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Cognitive and affective correlates of current physical activity: Does the length of regular participation moderate the relationships?

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Cognitive and affective correlates of current physical activity: Does the length of regular participation moderate the relationships?

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The student author, whose presentation of the scholarship herein was approved by the program of study committee, is solely responsible for the content of this thesis. The Graduate College will ensure this thesis is globally accessible and will not permit alterations after a degree is conferred.

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DEDICATION

To my husband, Trevor, thank you for your unwavering support in my pursuit of this degree and all of my dreams. I appreciate all you have done to help me.

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ABSTRACT

In the United States, the majority of the population is not regularly physically active in accordance with established national guidelines. Research has uncovered several variables that show significant and consistent relations with physical activity, including some that refer primarily to cognitions (e.g., appraisals of personal capabilities, such as self-efficacy, or beliefs about health benefits, such as cognitive attitude) and some that refer primarily to affect (e.g., beliefs about deriving pleasure, such as affective attitude, and experiences of enjoyment). It has been suggested that cognitive variables might be more strongly associated with physical activity during the early stages of participation, but affective variables might be more strongly associated with physical activity during later stages. The present study aimed to empirically test this suggestion. Therefore, the hypothesis was that length of time (in weeks) of being consistently physically active would moderate the relation of cognitive correlates (self-efficacy, cognitive attitude) and affective correlates (affective attitude, enjoyment) with the current level of physical activity. Using the Amazon Mechanical Turk platform, 747 US-based adults completed questionnaires that measured: (a) current physical activity, (b) cognitive attitude, (c) exercise self-efficacy, (d) affective attitude, (e) physical activity enjoyment, and (f) physical activity history. The results confirmed that all postulated correlates (cognitive attitude, exercise self-efficacy, affective attitude, physical activity enjoyment) exhibited significant (all $p < 0.001$) and meaningful relations with current physical activity. Furthermore, a positive relationship was found between current physical activity and physical activity history in weeks ($r = 0.303$, $p < 0.001$). However, physical activity history was not found to significantly moderate the relation of any of the postulated correlates with current physical activity (R^2 change for the addition of the interaction term < 0.06%). This finding suggests that the strength of the relation of cognitive and

affective variables with physical activity does not change in a systematic way as a function of the duration of continuous participation in physical activity. In turn, this finding implies that efforts to promote physical activity participation and adherence should maintain a balanced focus on cognitive and affective factors. Methodological strengths and limitations of the study that may inform future investigations on this topic are also discussed.

CHAPTER 1: INTRODUCTION

World Health Organization (2018) statistics suggest that one in every four adults worldwide is not active enough to satisfy current guidelines. In the United States, two out of every three adults are not reaching the Physical Activity Guidelines each week (U.S. Department of Health and Human Services, 2010). The 2nd edition of the Physical Activity Guidelines for Americans recommends 150 minutes per week of moderate-intensity physical activity or 75 minutes per week of vigorous-intensity activity, or an equivalent combination, and muscle-strengthening 2 days per week. Even though health promotion initiatives at state and national levels are in place (Cavill & Bauman, 2004), a large percentage of the population are still not physically active enough to benefit their health. This is problematic because adequate levels of physical activity and exercise have been associated with a longer average life expectancy and better quality of life (Lee et al., 2012).

A majority of the health promotion efforts in the last fifty years have been based on cognitive theories of behavior change and have followed a rational-educational approach (Hou, 2014). The Health Belief Model (Maiman & Becker, 1974), Social Cognitive Theory (Bandura, 1986), and Theory of Planned Behavior (Ajzen, 1991) have been prominent guides to health promotion campaigns that distribute information and encourage increased physical activity and exercise. Large-scale promotions such as 'Exercise. You only have to take it regularly, not seriously' in Australia or the Minnesota Heart Health Program involved mass media, hundreds of thousands of dollars, were theory based, and resulted in small increases of physical activity among participants (Cavill & Bauman, 2004). Physical activity trends have not changed to any meaningful extent at the population level in the United States over the last ten years (Whitfield et al., 2019). In a review of physical activity and exercise campaigns, there was "little evidence of

population-level changes in intention to be active" (Cavill & Bauman, 2004). Moreover, it has been established that exercise interventions have attrition as high as 87% (Marcus et al., 2006).

One common explanation for physical inactivity is lack of motivation or lack of readiness for change. Another consideration is that physical activity and exercise are physiologically effortful and can create unpleasant experiences for individuals. Bandura explains that affect can be a mediator of self-efficacy (1997). Situations that can be perceived as stressful, such as exercise, may result in avoidance and high anxiety. Displeasurable exercise experiences can be shaped from negative affective responses, high perceived exertion, dyspnea, and musculoskeletal pain among other factors (Ekkekakis et al., 2016). Displeasurable and relatively unpleasant activities are avoided as a natural part of human behavior. Additionally, there are more prevalent competing leisure-time activities that may be perceived as more pleasant than exercise, such as sitting and watching TV.

Researchers have reasoned that cognitive factors may be more important for initial engagement, whereas affective factors may be more important for continued participation in exercise or physical activity (Dishman et al., 1985). However, this hypothesis has never been tested. The present study investigated whether length of time (in weeks) of being consistently physically active can moderate the relationship of cognitive and affective factors with current levels of physical activity and exercise participation.

Hypothesis: Physical activity history is a significant moderator of the relation of cognitive and affective variables with individuals' current level of physical activity.

CHAPTER 2: REVIEW OF LITERATURE

Physical activity trends and adherence

World Health Organization (2018) statistics suggest that one in every four adults worldwide is not active enough to satisfy current guidelines. In the United States, two out of every three adults are not reaching the physical activity guidelines each week (U.S. Department of Health and Human Services, 2010). In a large, national, accelerometer-based study, fewer than 5% of adults met the 1996 Physical Activity and Health recommendations of 30 minutes of moderate-intensity physical activity most days of the week (Troiano et al., 2008). In 2008, the U.S. Department of Health and Human Services released the first national Physical Activity Guidelines (2008). At a population level, 2008-2017 trends in physical activity indicated only a marginal increase in participation (Whitfield et al., 2019). The prevalence of those in the population who reported meeting the defined physical activity guidelines increased from 18.2% to 24.3% from 2008 to 2017 (Whitfield et al., 2019). These estimates, when compared to the 2004 accelerometer data, suggest that self-reports of physical activity may overestimate the amount of physical activity individuals perform. Some of the initial increases in self-reported physical activity seen after 2008 could be attributed to increased awareness of physical activity being a socially desirable health behavior following the release of the 2008 guidelines. The modifications in recommendations that occurred from 1996 to 2008 and from 2008 to 2018 have encouraged a more individualized pattern of physical activity accumulation. Changing from the 1996 recommendations of 30 minutes per day on most, preferably all, days of the week, in 2008 the Physical Activity Guidelines recommended 150 minutes/week of moderate-intensity physical activity in bouts of at least 10 minutes in duration (U.S. Department of Health and Human Services, 1996; U.S. Department of Health and Human Services, 2008). In 2018, the guidelines

recommended 150 minutes/week of moderate-intensity physical activity, 75 minutes per week of vigorous-intensity physical activity, or an equivalent combination. With this recommendation, activity can be performed at different levels of intensity, and can be accumulated in any number of days during the week, as well as in bouts of any duration. This allows an individual to achieve an adequate amount of physical activity in a variety of ways.

Physical activity and exercise are beneficial for health, yet few people start exercising and, of those who start, few stick with it. In a review of physical activity and exercise campaigns, two thirds of the campaigns reported successfully increased awareness of the campaign itself but resulted in "little evidence of population-level changes in intention to be active" (Cavill & Bauman, 2004). The recurring issue of high attrition limits the long-term practical value of these interventions (Cavill & Bauman, 2004; Heiestad et al., 2016; Marcus et al., 2006). In the same study of campaigns, only one third of the mass media campaigns reported a significant increase in physical activity in those who were exposed to the campaigns (Cavill & Bauman, 2004). In physical activity and exercise interventions, dropout rates have been as high as 87% (Marcus et al., 2006). This is concerning because participants in physical activity and exercise interventions receive considerable external motivation that cannot be implemented on a national level, such as consistent personal accountability or monetary compensation (Ekkekakis et al., 2019; Gourlan et al., 2016). These components do not mimic everyday access to structured programs or compliance when an individual self-regulates. The present study examines potential factors underlying regular adherence in physical activity and exercise by aiming to identify correlates of behavior at different stages of participation.

Correlates of Exercise and Physical Activity

There are a multitude of factors that can influence physical activity and exercise adherence. These include but are not limited to incentives, age, peer influence, education, weight, socioeconomic status, behavioral attributes, perceived effort, etc. In a choice study of low back-pain participants (n=112), the components that were identified to help improve adherence to exercise included: type of exercise, supervision, group dynamics, intensity, frequency, proximity, and incentives (Aboagye et al., 2017). The present study examined factors that relate to individual participation, specifically cognitive and affective factors.

