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A Pre-Registered Multi-Replication Examination Of The Independent And Interdependent Effects Of Big Five Traits And Facets In Predicting Physical Activity Via A Cybernetic Framework

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A PRE-REGISTERED MULTI-REPLICATION EXAMINATION OF THE INDEPENDENT AND INTERDEPENDENT EFFECTS OF BIG FIVE TRAITS AND FACETS IN PREDICTING PHYSICAL ACTIVITY VIA A CYBERNETIC FRAMEWORK

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CHAPTER 1: INTRODUCTION

Increasing physical activity engagement remains one of the top priorities of the nation's Healthy People 2020 initiatives (Office of Disease Prevention and Health Promotion, 2016). However, according to the Centers for Disease Control and Prevention, only about 20.6% of the adult population in the United States meets government guidelines in terms of both muscle-strengthening and aerobic physical activity (CDC, 2013). Moreover, behavioral and public health interventions that have aimed to increase physical activity through targeting practical or environmental barriers have seen limited effectiveness (Gallagher, Yancy, Denissen, Kühnel, & Voils, 2013). Taking a personality-oriented approach might provide another avenue to increasing physical activity engagement, as personality traits are informative and reliable predictors of health outcomes and health-related behaviors. However, an exclusive examination of main effects does not allow a fuller investigation of the possible synergistic effects of traits on health behaviors (Hampson & Friedman, 2008). Exploring how traits contribute independently and synergistically to physical activity engagement might provide added predictive and conceptual utility to aid in the design of interventions that emphasize physical activity as an important form of personalized medicine (Buford & Pahor, 2012). The goal of the present study was to examine and replicate pre-registered hypotheses for Big Five trait interactions in the prediction of physical activity using three samples of U.S. adults from Amazon's Mechanical Turk.

Physical activity and Big Five personality traits

A number of studies have identified links between physical activity engagement and traits, both at the broad trait level and lower-order facets (e.g., Bogg, 2008; Hoyt, Rhodes, Hausenblas, & Giacobbi, 2009; Rhodes, Courneya, & Jones, 2005). A proposed mechanism for how traits might affect physical activity engagement is that traits drive certain skills and general proclivities that

enable people to either facilitate engagement in, or overcome barriers to, physical activity (Gallagher et al., 2013). Research that has examined the relationship between Big Five traits and physical activity has generally found consistent, positive relations with conscientiousness (disciplined, diligent versus disorganized, irresponsible) and extraversion (sociable, energetic versus inhibited, lethargic) and consistent, negative relations with neuroticism (moody, anxious versus calm, emotionally stable) (Bogg & Roberts, 2004; Rhodes & Pfaeffli, 2012). Although links between openness (imaginative, curious versus conventional, narrow interests) and physical activity are less well-established, they are indeed emerging. For example, a more recent meta-analysis confirmed earlier findings on conscientiousness, extraversion, and neuroticism, but showed that greater openness predicted engagement in moderate physical activity as well (Wilson & Dishman, 2015). Additionally, Allen and colleagues (2016) found that increases in openness (and conscientiousness) were associated with physical activity increases across an eight-year time span. Findings for agreeableness (compliant, trusting versus spiteful, manipulative) are somewhat more limited, such that greater agreeableness was found to negatively predict physical activity only for adults between 35-65 years of age (Wilson & Dishman, 2015).

Although informative, the research focus to date has largely examined independent effects of personality traits, with little regard as to how they might contribute synergistically to affect physical activity engagement. Hampson and Friedman (2008) have argued that an exclusive focus on main effects may conceal multiplicative trait associations in predicting certain health behaviors. Thus, it is important to understand how traits might function together to facilitate or inhibit health-related behaviors, such as physical activity engagement. For example, individuals who score high on conscientiousness and individuals who score high on extraversion both tend to engage in more physical activity (Rhodes & Pfaeffli, 2012; Wilson & Dishman, 2015), but would an individual

who scores high on both conscientiousness and extraversion show an even greater, non-additive propensity for physical activity engagement? Contrarily, individuals who score high on neuroticism tend to engage in less physical activity. Would having a high level of conscientiousness or extraversion buffer the negative effects of having a high level of neuroticism? Similarly, would the moderate effects of openness on physical activity be enhanced when interacting with high levels of conscientiousness? These are all questions that deserve further investigation but have not been examined in research combining the Big Five traits and physical activity engagement.

Cybernetics and Cybernetic Big Five Theory

Inherent in personality functioning are interactions within the personality system that enable actions toward goals rather than each part working as an isolated entity (Allport, 1961), and thus, utilizing a cybernetic approach to personality is highly pertinent for the purposes of the present study. Cybernetics is the study of principles that govern self-regulating and goal-directed systems (Wiener, 1948). Originally applied to the development of artificial control systems, cybernetic principles were later adapted and applied to social psychology by Carver and Scheier (1998). The study of cybernetics was then further applied to Big Five traits by Van Egeren (2009) and DeYoung (2015), who assert that each of the Big Five traits maintain certain controls on the overall personality system to influence behavior.

Cybernetic Big Five Theory (CB5T; DeYoung, 2015) is a viable framework for examining physical activity because regular engagement in such behaviors requires an on-going monitoring process, thereby requiring a feedback mechanism similar to that of a cybernetic system. A central idea in the study of cybernetics is that unmet goals are the driving forces behind self-regulating actions, whose function is to fulfill those goals, thereby reducing the discrepancy between the

current state and a desired outcome. From a cybernetic perspective, traits function both independently and interdependently through a self-regulating feedback mechanism that evaluates outcomes and discrepancies to inform progress toward desired goals and values (DeYoung, 2015; Van Egeren, 2009).

According to CB5T, in accomplishing a goal, the cybernetic system moves cyclically through the five stages of goal activation, action selection, action, outcome interpretation, and goal comparison (DeYoung, 2015). In the final stage, if a desired goal is matched with the current results, then the system moves toward the next goal, repeating the cycle. However, if there is a discrepancy between the results and the desired goal, then the system searches for alternative strategies to accomplish the goal or it may abandon the goal completely and move on to another goal. Within this system, the states (i.e., searching for other strategies to continue with the current goal or abandoning the goal) toward which a person might lean are dependent upon a person's overall trait levels and how those traits interact.

