. Based on the variance inflation factor (VIF), there was no evidence of multicollinearity. The VIF = $1/(1-R^2) = 1/(1-0.179) = 1.21$. Figures related to assumptions are found at Appendix H.

Primary Analyses

Descriptive Statistics

Relevant descriptive statistics for the two IVs and DV from this dissertation study are included in Table 4.1. In reference to ethnicity, most of the participants classified themselves as White ($n_{White} = 104$, 56%). The remaining 44% of participants in this full study classified themselves as Asian ($n_{Asian} = 32$, 17%), Hispanic ($n_{Hispanic} = 20$, 11%), Other race/ethnicity ($n_{Other\ race} = 13$, 7%), Black/African-American ($n_{Black} =$

10, 5%), Native American ($n_{\text{Native American}} = 1$, 0.5%). Some participants selected "Prefer not to say" ($n_{\text{prefer not to say}} = 5$, 3%).

The majority of the 185 participants were male (110, 60%) followed by female (71, 38%). Three participants selected "Prefer not to say" (1.5%), and one participant self-described as bigender (0.5%). The mean age was around 21 years old, and 87% were 18 to 24 years old. The max age was 46 years. Class status for participants in this full study: Freshman (78, 42%); Sophomore (35, 19%); Junior (27, 15%); Senior (22, 12%); and Graduate (23, 12%). Self-reported GPA levels ranged from 1.0 to 4.0. Those with a GPA between 1.0 – 1.9 = 20 (1%); 2.0 – 2.9 = 40 (22%); 3.0 – 3.9 = 113 (61%); and 4.0 = 30 (16%).

Table 4.1

Descriptive statistics for IVs and DV

Variables	Range of Scores	*M*	*SD*	*Mdn*
Behavior Regulation style (BehReg) [a]	1 to 5	2.83	1.27	3
Self-regulation strategy usage (SelfRegPA score)	12 to 60	36.18	9.83	36
Physical activity participation (PA Score)	0 to 130	52.47	30.13	46

Note. N = 185.

[a] Behavior regulation style was measured with a 5-point Likert scale for six categories: Non-regulation, External, Introjected, Identified, Integrated, and Intrinsic. Participants were assigned to the behavior regulation style category with the highest score.

Key Attributes

Questionnaires were used in this study to measure specific factors related to physical activity. Behavior regulation style, self-regulation strategy usage, and physical activity levels were measured and are described in the following section.

Behavior regulation. Table 4.2 shows results for 24 statements regarding behavior regulation as it relates to physical activity and exercise. Mean responses for these statements range from 1.30 to 4.32. With an overall response mean of 2.83 (*SD* = 1.27), this suggests the participants' responses were not strong, falling higher than Sometimes True for Me on the Likert scale. Out of the 24 statements about behavior regulation in exercise, the statement with the lowest mean score (i.e., the statement participants agreed with the least) was "I think exercising is a waste of time" (*M* = 1.30, *SD* = 0.65). The statement participants agreed with the most was "I value the

benefits of exercise" (M = 4.32 SD = 0.87). Mean scores between the six regulation style categories shows most fit within the category of Identified (N = 49, M = 3.76 SD = 0.81) or Intrinsic (N = 88, M = 3.66 SD = 0.95). The regulation category with the lowest mean score was Non-regulation/Amotivation (N = 4, M = 1.43 SD = 0.60).

Table 4.2

Summary of Responses for Behavior Regulation in Exercise questionnaire (BREQ-3)

Statement responses by Behavior Regulation style category	*M*	*SD*
Non-Regulation/Amotivation	1.43	0.60
I don't see why I should have to exercise.	1.48	0.78
I can't see why I should bother exercising.	1.53	0.79
I don't see the point in exercising.	1.39	0.75
I think exercising is a waste of time.	1.30	0.65
External regulation	2.00	0.95
I exercise because other people say I should.	2.18	1.17
I take part in exercise because my friends/family/partner say I should.	2.06	1.17
I exercise because others will not be pleased with me if I don't.	1.66	1.04
I feel under pressure from my friends/family to exercise.	2.06	1.22
Introjected regulation	3.09	1.13
I feel guilty when I don't exercise.	3.54	1.22
I feel ashamed when I miss an exercise session.	2.94	1.31
I feel like a failure when I haven't exercised in a while.	2.93	1.36
I would feel bad about myself if I was not making time to exercise	2.96	1.31
Identified regulation	3.76	0.81
It is important to me to exercise regularly.	3.86	0.95
I value the benefits of exercise.	4.32	0.87
I think it is important to make the effort to exercise regularly.	4.10	0.97
I get restless if I don't exercise regularly.	2.75	1.34
Integrated regulation	3.08	1.09
I exercise because it is consistent with my life goals.	3.63	1.11
I consider exercise part of my identity.	2.60	1.40
I consider exercise a fundamental part of who I am.	2.65	1.41
I consider exercise consistent with my values.	3.44	1.19
Intrinsic regulation	3.66	0.95
I exercise because it is fun.	3.41	1.14
I enjoy my exercise sessions.	3.79	1.02
I find exercise a pleasurable activity.	3.60	1.10
I get pleasure and satisfaction from participating in exercise.	3.86	1.07

Note. N=185. Scores measured on 5-point Likert scale.

Self-regulation strategy usage. The PASR-12 measured six categories of self-regulation. The categories with the highest mean scores (i.e., types of strategies used most by participants) were Reinforcements (M = 3.47, SD = 1.09), Self-monitoring (M = 3.35, SD = 1.14), and Goal-setting (M = 3.18, SD = 1.19). The category with the lowest mean score, and the least-used set of strategies by participants, was Relapse Prevention (M = 2.43, SD = 1.31).

Table 4.3 presents the results for participants' responses to 12 statements regarding self-regulation usage related to physical activity. Mean for responses ranged between 1.21 and 3.36; the overall response mean was 3.01. Considering the range of scores for each statement was 1 to 5, this suggests self-regulation strategy usage for the participants was somewhat average.

Out of the 12 statements regarding self-regulation strategy usage, the lowest mean score (i.e., the strategy least used by participants) was "I ask an exercise expert or health professional for exercise advice or demonstration" (M = 2.27, SD = 1.15). The highest mean score (i.e., the strategy most used by participants) was "I remind myself of exercise health benefits" (M = 3.58, SD = 1.07).

Table 4.3

Summary of Responses to the Physical Activity Self-Regulation scale (PASR-12)

Statement responses by Self-Regulation category	*M*	*SD*
Self-monitoring	3.35	1.14
I mentally keep track of my PA	3.34	1.17
I mentally note specific things that helped me be active.	3.35	1.10
Goal-Setting	3.18	1.19
I set short-term goals for how often I am active.	3.17	1.18
I set exercise goals that focus on my health.	3.18	1.20
Eliciting Social Support	2.58	1.22
I ask someone for exercise advice or demonstration.	2.88	1.20
I ask an exercise expert or health professional for exercise advice or demonstration.	2.27	1.15
Reinforcements	3.47	1.09
After exercise, I focus on how good I feel.	3.35	1.10
I remind myself of exercise health benefits.	3.58	1.07
Time Management	3.09	1.32
I mentally schedule specific times for PA.	3.26	1.31
I rearrange my schedule to ensure I have time for exercise.	2.93	1.32
Relapse Prevention	2.43	1.31
I purposely plan ways to exercise when on trips away from home.	2.43	1.30
I purposely plan ways to exercise in bad weather.	2.43	1.31

Note. N=185. Scores measured on 5-point Likert scale.

Physical activity. Table 4.4 shows results for the responses regarding typical physical activity participation during a week. The Leisure-Time Physical Activity questionnaire (LTPAQ) provided a score (PA score) based on intensity and amount of physical activity. To calculate the PA score, participants were asked how often they engage in strenuous, moderate, and mild activity throughout the week. Responses were summed (Mild + Moderate + Strenuous activity) resulting in the PA score.

Table 4.4

Mean Responses for the Leisure-Time Physical Activity Questionnaire (LTPAQ)

Physical Activity by Intensity	Range of Scores	*M*	*SD*
Strenuous	0 to 12	2.70	2.53
Moderate	0 to 15	3.12	2.56
Mild/Light	0 to 30	4.20	3.53

Note. N = 185.

Participants engaged the most in mild physical activity ($M = 4.20$, $SD = 3.53$) followed by moderate physical activity ($M = 3.12$, $SD = 2.56$) and strenuous physical activity ($M = 2.70$, $SD = 2.53$). The average PA score for all 185 participants was 52 ($SD = 30.13$). Based on the LTPAQ standards, more participants were Active ($n = 172$) than Inactive/Sedentary ($n = 13$). Most participants engaged in some type of strenuous activity (139, 75%). A smaller number engaged only in non-strenuous activity (46, 25%). This was worth noting as strenuous/vigorous types of activity can yield more health benefits than participating only in lower-intense physical activities.

Inferential Statistics

The following section discusses regression analysis and ANOVA as they relate to each research question of this study. Figures associated with inferential statistics are found in Appendix I. Additional analyses allowed for a deeper investigation into what influences participation in activity.

ANOVA for research question 1. An ANOVA was performed in JMP to look for differences between physical activity participation (PA score) and six different behavior regulation styles (BehReg). Based on a Levene's test, homogeneity of

variance assumption was not violated. However, as shown on the Shapiro-Wilk goodness of fit test, the assumption of normality was violated at two levels of behavior regulation: non-regulation (p = .0168) and intrinsic (p = .0050). Due to this, a Kruskal-Wallis test was run resulting in X^2 (5, N = 185) = 16.11, p = .0065. This showed evidence that behavior regulation style impacted the PA score and leads to a rejection of the null hypothesis.

Because the Kruskal-Wallis test was significant, a post-hoc Dunn test for nonparametric comparisons of all pairs was performed to see which behavior regulation styles were different. Statistically significant differences in PA scores were discovered between non-regulation and integrated styles of behavior regulation (p = .0101). Additionally, statistically significant differences were seen between integrated and introjected behavior regulation styles (p = .0287). See Appendix I for tables and figures from JMP 17.

The PA score ranged low with an average score of 16 among the non-regulation participants. However, those within the integrated regulation style — which is more autonomous (or self-determined) — had higher PA scores with an average score of 74. This suggests highly autonomous regulation styles have higher levels of physical activity participation. Within non-regulation and integrated regulation categories, there were a low number of participants (only 14 out of 185); but as expected, higher physical activity participation levels were found among the highly autonomous behavior regulation styles. Table 4.5 provides the differences in score ranges, means, and medians for these two behavior regulation styles.

Table 4.5

Differences in PA scores by Non-regulation and Integrated behavior regulation styles

Behavior regulation style	*n*	Range of PA scores	*M*	*Mdn*
Non-regulation	4	6 to 38	16	9
Integrated	10	36 to 126	74	75

Regression analysis for research question 2. To help answer research question 2, a linear regression was conducted with self-regulation strategy usage (SelfRegPA score) as the IV and physical activity (PA score) as the DV. When assumption of linearity was checked, it was discovered there was a violation. The scatterplot showed points were scattered in this model; they did not fall on a line. This indicates there was no linear relationship seen between the variables. Linear regression did not appear to be a good fit for this model. Because initial regression analysis did not produce the anticipated results, and to continue the investigation, an additional method of analysis (ANOVA) was performed. More details for this data analysis are provided in Appendix K.

ANOVA for research question 3. To investigate if there were differences in self-regulation strategy usage (SelfRegPA scores) between behavior regulation styles, a one-way ANOVA was performed. The normality assumption was not violated based on Shapiro-Wilk test. However, a Levene's test indicated unequal variance (p = 0.011). Because of this, a Welch's test was performed and found to be statistically significant, *Welch's* $F(5, 21.82) = 8.46$, $p = 0.0001$. This leads to rejection of the null hypothesis.

A post-hoc Games-Howell test showed significant differences in the mean of SelfRegPA scores (i.e., self-regulation strategy usage) between the following behavior regulation groups: Integrated and Non-Regulation with a difference of 25.65 (p = .012); Integrated and External with a difference of 16.40 ($p < .001$); Integrated and Introjected with a difference of 12.21 (p = .015); Integrated and Identified with a difference of 10.50 (p = .010); Integrated and Intrinsic with a difference of 9.11 (p = .026). See Appendix I for figures and tables. See Table 4.6 for a list of Games-Howell significant multiple comparisons.

Table 4.6

Games-Howell multiple comparisons of SelfRegPA scores by behavior regulation style

					95% confidence interval	
BehReg (I)	BehReg (J)	mean difference (I-J)	Std. Error	Sig.	Lower bound	Upper bound
Integrated	Non-Regulation	25.65	4.39	.012	7.34	43.96
Integrated	External	16.40	3.12	< .001	6.61	26.19
Integrated	Introjected	12.21	3.39	.015	1.80	22.61
Integrated	Identified	10.50	2.47	.010	2.29	18.70
Integrated	Intrinsic	9.11	2.49	.026	.89	17.33

In regards to self-regulation strategy usage levels (low, moderate, and high), participants in the least-autonomous behavior regulation styles (non-regulation, external, and introjected) had the lowest levels of self-regulation strategy usage (SelfRegPA score = 5 to 20) compared to the most-autonomous behavior regulation styles (identified, integrated, and intrinsic).

Approximately 23% of those in the least-autonomous behavior regulation styles had low self-regulation strategy usage (only 2.66% of those within the most-autonomous behavior regulation styles. This suggests those with less self-determination (autonomy) also use fewer self-regulation strategies than those with higher self-determination in physical activity. This allowed for rejection of the null hypothesis and acceptance of the hypothesis, as behavior regulation style was related to self-regulation strategy usage.

T-test for research question 4. Evidence suggests strenuous activity may lead to more health benefits compared to engaging in lower-intense activities. To continue exploring ways by which self-regulation relates to physical activity, a *t*-test was performed to see the differences in self-regulation strategy usage between 2 groups: those who participated in strenuous activity and those who did not participate in strenuous activity. The SelfRegPA score was a measure of the degree to which participants used self-regulation strategies specific for physical activity. The scale ranged from 1 – Never (low level of use) to 5 – Very Often (high level of use).