Cognitive Correlates of Exercise and Physical Activity

The World Health Organization (Hou, 2014) identified twelve theories that can guide successful health promotion strategies. In a meta-analysis of theory-based randomized controlled trials to promote physical activity behavior, 82 studies used a variety of theories including the transtheoretical model, social cognitive theory, theory of planned behavior, and self-determination theory (Gourlan et al., 2016). From 1986 to 2005, the most commonly and consistently used health behavior theories were the Health Belief Model (HBM), Theory of Planned Behavior (TPB), and Social Cognitive Theory (SCT) (Glanz et al., 2008).The Health Belief Model is based on psychological decision making with components of (1) perceived susceptibility to disease, (2) perceived severity of the consequences of contracting the disease, (3) perceived benefits of undertaking the recommended health action, (4) perceived barriers to undertaking the recommended health action, and (5) cue(s) to action. These components identify an individual's motivation to complete a health behavior as an "expectancy of goal attainment" (Maiman & Becker, 1974). The Theory of Planned Behavior predicts behaviors based on the assessed ease of performing the behavior through the individual's (1) attitude towards the

behavior, (2) perceived subjective norm of the behavior, (3) perceived behavioral control, and (4) intention (Ajzen, 1991). Social Cognitive Theory outlines behavior as being codetermined by an interaction of (1) environmental factors, (2) behavioral factors, and (3) personal factors (Bandura, 1986).

There are consistent overlaps between concepts in these theories. In a meta-analysis of randomized controlled trials with theory-based interventions, each theory had statistically significant impacts on levels of physical activity relative to control groups, but there was no significant difference between the different theories' effectiveness (Gourlan et al., 2016). Each of the three identified theories addresses education about risk and benefits of health behavior in some manner. Data from participants who were surveyed over a seven-year period indicated that knowledge of perceived benefits and barriers to physical activity was more consistent than actual participation in physical activity (Bourdeaudhuij et al., 2002). One way to assess the views of an individual toward physical activity and exercise is to evaluate their cognitive attitude. Cognitive attitude refers to the attributes and beliefs about something (an object or concept) that an individual holds and encodes (Millar & Tesser, 1986). Cognitive attitude about physical activity refers to the belief that physical activity is useful, important, valuable, worthwhile, and beneficial (Conner et al., 2011; Crites et al., 1994; Lawton et al., 2009). Cognitive attitude has been found to be a significant predictor of many health-related behaviors (Lawton et al., 2009). Although this literature is based on correlational studies, attitude measures based on TPB have been shown to relate to intention to exercise, with, on average, a large effect size across multiple TPB-based exercise studies (Hausenblas et al., 1997).

Another point of overlap in the theories is self-evaluation. Specifically, the SCT concept of self-efficacy is conceptually similar to perceived behavioral control in TPB, both of which are

self-evaluative. The HBM was not originally structured to influence complex behaviors, and was revised to include the construct of self-efficacy because of its influence on perceived susceptibility and severity (Champion & Skinner, 2008). The concept of self-efficacy from SCT is an important predictor of long-term exercise adherence (Dishman et al., 1985; Sallis et al., 1986). In a community sample, the level of initial exercise self-efficacy could predict moderate-intensity physical activity (Sallis et al., 1986). As reported in a meta-analysis published in 2016, randomized controlled trials that were based on SCT had an effect size of $d = 0.42$, with the theory-based intervention group becoming more physically active relative to the control group (Gourlan et al., 2016). Self-efficacy is the belief in one's ability to carry out the steps required to accomplish a task. This social-cognitive concept is foremost influenced by previous mastery experiences but is also influenced by vicarious experiences, verbal persuasion, as well as physiological and affective responses (Bandura, 1997). Over a seven-year follow-up in young adults, self-efficacy was a reliable correlate of physical activity (Bourdeaudhuij et al., 2002). Self-efficacy is a task-specific construct usually assessed from 0-100% confidence in one's ability to complete an action at increasing levels of difficulty (Bandura, 1997). In a previous observational study, the Exercise Self-efficacy Scale (EXSE; McAuley, 1993) was used to assess exercise self-efficacy and researchers found a positive correlation with current physical activity and exercise (Conn et al., 2003).

Behavior change is generally considered a process. Therefore, initially starting a health behavior like regular physical activity or exercise is not the same as maintaining that behavior for an extended period of time. Both SCT and TPB have been identified as guides for maintenance programs (Glanz & Bishop, 2010). Cognitive-based theories have been used extensively as guides for health behavior change and have been applied to physical activity and

exercise promotion. However, these theories assume that a rational evaluation by an individual about the benefits to be accrued is the main mechanism that leads to initiation of physical activity and exercise. This assumption, however, may not be fully justified for behavioral initiation and maintenance. The present study measured the cognitive factors of self-efficacy and cognitive attitude as correlates of physical activity and exercise.

Affective Correlates of Exercise and Physical Activity

For behaviors that elicit a strong affective response, such as physical activity and exercise, affective attitudes may be a relatively stronger predictor of the intention to complete a behavior than cognitive attitudes (Lawton et al., 2009). Affect is a nonreflective state conceptualized and measured as the combination of two orthogonal dimensions, namely pleasure/displeasure and arousal/sleep (Russell, 1980). Proposed in the dual-process based Affective-Reflective Theory of physical inactivity and exercise (ART), the interaction of type-one affective valuation and type-two reflective evaluation underlies behavior initiation (Brand & Ekkekakis, 2018). In a single decision, type-one valuation reflects positive or negative past affective experiences in regard to a stimulus, and type-two evaluation reflects the cognitive consideration of benefits, beliefs, or other higher-level cognitive factors. The ART proposes that the behavioral decision to engage in is not always rationally based but instead can be influenced by negative past affective experiences acting as a "restraining factor" (Brand & Ekkekakis, 2018). Past affective responses will influence the automatic affective valuations of physical activity and shape the subsequent reflective evaluations of initiating physical activity leading to the formulation of an action plan (Brand & Ekkekakis, 2018). When physical activity has been experienced as pleasant or enjoyable, the positive or pleasurable association of the activity will

influence the subsequent cognitive evaluation of the activity when considering initiating physical activity.

Enjoyment is an important predictor of participation in physical activity and exercise (Allender et al., 2006; Ungar & Sieverding, 2016). A majority of correlational studies reviewed showed a positive correlation between leisure-time physical activity and enjoyment (Rhodes et al., 2009). Enjoyment can be underestimated before physical activity and may be significantly increased immediately following a fitness activity (Ruby et al. 2011). Enjoyment of physical activity and exercise is most commonly measured with the Physical Activity Enjoyment Scale (PACES) (Kendzierski & DeCarlo, 1991).

Affective attitude refers to an individual's feelings associated with an object or activity (Millar & Tesser, 1986). Affective attitude of physical activity reflects the belief that the feelings associated with physical activity experiences will be satisfying, pleasant, enjoyable, and exciting or, conversely, unpleasant, boring, or aversive (Conner et al., 2011; Crites et al., 1994). Affective attitude has been found to be a significant independent predictor of many health behaviors, and a stronger predictor than cognitive attitude for nine out of fourteen health behaviors (Lawton et al., 2009). Affective messages resulting in increased affective attitude have been found to be more effective at increasing self-reported physical activity than cognitive messages and cognitive attitude (Conner et al., 2011). Furthermore, affective attitude has been found to predict future physical activity in prospective studies (Lowe et al., 2002; Rhodes et al., 2009). The present study measured the affective factors of enjoyment and affective attitude to assess their correlation with physical activity and exercise.

Sustaining physical activity

For behaviors such as physical activity and exercise, there can be “divergence” between cognitive and affective attitudes. For example, physical activity can be seen as very beneficial [high cognitive attitude] but not enjoyable [low affective attitude]. When there are larger levels of divergence, affective attitude may be a weaker predictor of behavior (Lawton et al., 2009). If, over time, physical activity and exercise are repeated, divergence could be decreased. For example, positive affective experiences from physical activity may lead to physical activity being viewed as more enjoyable. Those who adhered to exercise for a fourteen-week course had more positive associations with exercise prospectively relative to those who did not adhere (Antoniewicz & Brand, 2016). Repetition of successful physical activity experiences could also increase exercise self-efficacy through mastery experiences. Self-efficacy and enjoyment predicted physical activity twelve months after the initial measurement (Lewis et al., 2016). Initiating physical activity and maintaining regular physical activity may help facilitate adherence and belief in one's ability to maintain regular lifestyle change (Jarbøl et al., 2017).

CHAPTER 3: METHODS

Participants

Adults aged 18-69 years who are willing participants on Amazon's Mechanical Turk (MTurk) and based in the United States were offered the option to complete the survey. Exclusion criteria included I.P. addresses outside of the United States, those who self-reported age over 69 years, invalid survey codes, and lack of MTurk qualifications. There was a monetary incentive for completing the survey of $0.65.

Procedure

The survey was designed in Qualtrics, and all response data were collected through Qualtrics (Provo, UT). The survey consisted of multiple questionnaires detailed in the Measures section below. To mitigate order effects, the questionnaires were presented to each respondent in randomized order (see Appendix B, Figure 1B). The MTurk Human Intelligence Task (HIT) asked respondents to follow a link to the survey, complete the survey, copy the survey code provided into the HIT report, and submit.