One of the tasks of the cybernetic system is to prevent or reduce uncertainty in the system's ability to move toward its goals. This uncertainty may happen when violations of expectations are detected, which may threaten goal achievement. Within CB5T, all five traits (and their interplay) are responsible for keeping this uncertainty at a minimum level. As a self-regulating system, personality traits work together throughout the different stages of the cycle, although some traits contribute more prominently than others, in correspondence with the stage and functions ascribed to each trait (DeYoung, 2015).

Cybernetic functions of each Big Five trait

The cybernetic function ascribed to extraversion is that of reward seeking in order to start the process of attaining a desired goal – it is thus related strongly to the first stage (goal activation)

of the cybernetic cycle. Because the function of neuroticism is that of error control signaling, this trait is related most strongly to the last stage when the desired state is to be compared with the currently achieved state. Along the way, however, neuroticism may also hinder or slow actions being carried out due to its defensive function when a mismatch occurs between the current goal and the actual progress or outcome. The role of openness is to find stimuli that are related to the current goal and identify potential strategies that may move the goal forward; it thus requires an ability to explore sensory and abstract information from the environment. Openness is perhaps the trait most suitable for facilitating flexible adjustment of goals, and thus, is relevant to the middle stages of the cybernetic cycle. The function ascribed to conscientiousness is that of goal prioritization (especially when the goal is not urgent) and prevention of distractions from the incomplete goal. Conscientiousness is posited to play a dominant role in maintaining actions that facilitate stable progress toward the desired goal. Due to these control functions, conscientiousness is most closely related to the first three stages of the cybernetic cycle. Finally, the function of agreeableness is to ensure that the goals and strategies of the individual person are well-coordinated with that of surrounding individuals. Agreeableness is not posited to pertain to a particular stage, but is nonetheless thought to be important throughout the cycle because people often must coordinate their goals with those around them (Graziano & Tobin, 2013). Overall, however, it is important to note that although there are certain traits that map more strongly onto one part of the cycle than others, most of these mechanisms function in a parallel fashion and therefore may contribute to multiple stages at the same time (DeYoung, 2015).

Through functioning as a cybernetic system, the Big Five traits are thought to be subsumed under two meta-traits—Stability and Plasticity—which work in opposing but also complementary ways (DeYoung, 2015). Conscientiousness, neuroticism, and agreeableness share variance under

the Stability meta-trait, and they represent motivational, emotional, and social stability (respectively) in the service of maintaining the viability of broad and long-term goals (DeYoung, 2015). On the other hand, extraversion and openness share variance under the Plasticity meta-trait, and they represent behavioral and cognitive exploration (respectively) in order to adapt to changes in the environment by way of creating new goals and/or new interpretations and strategies for current goals (DeYoung, 2013; 2014). Stability depends on the constraint or inhibition of motivational, social, and emotional impulses, and Plasticity depends on the activation of behaviors and cognitions.

In order to maintain stable and consistent functioning, the cybernetic system must also be able to adapt to changes in the environment. Moreover, in line with a contextualist view, CB5T posits that traits are contextualized, meaning that they require stimuli from the environment to evoke certain responses or behaviors (DeYoung, 2015). Therefore, context plays an important role in affecting overall cybernetic functioning. Although seemingly paradoxical, flexibility is a necessary component that helps facilitate stability because changes in the environment are both inevitable and unpredictable. Because stability and plasticity counterbalance each other, it should be noted that having an extreme of either is dysfunctional, as constant change presents a challenge for stability, while rigidity presents a challenge for plasticity. With regard to behaviors, any behavior that is enacted at any given time is dependent on the complex and multidimensional interplay between environmental contexts and the underlying mechanisms of the presently interactive traits, which might inhibit or facilitate behaviors. The balancing between stability and plasticity is especially pertinent to physical activity because engaging in regular physical activity itself is a complex process that requires the management of resources, energy, and commitments

to other activities, whereby individuals must overcome several self-regulation challenges (Bélanger-Gravel, Godin, & Amireault, 2011).

Examining physical activity via CB5T

The associations between each of the Big Five traits and physical activity may be explained via the cybernetic functions of each trait. The cybernetic function of conscientiousness is to protect long-term goals from current distractions. From this perspective, conscientious individuals should tend to engage in more physical activity, in part, because they are able to delay gratification and control the self from engaging in behaviors that do not pertain to long-term health outcomes (Booth-Kewley & Vickers, 1994). Conscientious individuals also tend to engage in more preventive health behaviors overall (Ozer & Benet-Martinez, 2006). As such, setting aside time to engage in physical activity, regardless of other, more immediately gratifying activities may be more easily achieved for individuals who are more highly disciplined.

Individuals who score high on extraversion tend to be more energetic, and thus, engaging in physical activity may come from a more natural propensity to stay active (Rhodes et al., 2005) rather than a focus on long-term health goals. Moreover, highly extraverted people are more sensitive to the possibility of reward (Depue & Collins, 1999; Larsen & Ketelaar, 1991), which is aligned with the cybernetic function of behavioral exploration and motivation in search for expected rewards. In turn, these individuals might engage in physical activity to experience the positive affect that arises from engagement in vigorous and fast-paced activities.

Because neuroticism has a defensive mechanism (combined with a heightened experience of negative affect), engagement in physical activity might be seen as a threat to the individual's current well-being. Some researchers (e.g., Rothbart, Ahadi, & Evans, 2000) have ascertained that neuroticism has biological roots stemming from the need to keep the individual from harm. In

alignment with this function, for individuals high in neuroticism, physical activity may be considered a stressor or a potentially harmful situation from which the body needs to be protected. Moreover, because engagement in physical activity can have immediate, unattractive costs (e.g., physical exhaustion, muscle soreness, disruption of daily routines), with the benefits not always immediately apparent, a previous negative experience with physical activity engagement might trigger a heightened defensive response in individuals high in neuroticism.