Both Q-Q plots and Shapiro-Wilk goodness of fit tests show the normality assumption was met. To check for equality (homogeneity) of variances between the groups, a Levene's test was run and was found to be not significant ($p = 0.38$). From

this we can conclude that the variance is equal among the groups. The difference in SelfRegPA scores between the strenuous activity group (M = 39.14, SD = 8.62) and the non-strenuous activity group (M = 27.26, SD = 7.65) was statistically significant (t (183) = 8.31; $p < 0.0001$). Because the p-value was smaller than 0.05, we can be confident that the groups are different in regards to SelfRegPA scores. This shows self-regulation strategy usage (i.e., SelfRegPA scores) was higher among those who participated in strenuous activity, and leads to a rejection of the null hypothesis. The output from the t-test is listed in Appendix I. See Table 4.6 for means and standard deviations listed for each level.

Table 4.7

Self-regulation strategy usage (SelfRegPA scores) by Strenuous & Non-strenuous activity

Physical Activity Intensity	*n*	*M*	*SD*
Strenuous	139	39.14	8.62
Non-strenuous	46	27.26	7.65

Note. N=185. SelfRegPA score (M = 36, SD = 9.83).

Additional Statistical Analyses

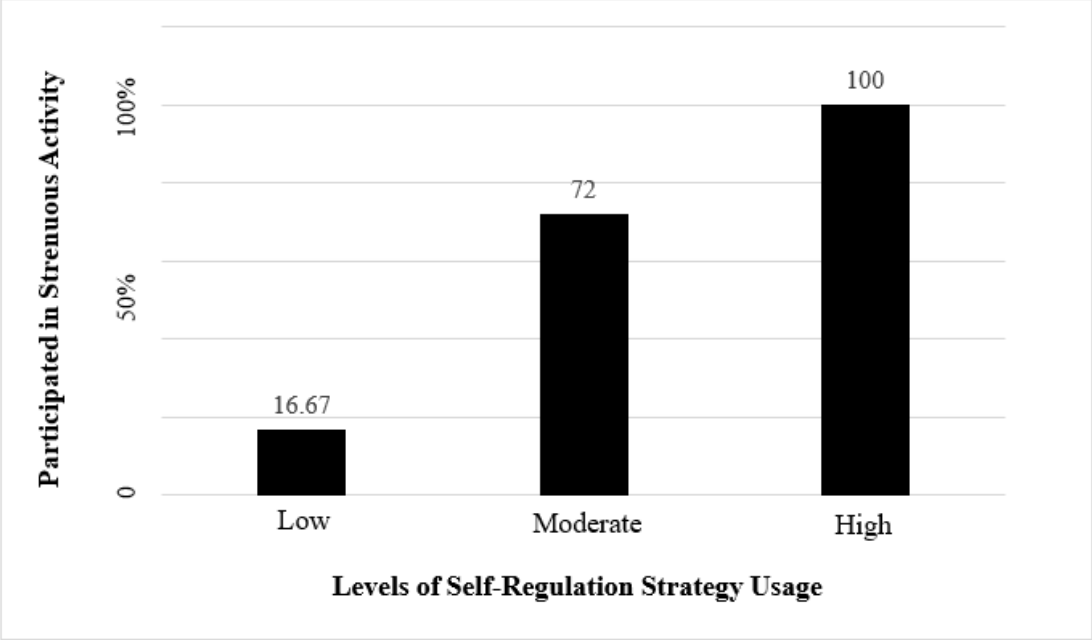
Although the four research questions were answered, to broaden the investigation into what factors have a connection to physical activity participation, additional analyses were performed. Because the volunteers for this dissertation study were college students, the impact that class status and grade-point average (GPA) had on physical activity and self-regulation was also examined.

Strenuous activity and Self-Regulation. A Chi-square test was run to look at the relationship between levels of self-regulation strategy usage (low, moderate, high) and the intensity of physical activity (strenuous and non-strenuous groups). There was a statistically significant relationship found between the variables, X^2 (2, N = 185) = 34.39, p = .0001. Between the strenuous and non-strenuous activity groups, there were notable differences in respect to levels of self-regulation strategy usage.

Of those who had high levels of strategy usage (SelfRegPA score = 45 to 60), 100% participated in strenuous activity during a week. On the other hand, among those with lower levels of strategy usage (SelfRegPA score = 5 to 20), only 16.67% participated in strenuous activity. See Figure 4.2. The highest percentage of non-strenuously active participants were found among the low-level strategy users. In turn, the highest percentage of strenuously active participants were found among high-level strategy users. This suggests those who used more self-regulation strategies to be more likely to participate in vigorous (strenuous) types of physical activity. Tables and figures associated with this analysis are located within Appendix I.

Figure 4.1

Strenuous physical activity participation by Level of Self-Regulation strategy usage (SelfRegPA)



Note. Percentage of those who participated in strenuously intense activity per level of self-regulation strategy usage. Low strategy usage: SelfRegPA = 5 to 20; Moderate strategy usage: SelfRegPA = 21 to 44; High strategy usage: SelfRegPA = 45 to 60.

Physical activity and Class status. To continue examining factors contributing to physical activity participation, a one-way ANOVA was run to look for differences between physical activity (PA scores) and class status (Freshman, Sophomore, Junior, Senior, and Graduate). The assumption of the homogeneity of variance was not violated based on Levene's test (p = .311); however, Shapiro-Wilk goodness of fit test showed assumption of normality was violated at the Freshman (p = .009) and Sophomore (p = .045) levels. Because the normality assumption was not

met, a Kruskal-Wallis test was performed with the following result: X^2 (4, N = 185) = 10.61, p = .0313.

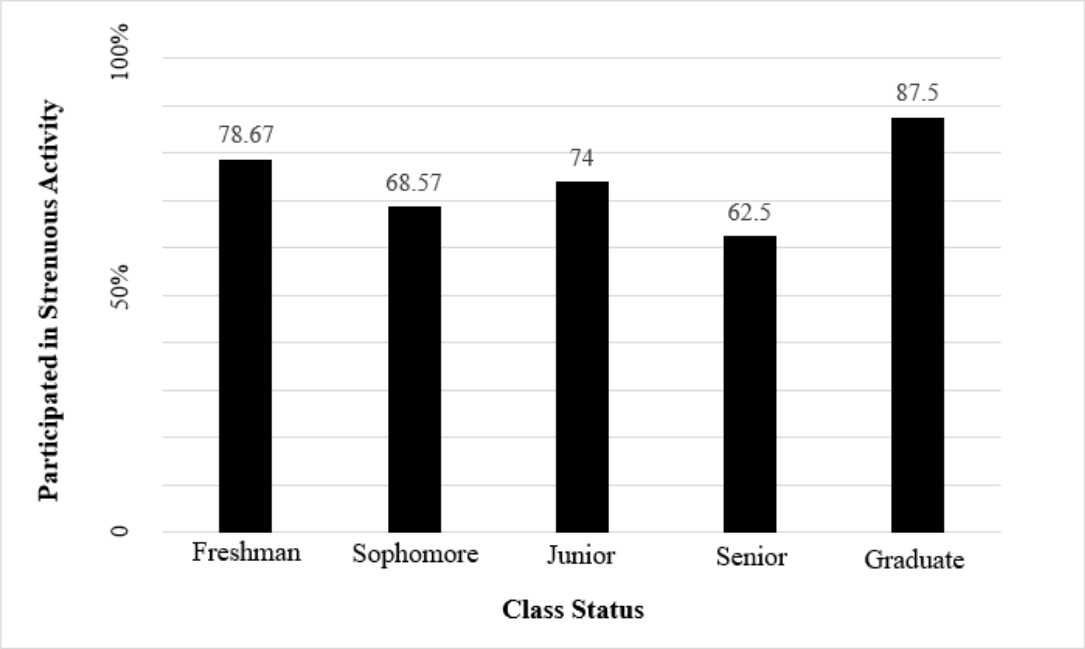
This statistical significance indicates there were different mean PA scores across the five groups of class status. Although a follow-up Dunn test for non-parametric comparison of all pairs was performed, it showed no statistically significant differences of PA scores between the levels of class status. When investigating the PA scores, Graduates (104.75) and Freshmen (104.39) had highest score means by class status. This indicates higher levels of physical activity participation among these two groups.

Strenuous activity and Class status. To explore the range of factors that relate to physical activity participation, a Pearson's Chi-square test was performed to see if the proportion of those who participated in strenuous activity differed by level of class status (Freshman, Sophomore, Junior, Senior, Graduate). There was no statistically significant relationship between participation in strenuous activity and class status, X^2 (4, N = 185) = 5.33, p = .2540. This does not provide sufficient evidence of a relationship between class status and strenuous physical activity.

Within this study's sample, those with the highest percentage of strenuous physical activity throughout the week were: graduate (87.5%) and freshman (78.67%) students followed by juniors (74.07%), sophomores (68.57%), and seniors (62.50%). The age range for freshmen was 18 to 23 years old. For graduates, the age range was 22 to 46 years of age. Some would expect younger students (freshmen) to participate in vigorous types of physical activity more than older (graduate) students. In this case the opposite seemed to be true; the reasons for this are unclear.

Figure 4.2

Strenuous physical activity participation by Class status



Note. Percentage of those who participated in strenuously intense activity per undergraduate and graduate students.

Although the overall physical activity (PA scores) did not seem to be impacted by class rank, a gradual decrease in strenuous activity among the undergraduate students could be related to progress in their college careers. As one advances in a major field of study, more time may be required for educational pursuits with less time available (or fewer opportunities) for vigorous activity. It is important for individuals to remember even short sessions of physical activity throughout the day can contribute to a healthy lifestyle. Students who feel short on time may find participation in moderately intense activities (e.g., walk or yoga), or quick bouts of strenuous activity (e.g., jog for 10 minutes), to be more manageable during busy parts of the semester.

Self-Regulation and Class Status. To look for differences in self-regulation strategy usage (SelfRegPA) between levels of class status (Freshman, Sophomore, Junior, Senior, and Graduate), a one-way ANOVA was performed in JMP. Per Shapiro-Wilk goodness of fit test, normality assumption was not violated; and a Levene's test (p = .3534) shows no violation in the homogeneity of variances assumption. There was no statistically significant difference in SelfRegPA means between the five groups, $F(4, 180) = 1.66$. p = .16. This indicates strategy usage for self-regulation of physical activity (SelfRegPA score) did not differ based on class status. In this sample, the mean scores ranged from 32.54 to 38.80; these results show self-regulation of physical activity was not impacted by level of class status.

Self-Regulation and GPA. A one-way ANOVA was run to see if there were differences in self-regulation strategy usage (SelfRegPA scores) between GPA levels (1.0 – 1.9; 2.0 – 2.9; 3.0 – 3.9; 4.0). A Shapiro-Wilk goodness of fit test indicated the assumption of normality was not violated for each GPA level. A Levene's test was found to be not significant (p = .44), which shows homogeneity of variances assumption was not violated. No statistically significant difference was found in self-regulation strategy usage by GPA level, $F(3, 181) = 1.50$, p = .22. Because this was not statistically significant, the findings could be specific only to this sample and less able to be generalized to a population outside of this study.

When reviewing the SelfRegPA mean scores for each GPA level, the range of these scores was between 34.20 and 39.20 (for 2.0 – 2.9 and 4.0, respectively) out of a max of 60. A mean score of 36 was found at GPA levels 1.0 – 1.9 and 3.0 – 3.9. In regards to self-regulation strategy usage, there was not very much difference between

the four levels of GPA. This suggests grade-point average does not relate to self-regulation of physical activity.

PA score and GPA. To see if there were differences in physical activity participation (PA score) according to GPA level, an ANOVA was performed. In addition to a violation in normality being discovered at two levels (2.0 – 2.9 GPA and 3.0 – 3.9 GPA), a Levene's test showed unequal variances among the groups (p = .014). Due to a violation in normality, a nonparametric test (Kruskal-Wallis) was performed with the following results: X^2 (3, N = 185) = 3.65, p = .3022. Because the findings were not statistically significant, there is not enough evidence of a relationship between GPA levels and physical activity participation (PA score). Due to a violation in homogeneity of variances assumption, a Welch's test was run with the following results: *Welch's* F(3, 4.83) =1.07, p = .4424. There were no statistically significant differences found in the PA scores (i.e., physical activity participation) between the GPA levels. Any differences seen between the groups is likely due to chance and may be specific only to this dissertation study.

The mean PA scores in this study were only slightly different by GPA level. The lowest GPA level (1.0 – 1.9) had the lowest number (n = 2), the lowest mean PA score, and the biggest spread among the scores (M = 43, SD = 48.08). Additionally, the max PA score for the 1.0 – 1.9 GPA level was the lowest at 77 compared to 124 (2.0 - 2.9 GPA) and 130 (3.0 – 3.9 and 4.0 GPA). Those with the lowest GPAs also reported the lowest weekly physical activity participation. These findings are similar to previous studies that noted a positive association between student GPA and physical activity levels (Weston, 2020; Flynn et al., 2009).

The next chapter sums up the findings from this full study. There is discussion of each research question and the additional analyses performed as well as the relevance to this research study. To conclude, a review of what was discovered from this dissertation study and future research recommendations are presented.

Chapter 5

Summary, Conclusions, and Recommendations

Summary of the Study

The purpose of this study was to examine how behavior regulation styles and self-regulation strategy usage relate to physical activity. Self-determination theory was used as the theoretical framework (Ryan & Deci, 2000). Regression analysis, ANOVAs and *t*-tests were performed to consider how variables impacted physical activity participation.

One measured variable was behavior regulation style; there were 6 categories of regulation style for physical activity ranging from low- to high-autonomous (self-determined) regulation. Strategy usage for self-regulation of physical activity was another variable measured in this study; the numeric score ranged from 5 to 60. The dependent variable was a measure of overall physical activity participation within a week. Factors such as GPA level and class status were investigated to see if they were connected to physical activity and self-regulation.