Amazon MTurk

Amazon MTurk was used to recruit participants for the survey. Initially, a batch of participants with minimal qualifications completed the first public version of the survey in July 2020 (see Appendix A). Multiple test surveys were developed, with the goal of increasing the efficiency of the survey and improving the user experience, including changes to the design of questions and the flow of the survey, as discussed below. Amazon MTurk allows a Requester (researcher) to post a task (MTurk Human Intelligence Task - HIT) to be completed by anyone on the crowd sourcing platform, with the ability to set qualifiers and deem responses acceptable or not (approval or rejection of a HIT).

After initial testing that resulted in the realization that there was a need to increase the quality of responses, a new HIT was opened in Fall 2020 with the goal of collecting at least 300 high-quality responses. Compensation was set at $0.65 for completion of the survey and participants were required to be MTurk Masters located in the U.S. An MTurk Master is a worker who 'demonstrates accuracy across multiple types of tasks,' is consistent, and has been assigned this qualifier by MTurk through a process over time (Amazon Mechanical Turk, 2019). Anecdotally, one respondent directly messaged the investigator voicing a desire to complete the survey but being unable to do so as they were not an MTurk Master. This respondent expressed the frustration that 'Master' qualification was exceedingly difficult to achieve even if a worker was a consistent high-quality performer. This survey batch was open for 7 weeks but only resulted in the collection of 59 responses.

Because of the lack of responses at the MTurk Master's level, reassessment of alternative qualifications was conducted in December 2020. After reviewing other qualifications used in previous research and taking into account the suggestions of MTurk guides (McInnis et al., 2016; Zhang & Gearhart, 2020; Amazon Mechanical Turk, 2019), two additional batches of the survey were opened to general MTurk workers in Spring 2021. MTurk workers had to meet all four of the following criteria to be eligible to complete the survey: 1) HIT approval rate greater than or equal to 98%, 2) number of HITs approved greater than or equal to 5000, 3) location in the U.S., and 4) not a previous respondent. Batch one ran from February 1 – 8, 2021, and resulted in the collection of 300 responses. Batch two ran from February 8 – 15 and resulted in the collection of 400 additional responses. The qualifier of 'not a previous respondent' ensured that those in the Fall 2020 batch could not participate and that workers from Spring 2021 "batch one" could not

participate in Spring 2021 "batch two," thus avoiding possible multiple entries from a single individual.

Measures

A total of seven questionnaires (see Appendix B) were answered through the survey for a total of approximately 50 statement responses (the number could be higher depending on options selected on the International Physical Activity Questionnaire and the physical activity history questionnaire, as described below). Each question in the survey requested a response but did not force a response from participants. The order of the surveys was randomized for each individual, in order to avoid order effects.

International Physical Activity Questionnaire

The International Physical Activity Questionnaire (IPAQ; 2002) Short Form was used to assess current level of physical activity. The IPAQ Short Form has been shown to have psychometric properties at least as good as other, lengthier self-reports of physical activity and exercise (Craig et al., 2003). One adjustment made to the IPAQ questions was to omit the sentence that asks respondents to “only consider physical activity that was at least 10 minutes.” The 10-minute bout requirement is a remnant from the 2008 Physical Activity Guidelines and has since been dropped. For this survey, ‘being physically active’ implied meeting the 2018 U.S. Physical Activity Guideline requirements. Though the IPAQ is meant to have text entries for times and days being physically active, in order to ensure the validity of entries and improve the efficiency of the survey, it was decided to change data entry to drop-down menus and to make the appearance of time and intensity questions conditional upon previous answers (see Appendix B, Figure 2B).

In the survey, IPAQ questions about the number of days [0, 1, 2, 3, 4, 5, 6, 7 days] and time spent on activity types (i.e., vigorous, moderate, walking, sitting) were all converted to drop-down menu selections, in order to help deter misunderstandings about what was being asked. The ranges were created to reflect common times for each type of activity, 1 minute – 6 hours [minutes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 30, 35, 40, 45, 50, 55, 60, 75, 90, 120, 3 hours, 4 hours, 5 hours, 6+ hours, other]. The sitting question range was derived from the assumption that sitting is a large part of the day and ranged from less than 30 minutes – 13 hours [less than 30 minutes, 45 minutes, 60 minutes, 90 minutes, 120 minutes, 3 hours, 4 hours, 5 hours, 6 hours, 7 hours, 8 hours, 9 hours, 10 hours, 11 hours, 12 hours, 13+ hours]. To help make the IPAQ form more user-friendly and to reduce time spent on the survey, questions were formatted to only ask for time and intensity if the selected number of 'days' for the activity in question was greater than 0.

The guidelines for data processing and analysis of the IPAQ Short Form were followed (IPAQ scoring, 2005). The estimated number of MET-minutes for moderate and vigorous physical activity were used for analysis. Solely for descriptive purposes (i.e., not used in statistical analyses), distinct categories were also created for participants who (1) did not meet any part of the 2018 PA Guidelines, (2) met the criteria for IPAQ 'moderate' category, (3) met the criteria for IPAQ 'high' activity, (4) met the 2018 PA guidelines pertaining to resistance exercise, (5) met both the MET minute and resistance training requirements of the 2018 PA Guidelines, and (6) met the vigorous activity and resistance training requirements of the 2018 PA Guidelines.

Self-reported physical activity history

A self-report question regarding stable physical activity history (PAH) defined stable physical activity and exercise for this survey as ‘consistently meeting the 2018 Physical Activity Guidelines (at least 150 minutes/week of moderate physical activity OR 75 minutes/week of vigorous physical activity, or an equivalent combination of the two, AND muscle-strengthening activities at least 2 days/week)’. Participants were asked if they had been participating in "stable physical activity" (as defined) for at least one week [yes or no]. From their answer, if they reported having been physically active for at least one week, they were subsequently asked to select from drop-down menus the number of weeks, months, and years during which they had been consistently active (see Appendix B, Figure 3B). Additionally, participants who reported being physically active for at least one week were asked ‘which statement aligns more with how you view exercise history’ and could select among (1) Exercise history is all one long journey or (2) Exercise history is comprised of starts and stops.

Self-efficacy

Physical activity self-efficacy was measured with questions based on the Exercise Self-Efficacy questionnaire (EXSE; McAuley, 1993), with a modification to refer to "physical activity" rather than "exercise." This wording change allowed any type of physical activity to be considered, to align with the current study’s focus on physical activity. Exercise refers to only a subsample of physical activity that satisfies the additional criteria of being (a) planned, (b) structured, and (c) performed with the express purpose of improving and/or maintaining one or more components of physical fitness (Caspersen et al., 1985). Eight questions assessed a participant’s confidence (on 0-100% scales) in their ability to participate in physical activity that satisfies the 2018 Physical Activity Guidelines without quitting for the next one, two, three, four,

five, six, seven, and eight weeks. Participants moved an on-screen slider for each week to express their level of confidence. The sliders were all initially positioned at 50%. The score of EXSE was derived as the average of weeks one through eight on a scale of 0-100% (McAuley, 1993).

Cognitive Attitude

Cognitive attitude was measured with five items assessing instrumental attitude following the guidelines provided by the developer of the Theory of Planned Behavior (Ajzen, n.d.). A seven-point bipolar semantic-differential scale allowed participants to rate their evaluation of physical activity and exercise as being useless/useful, unimportant/important, worthless/valuable, worthwhile/not-worthwhile, and harmful/beneficial (Conner et al., 2011; Crites et al., 1994). Each statement was accompanied by a seven-point response scale, with 7 being most positive and 1 being most negative, with the exception of two of the items that were reverse-scored, following the original structure of the items, to help ensure participants were attentive to the scales and the questions being asked. The cognitive attitude score was an average of the five item scores, from 1-7.

Affective Attitude

Affective attitude was measured with three items based on the Theory of Planned Behavior (Ajzen, n.d.) and three additional items that have been used to assess affective associations of physical activity (Kiviniemi et al., 2007). A seven-point bipolar semantic-differential scale allowed participants to rate their evaluation of physical activity and exercise as being unsatisfying/satisfying, unpleasant/pleasant, and boring/exciting (Crites et al., 1994; Conner et al., 2011). For the assessment of affective associations, a seven-point bipolar semantic-differential scale allowed participants to rate their perceived associations of physical

activity and exercise with the words sad/happy, sorrow/joy, and annoyed/delighted (Kiviniemi et al., 2007). Each item was accompanied by a seven-point response scale, with 7 being most positive and 1 being most negative, with the exception of one affective attitude item and one affective association item that were reverse-scored, following the original structure of the items, to help ensure participants were attentive to the scales and the questions being asked. The affective attitude score was an average of the three affective attitude item scores and the three affective association statement scores, from 1-7.