The emerging evidence linking openness to physical activity is perhaps not surprising from a cybernetic perspective. The cybernetic function ascribed to openness is the ability to perceive different possibilities of the environment (Van Egeren, 2009). Moreover, individuals with greater levels of openness tend to introduce variety into their lives, actively seek out opportunities to engage in new activities, and show more flexibility when facing life transitions (Goldberg, 1993; Whitbourne, 1986). There is increasing research suggesting that openness may be an important trait domain for a variety of health-related factors. These factors include health-related Internet search frequency (Bogg & Vo, 2014), healthy dietary practices (Brummett, Siegler, Day, & Costa, 2008; Goldberg & Stryker, 2002), body mass index (Brummett et al., 2006), the development of walking limitations in old age (Tolea et al., 2012), functional status (Duberstein et al., 2003; Suchy, Williams, Kraybill, Franchow, & Butner, 2010), and all-cause mortality (Iwasa et al., 2008; Masui, 2006). More specifically related to physical activity, it is likely that individuals high on openness are in favor of trying new types of activities, and thereby are adept at thinking of possibilities to make the process of engaging in physical activity more exciting and/or less mundane.

Perhaps the fact that engagement in physical activity can be (and often is) conducted alone contributes to the limited associations found between agreeableness and physical activity, given that the function of agreeableness is keeping the individual's goals in alignment with close others.

From a cybernetic perspective, a possible explanation for Wilson and Dishman's (2015) meta-analytic finding that highly agreeable adults between 35-65 years old engage in less physical activity is that people within this age range are more likely to have significant others and children, with whom they have to coordinate their goals. Because highly agreeable people are more empathetic and in tune in others' emotions and needs (Graziano, Habashi, Sheese, & Tobin, 2007; Mayer, Roberts, & Barsade, 2008), they might see physical activity engagement as conflicting with their other social and familial responsibilities that may seem more urgent. Perhaps it is this juggling of multiple responsibilities and coordination of goals that prevents these individuals from being able to prioritize leisure-time physical activities in daily life.

Within the Stability and Plasticity framework of the CB5T (and the cybernetic functions of each trait), leisure-time physical activity can be conceptualized as behaviors that require inhibiting certain habitual tendencies to be sedentary or inhibiting negative affect or a dearth of motivation that might obstruct one's effort. At the same time, engagement in physical activity also requires the activation of both behavioral and cognitive exploration of strategies to engage in physical activity, especially when certain obstacles arise, such as not having specific types of exercise equipment or the weather not permitting outdoor activities. Engagement in regular physical activity may be conceptualized as the continuous re-initiation of individual bouts of physical activity, where re-initiation occurs over various time points and settings, during and within which an individual is likely to experience varying internal states. As a consequence of this multi-faceted variability, physical activity engagement is thought to defy a pure form of automation or habituation, but rather requires continual evaluation and re-evaluation of efforts and outcomes in light of external and internal factors (Milne, Rodgers, Hall & Wilson, 2008). Almost

by necessity, then, consistent engagement in physical activity requires self-regulatory control to evaluate the many possible external and internal factors that might arise across time and settings.

The present study and hypotheses

Examination of both independent effects and interdependent effects of the Big Five traits from a cybernetic perspective might provide some conceptual insight into how the interplay of Stability and Plasticity traits contribute to facilitate regular physical activity amidst varying circumstances. This insight may provide important groundwork for testing longitudinal effects of how traits function synergistically to affect physical activity engagement in the long term. Accounting for individual differences in understanding engagement in (or lack of) physical activity is paramount and can be useful for personalized intervention efforts. The present study examined independent and interdependent relationships of traits to engagement in physical activity using a CB5T framework. Consistent with the proposed complementarity of the two meta-traits of CB5T, it was posited that there would be interactions between the components of Stability (i.e., conscientiousness, agreeableness, and neuroticism) and Plasticity (i.e., extraversion and openness).

Specifically, it was expected that there would be an interaction between conscientiousness and extraversion in the prediction of physical activity. Prior research has shown consistent, positive bivariate relations between physical activity and these two traits – synergistically, their possible interaction could be characterized as *energetic persistence*. As openness is another Plasticity component that has more recently been found to show a positive relationship with physical activity, a similar interaction was expected between openness and conscientiousness, whose possible interaction could be characterized as *adaptive persistence*. Having a greater level of exploration

(in terms of strategies) may further enhance the ability to delay gratification of immediate desires and help individuals focus on the long-term benefits of engaging in physical activity.

Neuroticism is a component of Stability that has shown consistent negative relations with physical activity. Given this independent effect of neuroticism, and because the cybernetic function ascribed to neuroticism is that of a defensive mechanism that is highly sensitive to signals of threat, it was expected that neuroticism would interact with both extraversion (whose profile might be *energetic vigilance*) and openness (whose profile might be *adaptive vigilance*). However, because the positive relationship between extraversion and physical activity is generally stronger than the negative relationship between neuroticism and physical activity, it was posited that having a high level of extraversion might buffer the effects of a high level of neuroticism, such that individuals high on both of these traits might still engage in physical activity, despite a high level of neuroticism. Some research suggests that there is a health-promoting aspect of neuroticism, whereby a "healthy neurotic" may be hypervigilant about his health and accordingly engage in some health-promoting behaviors (Friedman, 2000). In this sense, perhaps having a high level of concern for one's health, as well as a greater propensity to seek stimulating activities, may prompt an individual to engage in more physical activity.

Because the relationship between neuroticism and physical activity tends to be consistently negative, it is unclear whether having a certain level of openness might be enough to buffer the negative effect. However, it is possible that individuals with high levels of neuroticism and low levels of openness may be at risk of engaging in very low levels of physical activity. From a cybernetic perspective, individuals with narrow interests who also have a heightened defensive mechanism might eschew a variety of activities in order to protect the body from potential harm. And finally, due to few consistent relations found between agreeableness (the final Stability

component) and physical activity in the literature, no interactions were expected between agreeableness and extraversion and between agreeableness and openness, and therefore these interactions were not included in the present study.