Instruments used in this study were previously designed, reliable questionnaires with numeric fill-in-blank and Likert-type scales to measure physical activity participation, regulation style, and self-regulation usage. The Leisure-Time and Physical Activity questionnaire (LTPAQ) measured physical activity participation, including the amount and intensity of activity, accumulated during a

week. The Behavior Regulation for Exercise questionnaire (BREQ-3) was used to categorize the participants into one of six styles of behavior regulation for physical activity which reflected degree of motivation. The Physical Activity Self-regulation questionnaire (PASR-12) measured strategy usage related to self-regulation of physical activity. Information on participants' general demographic questions—such as GPA, gender, and class status—was also collected at the same time as the other self-report questionnaires. Reliability of Likert-scale instruments (BREQ-3 and PASR-12) measured by Cronbach's alpha ranged from 0.72 to 0.96. Because these values were 0.70 and above, this suggests adequate reliability for these questionnaires. For the LTPAQ, the correlation coefficient ranges from 0.74 to 0.81 which represents acceptable reliability for this instrument (Arey, Blatt & Gutman, 2022; Godin & Shephard, 1985; Sallis et al, 1993).

The questionnaires were administered electronically to 189 participants who volunteered at Florida Institute of Technology in Melbourne, Florida, in March of the spring 2023 semester. Data collected from this sample was complete (no missing data) and used to explore relationships between variables and to test hypotheses associated with the research questions. Linear regression, ANOVAs, and *t*-tests were used for this purpose.

Summary of Findings

Based on the desired power, the sample size was acceptable. The number of outliers was low, and the four outliers were removed. This brought the participant number to 185. The results from the descriptive and inferential statistics are discussed in the upcoming section. Supplemental analyses were performed to further explore

relationships among other factors which may impact physical activity. Discussion of the conclusions for inferential statistics were divided by research question (RQ).

To answer RQ 1 (Do behavior regulation styles relate to physical activity participation?), an ANOVA was performed to see if the mean PA scores were different among six behavior regulation styles. The PA score measured an individual's level of physical activity participation in a typical week. Because the assumption of normality was not met, a Kruskal-Wallis test was performed and revealed statistically significant differences in the median PA scores across the behavior regulation styles. Additionally, comparisons of all pairs of regulation styles revealed significant differences in physical activity participation between two styles: non-regulation and integrated regulation.

Measured on the self-determination continuum, the non-regulation style has the lowest degree of autonomy and motivation. The integrated regulation style involves higher autonomy, and it is the fifth highest of six behavior regulation styles on the self-determination continuum. Those within the integrated regulation style had a higher average and range of PA scores (M = 74; 36 to 136) compared to those within the amotivated, non-regulation style (M = 16; 6 to 38). These findings show physical activity participation was higher among those who were more self-determined and intrinsically motivated. Because behavior regulation styles do relate to physical activity, the null hypothesis was rejected.

To answer RQ 2 (Does self-regulation strategy usage relate to physical activity participation levels?), a linear regression was performed to see if SelfRegPA score (x) significantly predicted the PA score (y). The SelfRegPA score represents the degree of

self-regulation strategy usage (specific to physical activity). When checked, the linearity assumption for this model was violated, and a different data analysis was performed. The SelfRegPA score was divided into three categories: low, moderate, and high self-regulation strategy usage. To continue exploring how self-regulation impacts physical activity, an ANOVA was performed.

When the assumption of normality was not met, a Kruskal-Wallis rank sums test was then performed resulting in: X^2 (2, N = 185) = 21.37, p < .0001. This statistical significance indicates there were differences in the PA score means among the three levels of strategy usage (low, moderate, and high). Participants with low strategy usage also had the lowest PA score mean (61.67) compared to moderate strategy users (86.43) and high strategy users (127.32). These findings suggest self-regulation strategy usage does relate to physical activity participation. This provides enough evidence to reject the null hypothesis.

For RQ 3 (Do behavior regulation styles relate to self-regulation strategy usage?), an ANOVA was performed. Due to unequal variances, a Welch's test was run and found statistically significant differences in self-regulation strategy usage between behavior regulation styles, $F(5, 21.82) = 8.46$, p = 0.000. This shows there were differences in the mean SelfRegPA scores among the six regulation styles. The biggest difference in SelfRegPA score means (i.e., strategy usage) was found between Integrated and Non-regulation styles. As expected, highly autonomous regulation styles were found to have higher strategy usage in regards to self-regulation of physical activity.

The regulation styles with the highest mean SelfRegPA scores (i.e., highest strategy usage) were Integrated ($M = 46$), Identified ($M = 36$), and Intrinsic ($M = 37$). These highly autonomous regulation styles had the highest score means which indicates a high degree of self-regulation strategy usage among these regulation styles. On the other hand, there was a lower degree of strategy usage (demonstrated by lower SelfRegPA score means) among the low-autonomous regulation styles: Non-regulation ($M = 21$), External ($M = 30$), and Introjected ($M = 34$). These findings lead to rejecting the null and accepting the hypothesis: behavior regulation styles are related to self-regulation strategy usage.

To explore RQ 4 (Does self-regulation strategy usage differ between groups who are strenuously active and not strenuously active?), a *t*-test was performed. There were statistically significant differences in self-regulation strategy usage (SelfRegPA score) between strenuous and non-strenuous groups. Mean scores differed between strenuous ($M = 39$) and non-strenuous ($M = 27$) groups. This indicates strenuously active individuals used self-regulation strategies for physical activity more so than those who were only non-strenuously active.

To continue the investigation, a Chi-square (X^2) test was performed to look for a relationship between levels of self-regulation strategy usage (low, moderate, and high) and intensity of physical activity (strenuous and non-strenuous). Most participants were moderate strategy users ($n = 136$) with about 74% engaging in weekly strenuous physical activity. A notable difference was found: Of those with high-levels of strategy usage ($n = 37$), 100% participated in strenuous activity in an average week. Among low-level strategy users ($n = 12$) only 16% ($n = 2$) participated

in strenuous activity during an average week. As seen with the *t*-test, levels of self-regulation strategy usage differed between strenuous and non-strenuous physical activity groups. This evidence leads to rejection of the null hypothesis. See Table 5.1 for a list of hypotheses by research questions.

Table 5.1

Summary of Hypotheses Testing by Research Question

Hypothesis	Null hypothesis	Decision
H1	Behavior regulation styles are not related to physical activity participation.	Reject
H2	Self-regulation strategy usage is not related to physical activity participation.	Reject
H3	Behavior regulation styles are not related to self-regulation strategy usage.	Reject
H4	Self-regulation strategy usage does not differ between strenuous and non-strenuous groups.	Reject

Overall, GPA levels were not significantly different in terms of mean scores for both SelfRegPA score (i.e., self-regulation of physical activity) and PA score (i.e., physical activity participation). Statistically speaking, any differences found may be more related to chance or specific to this study only. There was not enough evidence to show an association between (1) GPA and self-regulation or between (2) GPA and physical activity participation.

When investigating the scores within this study, the mean scores representing self-regulation (SelfRegPA score) were not very different (range between 34 to 39) among the levels of GPA. This supports the statistical finding and suggests self-regulation strategy usage was not impacted by grade-point average. The mean scores for physical activity (PA score) did not differ very much between GPA levels,

especially among the 2.0 – 2.9, 3.0 – 3.9, and 4.0 levels (range of 124 to 130). This indicates that grade-point average did not impact physical activity participation. However, it should be noted that in this study, the two participants with the lowest grade-point average (1.0 – 1.9) also reported the lowest amount of weekly physical activity (PA score = 77). Those who reported the highest amount of physical activity per week (PA score = 130) also had the highest GPA (3.0 – 4.0).

When considering class status, the highest PA score means were found among two groups: Graduates (104.75) and Freshmen (104.39). This represents higher levels of physical activity participation during a week among Freshmen and Graduate students than Sophomores, Juniors, or Seniors. The findings are likely due to a requirement at Florida Institute of Technology (FIT) for freshmen to live on campus. An increased amount of walking is common for students living in dormitories compared to upperclassmen who may commute and live off campus. The reasons for higher physical activity participation among the Graduate students was unclear. Perhaps it is because older students understand the importance of maintaining physical health.

Conclusions and Recommendations

In the upcoming section, the four research questions with corresponding hypotheses are discussed. For a deeper dive into factors that may influence physical activity, other supplemental analyses were performed. A discussion will follow on how student-specific factors (i.e., GPA levels and class status) impact self-regulation and participation in physical activity.

Research question 1: Do behavior regulation styles relate to physical activity participation?

Higher physical activity participation levels were expected among the highly autonomous behavior regulation styles (i.e., Integrated and Intrinsic). An ANOVA was run to see if there were differences in the PA scores (i.e., physical activity participation) among six behavior regulation styles (Non-regulation, External, Introjected, Identified, Integrated, and Intrinsic). A Kruskal-Wallis test was run, as the normality assumption was not met. The results are: X^2 (5, N = 185) = 16.11, p = .0065, thus providing evidence that behavior regulation impacted the PA score, and the null hypothesis was rejected. This shows behavior regulation styles were related to physical activity participation

Within this study, statistically significant differences in physical activity scores were found between Non-regulation and Integrated regulation styles (p = .0143). A comparison of average PA scores shows a lower range of physical activity among Non-Regulation style (6 to 38; average = 16) while a higher range of physical activity scores was seen among the more-autonomous (highly motivated) style, Integrated (36 to 136; average = 74). We can see the least-motivated style (Non-Regulation) was associated with low weekly physical activity participation. On the other hand, physical activity participation was higher among the highly motivated style (Integrated).

Research question 2: Does self-regulation strategy usage relate to physical activity participation?

To look at how using self-regulation strategy of physical activity was related to weekly participation, a linear regression was performed. SelfRegPA score (self-

regulation strategy usage) was the IV and PA score (physical activity participation) was the DV. Because the linearity assumption was violated, a different analysis was performed to investigate if self-regulation strategy usage had a relationship with physical activity. An ANOVA was performed to see how physical activity participation (y) differs by self-regulation strategy usage (x).

Self-regulation strategy usage (SelfRegPA score) was categorized into low, moderate, and high. As the normality assumption was violated, a Kruskal-Wallis rank sums test was performed and found to be statistically significant: X^2 (2, N = 185) = 21.37, p < .0001. This indicates there were differences in mean PA scores (i.e., physical activity participation) across the three levels of self-regulation strategy usage. Lower physical activity was seen among low-strategy users (PA score mean = 61.67) than with moderate-strategy users (PA score mean = 86.43) or high-strategy users (PA score mean = 127.32). These findings suggest self-regulation strategy usage was related to physical activity participation. Overall, due to the results of this model, the null hypothesis was rejected.

In this study, the participants responded (on the PASR-12) that the strategies used most to regulate their physical activity involved: self-monitoring, reinforcements, and time management. These strategies may be important to include when designing a successful physical activity plan.

Research question 3: Do behavior regulation styles relate to self-regulation strategy usage?

To continue investigating how behavior regulation styles were associated with self-regulation strategy usage (SelfRegPA score), an ANOVA was performed.

Because there were unequal variances, a Welch's test was performed with the following results: $F(5, 21.82) = 8.46$, $p = .000$, which provides evidence of statistically significant differences in the mean scores for self-regulation strategy usage among behavior regulation styles. The findings presented enough evidence to reject the null hypothesis, as there were differences in self-regulation strategy usage between behavior regulation styles. Because there were differences seen, this indicates a relationship between regulation styles and self-regulation of physical activity.

The biggest differences in means for the SelfRegPA score (i.e., self-regulation strategy usage) was between the higher-autonomous (self-determined) and the least-autonomous regulation styles. SelfRegPA score means differed the most between Integrated and Non-Regulation styles (26.65, $p = .0001$). Intrinsic and Non-Regulation styles had the next biggest difference in SelfRegPA score (16.58, $p = .0068$). These behavior regulation styles are on opposite ends of the self-determination continuum. As anticipated, those within the highly motivated regulation styles (Intrinsic and Integrated) used self-regulation strategies for physical activity more so than those within the least-motivated regulation style (Non-Regulation). This reinforces that motivation plays a role in the decision to engage in healthy behaviors.

Research question 4: Does self-regulation strategy usage differ between groups who are strenuously active and groups who are not strenuously active?

Participation in strenuous activity has been linked to health benefits such as: increased metabolic rate (which burns excess calor ies) leading to weight loss, cardiovascular improvements (i.e., better control of blood sugar and blood pressure), and a decrease in mortality, also called early death (Noh et al., 2015; Swain &

Franklin, 2005; Gebel et al., 2015). Therefore, comparing differences between strenuous and non-strenuous groups was of interest to this research on physical activity participation.

To investigate if usage of self-regulation strategies was associated with intensity of physical activity, a *t*-test was performed. There were statistically significant differences found in the SelfRegPA score means between two groups: those who participated in strenuous (M = 39.14, SD = 8.62) and non-strenuous (M = 27.26, SD = 7.65) physical activity, $t(183) = 8.31$, $p < .0001$. This shows evidence of differences between the groups regarding SelfRegPA scores. Those who were strenuously activity used self-regulation strategies for physical activity more than those who were only non-strenuously active. About 3/4 of the participants in this study (n = 139) reported engaging in weekly strenuous physical activity; the remaining participants (n = 46) reported engaging in only non-strenuous physical activity during a normal week.

To further investigate how levels of self-regulation strategy usage related to strenuously and non-strenuously intensity activity, a Chi-square test was performed with the following results: X^2 (2, N = 185) = 34.39, p = .0001. This shows a statistically significant relationship between levels of self-regulation strategy usage (low, moderate, and high) and intensity of physical activity (strenuous and non-strenuous). In respect to levels of self-regulation strategy usage, there were noteworthy differences between strenuously and non-strenuously active groups.

Most of the participants (n = 139) fell within the category of moderate-level strategy usage. However, out of the high-level strategy users (SelfRegPA score = 45 to

60), 100% reported strenuous activity participation during a typical week. In contrast, out of the low-level strategy users (SelfRegPA score = 5 to 20), only 16.67% reported strenuous activity participation during a week. This suggests those who were high-level strategy users were more likely to participate in strenuous physical activity during a week compared to low-level strategy users. Self-regulation does appear to have a positive relationship to physical activity participation.