Physical Activity Enjoyment Scale

Physical activity enjoyment was measured with the Physical Activity Enjoyment Scale (PACE; Kendzierski & DeCarlo, 1991). Eighteen questions, each with a seven-point bipolar semantic-differential scale allowed a participant to rate on a scale of 1-7 their experiences of enjoyment or aversion related to physical activity. The instructions were slightly modified to refer to "physical activity" in general rather than the physical activity they “have been doing.” This change allowed participants in the survey who were not currently physically active to still respond with their experiences regarding physical activity. The PACES results in a total score of 18-126, with 11 of 18 questions being reverse-scored, following the original structure of the questionnaire, to ensure participants were attentive to the scales and the questions being asked.

Demographic Information

Age, state of residence, sex, and race demographic information was collected for descriptive purposes.

Statistical Analysis

Sample Size

The sample size was determined on the basis of a power analysis. Specifically, the targeted effect size was a "small" ($R^2 = 0.02$) improvement in the criterion variance accounted for in a multiple linear regression model containing one predictor when a second predictor is added (in the case of regression models testing a moderation effect, the second predictor would be the interaction of the predictor variable with the postulated moderator). The analysis showed that, in order to achieve 80% statistical power with alpha = .05, a minimum sample size of 395 participants was needed.

After a large-scale data collection that yielded responses of unacceptably low quality (see Appendix A), it was determined that higher qualifications would be required. The subsequent increased costs limited the research budget, allowing to recruitment of approximately 800 participants. Of these, 759 survey attempts were completed. Through data processing eliminations, the final data set analyzed was $N = 747$.

Data Processing

To de-identify the responses to this survey and verify that only MTurk-approved responses were included in the analysis, the following steps were taken. (1) All Qualtrics responses were downloaded, including responses to the questionnaires and the individualized survey code (labeled RANDOM ID), and all responses that ‘disagreed’ with the electronic informed consent were deleted. (2) Full response data were downloaded from MTurk, including the survey code submitted, whether the task was approved or rejected, and Worker IDs. (3) Rejected task lines were deleted from the MTurk list. (4) The remaining MTurk list of survey codes were copied and cross referenced with the survey codes (RANDOM ID) from Qualtrics

responses. Only response lines with a cross-referenced survey code were kept, while all other lines were deleted (n=4). (5) RANDOM IDs were then deleted from response data.

Following this process, data coding started with IPAQ days for each type of activity: vigorous, moderate, and walking were coded as a numeric value of 0-7 corresponding to the selected number of days an individual reported participating in each type of activity each week. IPAQ time, MET-minutes, and categories were then calculated following the IPAQ scoring protocol (IPAQ scoring, 2005). The results of this section included: METs from self-reported vigorous, moderate, and walking weekly times, IPAQ physical activity categories. The reported and calculated METs for moderate activity and vigorous activity were combined to describe current level of physical activity (MVPA). The physical activity criterion variable used in the present study combined moderate and vigorous physical activity (MVPA). Walking was not included due to concerns about the susceptibility of self-reported walking to random measurement error (unreliability) and volatile estimates of concurrent and criterion validity (in many cases < 0.20; see Kurtze et al., 2008; Van der Ploeg et al., 2010).

The seven-point scales used for cognitive attitude, affective attitude, and PACES were then checked to ensure the validity of the entries were made, required items were reversed-scored, and total scores were derived. Blank questions were possible as each question in the survey requested a response but did not force a response from participants. This decision to not force responses aligned with the IRB guidelines of allowing participants to exit the survey at any point. The only exclusion from this policy was the informed consent question, for which every participant had to answer Agree or Disagree to either proceed to the survey or end the survey (see Appendix B). Because of differences in the number of items and the scoring format for each section, blanks were addressed differently for each variable. According to the IPAQ scoring

protocol, any entry that had a day selected but time was left blank had to be eliminated (n = 1). For cognitive attitude, with five items, it was accepted that, if there was a single missing value, the average of the remaining values could be calculated and imputed (n=0), whereas entries with more than a single missing value were eliminated (n=0). For affective associations and affective attitude, each with 3 items, any missing value would result in elimination (n=0). For EXSE, with 8 items, it was accepted that, if there was a single missing value, a linear regression formula would be used to estimate and impute the missing value (n=0), whereas more than a single missing value would result in elimination (n=0). For PACES, having 18 items, 11 of them reverse-scored, it was accepted that, if there was a single missing value, the remaining values would be averaged and imputed (n=1), whereas more than a single missing value would result in the entry being eliminated (n=0). Demographic responses that included age outside the range of the inclusion criteria resulted in the entry being eliminated (n=6).

For physical activity history (PAH), participants who reported that they had been participating in physical activity meeting the 2018 PA Guidelines were asked how long they had been doing so through a series of drop-down menus inquiring about the number of weeks, months, and years. Additionally, there was the option to select ‘Other’ at any point and write in a response. The resulting lengths of time were all converted to weeks with 1 month = 4 weeks and 1 year = 52 weeks. Responses indicating more than 20 years (1040 weeks) of continuous physical activity participation were truncated at 20 years. Any participant who marked that they had been physically active for at least one week but did not provide a time, or any participant who selected "other" and wrote-in an un-processable amount of time was eliminated (n=1).

Analysis

Microsoft Excel and SPSS (IBM Corp. Released 2020. IBM SPSS Statistics for Macintosh, Version 27.0. Armonk, NY: IBM Corp.) were used for statistical analysis.

Variables of interest

Pearson correlations were computed between the variables to assess the strength of associations of the postulated predictors (self-efficacy, cognitive and affective attitude, enjoyment) and the criterion of current physical activity. A moderation model using the macro PROCESS was examined for each relation of interest (Hayes, 2018). The models consisted of one predictor (X), one criterion (Y), and one moderator (W). Four models were examined, with Y = MVPA, W = physical activity history, and X = self-efficacy, cognitive attitude, affective attitude, and enjoyment. In each case, the hypothesis was that physical activity history would significantly moderate the relation between the postulated cognitive and affective predictor and the criterion variable of current physical activity.

Because of a high number of respondents who reported zero weeks of physical activity history, in order to avoid severe violations of the assumption of normality in the distribution of the data (Frazier et al., 2004; Hayes & Rockwood, 2017), the models were restricted to only those participants who reported physical activity history for at least 1 week (n = 493). Therefore, a new restricted data set was derived from the original, with individuals reporting zero for physical activity history removed from the analysis.

CHAPTER 4: RESULTS

Table 1. Demographic information

SEX	**n**	**%**
MALE	401	54%
FEMALE	341	46%
PREFER NOT TO ANSWER	5	1%
TOTAL	**747**	100%
AGE	**n**	**%**
18-24	23	3%
25-34	255	34%
35-54	332	44%
55-64	108	14%
65-69	29	4%
TOTAL	**747**	100%
RACE	**n**	**%**
WHITE	592	79%
BLACK	67	9%
ASIAN	63	8%
AMERICAN INDIAN	2	0%
NATIVE ALASKAN	0	0%
NATIVE HAWAIIN / PACIFIC ISLANDER	1	0%
OTHER	7	1%
MULTIRACIAL	15	2%
TOTAL	**747**	100%
MTURK QUALIFICATIONS	**n**	**%**
MASTERS	59	8%
HIGH QUALITY NON MASTERS	688	92%
TOTAL	**747**	100%
SELF REPORT MET PA GUIDELINES AT LEAST 1 WEEK	**n**	**%**
YES	493	66%
NO	254	34%
TOTAL	**747**	100%
VIEW ON PA	**n**	**%**
ONE LONG JOURNEY	313	63%
SERIES OF START AND STOPS	180	37%
TOTAL	**493**	100%

Demographic characteristics appear in Table 1. All participants in the sample were U.S.-based MTurk users, of whom 59 were Master's level and 688 were high-quality non-master's. The participants were nearly equally distributed in terms of gender (53% male and 47% female). The age range indicated that this sample comprised mainly participants from ages 25-54 years old. The majority of participants in this sample identified as white.

Table 2. Physical Activity information

PHYSICAL ACTIVITY GUIDELINES	**n**
PA GUIDELINES MET	348
GUIDELINES NOT MET	399
RESISTANCE ONLY	49
MET MINUTES ONLY	211
NO PARTIAL GUIDES	139
TOTAL	**747**

The physical activity characteristics of the sample are shown in Table 2 indicating which parts of the 2018 PA Guidelines were met, namely (1) at least 150 minutes of moderate activity or at least 75 minutes of vigorous activity and – assessed using the IPAQ categories of moderate and high (2) at least 2 days of resistance training. Just under half of the participants met the 2018 Physical Activity Guidelines (approximately 47%).

Table 3. IPAQ Categories

IPAQ CATEGORIES	**n**
LOW	188
MODERATE	275
HIGH	284
TOTAL	**747**

Table 3 shows the levels of physical activity according to responses on the IPAQ Short Form (i.e., Low, Moderate, High based on MET-minutes/week and or time active per week). A majority of the sample was either in the 'moderate' or 'high' categories (approximately 75%).