Trait facet relations with exercise

Additionally, a body of research has examined the roles of conscientiousness-related facets (such as self-discipline and industriousness) and extraversion-related facets (such as activity) to physical activity engagement (Bogg, 2008; Bogg & Roberts, 2004; Hoyt, Rhodes, Hausenblas, & Giacobbi, 2009; Rhodes & Courneya, 2003; Rhodes, Courneya, & Jones, 2004, 2005; Vo & Bogg, 2015). Because it is possible that any observed trait interactions may be driven by certain lower-order facets, the proposed study also aims to examine the independent and interdependent effects of physical-activity-relevant trait facets. Of particular interest are the activity facet of extraversion, the industriousness facet of conscientiousness, the anxiety facet of neuroticism, and the ingenuity facet of openness. These trait facets have been validated to provide measurement at a more specific level of abstraction (Chernyshenko, 2003; Goldberg et al., 2006), and in many cases, may have greater predictive utility than their broader counterparts (Bogg & Roberts, 2004). In line with predictions for the broad Big Five traits, it was hypothesized that at the facet level, there would be an interaction between the activity facet and the industriousness facet, between the activity facet and the anxiety facet, between the industriousness facet and the ingenuity facet, and between the anxiety facet and the ingenuity facet.

Contextual input and three-way interactions

Moreover, in line with the idea of a contextualized personality system, several relevant background factors were included as covariates to extend prior research and to examine whether trait interactions would remain even after accounting for sex, age, income and education (i.e.,

SES), body mass index, self-rated health, physical limitations, and exercise stage of change from the Transtheoretical Model (TTM; Prochaska & DiClemente, 1983), which are all factors that can influence engagement (or lack thereof) in physical activity. Furthermore, from a cybernetic perspective, it is expected that certain contextual inputs, such as one's health and physical limitations, might act as moderators that either diminish or amplify the effects of the trait interactions on physical activity engagement. For example, it is possible that having a greater number of physical limitations or poorer health status might diminish any positive effects of high levels of conscientiousness, extraversion, or openness on physical activity. Alternatively, it could be that having good health might increase the positive effects of also having high levels of conscientiousness, extraversion, or openness. Moreover, greater physical limitations and poorer health might amplify the effects of having a high level of neuroticism or low levels of conscientiousness, extraversion, or openness, thereby resulting in an even lower propensity to engage in physical activity.

Aside from physical health and limitations, social cognitions, especially self-efficacy, also may act as important correlates and determinants of exercise behavior (McAuley & Blissmer, 2000). Self-efficacy pertains to individuals' confidence in their ability to enact certain behaviors, despite challenges or barriers that may arise (Bandura, 1977). Having high levels of self-efficacy predicted exercise adoption and exercise maintenance (as measured over 6-month and 12-month follows) for adults who were previously sedentary (Sallis, Hovell, & Hofstetter, 1992; Williams et al., 2008). As such, in addition to physical contextual inputs, confidence in one's abilities to overcome exercise-related barriers may also interact with the expression of traits to influence physical activity engagement. Out of the Big Five traits, conscientiousness has shown consistent positive relations with exercise self-efficacy due to its ability to protect from current distractions

(e.g., bad weather, closed gym, travel, etc.) and follow through with actions (Bogg, 2008; Vo & Bogg, 2015). Additionally, due to the positive relation between the activity facet of extraversion and exercise self-efficacy (Vo & Bogg, 2015), it is expected that highly extraverted individuals would have greater self-efficacy for leisure-time physical activity owing to a natural propensity to be motorically active.

Overall, regarding the expected interactive effects of traits and contextual inputs, a three-way interaction was expected among conscientiousness, extraversion, and health status, such that individuals high on both conscientiousness and extraversion who also have good health, are most likely to engage in high levels of physical activity. In alignment with the broad trait-level predictions, a three-way interaction was expected among the lower-order facets of industriousness and activity and health status, such that individuals high on both the industriousness and the activity facets, who also have good health are most likely to engage in high levels of physical activity. On the other hand, it was expected that having greater physical limitations might diminish any positive effects of high levels of conscientiousness and openness on physical activity. As such, another three-way interaction was expected among conscientiousness, openness, and physical limitations. Similarly, a three-way interaction was expected at the facet level, such that greater physical limitations might diminish the positive effects of greater levels of the industriousness facet and the ingenuity facet. A three-way interaction was expected among neuroticism, extraversion, and physical limitations, such that individuals who score high on neuroticism and low extraversion, who also have many physical limitations were expected to have the lowest level of physical activity engagement, given the defensive mechanism of neuroticism. Again, in alignment with the broad traits, a three-way interaction was expected among the lower-order facets of anxiety and activity and physical limitations, such that individuals who score high on the anxiety

facet and low on the activity facet, who also have several physical limitations were expected to have the lowest level of physical activity engagement. Finally, a three-way interaction was expected among conscientiousness, extraversion, and self-efficacy, such that high levels of self-efficacy would be enhanced with high levels of both extraversion and conscientiousness; thus, individuals who have greater exercise self-efficacy, along with high levels of conscientiousness and extraversion, would likely engage in the greatest amount of physical activity. Furthermore, three-way interactive effects were also expected to be observed for high levels of the industriousness facet of conscientiousness, high levels of the activity facet of extraversion, and high levels of exercise self-efficacy.

Because past research has shown that facet-level traits provide a more specific level of measurement that demonstrate stronger physical activity relations than domain-level traits (e.g., Bogg & Roberts, 2004; Hoyt et al., 2009; Rhodes et al., 2005), the facet-level interactions were similarly expected to be stronger than any corresponding domain-level interactions. Figure 1 shows the expected interaction effects among the broad-level traits and potential contextual moderators in predicting physical activity engagement. Figure 2 shows the expected interaction effects among the facet-level traits and potential contextual moderators in predicting physical activity engagement.

To increase confidence in any observed interaction effects, the present study used three samples and two different measures of physical activity to examine the hypotheses. Across the three samples, the aim was to conduct direct replications (i.e., using the same procedures, materials, and measures), and in using two different leisure-time physical activity measures, another aim was to conduct a conceptual replication (i.e., using same procedures and samples, but different measures of physical activity) to explore whether the interaction effects would hold for

either point of this replication continuum (*cf.* Shrout & Rodgers, 2018). Examining two types of replication results may provide further insight into how personality traits, facets, and contextual factors may work together to influence physical activity and whether the measurement method makes a difference in the ability to observe these interactions.