GPA

On examination of GPA levels, there were no statistically significant differences found in regards to SelfRegPA score (i.e., self-regulation strategy usage) or PA score (i.e., physical activity participation). Any differences seen were more likely due to chance. Findings could be specific to this research study. Statistically speaking, there was not enough evidence provided to see an association between: (1) GPA and self-regulation strategy usage, and (2) GPA and physical activity participation.

Among the SelfRegPA score means, there were no statistically significant differences seen between the four GPA levels: $F(3, 181) = 1.50$, $p = .22$. There was not much difference seen in the SelfRegPA score among the GPA levels, with the range being 34 to 39 (60 max). The mean score for participants with a GPA of 2.0 – 2.9 was 34.20; the mean score for 1.0 – 1.9 and 3.0 – 3.9 was 36; the mean score for 4.0 was 39.20. Again, this shows grade-point average did not relate to strategy usage for self-regulation of physical activity. There does not appear to be a relationship between GPA and self-regulation strategy usage.

Regarding PA score means, there was very little difference seen among the four GPA levels. A Welch's test was performed with the following results: *Welch's* $F(3, 4.83) = 1.07$, $p = .4424$. This shows no statistically significant differences in the mean PA score between GPA levels; and differences seen may be due to chance. Participants with the lowest GPA (1.0 – 1.9) had the lowest mean PA score ($M = 43$; $SD = 48.08$) and the lowest PA score (77) compared to the other three GPA levels. The PA score was 124 for those with a 2.0 – 2.9 GPA; the PA score was 130 for GPA levels 3.0 – 3.9 and 4.0. When the GPA was low, the weekly physical activity participation was low, but due to lack of statistical significance, there was not enough evidence to apply the findings outside of this study.

Class Status

To see if there were differences in the SelfRegPA score (i.e., self-regulation strategy usage for physical activity) between levels of class status (Freshman, Sophomore, Junior, Senior, and Graduate), an ANOVA was run with these results: $F(4, 180) = 1.66$, $p = .16$. This shows no statistically significant difference in the SelfRegPA means based on class status. Within this study, the mean scores ranged from 32.54 to 38.80, and this reinforces self-regulation strategy usage was not impacted by class status.

To continue exploring what contributes to physical activity, an ANOVA was performed to see if there were differences in the PA score (i.e., physical activity participation) among the five levels of class status. A Kruskal-Wallis test was performed because the assumption of normality had be violated. The results were: $X^2 (4, N = 185) = 10.61$, $p = .0313$. This shows statistically significant differences in the

mean PA scores among the five class status levels. Based on a Dunn test, when a comparison of all pairs (of class status levels) was performed, there were no significant differences shown in the PA scores. The PA score means were the highest among Graduates (104.75) and Freshmen (104.39) and indicates a higher level of physical activity participation per week compared to Juniors (85.65), Seniors (82.13), and Sophomores (73.67).

To see if the participation in strenuous activity differed by class status, a Pearson's Chi-square test was run resulting in: X^2 (4, N = 185) = 5.33, p = .2540. This shows no statistically significant relationship between participation in strenuous physical activity and class status. For this study, the findings show those who participated in strenuous physical activity the most were Graduates (87.5%) and Freshmen (78.67%). The next highest percentages to participate in strenuous activity were Juniors (74.07%), Sophomores (68.57%), and Seniors (62.50%).

Because the range of ages for Graduates (22 to 46 years old) was higher than the Freshman (18 to 23 years old), it was unexpected to see the highest percentage of strenuously active individuals in an older age group. However, these findings are specific to this study and may not be applicable to populations outside of this dissertation study.

Conclusion

The aim of this study was to better understand the relationship among motivation and self-regulation on a student's physical activity participation. Behavior regulation styles corresponded to types of motivation (Amotivation, External and Intrinsic) on a continuum of self-determination (or autonomous behavior). The

SelfRegPA score measured usage of self-regulation strategies for physical activity. Physical activity participation was measured by the PA score; the score includes an individual's frequency and intensity of physical activity during a week.

Self-regulation strategy usage was related, not only to physical activity participation, but also to intensity of activity. High-level strategy users participated in more physical activity in a week compared to low-level strategy users. Additionally, 100% of the high-level strategy users participated in strenuous physical activity (compared with 73.5% of moderate-level strategy users, and only 16.67% of the low-level strategy users). Knowing specific self-regulation strategies which influence physical activity participation could be ideal in finding ways to promote healthy amounts of activity.

Behavior regulation styles were related to physical activity participation and self-regulation. Non-Regulation, the least-motivated (least-autonomous) style was associated with low physical activity participation. Conversely, physical activity participation was higher among the highly motivated (more-autonomous) style, Integrated. Understanding how one regulates their physical activity may help health experts design better ways to promote activity. Goals and strategies can be planned for someone based on the degree of motivation for physical activity or exercise.

Highly autonomous behavior regulation styles were linked to a high degree of self-regulation strategy usage; and there was a lower degree of strategy usage among those in the low-autonomous regulation styles. This suggests motivation does have some impact on physical activity participation. Behavior regulation styles had an association with physical activity participation and self-regulation usage.

As the participants of this study were from a student population, factors such as GPA and class status were investigated as to their influence on physical activity and self-regulation. However, GPA did not seem to impact self-regulation strategy usage or physical activity participation (not enough to generalize to a population outside of this study). Class status did not appear to be related to strategy usage. However, higher levels of weekly physical activity were noted among Freshmen and Graduates.

An explanation for high physical activity participation among the Freshmen could be due to the requirement at Florida Institute of Technology (FIT) for Freshmen to live on campus during their first year of enrollment. On-campus living often requires more walking by students compared to those who commute and live an off-campus experience. Whether going to and from the dormitory, the dining hall, or classes, many FIT freshmen are in an environment conducive to walking. Typical freshman "dorm life" may be one reason for the higher physical activity scores seen among the Freshman class. Higher physical activity participation among the Graduates is unclear. One reason for this may be that graduate students tend to be older than undergraduates and realize the importance of daily activity for health. However, these findings may be specific only to this study.

Physical activity levels may have been influenced by the location of the participants recruited for this study. The main campus for FIT is located on the east coast of Florida close to beaches and campgrounds. The mild climate provides many opportunities for outdoor activities (e.g., swimming, tennis, hiking) and visiting tourist attractions during the year. Compared to other areas which experience colder, harsher

weather during the winter months, students at this university have an advantage when it comes to the availability of year-around activities.

Recommendations for Research

Future studies could investigate possible changes in physical activity at different stages of higher education. Freshman participants in this study were more physically active on average than the upperclassmen. Because FIT freshmen live on campus, an environment conducive to walking (due to general dorm life) may be a reason for the increased physical activity. This may offer a remedy for the decreased physical activity generally experienced as one progresses through college.

Strenuous activity has been linked to good health. Most of the participants in this study were engaged in some type of strenuously intense activities throughout the week. Students at this world-renown research university may be considered over-achievers, so the high percentage of strenuously activity students may reflect this. Factors such as marital status may also contribute to someone's decision to be physically active or not. Marital status was not checked for the current study, but it may be a variable in the amount of activity someone accumulates weekly.

As in previous research, this study showed self-regulation of physical activity was connected to engagement in activity. Physical activity interventions can be made to suit individual needs. Future research is suggested to find out which type of self-regulation strategies are best for activity promotion. Appropriate goal-setting, self-monitoring, and planning to reach health objectives may be guided with health apps and devices (e.g., wearable activity trackers).

Knowledge about someone's behavior regulation style may also be beneficial for activity promotion. For instance, someone who is amotivated to engage in physical activity (i.e., Non-Regulation style) may need hourly reminders from their activity tracker to get up and be active. On the other hand, someone who fits a more autonomous regulation style (higher motivation) may need assistance with time management (e.g., planning out specific times and days to be active during the week). Making use of wearable technology to track activity and other health goals can provide information about an individual's needs to better develop physical activity interventions.

Strategy usage can be easily monitored and goals adapted based on an individual's current progress towards their health objectives. To continue learning which strategies are successful in promotion of physical activity, a quantitative study to measure physical activity and strategy usage through participant wearable activity trackers (e.g., Fitbit or Apple Health app) can give insight into what does (and does not) influence engagement in activity. This research could also provide insight as to the factors that contribute to lifelong adherence to physical activity.

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Appendix A

Metacognitive Awareness Inventory (19-item subset)

I think about what I really need to learn before I begin a task. R P

I set specific goals before I begin a task. R P

I know what kind of information is most important to learn. K DK

I know what the teacher expects me to learn. K DK

I have control over how well I learn. K DK

I periodically review to help me understand important relationships. R M

I summarize what I've learned after I finish. R E

I can motivate myself to learn when I need to. K CK

I am aware of what strategies I use when I study. K PK

I am a good judge of how well I understand something. K DK

I find myself using helpful learning strategies automatically. K PK

I know when each strategy I use will be most effective. K CK

I try to translate new information into my own words. R IMS

I change strategies when I fail to understand. R DS

I use the organizational structure of the text to help me learn. R IMS

I ask myself if what I'm reading is related to what I already know. R IMS

I re-evaluate my assumptions when I get confused. R DS

I ask myself if I learned as much as I could have once I finish a task. R E

I stop and go back over new information that is not clear. R DS

Response scale:
1 = Not at all typical of me; 2 = Not very typical of me; 3 = Somewhat typical of me; 4 = Fairly typical of me; 5 = Very typical of me

K = Knowledge of cognition (DK = Declarative Knowledge; PK = Procedural Knowledge; CK = Conditional Knowledge)
R = Regulation of cognition (P = Planning; IMS = Information Management Strategies; CM = Comprehension Monitoring; DS = Debugging strategies E = Evaluation)

Appendix B

Metacognitive Awareness Inventory in Exercise (MAI-E)

Think of yourself as an exerciser. Read each statement carefully. Consider if the statement is true or false as it generally applies to you in the role of an exerciser. Check True or False for each statement.

	TRUE	FALSE
I ask myself periodically if I am meeting my exercise goals. R CM		
I think about what is best for me to learn before I begin exercising. R P		
I set specific goals before I begin exercising. R P		
I know what kind of exercises are important to perform. K DK		
I know how fitness experts expect me to exercise. K DK		
I have control over how well I exercise. K DK		
I periodically review my exercises to help me understand important relationships. R M		
After I finish, I summarize what I have exercised. R E		
I can motivate myself to exercise when I need to. K CK		
I am aware of what strategies I use when I exercise. K PK		
I am a good judge of how well I understand exercise. K DK		
I find myself using helpful strategies for exercise automatically. K PK		
I know when each exercise strategy I use will be most effective. K CK		
I try to translate new exercise information into my own words. R IMS		

I change exercise strategies when I fail to understand. R

DS

I ask myself if exercises I am performing are related to

exercises I already know. R IMS

I re-evaluate how I perform exercises when I get confused.

R DS

I organize my time to best accomplish my exercise goals.

R P

Once I finish, I ask myself if I exercised as much as I

could have. R E

I stop and go back over new exercises that are not clear. R

DS

Adapted from the Metacognition Awareness Inventory (Schraw & Dennison, 1994; Harrison & Vallin, 2018; Leno, 2019).

K = Knowledge of cognition (DK = Declarative Knowledge; PK = Procedural Knowledge; CK = Conditional Knowledge)

R = Regulation of cognition (P = Planning; IMS = Information Management Strategies; CM = Comprehension Monitoring; DS = Debugging strategies E = Evaluation)

Appendix C

Physical Activity Self-Regulation Scale (PASR-12)

The following statements relate to your behaviors regarding physical activity (PA) and exercise. Please respond to each item on a scale of 1 to 5 (1 = Never and 5 = Very Often). There are no right or wrong answers. Please answer each item honestly.

	Never	Rarely	Sometimes	Often	Very Often
I mentally keep track of my PA	1	2	3	4	5
I mentally note specific things that helped me be active.	1	2	3	4	5
I set short-term goals for how often I am active.	1	2	3	4	5
I set exercise goals that focus on my health.	1	2	3	4	5
I ask someone for exercise advice or demonstration.	1	2	3	4	5
I ask an exercise expert or health professional for exercise advice or demonstration.	1	2	3	4	5
After exercise, I focus on how good I feel.	1	2	3	4	5
I remind myself of exercise health benefits.	1	2	3	4	5
I mentally schedule specific times for PA.	1	2	3	4	5
I rearrange my schedule to ensure I have time for exercise.	1	2	3	4	5

I purposely plan ways to exercise when on trips away from home.	1	2	3	4	5
I purposely plan ways to exercise in bad weather.	1	2	3	4	5

Adapted from original 43-item list, PASR-43 (Petosa, 1993; Umstattd et al., 2009)

Appendix D

Godin-Shephard Leisure-Time Physical Activity Questionnaire

During a typical 7-day period (a week), how many times on average do you do the following kinds of exercise for **more than 15 minutes** (write on each line the appropriate number)?