Table 4. Qualitative questions about Physical Activity History

MET PA GUIDELINES AT LEAST 1 WEEK	**n**
YES	493
NO	254
TOTAL	**746**
VIEW ON PA	**n**
ONE LONG JOURNEY	313
SERIES OF START AND STOPS	180
TOTAL	**493**

Table 4 presents information about physical activity history. Participants were asked if they met the 2018 Physical Activity Guidelines (as defined) for one week and, in response, 493 participants self-reported they indeed had met guidelines. Of those participants, approximately 63% viewed physical activity as 'one long journey' and approximately 37% viewed physical activity as 'being comprised of a series of start and stops.'

Table 5. Variances and descriptions of MVPA and Walk MET-minutes/Week

	MVPA + WALK	**MVPA**
N	747	747
Mean	1753	1222
Median	1388	900
Std. Deviation	1637	1290
Variance	2680052	1664112

Table 5 summarizes the results of the IPAQ Short Form. In the full data set of n = 747, there was more variance in MVPA + Walking compared to MVPA. MVPA was selected as the variable that was most relevant to current physical activity guidelines.

Table 6. Pearson Correlations of Variables

	Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals	
n = 747			**Lower**	**Upper**
MVPA - Cognitive attitude	0.291	< 0.001	0.224	0.355
MVPA - Affective attitude	0.393	< 0.001	0.331	0.452
MVPA - PACES	0.372	< 0.001	0.309	0.433
MVPA - Exercise self efficacy	0.486	< 0.001	0.429	0.539
MVPA - Physical activity history	0.393	< 0.001	0.331	0.452
Cognitive attitude - Affective attitude	0.551	< 0.001	0.499	0.599
Cognitive attitude - PACES	0.559	< 0.001	0.508	0.606
Cognitive attitude - Exercise self efficacy	0.362	< 0.001	0.298	0.423
Cognitive attitude - Physical activity history	0.264	< 0.001	0.196	0.33
Affective attitude - PACES	0.864	< 0.001	0.844	0.881
Affective attitude - Exercise self efficacy	0.643	< 0.001	0.599	0.684
Affective attitude- Physical activity history	0.351	< 0.001	0.286	0.412
PACES - Exercise self efficacy	0.627	< 0.001	0.582	0.669
PACES - Physical activity history	0.355	< 0.001	0.291	0.416
Exercise self efficacy - Physical activity history	0.42	< 0.001	0.359	0.478

Table 6 shows the Pearson product-moment intercorrelations among the variables. Moderate and vigorous physical activity (MVPA) correlated significantly and positively with cognitive attitude, exercise self-efficacy, affective attitude, physical activity enjoyment (PACES), and physical activity history (PAH). The strongest correlation was between MVPA and exercise self-efficacy, with r = 0.486 (95% CI [0.429,0.539]).

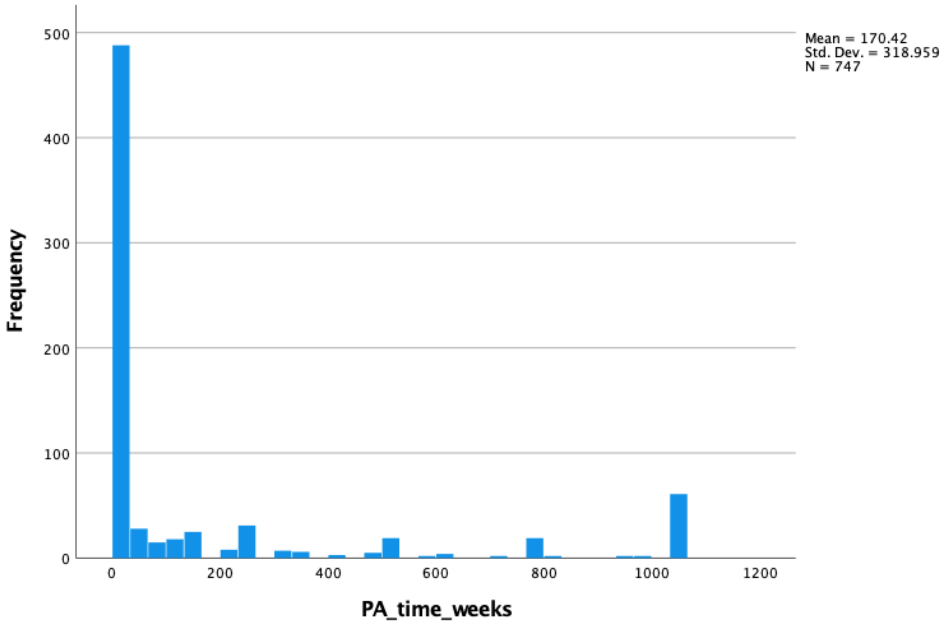

Figure 1. Distribution of Physical Activity History

Figure 1 shows the distribution of Physical Activity history in weeks and a considerable amount of the data being in the low range of weeks. This view led to further assessment of the physical activity history variable data.

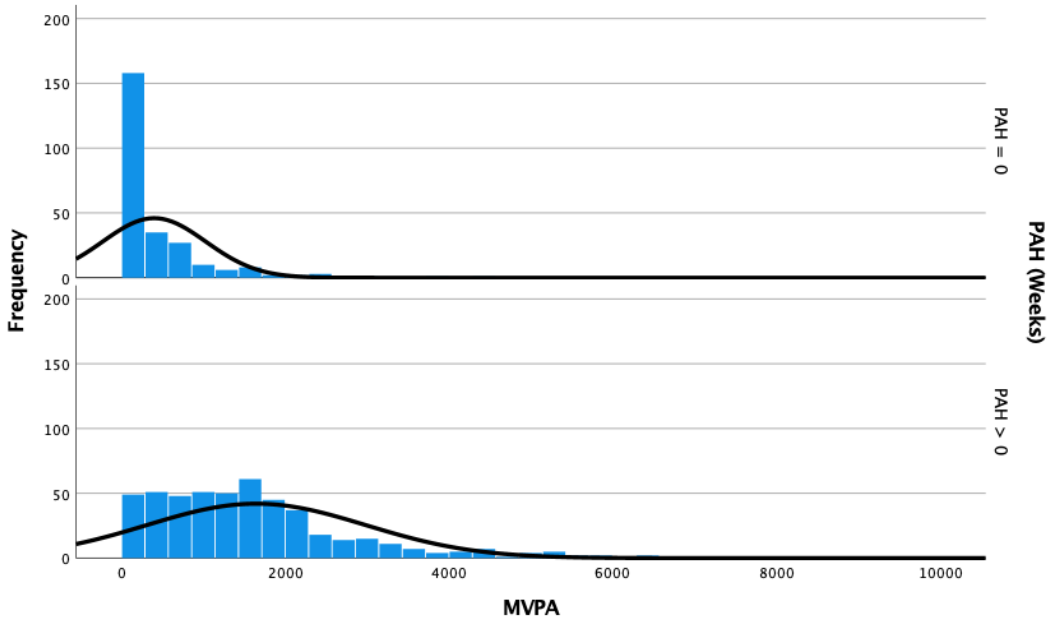

Figure 2. Distributions of MVPA PAH = 0 compared to PAH > 0 (restricted data set)

Figure 2 shows the frequency distributions of MVPA for the entire sample of n = 747 (which included individuals who reported zero weeks of physical activity history, (n = 254) and the restricted sample (n = 493) of individuals with a physical activity history of more than zero weeks. As shown, removal of the respondents with no physical activity history allowed for a distribution that reduced the skewedness from 1.868 to 1.727.

Table 7. Independent T-test PAH = 0, PAH > 0

		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
MVPA	Equal variances assumed	14.063	745	< 0.001	1246.431	88.629
	Equal variances not assumed	17.299	739.975	< 0.001	1246.431	72.051

Table 7 shows the results of an independent-samples t-test comparing the current physical activity levels of the individuals without (n = 254) and with (n = 493) a physical activity history. The comparison indicates that there was a significant difference, with the mean MVPA of the restricted data set (PAH > 0, mean = 1646 MET-minutes/week) being 4x larger than the MVPA of the subsample with no physical activity history (PAH = 0, mean = 399 MET-minutes/week). Therefore, those who had been physically active for at least one week had significantly higher current levels of moderate and vigorous physical activity (MVPA).

Table 8. Pearson Correlations of MVPA and Variables of Interest in Restricted Data Set

	Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals	
n = 493			**Lower**	**Upper**
MVPA - Cognitive attitude	0.253	< 0.001	0.169	0.334
MVPA - Affective attitude	0.252	< 0.001	0.167	0.333
MVPA - PACES	0.224	< 0.001	0.139	0.306
MVPA - Exercise self efficacy	0.291	< 0.001	0.208	0.37
MVPA - Physical activity history	0.279	< 0.001	0.196	0.359
Cognitive attitude - Affective attitude	0.578	< 0.001	0.516	0.634
Cognitive attitude - PACES	0.598	< 0.001	0.538	0.652
Cognitive attitude - Exercise self efficacy	0.406	< 0.001	0.329	0.477
Cognitive attitude - Physical activity history	0.27	< 0.001	0.186	0.35
Affective attitude - PACES	0.822	< 0.001	0.791	0.849
Affective attitude - Exercise self efficacy	0.465	< 0.001	0.393	0.531
Affective attitude- Physical activity history	0.306	< 0.001	0.224	0.384
PACES - Exercise self efficacy	0.498	< 0.001	0.429	0.562
PACES - Physical activity history	0.312	< 0.001	0.23	0.39
Exercise self efficacy - Physical activity history	0.325	< 0.001	0.244	0.402

Table 8 shows the Pearson product-moment correlations among the variables in the restricted sample that had more than zero weeks of physical activity history. These analyses indicate that all correlations remained significant in the restricted sample.