Furthermore, the hypothesized independent and interdependent relationships were examined using separate (i.e., vigorous/strenuous, moderate, and mild) and combined levels of physical activity scores to test effects based on clearly defined intensity levels of physical activity – distinctions in measurement that have been missing in most prior work (*cf.* Wilson & Dishman, 2015). Through a cybernetic perspective, this distinction is also important because each intensity level of physical activity represents a different type of eliciting stimulus that necessitates varying forms of independent and interdependent trait expressions. The present study underscores the importance of examining and understanding the interplay of personality traits in the prediction of health-related behaviors, such as physical activity. Big Five interactions have been examined in the prediction of other health and well-being outcomes and behaviors, such as coping behaviors in sports (Allen, Greenlees, & Jones, 2011), interleukin-6 levels (Turiano, Mcrozek, Moy, & Chapman, 2013), perceived social support (Swickert, Hittner, & Foster, 2010), health-related Internet searches (Bogg & Vo, 2014), and mortality (Friedman, Kern, & Reynolds, 2010). However, to the author's knowledge, there are currently no studies that test Big Five (or trait facet) interactions in the prediction of physical activity engagement across a wide range of ages in adulthood. This is a particularly important emphasis, given that prior research examining physical activity and personality has largely focused on young adults and single trait effects (Allen & Laborde, 2014; Rhodes & Pfaeffli, 2012; Wilson & Dishman, 2015). While prior research examining bivariate relations between Big Five traits and physical activity has been informative,

extending these relations by way of examining trait and trait facet interactions in the prediction of physical activity may be more illustrative of the workings of the dynamic personality system.

CHAPTER 2: METHODS

Participants

Three community samples were recruited via Amazon Mechanical Turk (MTurk), an Internet crowdsourcing service that coordinates participants for a variety of tasks, including social science research. Participants were 18 years or older and were able to read and respond to questions in English. Only "MTurkers" who had an approval rating of at least 95% were able to participate in the study.

Materials

Background variables.

Demographics information. Participants' age, sex, marital status, education, income, and ethnicity were obtained.

Body mass index. BMI was calculated based on self-reported weight (in pounds) and height (in inches).

Self-rated health. Health status was assessed with a single self-rated item on a five-point Likert scale (In general, would you say your health is? 1 = Poor, 5 = Excellent).

Physical limitations. Limitations in daily physical activities from health problems were assessed using the sum of ten items from the SF-36 (Ware & Sherbourne, 1992; α = .92-.93). Example items include: lifting or carrying groceries, climbing stairs, and bending, kneeling, or stooping.

Exercise self-efficacy scale. The 18-item multidimensional exercise self-efficacy scale (Benisovich, Rossi, Norman, & Nigg, 1998) included six subscales that assessed participants' confidence in being able to exercise despite bad weather, inconvenience, negative affect, exercising alone, excuse making, and resistance from others. Participants were asked to rate "how

confident [they] are to exercise when other things get in the way" on a 5-point Likert scale (1 = Not at all confident, 5 = Extremely confident; α = .93-.94). Example items include, "I don't have access to exercise equipment," "I don't feel like it," and "I am spending time with friends or family who do not exercise."

TTM staging measure. Participants indicated their current exercise level and/or readiness to start exercising from five choices, which categorized them as being in the precontemplation (not exercising regularly and does not intend to begin in the next six months), contemplation (not exercising regularly but intends to begin in the next six months), preparation (not exercising regularly but intends to begin in the next 30 days), action (have been exercising regularly, but for less than six months), or maintenance (have been exercising regularly for more than six months) stage (Prochaska & DiClemente, 1983). Guidelines for exercise activity were defined by the National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP).

Trait variables.

Big Five traits. The five broad domains of personality traits were assessed using the well-validated 44-item BFI (John, Donahue, & Kentle, 1991). All items were rated using a five-point Likert scale (1 = Disagree Strongly, 5 = Agree Strongly). A nine-item scale was used to assess conscientiousness (e.g., "does a thorough job"; α = .84-.85). An eight-item scale was used to assess neuroticism (e.g., "gets nervous easily"; α = .89-.90). An eight-item scale was used to assess agreeableness (e.g., "is helpful and unselfish with others"; α = .81-.83). A 10-item scale was used to assess openness (e.g., "is curious about many different things"; α = .83-.84). A nine-item scale was used to assess extraversion (e.g., "is outgoing, sociable"; α = .86-.87).

Trait facets. The four facets of interest for the present study (i.e., the activity facet of extraversion, the industriousness facet of conscientiousness, the anxiety facet of neuroticism, and

the ideas/ingenuity facet of openness) were assessed with 40 total items. All facet items were rated using a 5-point Likert scale (1 = Disagree strongly, 5 = Agree strongly). The extraversion-related facet of activity was assessed using an International Personality Item Pool analog scale of the NEO-Personality Inventory-Revised activity scale (Goldberg et al., 2006). Participants rated 10 items indicating the extent to which they are "someone who: is always on the go, is always busy, [or] does a lot in my spare time" (α = .73-.75). The conscientiousness-related facet of industriousness was assessed using a 10-item measure (Chernyshenko, 2003). Participants indicated the extent to which they are "someone who: has high standards and works toward them; is satisfied with getting average grades (reversed); [or] goes above and beyond of what is required" (α = .85-.86). The neuroticism-related facet of anxiety was assessed using an International Personality Item Pool analog scale of the NEO-Personality Inventory-Revised activity scale (Goldberg et al., 2006). Participants rated the extent to which they "worry about things [or] get stressed out easily" (α = .89-.90). The openness-related facet of ideas/ingenuity was assessed using an International Personality analog scale of the Jackson Personality Inventory ingenuity scale (Goldberg et al., 2006). Participants rated 10 items indicating the extent to which they are someone who "has a vivid imagination [or] loves to think up new ways of doing things" (α = .86-.87).