Times Per Week

(a) STRENUOUS EXERCISE _____

Heart beats rapidly

(e.g., running, jogging, hockey, football, soccer, squash, basketball, cross-country skiing, judo, roller skating, vigorous swimming, vigorous long-distance bicycling)

(b) MODERATE EXERCISE _____

Not exhausting

(e.g., fast walking, baseball, tennis, easy bicycling, volleyball badminton, easy swimming, alpine skiing, dancing)

(c) LIGHT/MILD EXERCISE _____

Minimal effort

(e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)

Appendix E

Scoring Sheet for the Godin-Shephard Leisure-Time Physical Activity Questionnaire (LTPAQ)

To determine physical activity (overall):

	Times per week		Totals
(a) STRENUOUS EXERCISE Heart beats rapidly (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross-country skiing, judo, roller skating, vigorous swimming, vigorous bicycling)		x 9	=
(b) MODERATE EXERCISE Not exhausting (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, dancing)		x 5	=
(c) LIGHT/MILD EXERCISE Minimal effort (e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)		x 3	=
Total weekly Physical Activity (overall) score =			

LTPAQ Scale Score	Results
24 or more units	Active (Substantial benefits)
14 – 23 units	Moderate (Some benefits)
Less than 14 units	Insufficiency Active/Sedentary (Less substantial or low benefits)

Adapted from Godin and the Leisure-Time Physical Activity Questionnaire score interpretation (Godin, 2011)

Appendix F

IRB Exemption Form and Certificate of Clearance for Human Participants Research

Florida Institute of Technology
Institutional Review Board

Notice of Exempt Review Status
Certificate of Clearance for Human Participants Research

Principal Investigator:	Kay Sharon Stanfield
Date:	February 12, 2021
IRB Number:	21-018
Study Title:	Exploring the Relationship Between Metacognition, Self-Regulation Strategy Use, and Physical Activity Participation

Your research protocol was reviewed and approved by the IRB Chairperson. Per federal regulations, 45 CFR 46.101, your study has been determined to be minimal risk for human subjects and exempt from 45 CFR46 federal regulations. The Exempt determination is valid indefinitely. Substantive changes to the approved exempt research must be requested and approved prior to their initiation. Investigators may request proposed changes by submitting a Revision Request form found on the IRB website.

Acceptance of this study is based on your agreement to abide by the policies and procedures of Florida Institute of Technology's Human Research Protection Program (http://web2.fit.edu/crm/irb/) and does not replace any other approvals that may be required.

All data, which may include signed consent form documents, must be retained in a secure location for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Access to data is limited to authorized individuals listed as key study personnel.

The category for which exempt status has been determined for this protocol is as follows:

3. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) require(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

Florida Institute of Technology

RESEARCH INVOLVING HUMAN PARTICIPANTS
EXEMPT APPLICATION

This form shall be used if there is **minimal risk** to human subjects; one of the categories on the next page applies to the research. If there is more than minimal risk associated with the research (none of the conditions apply) or if the research utilizes a special population (children, prisoners, institutionalized individuals, etc.), please use the expedited/full application form found on the IRB website.

You should consult the university's document "Principles, Policy, and Applicability for Research Involving Human Subjects" and instructions on the IRB Committee website prior to completion of this form.
https://www.fit.edu/research/compliance--regulations/institutional-review-board

Submit via email to FIT_IRB@fit.edu.

IRB Contact Information:
Dr. Jignya Patel
IRB Chairperson
FIT_IRB@fit.edu
321-674-7347

INVESTIGATOR INFORMATION

Title of Project: Exploring the Relationship between Metacognition, Self-Regulation strategy use, and Physical Activity Participation

Date of Submission: February 1, 2021

Expected Project Start Date: February 2021 Expected Project Duration: December 2021

Principal Investigator: Kay Sharon Stanfield

Title: Ph.D. student

Academic Unit: Mathematical Sciences

Phone: 251-753-3302 Email: sstanfield2009@my.fit.edu

List all co-investigator(s). Please include name, title, academic unit/affiliation and email.

CATEGORIES OF EXEMPT RESEARCH
Research must choose one:

☐ Research conducted in established or commonly accepted educational settings, involving **normal educational practices**, such as:
a. research on regular and special education instruction strategies, or
b. research on the effectiveness of or the comparison among instruction techniques, curricula or classroom management methods.

☐ Research involving the use of **educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior** unless:
a. the subjects can be identified, directly or through identifiers linked to the subjects and
b. any disclosure of subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability or reputation.
Note: This exemption does not apply to survey procedures or interviews involving minors.

☐ Research involving the use of educational tests, survey or interview procedures, or observation of **public behavior** if:
a. the subjects are elected or appointed public officials or candidates for public office, or
b. the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

☐ Research involving the **collection or study of existing data, documents, records or specimens** if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, indirectly or through identifiers linked to the subjects.

☐ Research and demonstration projects that are conducted by or subject to the approval of department or agency heads and that are designed to study, evaluate or otherwise examine:
a. **public benefit or service programs**,
b. procedures for obtaining benefits or services under those programs,
c. possible changes in or alternatives to those programs or procedures, or
d. possible changes in methods or levels of payment for benefits or services under those programs.

☐ **Taste and food quality evaluation** and consumer acceptance studies if:
a. wholesome foods without additives are consumed, or
b. food is consumed that contains food ingredients found to be safe by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

RESEARCH FUNDING
If any part of this study will be funded by an external funding source, you must note the funding source and award/solicitation number below:

N/A

ANSWER THE FOLLOWING QUESTIONS AS THOROUGHLY AS POSSIBLE.

1. List the objectives of the proposed project.

In order to promote healthy physical activity levels among adults, this study will explore the relationship between use of metacognitive and self-regulation strategies on levels of physical activity participation. Metacognitive strategy use (related to activity) will be compared to physical activity participation levels. Self-regulation strategy use (related to activity) will be compared to physical activity participation levels. Recognizing factors, including strategies and techniques associated with healthy physical activity, will contribute to knowledge within health education regarding promotion of healthy behavior.

2. Describe the research project design/methodology. Discuss how you will conduct your study, and what measurement instruments you are using. Attach all research materials to this application. Please describe your study in enough detail so the IRB can identify what you are doing and why.

Self-report surveys will be used to measure independent and dependent variables. The Metacognition Awareness Inventory (Exercise version) will be used to measure three IVs: knowledge of cognition, regulation of cognition, and overall metacogniton strategy use. The Physical Activity Self-Regulation survey will measure the fourth IV, self-regulation strategy use, consisting of 6 subsets.

The Godin-Shephard Leisure Time Physical Activity Questionairre will measure two DVs: Physical Activity (overall) and Health-related Physical Activity (mild + vigorous activity). Participants will be asked to estimate daily activity (in 15-min blocks) and given examples of each intensity of light, mild/moderate, and vigorous activity.

Additionally, participants will be asked questions regarding changes to their physical activity before and after COVID-19. These questions will help supplement knowledge on how individuals regulate health behavior and overcome obstacles caused by life events (such as the pandemic).

3. Describe the characteristics of the participant population, including number, age, sex and recruitment strategy (attach actual recruitment email text, recruitment fliers, etc).

Participants for this study will be selected from the FIT campus community to include students, faculty, and staff members (male and female) age 18 years and older. Required sample size is 99 based on a priori analysis with err prob = 0.5, effect size = 0.15, power = 0.9. Recruitment email will be sent through FITforum to reach out to Florida Tech community to encourage participation.

4. Describe any potential risks to the participants (physical, psychological, social, legal, etc.) and assess their likelihood and seriousness. Describe steps that will be taken to mitigate each risk.

There is low likelihood of potential risks for the participants in this study on metacognition and physical activity. Participants will be reminded to honestly report current levels of activity, as there no right or wrong answers, no judgement on levels of performance, and the data gathered will be held confidental.

5. Describe the procedures you will use to maintain the confidentiality and privacy of your research participants and project data. If video or audio recordings will be made, you must review the video/audio recording policy found on the IRB website and address precautions you will take in this section.

Participants will be assigned a userID with any collected demographic information and survey responses. The project data will be analyzed and stored with no personally identifiable information.

6. Describe your plan for informed consent (attach proposed form).

Informed consent form will be presented to participants at the beginning of the electronic survey to explain the purpose and benefits of the study. Additionally, participants are reminded that all answers will be kept confidental, and they may withdraw from the study at any time without penalty. If they agree to volunteer for the study, and they are 18 years of age and older, they will be able to click to confirm and proceed to the survey (presented through Google forms).

7. Discuss the importance of the knowledge that will result from your study (benefits to the field and to society) and what benefits will accrue to your participants (if any). Include information about participant compensation if appropriate.

This study will continue to explore factors that encourage healthy levels of physical activity participation. Specifically, self-regulation and metacognitive strategies and techniques associated with physical activity will be investigated. This will contribute to knowledge within health education regarding promotion of healthy behavior. Participants will have the opportunity to self-reflect on activity levels and strategies they use for regulation of health behavior.

Additionally, participants will be asked questions regarding current physical activity and activity levels before and after COVID-19 events. This will supplement the growing body of knowledge about how individuals regulate health behavior when faced with obstacles in life, such as world-changing events.

8. Explain how your proposed study meets criteria for exemption from Institutional Review Board review (as outlined on page 2 of this form).

This study will use survey responses to measure the variables. All personally identifiable information will be kept confidental during data collection and after research is complete.

SIGNATURE ASSURANCES

I understand Florida Institute of Technology's policy concerning research involving human participants and I agree:

1. to accept responsibility for the scientific and ethical conduct of this research study.
2. to obtain prior approval from the Institutional Review Board before amending or altering the research protocol or implementing changes in the approved consent form.
3. to immediately report to the IRB any serious adverse reactions and/or unanticipated effects on subjects which may occur as a result of this study.
4. to complete, on request by the IRB, a Continuation Review Form if the study exceeds its estimated duration.

PI Signature Kay Sharon Stanfield Date 2/3/2021

PI Signature (print) Kay Sharon Stanfield

ADVISOR ASSURANCE: IF PRIMARY INVESTIGATOR IS A STUDENT

This is to certify that I have reviewed this research protocol and that I attest to the scientific merit of the study, the necessity for the use of human subjects in the study, to the student's academic program, and the competency of the student to conduct the project.

Major Advisor Signature DocuSigned by: B94BFB2C0588443... Date 2/5/2021

Major Advisor (print) Samantha Fowler

ACADEMIC UNIT HEAD: IT IS THE PI'S RESPONSIBILITY TO OBTAIN THIS SIGNATURE

This is to certify that I have reviewed this research protocol and that I attest to the scientific merit of this study and the competency of the investigator(s) to conduct the study.

Academic Unit Head Signature DocuSigned by: Munevver Mine Subasi 4DE72C43FE62443... Date 2/5/2021

Academic Unit Head (print) Munevver Mine Subasi

FOR IRB USE ONLY

IRB Approval _____ Date _____

IRB # _____

You are invited to participate in a survey to explore how self-regulated behaviors and metacognitive strategies are associated with physical activity. You will be asked questions about current physical activity levels (including exercise routines) and activity before and after COVID-19 events. This can include unstructured physical activity performed during someone's leisure time (i.e., walking, jogging, fitness classes, and sports activities.) There are no right or wrong answers. Your responses are important to supplement knowledge about how individuals have overcome obstacles to being physically activity and how they regulate health behavior.

Demographics

1) Age: _____

2) What is your race/ethnicity?

A) African-American, Black

B) Asian

C) Hispanic

D) Native American

E) Native Hawaiian

F) White

G) Other race/ethnicity _____

H) Prefer not to say

3) What is your gender?

A) Female

B) Male

C) Prefer to self describe as_____

D) Prefer not to say

4) I am a Florida Tech _____.

A) Student

(if "Student" is selected) What is your college class status?

a. Freshman

b. Sophomore

c. Junior

d. Senior

e. Graduate

B) Staff/Faculty member

5) How many years did you play competitive high school sports or club sports?

A) 0

B) 1

C) 2

D) 3

E) 4

6) Have you played competitive sports while in college (including off-campus club sports)?

Yes

(If "yes" is selected) How many years did you play competitive sports while in college?

A) Less than 1 year

B) 1

C) 2

D) 3

E) 4 or more

No

7) What is your approximate grade point average?

A) 4.0

B) 3.0 – 3.9

C) 2.0 – 2.9

D) 1.0 - 1.9

8) How would you describe your general health?

A) Excellent

B) Very Good

C) Good

D) Fair

E) Poor

F) Don't know

9) Where do you go for advice on health and fitness?

A) Social media (TikTok, Instagram, Facebook, etc.)

B) Online (health websites, YouTube videos, fitness blogs, etc.)

C) Professional organizations (American Heart Association, National Strength and Conditioning Association, World Health Organization, etc.)

D) Fitness or health professionals (certified personal trainer, athletic trainer, fitness coach, etc.)

E) Magazines

F) Friends and/or family members

G) Intuition

H) Other (please specify) _____

10) How do you describe your weight?

A) Very underweight

B) Slightly underweight

C) About the right weight

D) Slightly overweight

E) Very Overweight

11) Currently, I plan to _____.

A) stay the same weight

B) lose weight

C) gain weight

D) do nothing about my weight

12) Do you have a pre-existing health condition that would impact your ability to be physically active?

Yes

No

13) Where do you live?

A) Midwest region (Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin)

B) Northeast region (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, Rhode Island, Vermont)

C) Southeast region (Arkansas, Alabama, Delaware, District of Columbia, Florida, Georgia, Kentucky, Maryland, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia

D) Southwest region (Arizona, New Mexico, Oklahoma, Texas)

E) West region (California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming)

F) Outside of the United States (please specify) _____

Consent to Participate in Research Study

Purpose of Research:

This study will explore how self-regulation and metacognition strategy use relates to physical activity participation. Recognizing factors and strategies associated with physical activity will help health educators learn more about promotion and adherence to healthy behavior.

Explanation of Research:

To promote healthy levels of physical activity, this research will examine how strategies involving self-regulation, knowledge of cognition, and regulation of cognition are associated with levels of physical activity. You will be asked questions regarding use of specific strategies, current physical activity, and activity levels before and after COVID-19 events. This information will supplement knowledge about how individuals overcome obstacles and regulate health behavior.

Benefits of Participation:

Participants will be able to self-reflect on current physical activity levels and any strategies used for regulation of health behavior.

Compensation and Incentives:

There is no compensation for participation.

Conditions of Participation:

There are no known risks to participants in this research.

The identity of individual participants will be held in strictest confidence.

Participants are free to withdraw from the study at any time with no penalty or prejudice.

If you have questions about participating in this research, contact:

Kay Stanfield

Sstanfield2009@my.fit.edu

251-753-3302

By continuing this survey, you agree that you have read and understood the above. You are 18 years old or older and volunteer to participate in this research study.

AGREE & CONTINUE

Metacognition Awareness Inventory, Exercise version (MAI-Ex)

Think of yourself as an exerciser. Read each statement carefully. Consider if the statement is true or false as it generally applies to you in the role of an exerciser. Check True or False for each statement.