Table 9. Reliability (internal consistency) of the measurements

Reliability		
	Full data set	Restricted data set
Cognitive attitude (alpha)	0.911	0.872
Affective attitude (alpha)	0.922	0.872
PACES (alpha)	0.968	0.952
Exercise self-efficacy (alpha)	0.991	0.978
n	747	493

Table 9 presents Cronbach's alpha indices of internal consistency reliability of the measurements. The values for each measurement show a high degree of internal consistency in both the full sample and the restricted sample.

Table 10. Moderation Models

Exercise self-efficacy – MVPA moderated by physical activity history		
Change in R^2	**F**	**P**
0.0008	0.4548	0.5004
Cognitive attitude – MVPA moderated by physical activity history		
Change in R^2	**F**	**p**
0	0.0151	0.9021
Affective attitude – MVPA moderated by physical activity history		
Change in R^2	**F**	**p**
0.0058	3.1853	0.0749
PACES – MVPA moderated by physical activity history		
Change in R^2	**F**	**p**
0.0056	3.0846	0.0797

Table 10 summarizes the results of the tests of moderation and, in particular, the results of the addition of the products of the four predictors (self-efficacy, cognitive attitude, affective attitude, enjoyment) and the postulated moderator (physical activity history) in hierarchical regression analyses, with current MVPA as the criterion variable. The R^2 change describes the difference in variance accounted for in the model from step one in the hierarchical regressions (completed through PROCESS) to step two. In step one, a predictor (self-efficacy, cognitive

attitude, affective attitude, enjoyment) is entered as the sole predictor of MVPA. In step two, the interaction between the predictor and the moderator (physical activity history) is added to the model. The R^2 change values were all not statistically significant.

Therefore, physical activity history was not found to significantly moderate the relation between any of the predictors of interest and the current level of moderate and vigorous physical activity (MVPA).

CHAPTER 5: DISCUSSION

The results of this study showed that there are statistically significant correlations between cognitive and affective constructs (Table 6) and moderate to vigorous physical activity (MVPA). This was an expected finding as the variables of interest (i.e., self-efficacy, cognitive attitude, affective attitude, enjoyment) were chosen specifically because they are known cognitive and affective correlates of physical activity, as summarized in the review of literature.

In addition, physical activity history had a positive and statistically significant correlation with the current level of moderate and vigorous physical activity (MVPA). This relationship aligns with the expectation that previous physical activity experiences may influence present-day level of physical activity in an individual (Bandura, 1997; Thompson et al., 2003).

On the other hand, the results of the present study did not support the hypothesis (Dishman et al., 1985) that the pattern of relationships between cognitive and affective correlates of physical activity would be moderated by the length of involvement in physical activity (specifically, that cognitive correlates may be more closely associated with physical activity during the earlier stages of participation, and affective correlates gaining prominence during later stages). None of the interactions between the cognitive (self-efficacy, cognitive attitude) and affective (affective attitude, enjoyment) predictors with the postulated moderator (history of physical activity history) accounted for a significant portion of the variance in current physical activity. This finding suggests that the relations between these correlates and physical activity does not change systematically as a function of the length of physical activity involvement.

Reported Physical Activity Reported and Physical Activity Guidelines

Physical activity self-reports are known to overestimate objectively measured levels of physical activity (Steene-Johannessen et al., 2016). In the present sample, 75% of respondents reported sufficient amounts of physical activity to be classified among the "moderate" and "high" activity categories according to their responses on the IPAQ (Table 3). This amount of self-reported physical activity is triple that of the expected value in the U.S. adult population (Whitfield et al., 2017). The reasons for this exceedingly high level of self-reported physical activity are unclear. One possibility is that there was strong self-selection bias, with individuals who are physical active being more likely to choose to work on a survey regarding physical activity for very modest monetary compensation. Another possibility is that the high amount of self-reported physical activity could be attributed to the nature of the platform used, which might have exacerbated social desirability tendencies to be seen as physically active. MTurk worker qualifications are based on the percentage of HITs approved. Therefore, it is possible that respondents might have perceived an implied expectation on the part of the investigators to report high amounts of physical activity in an effort to facilitate a positive study outcome in hopes of receiving an approval (McInnis et al., 2016). It has been noted that MTurk being a publicly open survey platform has led to lines being blurred between surveys for opinion and research studies (Couper, 2000). Additionally, recent assessments of physical activity data have shown levels of compliance with guidelines could be measured as high as 96% (Zenko et al., 2019).

Despite a high percentage of participants being classified as "moderate" and "high" activity levels based on the IPAQ categories (Table 3), only 47% (Table 2) of the sample satisfied the full criteria for being classified as physically active according to the 2018 PA

Guidelines via the IPAQ reported activity and frequency of resistance training. This percentage (47%) of the sample self-reporting sufficient physical activity to meet the 2018 PA Guidelines seems to contrast sharply with previously reported percentages based on accelerometer data, which had suggested that fewer than 5% of American adults met the guidelines at the time (Troiano et al., 2008). Part of this large discrepancy can be attributed to the changing nature of the guidelines (e.g., "every minute counts" compared to counting only activity performed in bouts). Reanalyzes of national physical activity surveys based on accelerometers have suggested that, with current criteria, 44% of the population could be considered as meeting physical activity guidelines (Zenko et al., 2019).

The discrepancy in the present study between answering 'yes' to the question 'have you met the 2018 Physical Activity Guidelines as defined for at least the past week' (n = 493) and the percentage meeting the 2018 PA Guidelines derived from IPAQ responses that included an assessment of resistance training (n = 348) shows that there was a possible overestimation at the individual level in the belief that the PA Guidelines were being met. This could be attributed to social desirability motivating participants to report that they believed they were achieving the recommended amount of physical activity every week.

Upon answering the question 'have you met the 2018 Physical Activity Guidelines as defined for at least the past week' affirmatively, participants were asked to choose which of two statements matched their view of physical activity over time. Of those who answered 'yes' (n = 493), 63% agreed with the view that physical activity over time is one long journey (Table 4). Individuals who do not consider physical activity history to have stops may not properly recall periods of time during which they were not consistently physically active.

Moderation Models

Each of the variables of interest (self-efficacy, cognitive attitude, affective attitude, enjoyment) was modeled as a predictor of MVPA. However, none of the models was improved by the interaction of the variable of interest with physical activity history. Less than 0.06% of the variance in MVPA was explained in any model by the interaction of physical activity history with a predictor (Table 10).

Correlates

The cognitive correlates, namely cognitive attitude and exercise self-efficacy produced correlations with current moderate and vigorous physical activity (MVPA) that were statistically significant and positive. The correlation between exercise self-efficacy and MVPA was higher than anticipated at $r = 0.486$ (95% CI [0.429, 0.539]) when the correlation estimated in a previous meta-analysis was $r = 0.34$ (Spence et al., 2005). On the other hand, cognitive attitude correlated with current level of physical activity as expected, $r = 0.291$ (95% CI [0.224, 0.355]), which is within the expected range of $r = 0.28$-0.30 (Hagger et al., 2002; McEachan et al., 2016). Both affective attitude and physical activity enjoyment (PACES) correlated with current level of physical activity slightly less strongly than expected. Affective attitude and enjoyment have been found to correlate $r = 0.42$ (95% CI [0.37 to 0.46]) with MVPA in a meta-analysis (Rhodes et al., 2009) but exhibited correlations of $r = 0.393$ (95% CI [0.331, 0.452]) and $r = 0.372$ (95% CI [0.309, 0.433]) in the present sample. In the restricted sample of n = 493 (Table 8), the correlations of the cognitive and affective variables with MVPA were reduced and more similar to each other (all within the narrow range between $r = 0.224$ and $r = 0.291$). This means that the

group that self-reported a history of physical activity tended to have relatively undifferentiated correlations of cognitive and affective variables with MVPA.

The relationship between MVPA and physical activity history (self-reported of meeting physical activity guidelines for a period of time) was significant and positive, namely $r = 0.393$ (95% CI [0.331, 0.452]) in the full data set and $r = 0.279$ (95% CI [0.196, 0.359]) in the restricted data set. The relationship between the length of physical activity history and current MVPA may be mediated by previous experiences increasing self-efficacy for physical activity (Bandura, 1986). Exercise self-efficacy was the strongest correlate of physical activity history at $r = 0.42$ (95% CI [0.359, 0.478]). When participants accumulate experiences being physically active, the length of their involvement in physical activity and their self-efficacy correlate highly (Conn et al., 2003). This supports the idea that self-efficacy is primarily influenced by previous mastery experiences (Bandura, 1986). Exercise self-efficacy has been shown to positively correlate with facets of intrinsic motivation, which can lead to completing exercise bouts and solidifying physical activity as a component of lifestyle over time (Ryan et al., 1997; Neace et al., 2020).