Outcome measures.

Physical activity. Physical activity was assessed using the Godin Leisure-Time Exercise Questionnaire (Godin & Shephard, 1985), which used three free-response items to assess the frequency (i.e., number of times) of engagement in leisure-time strenuous, moderate, and mild physical activity on a weekly basis (i.e., a 7-day period) for more than 20 minutes each time. Strenuous activity was defined as activities where the "heart beats rapidly," and examples of such activities were listed as "running, jogging, hockey, football, soccer, squash, basketball, cross

country skiing, judo, roller blading, vigorous swimming, [or] vigorous long-distance bicycling." Moderate activity was defined as activities that were "not exhausting," and examples of such activities were listed as "fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine (downhill) skiing, [or] social dancing." Mild activity was defined as activities that require "minimal effort", and examples of such activities were listed as "yoga, archery, fishing, bowling, horseshoes, golf, [or] easy walking." One additional item assessed frequency of engagement in leisure-time activities that "work up a sweat." Choices for this item were: often, sometimes, [or] never/rarely. Physical activity scores were assessed independently as well as via a total physical activity score. The total physical activity score was computed by multiplying each reported exercise frequency by its metabolic equivalent (MET) and then summing the totals: (strenuous x 9) + (moderate x 5) + (mild x 2) (Godin, Jobin, & Bouillon, 1986).

The study also used the long form of the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003) as another way to measure both time spent in physical activity and sedentary behaviors. The IPAQ contained 27 items that assess participants' engagement in different intensities of physical activities for work, household activities, transportation, and leisure, as well as time spent sitting. The questionnaire asked about the number of days that participants spent in each category of activities (i.e., strenuous activity, moderate activity, and walking (mild)) for 10 minutes or more for the past seven days. If participants reported engaging in those activities, they were asked to provide more specific information on how much time (i.e., hours and minutes) they spent in those activities on one of those days. The total physical activity score in the IPAQ was computed by multiplying each reported physical activity time by its metabolic equivalent (MET) and then summing the totals: (vigorous x 8) + (moderate x 4) + (mild x 3.3) (Craig et al., 2003). Individual physical activity scores were based on the reported weekly number of minutes

of engagement in the respective type of physical activity. It should be noted that for the purposes of the present study, only items that measured leisure-time physical activity (rather than those for work, transportation, etc.) were used in the analyses.

Procedure

As interaction effects are difficult to replicate across study populations, the proposed study used three samples recruited through MTurk. To further enhance confidence in the results, the study was pre-registered on the Open Science Framework (van 't Veer & Giner-Sorolla, 2016). Permission for research with human participants was obtained through the Wayne State University Institutional Review Board prior to data collection.

All participants had sufficient time to complete the surveys using Amazon's default setting, which was 60 minutes. The average time that participants took to complete the questionnaire was 20 minutes and three seconds. Participants' MTurk identification numbers were used to ensure that participants only complete the survey once. Participants were provided with an informed consent prior to survey commencement informing them of the topic of the study, time commitment, and compensation rate. They were also informed that their participation was voluntary and that they were able to skip any questions that they were not comfortable answering. Participants provided informed consent and completed survey questions through Qualtrics. After survey completion on Qualtrics, participants were provided with a code that they typed into MTurk to receive their $0.65 compensation. This compensation rate was in line with MTurk's guideline of $1.00/30 minutes.

Power

Power analyses conducted via G*Power, 3.1.6 (Faul, Erdfelder, Lang, & Buchner, 2007; 2009) for two-way and three-way interaction effects among continuous variables indicated that 900 participants were needed to detect a small effect size ($f^2 = 0.10$) with alpha error probability

at 0.05 and power at 1-*B* =.85. To account for missing data and/or participant inattentiveness, oversampling occurred at a little over 10%, thereby making the target sample 1,000 for each of the three samples, making the overall target *N* = 3,000. Due to missing data from some participants, the final overall sample consisted of 2,879 participants, with 967 participants in Sample 1, 963 participants in Sample 2, and 949 participants in Sample 3.

CHAPTER 3: RESULTS

Data screening and descriptive statistics

During the participant recruitment process, participants who failed at least two of the three the attention checks were rejected from the participant pool from the beginning and new participants (who passed the attention checks) were recruited into the participant pool to complete the planned 1000 participants per sample requirement. Thus, all participants who were part of the original 1000 in each sample had passed the attention checks. However, in each of the three samples, participants who had any missing data on variables of interest were removed from analyses using listwise deletion. In Sample 1, 33 participants (3.3% of the sample; final N = 967) were removed because they had missing information for one or more of the following variables: income, sex, age, BMI, or physical activity scores from the GLTEQ. In Sample 2, 37 participants (3.7% of the sample; final N = 963) were removed because they had missing information for one or more of the following variables: income, sex, BMI, or physical activity scores from the IPAQ. In Sample 3, 51 participants (5.1% of the sample; final N = 949) were removed because they had missing information for one or more of the following variables: age, income, sex, education, BMI, or physical activity scores from the GLTEQ. Because the percentage of missing data was 5% or less in each sample, removing these cases was deemed inconsequential to the overall analyses (Howell, 2013).

Means and standard deviations (or percentages) for the study variables in all three samples appear in Table 1. ANOVAs conducted among the variables comparing each sample showed that there were statistically significant differences in terms of the industriousness facet (F = 3.23, p = .040), the activity facet (F = 3.43, p = .033), and mild physical activity (Blom-transformed) from the GLTEQ (F = 4.74, p = .009). Other ANOVA results were non-significant, with F values >

2.82, $p > .06$. Bonferroni post-hoc tests showed that for the industriousness facet, the difference was between Sample 1 and Sample 2 ($p = .048$, 95% CI: .001 to .130). For the activity facet, differences were again between Sample 1 and Sample 2 ($p = .027$, 95% CI: .006 to .130). For the mild physical activity variable, the difference was between Sample 1 and Sample 3 ($p = .030$, 95% CI: -.21 to -.01) and between Sample 2 and Sample 3 ($p = .018$, 95% CI: -.22 to -.01). Aside from these differences, the samples were quite similar, with an overall average age of 37.29 years ($SD = 12.31$) and consisted of approximately 62% females and 38% males.