(1) I ask myself periodically if I am meeting my exercise goals. TRUE FALSE

(2) I think about what is best for me to learn before I begin exercising. TRUE FALSE

(3) I set specific goals before I begin exercising. TRUE FALSE

(4) I know what kind of exercises are important to perform. TRUE FALSE

(5) I know how fitness experts expect me to exercise. TRUE FALSE

(6) I have control over how well I exercise. TRUE FALSE

(7) I periodically review my exercises to help me understand important relationships. TRUE FALSE

(8) After I finish, I summarize what I have exercised. TRUE FALSE

(9) I can motivate myself to exercise when I need to. TRUE FALSE

(10) I am aware of what strategies I use when I exercise. TRUE FALSE

(11) I am a good judge of how well I understand exercise. TRUE FALSE

(12) I find myself using helpful strategies for exercise automatically. TRUE FALSE

(13) I know when each exercise strategy I use will be most effective. TRUE FALSE

(14) I try to translate new exercise information into my own words. TRUE FALSE

(15) I change exercise strategies when I fail to understand. TRUE FALSE

(16) I ask myself if exercises I am performing are related to exercises I already know. TRUE FALSE

(17) I re-evaluate how I perform exercises when I get confused. TRUE FALSE

(18) I organize my time to best accomplish my exercise goals. TRUE FALSE

(19) Once I finish, I ask myself if I exercised as much as I could have. TRUE FALSE

(20) I stop and go back over new exercises that are not clear. TRUE FALSE

Adapted from the Metacognition Awareness Inventory (Schraw & Dennison, 1994; Harrison & Vallin, 2018) and Metacognition Awareness Inventory for Exercise (Leno, 2019).

Physical Activity Self-Regulation Scale

The following statements relate to your behaviors regarding physical activity (PA) and exercise. Please respond to each item on a scale of 1 to 5 (1 = Never and 5 = Very Often). There are no right or wrong answers. Please answer each item honestly.

	Never	Rarely	Sometimes	Often	Very Often
(1) I mentally keep track of my PA	1	2	3	4	5
(2) I mentally note specific things that helped me be active.	1	2	3	4	5
(3) I set short-term goals for how often I am active.	1	2	3	4	5
(4) I set exercise goals that focus on my health.	1	2	3	4	5
(5) I ask someone for exercise advice or demonstration.	1	2	3	4	5
(6) I ask an exercise expert or health professional for exercise advice or demonstration.	1	2	3	4	5
(7) After exercise, I focus on how good I feel.	1	2	3	4	5
(8) I remind myself of exercise health benefits.	1	2	3	4	5
(9) I mentally schedule specific times for PA.	1	2	3	4	5
(10) I rearrange my schedule to ensure I have time for exercise.	1	2	3	4	5
(11) I purposely plan ways to exercise when on trips away from home.	1	2	3	4	5
(12) I purposely plan ways to exercise in bad weather.	1	2	3	4	5

The 12-item Physical Activity Self-Regulation Scale (PASR-12; Umstattd et al., 2009) was adapted from the original 43-item list, PASR-43 (Petosa, 1993).

Godin-Shephard Leisure-Time Physical Activity Questionnaire

During a typical 7-day period (a week), how many times on average do you do the following kinds of exercise for **more than 15 minutes** (write on each line the appropriate number)?

Times Per Week

(a) STRENUOUS EXERCISE
(Heart beats rapidly)
(e.g., running, jogging, hockey, football, soccer, squash, basketball, cross-country skiing, judo, roller skating, vigorous swimming, vigorous long-distance bicycling) _____

(b) MODERATE EXERCISE
(Not exhausting)
(e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, dancing) _____

(c) LIGHT/MILD EXERCISE
(Minimal effort)
(e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking) _____

Scoring Sheet for the Godin-Shephard Leisure-Time Physical Activity Questionnaire (LTPAQ)

Weekly Physical Activity (overall) score = (9 x Strenuous) + (5 x Moderate) + (3 x Light)
Weekly Physical Activity (for health benefits) score = (9 x Strenuous) + (5 x Moderate)

To determine physical activity (overall):

	Times per week		Totals
(a) STRENUOUS EXERCISE (Heart beats rapidly) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross-country skiing, judo, roller skating, vigorous swimming, vigorous long-distance bicycling)		x 9	=
(b) MODERATE EXERCISE (Not exhausting) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, dancing)		x 5	=
(c) LIGHT/MILD EXERCISE (Minimal effort) (e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)		x 3	=
Total weekly Physical Activity (overall) score =			

To determine physical activity (for health benefits):

	Times per week		Totals
(a) STRENUOUS EXERCISE (Heart beats rapidly) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross-country skiing, judo, roller skating, vigorous swimming, vigorous long-distance bicycling)		x 9	=
(b) MODERATE EXERCISE (Not exhausting) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, dancing)		x 5	=
Total weekly Physical Activity (for health benefits) score =			

Godin-Shephard LTPAQ Scale Score	Results

24 or more units	Active (Substantial benefits)
14 – 23 units	Moderate (Some benefits)
Less than 14 units	Insufficiency Active/Sedentary (Less substantial or low benefits)

Adapted from Godin and the Leisure-Time Physical Activity Questionnaire score interpretation (Godin, 2011)

Appendix G

BREQ-3: BEHAVIOR REGULATIONS FOR EXERCISE QUESTIONNAIRE

WHY DO YOU ENGAGE IN EXERCISE?

We are interested in the reasons underlying peoples' decisions to engage or not engage in physical exercise. Using the scale below, please indicate to what extent each of the following items is true for you. Please note that there are no right or wrong answers and no trick questions. We simply want to know how you personally feel about exercise. Your responses will be held in confidence and only used for our research purposes.

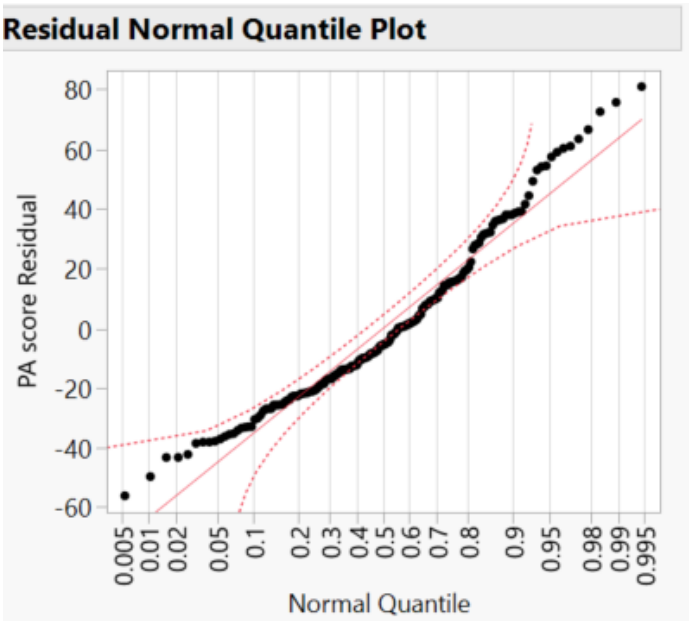
		Not true for me		**Sometimes true for me**		**Very true for me**
1	It's important to me to exercise regularly	0	1	2	3	4
2	I don't see why I should have to exercise	0	1	2	3	4
3	I exercise because it's fun	0	1	2	3	4
4	I feel guilty when I don't exercise	0	1	2	3	4
5	I exercise because it is consistent with my life goals	0	1	2	3	4
6	I exercise because other people say I should	0	1	2	3	4
7	I value the benefits of exercise	0	1	2	3	4
8	I can't see why I should bother exercising	0	1	2	3	4
9	I enjoy my exercise sessions	0	1	2	3	4
10	I feel ashamed when I miss an exercise session	0	1	2	3	4
11	I consider exercise part of my identity	0	1	2	3	4
12	I take part in exercise because my friends/family/partner say I should	0	1	2	3	4
13	I think it is important to make the effort to exercise regularly	0	1	2	3	4
14	I don't see the point in exercising	0	1	2	3	4
15	I find exercise a pleasurable activity	0	1	2	3	4
16	I feel like a failure when I haven't exercised in a while	0	1	2	3	4

17	I consider exercise a fundamental part of who I am	0	1	2	3	4
18	I exercise because others will not be pleased with me if I don't	0	1	2	3	4
19	I get restless if I don't exercise regularly	0	1	2	3	4
20	I think exercising is a waste of time	0	1	2	3	4
21	I get pleasure and satisfaction from participating in exercise	0	1	2	3	4
22	I would feel bad about myself if I was not making time to exercise	0	1	2	3	4
23	I consider exercise consistent with my values	0	1	2	3	4
24	I feel under pressure from my friends/family to exercise	0	1	2	3	4

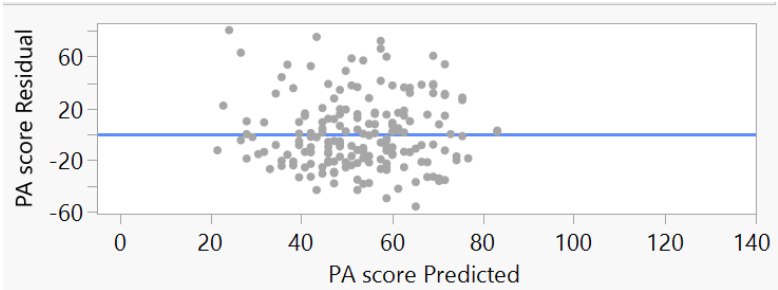
Appendix H

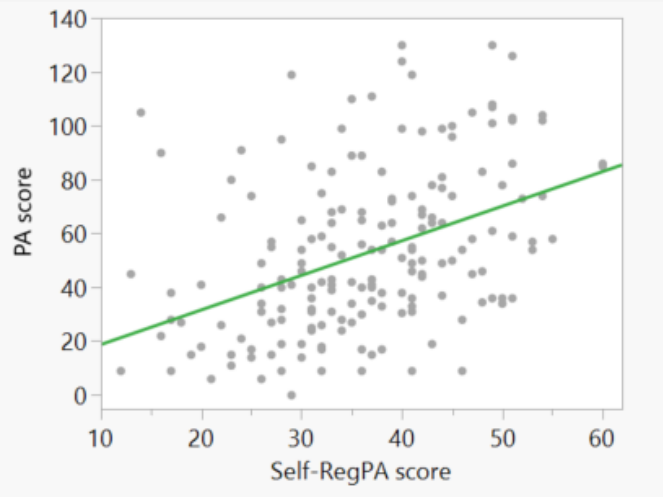
Figures Associated with Assumptions of Regression for the Full Study

H.1: Figures associated with the Normality Assumption



H.2: Figures associated with the Linearity Assumption

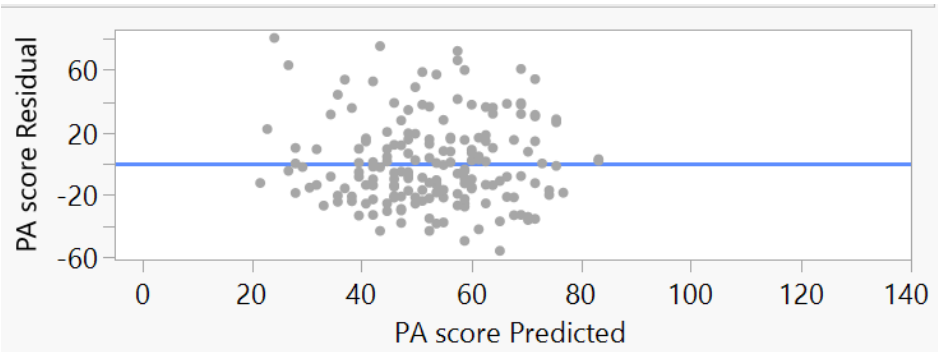




H.3: Figure associated with Independence of the Residuals

Durbin-Watson	Number of Obs.	AutoCorrelation	Prob<DW
2.1924759	185	-0.1030	0.9043

H.4: Figure associated with Constant Variance (Homoscedasticity) of Residuals Assumption



Appendix I

Figures associated with Inferential Statistics of Full Study

I.1: Figures related to PA score and Behavior Regulation styles

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Regulation style	5	14912.27	2982.45	3.5084	0.0047*
Error	179	152165.37	850.09		
C. Total	184	167077.64			

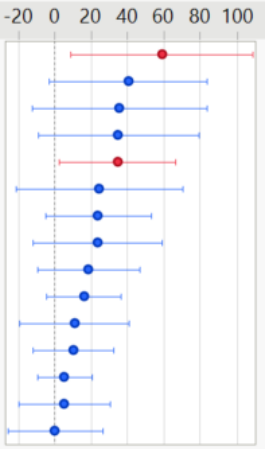
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
EXTERNAL	13	50.9231	8.086	34.97	66.880
IDENTIFIED	49	50.4592	4.165	42.24	58.678
INTEGRATED	10	74.4000	9.220	56.21	92.594
INTRINSIC	88	56.0114	3.108	49.88	62.145
INTROJECTED	21	39.9286	6.362	27.37	52.484
NON-REGULATION	4	15.5000	14.578	-13.27	44.267

Std Error uses a pooled estimate of error variance

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
INTEGRATED	NON-REGULATION	58.90000	17.24906	9.2082	108.5918	0.0101*
INTRINSIC	NON-REGULATION	40.51136	14.90576	-2.4298	83.4525	0.0767
EXTERNAL	NON-REGULATION	35.42308	16.67071	-12.6026	83.4488	0.2793
IDENTIFIED	NON-REGULATION	34.95918	15.16147	-8.7186	78.6370	0.1972
INTEGRATED	INTROJECTED	34.47143	11.20218	2.1997	66.7432	0.0287*
INTROJECTED	NON-REGULATION	24.42857	15.90603	-21.3942	70.2513	0.6416
INTEGRATED	IDENTIFIED	23.94082	10.11718	-5.2052	53.0868	0.1739
INTEGRATED	EXTERNAL	23.47692	12.26376	-11.8530	58.8069	0.3968
INTEGRATED	INTRINSIC	18.38864	9.72978	-9.6413	46.4186	0.4117
INTRINSIC	INTROJECTED	16.08279	7.08098	-4.3164	36.4820	0.2114
EXTERNAL	INTROJECTED	10.99451	10.28939	-18.6476	40.6366	0.8932
IDENTIFIED	INTROJECTED	10.53061	7.60454	-11.3769	32.4381	0.7361
INTRINSIC	IDENTIFIED	5.55218	5.19700	-9.4195	20.5239	0.8933
INTRINSIC	EXTERNAL	5.08829	8.66321	-19.8691	30.0456	0.9918
EXTERNAL	IDENTIFIED	0.46389	9.09615	-25.7407	26.6685	1.0000