Methodological Considerations

This study was based on correlational data, precluding any inferences about causation. Moreover, the sample size of the present study (especially in the restricted subsample of participants with some physical activity history) was not large enough to enable the detection of small differences in relationships that could have existed or possibly a moderating role of physical activity history.

Sample demographics

The sample of this study consisted primarily of participants self-identifying as white and between the ages of 25-54 years. Therefore, this sample offers a non-representative view of the adult U.S. population and, as a result, any results reported herein cannot be considered generalizable. In addition, as discussed, this sample was also highly physically active, with average MVPA of 1222 MET-minutes/week and 75% meeting IPAQ criteria for "moderate" or "high" levels of physical activity. This high level of activity may be especially noteworthy in light of the time that the survey was conducted (2020-2021). This period included the 2020 lockdown associated with the COVID-19 pandemic, a period during which studies reported overall decreases in MVPA (Yang & Koenigstofer, 2020). It has been found, however, that those who are established in their physical activity levels find a way to adapt even in periods of extremely adverse environmental shifts (Kaur et al., 2020) and the present sample had 66% of participants reporting at least one week of established physical activity.

Online survey limitations

Using MTurk allowed for a large-scale crowdsourcing sample, however, online surveys do have limitations. For example, online surveys are only accessible to those who have internet access and a device to complete them. This survey was only accessible to those who were on the MTurk platform and met defined qualifications. Therefore, these characteristics likely resulted in some degree of sampling bias in this data set. Furthermore, once qualifiers are set, those who participate in surveys are the people willing to complete them (Couper, 2000). Though MTurk has been found to usually result in more diverse samples of respondents than surveys conducted on university settings, mostly by expanding the age range (Smith et al., 2016), the present sample still exhibited some clear majorities in certain demographic characteristics (Table 1) and thus

may not reflect the nature and strength of relationships between variables and physical activity that may exist in the broader U.S. population.

Quality of respondents

Online surveys open to the public do present challenges, including the widespread use of automation (i.e., bots), individuals completing surveys in a mindless or random manner or investing a low degree of attention, and individuals skipping a large number of items. In a study comparing MTurk respondents to an online group from a commercially maintained survey panel, ensuring data quality proved difficult as MTurk users were on average faster at completing surveys (Smith et al., 2016). When the present study was originally submitted, a quality indicator that was implemented was a minimum of 7 minutes to complete the survey, based on the expectation of completing each of the 50 statements in approximately 10 seconds. The average time of completion was approximately 9 minutes (10.8 seconds average per statement). Although the relationships found in this study do support theoretical predictions, perhaps some of the challenges noted in the previous paragraphs (e.g., possible over-reporting of current physical activity or physical activity histories) could be attributed to some participants completing the survey in a quick or careless manner.

CHAPTER 6: CONCLUSIONS

The present study found relationships between cognitive correlates (self-efficacy, cognitive attitude) and current levels of physical activity, as well as between affective correlates (affective attitude, enjoyment) and current level of physically activity, consistent with expectations. Moreover, cognitive correlates, affective correlates, and moderate-to-vigorous physical activity all exhibited positive relationships with physical activity history. However, physical activity history did not moderate the relationships of cognitive or affective variables with present moderate-to-vigorous physical activity. Due to the lack of a moderating relationship, it was not feasible to find a cut point in weeks of physical activity history to create an assessment of 'early' exercisers relative to 'experienced' exercisers. Therefore, the present study did not assess evidence to support a systematic weaking of the relation of cognitive variables with MVPA and a systematic strengthening of the relation of affective variables with MVPA as a function of the length of physical activity involvement.

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APPENDIX A: SUMMER 2020 SURVEY

In July 2020, a HIT was opened on MTurk seeking 1,035 U.S. MTurk users by offering an incentive of $0.40. The HIT was filled in just 2 hours and 50 minutes. This was not expected and resulted in questions about the quality of the responses. There was originally a time minimum of 7 minutes listed in the informed consent, to deter participants from quickly clicking through the survey. In the first 24 hours, HITs that were reviewed and found to have been completed in less than 5 minutes were rejected. Multiple MTurk workers messaged the investigator to dispute their rejections, claiming to have taken the survey with intention. After consulting MTurk requester support, several rejections were reversed as 'The reputation of the MTurk marketplace relies on both Workers and Requesters engaging in good faith' and according to the MTurk Participation Agreement section 3.a.vi 'you will not reject Tasks performed by Workers without good cause.'

MTurk participants have been recorded as consistently faster than other online survey participants, which can make quality restrictions based on the time taken to complete a task difficult to justify (Smith et al., 2016). Therefore, rejections for tasks were only based on the following criteria: invalid survey code entered, HIT submitted in less than 2 minutes, and % of questions completed <10%. This original survey had multiple text entries that resulted in unclear responses and helped shape the final survey flow. A total of 1086 verified responses were collected from this survey batch. However, due to persistent concerns about the validity of responses, these data were not analyzed and were not included as part of the present thesis.

APPENDIX B: SURVEY DETAILS

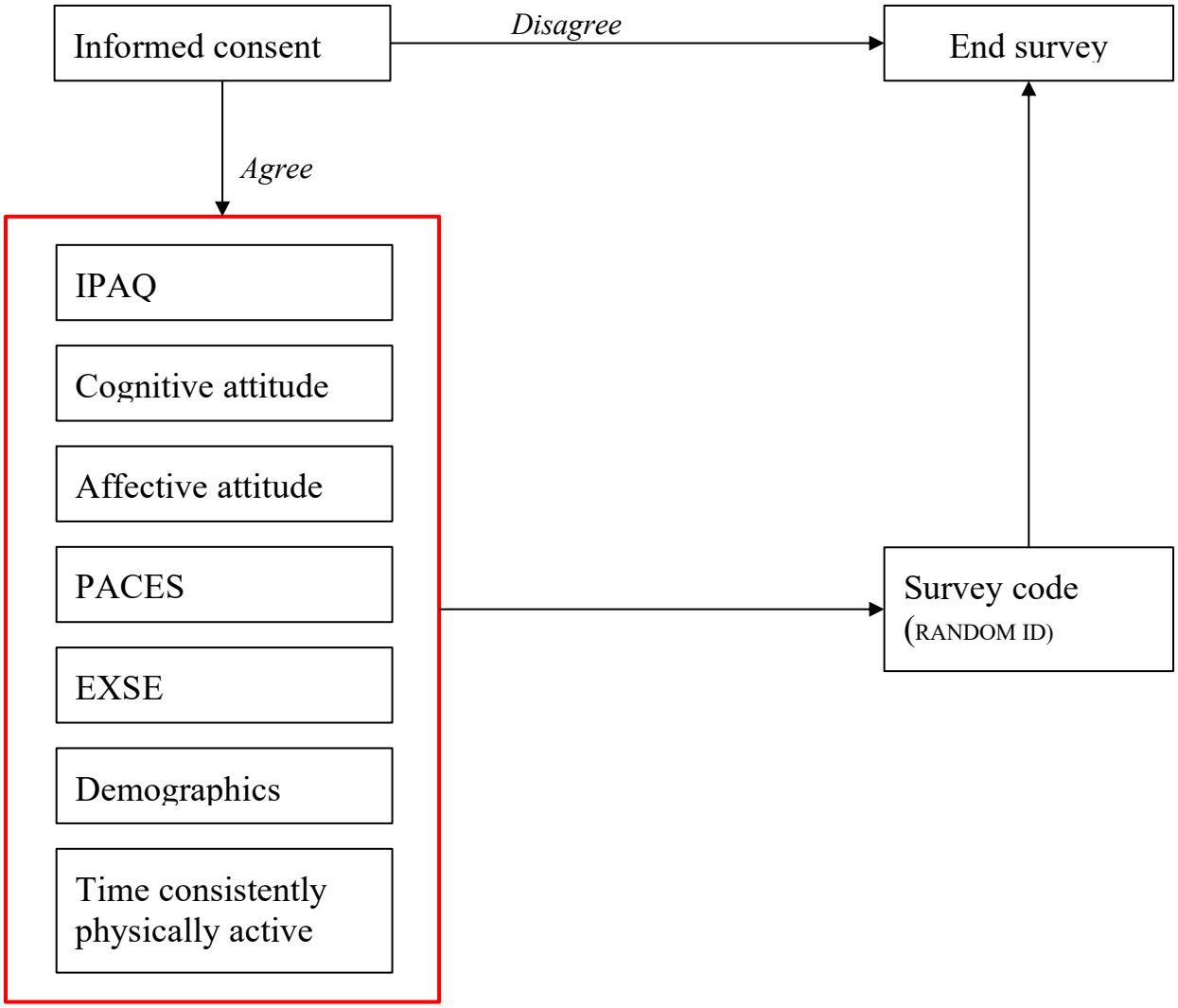

Figure 1B. General survey flow by section

The survey consisted of a series of seven questionnaires (outlined in red). Each questionnaire was presented to a participant in a random order. Informed consent was always presented first, and a participant had to agree to proceed to the questionnaire section. When all seven questionnaires were completed, a new page appeared to let participants know that their completion code would appear next, in order to minimize skipping the code and submitting an invalid survey response. The page first said "Your survey completion code is on the next page. A valid survey completion code must be entered into MTurk for compensation. Click the arrow when you are ready to enter the code in the MTurk assignment page." Then, on the final submission page, a survey code would appear that said "Here is your survey code…Copy this value to paste it into MTurk before submitting the survey. Select the arrow to submit the survey."