Correlational analyses

Correlations among study variables, including demographic variables, personality trait and the facet variables, and physical activity variables for Sample 1 (below the diagonal) and Sample 2 (above the diagonal) are shown in Table 2. Correlations among study variables for Sample 3 are shown in Table 3. Overall, correlations were similar across the three samples among the demographic and trait-related variables. In Sample 1 and Sample 2, some of the strongest correlation patterns with physical activity engagement emerged for age, sex, health, stage of change (TTM), and self-efficacy. Interestingly, in Sample 3, the strongest correlation patterns for physical activity engagement emerged only for health, limitations, stage of change, and self-efficacy, while age and sex did not show many strong correlations. One similarity in terms of the physical activity variables was that across three samples, strenuous physical activity (from both the GLTEQ and the IPAQ) seemed to have the strongest correlations with the demographic and trait variables. Particularly, strenuous physical activity from the GLTEQ showed the strongest and most consistent correlations with the background variables.

In Sample 1, both conscientiousness and the industriousness facet were positively correlated with total and strenuous physical activity from the GLTEQ, with the industriousness

facet having slightly stronger correlations. Conscientiousness also showed a positive correlation with strenuous physical activity from the IPAQ. Neuroticism and the anxiety facet also had very similar negative significant correlations with all physical activity variables except for moderate and mild physical activity from the GLTEQ, but with neuroticism having slightly stronger correlations. Openness was not correlated with any physical activity variables, but the ingenuity facet had positive significant correlations with total and moderate physical activity from the GLTEQ. Extraversion and the activity facet had positive significant correlations with total and strenuous physical activity from the GLTEQ, with the activity facet having slightly stronger correlations and an additional correlation with moderate physical activity. Positively significant correlations between extraversion and exercise and activity facet and exercise from the IPAQ were very similar, except that extraversion did not show a significant correlation with the walking (i.e., mild) IPAQ physical activity variable. Agreeableness did not show any statistically significant correlations with any physical activity variables.

In Sample 2, both conscientiousness and the industriousness facet were positively correlated with total, strenuous, and moderate physical activity from the GLTEQ, with the industriousness facet having slightly stronger correlations. Neuroticism and the anxiety facet had very similar negative significant correlations with total, strenuous, and moderate physical activity from the GLTEQ and with total and strenuous physical activity variables from the IPAQ. The anxiety facet also negatively correlated with moderate physical activity from the IPAQ. Patterns of associations were similar between openness and the ingenuity facet, with both variables exhibiting positive associations with total, strenuous, and moderate physical activity from the GLTEQ and IPAQ. Extraversion and the activity facet both had positive significant associations with total, strenuous, and moderate physical activity from the GLTEQ, with the activity facet

having stronger associations. On the other hand, Extraversion had positive associations with all exercise variables from the IPAQ, while the activity facet had positive associations with only total and strenuous physical activity from the IPAQ, which were also weaker than those of extraversion. Similar with Sample 1, agreeableness did not show any statistically significant correlations with any physical activity variables in Sample 2.

In Sample 3, both conscientiousness and the industriousness facet were positively correlated with all except the mild physical activity variables from the GLTEQ and IPAQ. Neuroticism and the anxiety facet had similar negative significant correlations with total and strenuous physical activity from the GLTEQ, with the anxiety facet also being significantly correlated with moderate physical activity. Neuroticism and the anxiety facet were also negatively correlated with total, strenuous, and moderate physical activity from the IPAQ. Openness was positively associated with total and mild physical activity from the GLTEQ while the ingenuity facet was not associated with any physical activity variables from this measure. However, the ingenuity facet was positively associated with all physical activity variables from the IPAQ, and openness was associated with all but strenuous physical activity from this measure. Extraversion was positively associated with total and strenuous physical activity from both the GLTEQ and IPAQ. The activity facet was positively associated with all but mild physical activity from the GLTEQ. Finally, agreeableness showed positive associations with total and moderate physical activity from the IPAQ.

To review, across the three samples, associations between traits and trait facets with physical activity variables were more consistent when the GLTEQ was used rather than the IPAQ. When measured by the GLTEQ, the associations between traits/trait facets and physical activity were consistent across all except the ingenuity facet. However, when measured by the IPAQ,

consistent correlations were only found for neuroticism, extraversion, the anxiety facet, and the activity facet. Overall, between both measures, consistent correlations were found most often for total and strenuous physical activity.

Regression analyses for Big Five traits and facets

Linear regression models were used to examine the independent and interdependent effects of traits and trait facets on physical activity engagement. All models were controlled for background variables that have known associations with physical activity levels (i.e., sex, age, income, education, self-rated health, physical limitations, BMI, and self-efficacy). It should be noted that the stages of change measure was not included in the regression models due to its similarity with the outcome variables of physical activity. Agreeableness was also not included in the regression models due to the few statistically significant correlations between this trait and the physical activity variables and also because agreeableness was not included as part of the study hypotheses. The limitations variable was Blom-transformed due to a positively skewed distribution. Additionally, all variables that were included in interaction terms were mean-centered prior to entry into the models. Three models were tested for each physical activity outcome (i.e., vigorous, moderate, mild, and total physical activity), which were repeated for each of the two measures of physical activity (i.e., GLTEQ and IPAQ). All physical activity variables were Blom-transformed due to evidence of skewed distributions. Regression analyses were conducted using the Blom-transformed scores for physical activity. Due to the number of interaction models that were tested, the critical value for all interaction tests was set at $p < .01$.

Comparing main effects of broad traits and trait facets

Regression models for the effects of background variables and personality trait and trait interactions for all three samples are shown in Tables 4-9. Tables 4, 6, and 8 depict the results for

the Big Five traits and their interactions in Samples 1, 2, and 3, respectively. Tables 5, 7, and 9 depict results for the corresponding trait facets and their respective interactions in Samples 1, 2, and 3, respectively.