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
EXTERNAL	9	12.2	23	40	78.5	110.4	124
IDENTIFIED	0	17	30.25	49	67.5	89	130
INTEGRATED	36	36.2	39.5	74.5	105.75	124.2	126
INTRINSIC	6	17.9	34	50	73.75	102.1	130
INTROJECTED	6	9	26	35	57	79.6	86
NON-REGULATION	6	6	6.75	9	30.75	38	38

I.2: Figures related to PA score and SelfRegPA score

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Strategy use level	2	19716.41	9858.21	12.1755	<.0001*
Error	182	147361.23	809.68		
C. Total	184	167077.64			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
HIGH	37	72.3919	4.6779	63.162	81.622
LOW	12	37.2500	8.2142	21.043	53.457
MODERATE	136	48.4007	2.4400	43.586	53.215

Std Error uses a pooled estimate of error variance

Kruskal-Wallis Test, ChiSquare Approximation

ChiSquare	DF	Prob>ChiSq
21.3683	2	<.0001*

I.3: Figures related to SelfRegPA score and Behavior Regulation styles

Test	F Ratio	DFNum	DFDen	Prob > F
O'Brien[.5]	2.5146	5	179	0.0315*
Brown-Forsythe	3.0195	5	179	0.0121*
Levene	3.0724	5	179	0.0110*
Bartlett	1.8911	5	.	0.0922

Warning: Small sample sizes. Use Caution.

Welch's Test

Welch Anova testing Means Equal, allowing Std Devs Not Equal

F Ratio	DFNum	DFDen	Prob > F
8.4617	5	21.816	0.0001*

Multiple Comparisons

Dependent Variable: SelfRegPA

Games-Howell

(I) BehReg	(J) BehReg	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
EXTERNAL	IDENTIFIED	-5.9000	2.38810	.185	-13.4989	1.6989
	INTEGRATED	-16.4000*	3.11849	<.001	-26.1886	-6.6114
	INTRINSIC	-7.2874	2.40483	.066	-14.9126	.3379
	INTROJECTED	-4.1905	3.33304	.805	-14.2919	5.9110
	NON-REGULATION	9.2500	4.34546	.394	-9.0688	27.5688
IDENTIFIED	EXTERNAL	5.9000	2.38810	.185	-1.6989	13.4989
	INTEGRATED	-10.5000*	2.47392	.010	-18.7031	-2.2969
	INTRINSIC	-1.3874	1.47599	.935	-5.6583	2.8836
	INTROJECTED	1.7095	2.73944	.988	-6.6896	10.1087
	NON-REGULATION	15.1500	3.90875	.113	-5.0198	35.3198
INTEGRATED	EXTERNAL	16.4000*	3.11849	<.001	6.6114	26.1886
	IDENTIFIED	10.5000*	2.47392	.010	2.2969	18.7031
	INTRINSIC	9.1126*	2.49007	.026	.8917	17.3336
	INTROJECTED	12.2095*	3.39506	.015	1.8045	22.6146
	NON-REGULATION	25.6500*	4.39321	.012	7.3409	43.9591
INTRINSIC	EXTERNAL	7.2874	2.40483	.066	-.3379	14.9126
	IDENTIFIED	1.3874	1.47599	.935	-2.8836	5.6583
	INTEGRATED	-9.1126*	2.49007	.026	-17.3336	-.8917
	INTROJECTED	3.0969	2.75403	.867	-5.3317	11.5255
	NON-REGULATION	16.5374	3.91899	.088	-3.5522	36.6270
INTROJECTED	EXTERNAL	4.1905	3.33304	.805	-5.9110	14.2919
	IDENTIFIED	-1.7095	2.73944	.988	-10.1087	6.6896
	INTEGRATED	-12.2095*	3.39506	.015	-22.6146	-1.8045
	INTRINSIC	-3.0969	2.75403	.867	-11.5255	5.3317
	NON-REGULATION	13.4405	4.54802	.152	-4.5089	31.3898
NON-REGULATION	EXTERNAL	-9.2500	4.34546	.394	-27.5688	9.0688
	IDENTIFIED	-15.1500	3.90875	.113	-35.3198	5.0198
	INTEGRATED	-25.6500*	4.39321	.012	-43.9591	-7.3409
	INTRINSIC	-16.5374	3.91899	.088	-36.6270	3.5522
	INTROJECTED	-13.4405	4.54802	.152	-31.3898	4.5089

Based on observed means.

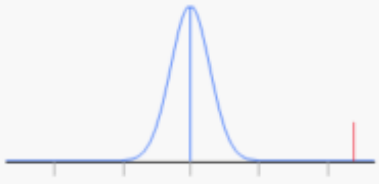
The error term is Mean Square(Error) = 84.272.

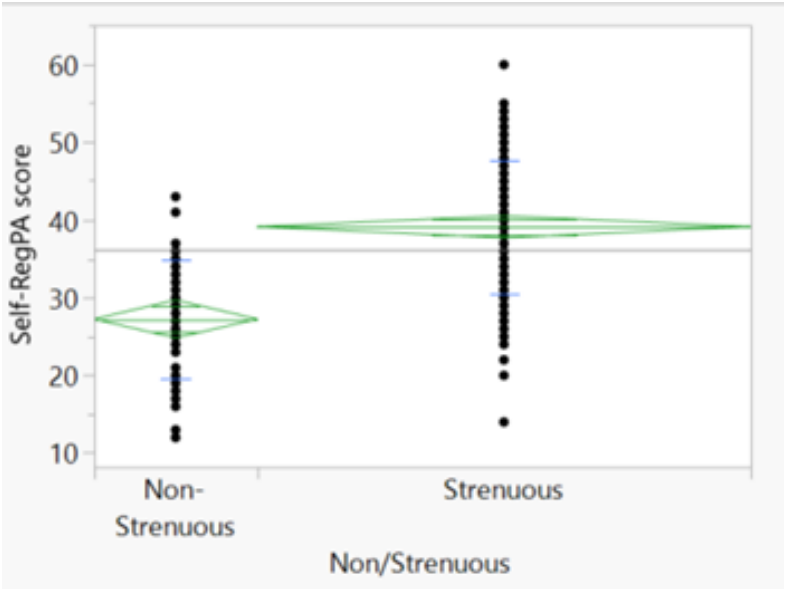
*. The mean difference is significant at the 0.05 level.

I.4: Figures related to *t*-test (SelfRegPA score by Strenuous/Non-strenuous groups)

Strenuous-Non-Strenuous
Assuming equal variances

Difference	11.8758	t Ratio	8.316502
Std Err Dif	1.4280	DF	183
Upper CL Dif	14.6932	Prob > |t|	<.0001*
Lower CL Dif	9.0584	Prob > t	<.0001*
Confidence	0.95	Prob < t	1.0000





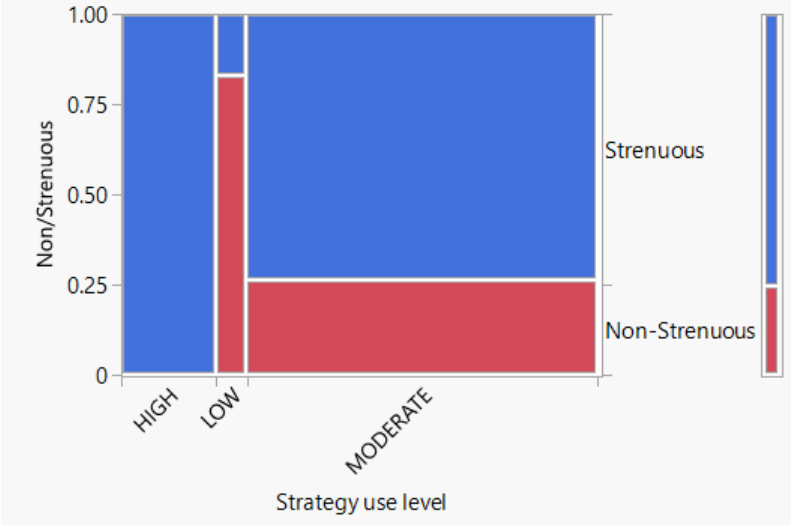
Tests that the Variances are Equal

Test	F Ratio	DFNum	DFDen	p-Value
Levene	0.7605	1	183	0.3843

I.5: Self-regulation strategy usage level by Strenuous/Non-strenuous activity

Contingency Analysis of Non/Strenuous By Strategy use level

Mosaic Plot



Non/Strenuous

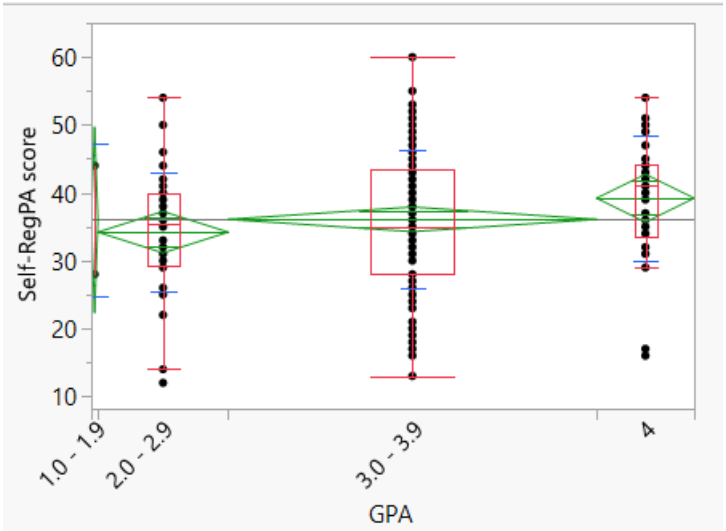
Strategy use level	Count Total % Col % Row %	Non-Strenuous	Strenuous	Total
	HIGH	0 0.00 0.00 0.00	37 20.00 26.62 100.00	37 20.00
	LOW	10 5.41 21.74 83.33	2 1.08 1.44 16.67	12 6.49
	MODERATE	36 19.46 78.26 26.47	100 54.05 71.94 73.53	136 73.51
	Total	46 24.86	139 75.14	185

Tests

N	DF	-LogLike	RSquare (U)
185	2	19.752348	0.1904

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	39.505	<.0001*
Pearson	34.390	<.0001*

I.6: Figures related to ANOVA of SelfRegPA by GPA levels



Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1.0 - 1.9	2	36.0000	6.9211	22.344	49.656
2.0 - 2.9	40	34.2000	1.5476	31.146	37.254
3.0 - 3.9	113	36.0885	0.9208	34.272	37.905
4	30	39.2000	1.7870	35.674	42.726

Oneway Anova

Summary of Fit

Rsquare	0.024277
Adj Rsquare	0.008104
Root Mean Square Error	9.787893
Mean of Response	36.18378
Observations (or Sum Wgts)	185

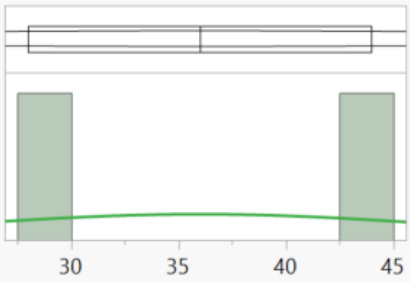
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
GPA	3	431.436	143.812	1.5011	0.2158
Error	181	17340.315	95.803		
C. Total	184	17771.751			

I.7. Distribution of SelfRegPA score by GPA

Distributions GPA=1.0 - 1.9

Self-RegPA score

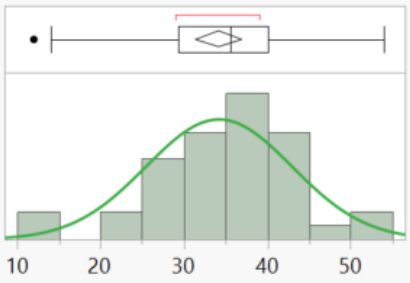


Goodness-of-Fit Test

	W	Prob<W
Shapiro-Wilk	1	1.0000

Distributions GPA=2.0 - 2.9

Self-RegPA score

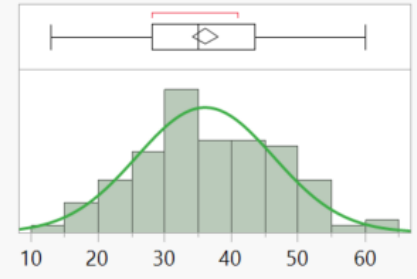


Goodness-of-Fit Test

	W	Prob<W
Shapiro-Wilk	0.9804777	0.7073

Distributions GPA=3.0 - 3.9

Self-RegPA score

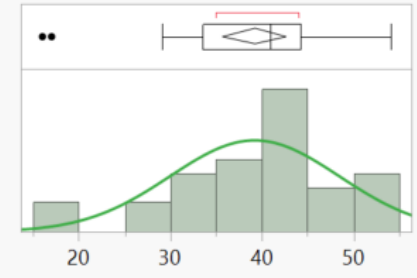


Goodness-of-Fit Test

	W	Prob<W
Shapiro-Wilk	0.9883263	0.4418

Distributions GPA=4

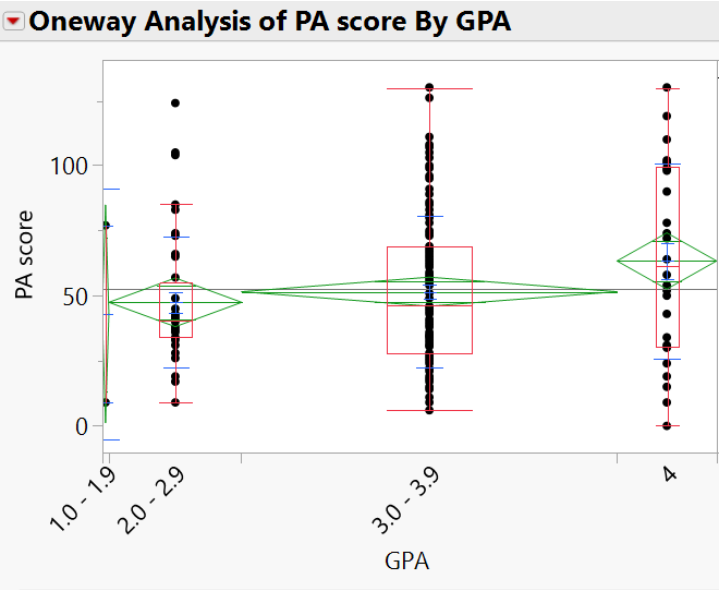
Self-RegPA score



Goodness-of-Fit Test

	W	Prob<W
Shapiro-Wilk	0.9487245	0.1563

I.8: Figures related to PA score and GPA



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
1.0 - 1.9	9	9	9	43	77	77	77
2.0 - 2.9	9	19.7	34.5	40.5	55	84.8	124
3.0 - 3.9	6	15	28	46	69	95.6	130
4	0	9.6	30.75	61	99.5	118.1	130