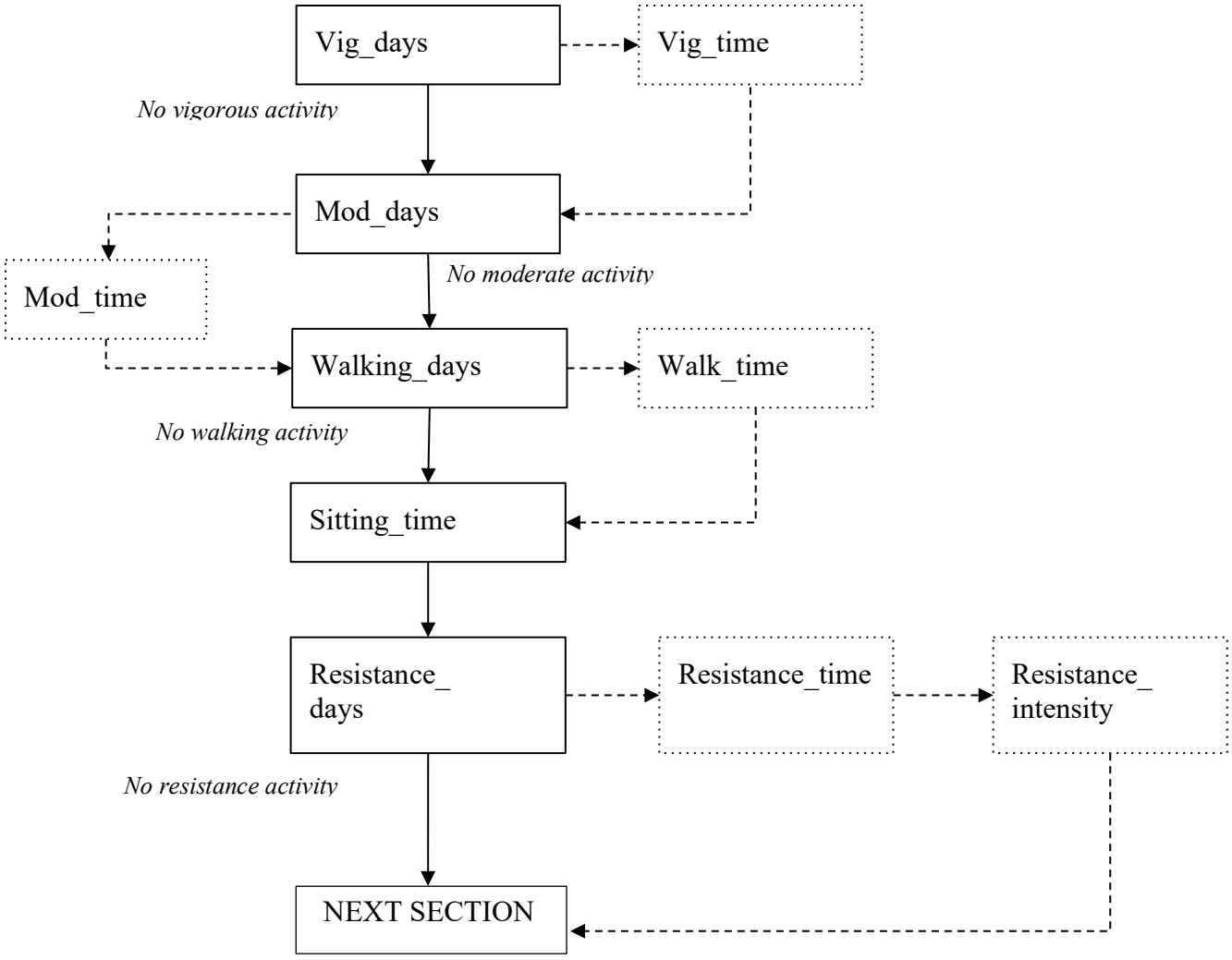

Figure 2B. IPAQ Question Flow

IPAQ questions for time of vigorous, moderate, walking, and resistance activities were only displayed for participants who answered that they participated in at least one day per week of each type of activity (dotted outlines were conditional).

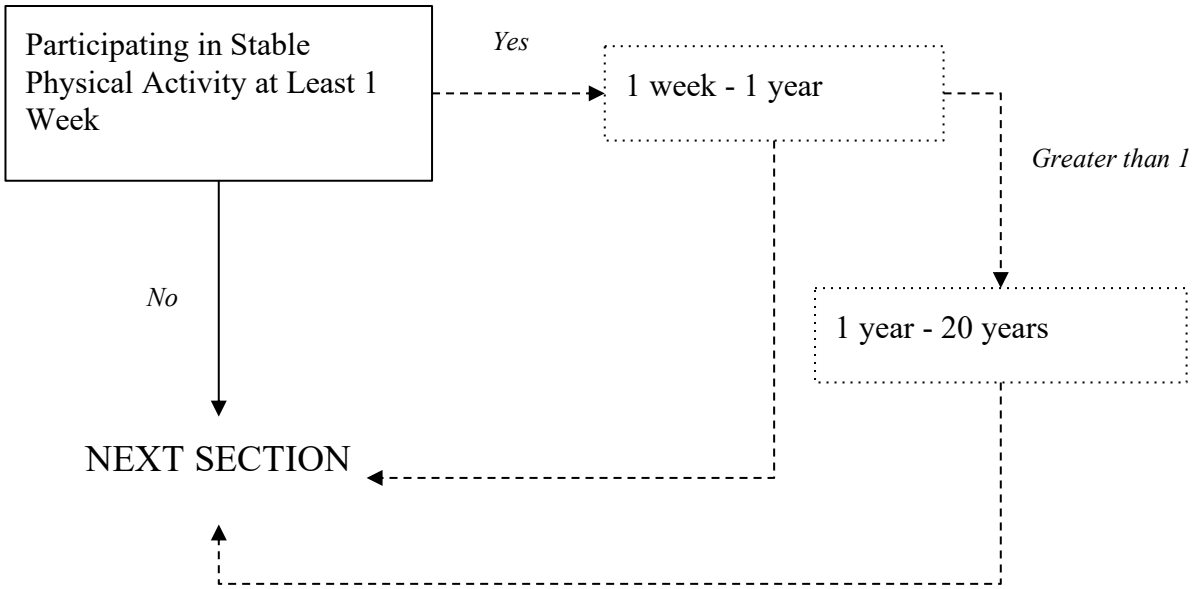

Figure 3B. Time Consistently Physically Active Question Flow

Questions for length of physical activity history (dotted outlines were conditional).

APPENDIX C: IRB LETTER

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office for Responsible Research
Vice President for Research
2420 Lincoln Way, Suite 202
Ames, Iowa 50014
515 294-4566

Date: 07/08/2020

To: Tanna Mafnas Panteleimon Ekkekakis, PhD

From: Office for Responsible Research

Title: **Cognitive and affective correlates of current physical activity: Does the length of regular participation moderate the relationships?**

IRB ID: **20-258**

Submission Type: Initial Submission **Exemption Date:** 07/08/2020

The project referenced above has been declared exempt from most requirements of the human subject protections regulations as described in 45 CFR 46.104 or 21 CFR 56.104 because it meets the following federal requirements for exemption:

2018 - 2 (ii): Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) when any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation.

The determination of exemption means that:

- **You do not need to submit an application for continuing review. Instead, you will receive a request for a brief status update every three years. The status update is intended to verify that the study is still ongoing.**
- **You must carry out the research as described in the IRB application.** Review by IRB staff is required prior to implementing modifications that may change the exempt status of the research. In general, review is required for any *modifications to the research procedures* (e.g., method of data collection, nature or scope of information to be collected, nature or duration of behavioral interventions, use of deception, etc.), any change in *privacy or confidentiality protections*, modifications that result in the *inclusion of participants from vulnerable populations*, removing plans for informing participants about the study, any *change that may increase the risk or discomfort to participants, and/or* any change such that the revised procedures do not fall into one or more of the regulatory exemption categories. The purpose of review is to determine if the project still meets the federal criteria for exemption.
- All ***changes to key personnel*** must receive prior approval.
- **Promptly inform the IRB of any addition of or change in federal funding for this study.** Approval of the protocol referenced above applies only to funding sources that are specifically identified in the corresponding IRB application.