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1.0 - 1.9	2	43	48.083261	34	-389.011	475.01096
2.0 - 2.9	40	47.45	25.163007	3.9786208	39.40248	55.49752
3.0 - 3.9	113	51.539823	29.067896	2.7344777	46.121806	56.95784
4	30	63.333333	37.42241	6.8323661	49.359576	77.307091

Test	F Ratio	DFNum	DFDen	Prob > F
O'Brien[.5]	4.0626	2	180	0.0188*
Brown-Forsythe	4.0597	3	181	0.0080*
Levene	3.6427	3	181	0.0138*
Bartlett	1.8773	3	.	0.1310

Warning: Small sample sizes. Use Caution.

Welch's Test

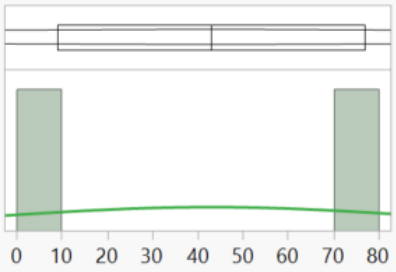
Welch Anova testing Means Equal, allowing Std Devs Not Equal

F Ratio	DFNum	DFDen	Prob > F
1.0708	3	4.8331	0.4424

I.9. Distribution of PA score by GPA

Distributions GPA=1.0 - 1.9

PA score

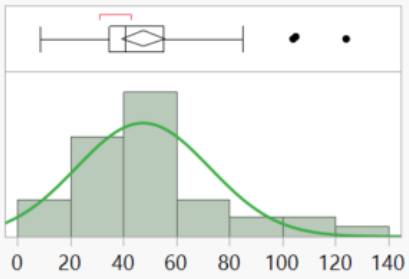


Goodness-of-Fit Test

	W	Prob<W
Shapiro-Wilk	1	1.0000

Distributions GPA=2.0 - 2.9

PA score

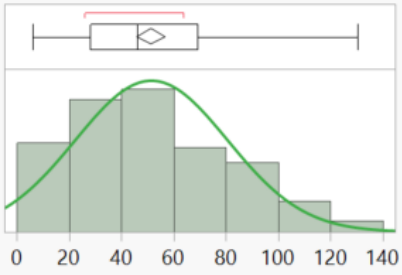


Goodness-of-Fit Test

	W	Prob<W
Shapiro-Wilk	0.8740978	0.0004*

Distributions GPA=3.0 - 3.9

PA score

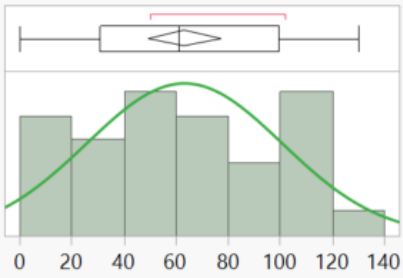


Goodness-of-Fit Test

	W	Prob<W
Shapiro-Wilk	0.9653146	0.0050*

Distributions GPA=4

PA score



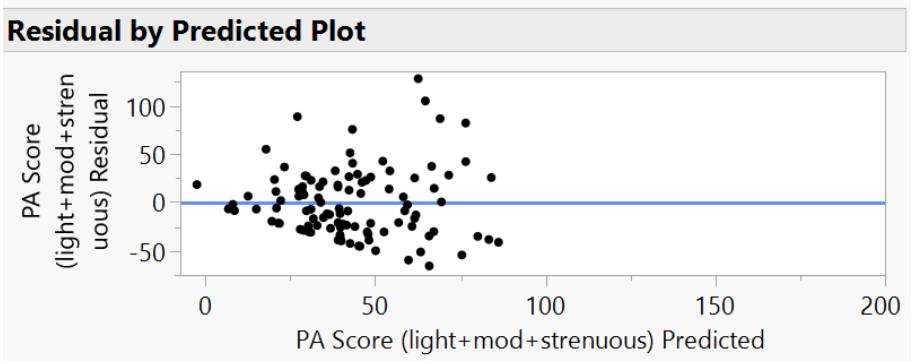
Goodness-of-Fit Test

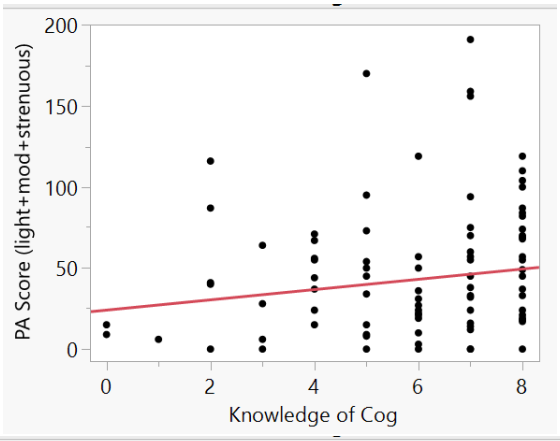
	W	Prob<W
Shapiro-Wilk	0.9594778	0.3004

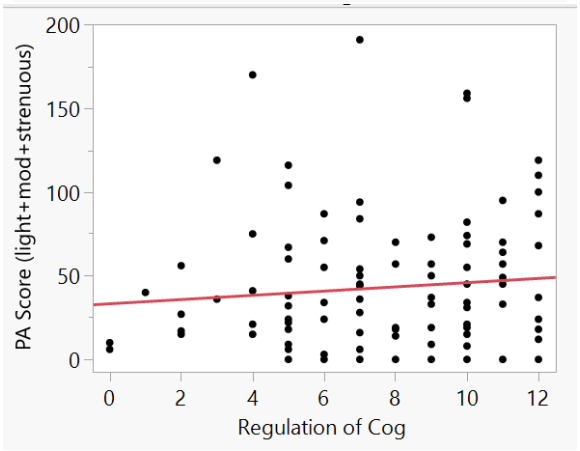
Appendix J

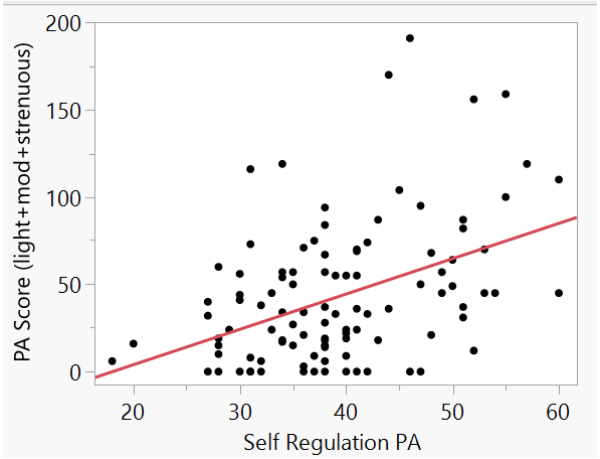
Figures related to Preliminary Pilot Study Findings

J.1: Figures associated with Linearity Assumption

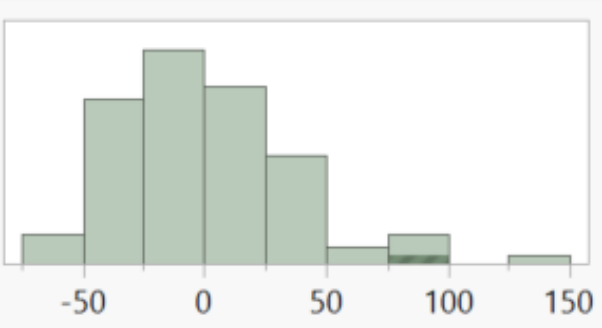


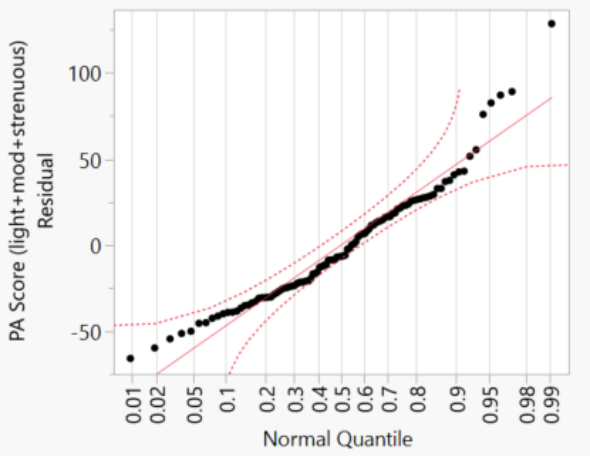





PA Score (light+mod+strenuous)
200
150
100
50
0
20
30
40
50
60
Self Regulation PA

J.2: Figures related with Normality Assumption

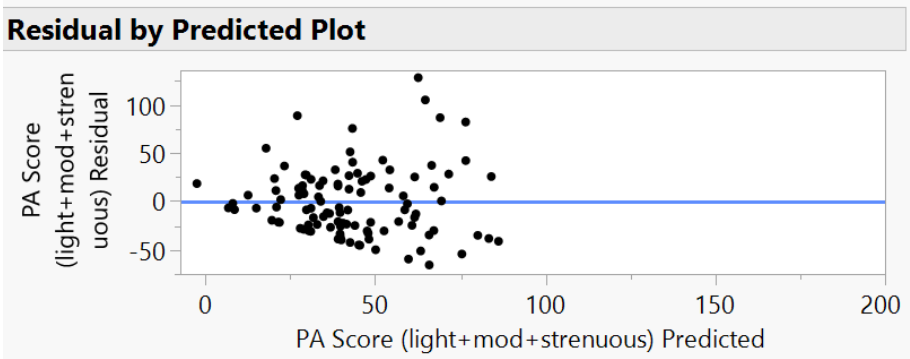




J.3: Figures related to Independence of Residuals Assumption

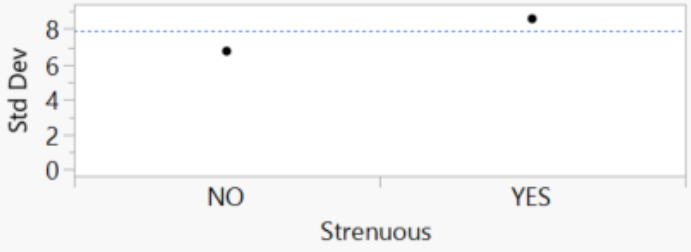
Durbin-Watson	Number of Obs.	AutoCorrelation	Prob<DW
2.0727964	105	-0.0607	0.6516

J.4: Figures related to Homoscedasticity of residuals Assumption



J.5: Figures related to *t*-test of SelfRegPA scores by Non-strenuous/Strenuous activity

Tests that the Variances are Equal



Level	Count	Std Dev	MeanAbsDif to Mean	MeanAbsDif to Median
NO	42	6.768788	5.097506	5.047619
YES	64	8.614872	7.119141	7.046875

Test	F Ratio	DFNum	DFDen	p-Value
O'Brien[.5]	3.1866	1	104	0.0772
Brown-Forsythe	4.4073	1	104	0.0382*
Levene	4.8572	1	104	0.0297*
Bartlett	2.7410	1	.	0.0978
F Test 2-sided	1.6199	63	41	0.1019

Welch's Test

Welch Anova testing Means Equal, allowing Std Devs Not Equal

F Ratio	DFNum	DFDen	Prob > F
16.5446	1	100.55	<.0001*

t Test
4.0675

Appendix K

Research Question 2 ANOVA Analysis

K.1: Research Question 2 Additional ANOVA Analysis

To continue exploring how PA scores and SelfRegPA scores may be related, the researcher performed an alternate analysis when regression did not provide the expected results. An ANOVA was performed to see if PA scores were impacted by SelfRegPA scores. Self-regulation usage categories: low (score = 6 to 20), moderate (score = 21 to 44), and high (score = 45 to 60). When, there appeared to be equal variances based on Levene's test ($p = .509$). The histograms and goodness of fit tests show distributions were not normal among the groups with low ($p = .0135$) and moderate ($p = .0004$) levels of strategy usage. Because of the non-normality, a Kruskal-Wallis rank sums test was performed resulting in: $X^2 (2, N = 185) = 21.37$, $p < .0001$. This statistical significance indicates there were different mean PA scores across the three levels of self-regulation strategy usage. Lower physical activity was seen among low-strategy users (PA score mean = 61.67) than with moderate-strategy users (PA score mean = 86.43) or high-strategy users (PA score mean = 127.32). These findings indicate self-regulation strategy usage impacts physical activity participation. This leads to rejection of the null hypothesis (and acceptance of the hypothesis) as strategy usage does relate to physical activity participation.