Physical activity predictions by traits and facets as measured by the GLTEQ. Across the three samples, both extraversion and the activity facet consistently showed statistically significant and positive predictions for total physical activity as measured by the GLTEQ. The activity facet also showed significant, positive predictions for strenuous and moderate physical activity in Sample 1 and Sample 2, but not in Sample 3. For mild physical activity, openness showed statistically significant and positive predictions across all three samples, while ingenuity only showed a positive prediction in Sample 2.

Physical activity predictions by traits and facets as measured by the IPAQ. No consistent predictions were found across the three samples for Big Five traits when physical activity was measured using the IPAQ. Extraversion showed positive predictions for total and strenuous physical activity, but only in Sample 2. In Sample 3, openness showed positive predictions for total, moderate, and mild physical activity. Trait facet predictions were similarly inconsistent, such that Samples 1 and 2 showed positive predictions from the activity facet while Sample 3 showed positive predictions from the ingenuity facet. Specifically, in Sample 2, the activity facet positively predicted total, strenuous, moderate and mild physical activity, while in Sample 1, it only predicted strenuous and moderate physical activity. And finally, in Sample 3, the ingenuity facet positively predicted total physical activity.

Two-way interaction models: Interdependent effects of traits

Overall, there were no statistically significant two-way interactions found across the three samples, nor within each of the two physical activity measures for any trait by trait or facet by

facet interactions (i.e., $p > .01$).

Three-way interaction models: Interdependent effects of traits with contextual moderators

Separate sets of regression models were conducted to examine the hypothesized three-way interactions among broad traits and contextual factors and among facets and contextual factors. Only models where there were interactions at $p < .01$ are shown in tables 10 through 13. Table 10 displays the 3-way interaction models for physical activity variables as measured by the IPAQ. Table 11 shows the 3-way interaction models that include limitations and health status in the prediction of physical activity as measured by the GLTEQ. Table 12 and Table 13 show the 3-way interaction models that include self-efficacy in the prediction of physical activity as measured by the GLTEQ; however, Table 12 shows models from Sample 1 while Table 13 shows models from Sample 3.

Although not consistent across all three samples, a few consistent interaction effects emerged within these 3-way interaction models. A negative interaction was found between the activity facet and limitations in the prediction of strenuous activity as measured by the IPAQ in both Sample 1 and Sample 3. In addition, there were several consistencies between Sample 1 and Sample 3 in the prediction of total and moderate physical activity, such that there was a statistically significant negative interaction between the activity facet and self-efficacy in both samples and for both intensity levels.

Of the other regression models that included 3-way interactions, there were only two 3-way interactions that reached statistical significance at the $p < .01$ level. Specifically, there was an interaction in Sample 2, among neuroticism, extraversion, and limitations ($\beta = -.10$, $p = .004$) in the prediction of mild physical activity. This interaction showed that individuals who scored high in both extraversion and neuroticism and reported few limitations reported engaging in more mild

physical activity (as measured by the GLTEQ) than those without the combination of these characteristics. The interaction also showed that, regardless of levels of physical limitations, individuals who scored low in both extraversion and neuroticism tended to engage in the lowest levels of mild physical activity. The form of this interaction is plotted and shown in Figure 3.

The other 3-way interaction that emerged was for the industriousness facet, the activity facet, and health. This interaction showed that individuals who score high on the activity facet and have good health but low on the industriousness facet reported engaging in the highest levels of strenuous physical activity (β = -.10, p = .007), as measured by the IPAQ. On the other hand, individuals who score high on the activity facet and low on the industriousness facet, but have poor health tend to engage in significantly lower levels of weekly strenuous physical activity. The form of this interaction is plotted in Figure 4.

CHAPTER 4: DISCUSSION

The present study examined the independent and interdependent effects of traits and trait facets on physical activity engagement through the framework of the Cybernetic Big Five model using three large samples of U.S. adults spanning the ages of 18-98. The present study also attempted to both directly (across samples) and conceptually (across physical activity measures) replicate any observed interaction effects to increase confidence in the findings. Prior research has consistently demonstrated main effects of Big Five traits on physical activity, but few have tested their interactions, and to the author's knowledge, no studies have tested the interactions of trait facets and their effects on physical activity engagement using a multi-sample replication. The present study extended prior work on Big Five traits, trait facets, and physical activity engagement by examining how personality traits and facets might function in relation to one another and within the realm of contextual factors such as health and physical limitations.

Because none the interactions found in the present study was replicated across the three samples nor within each of the two different measures of physical activity, it is difficult to discuss any specific and robust effects. However, a few general consistencies within the present study and confirmation of prior research findings can be noted. Regarding the main effects of traits in the regression models, extraversion and the lower-order activity facet showed the strongest and most consistent positive associations with physical activity, which is consistent with past research. That is, individuals who are highly extraverted and score high on the activity facet tend to engage in more physical activity overall.

With regard to conscientiousness and industriousness, the correlational results in the present study showed that both were consistent with prior studies (which mostly used the GLTEQ to measure physical activity) in showing that individuals who were more conscientiousness and/or

more industrious tended to engage in more physical activity. However, these consistent correlational patterns emerged more often when physical activity was measured using the GLTEQ, but not when physical activity was measured using the IPAQ. Moreover, when conscientiousness and industriousness were examined in the regression models, neither emerged as statistically significant predictors of physical activity engagement in any of the samples or for either of the physical activity measures.

Another notable consistency within the present study is that, of the physical activity variables, strenuous activity (particularly as measured by the GLTEQ) showed the strongest associations across the different background and trait variables. The interaction effects found regarding traits and contextual factors were also the strongest for measurements of strenuous physical activity engagement. These findings indicate that, out of the different intensity physical activity levels, the effects of traits and contextual interactions may be more pronounced for engagement in strenuous physical activity. Along these lines, engagement in strenuous physical activity may be more closely related to trait expression because it requires the most effort and control (in terms of the mechanistic feedback loop) out of all the other types of physical activity engagement. This finding is consistent with the cybernetic precept that each action (in this case, engagement in strenuous physical activity) represents a different type of eliciting stimulus, calling for varying forms of independent and interdependent trait expressions.

Relatedly, it should be noted that statically significant interactions were more commonly found between one trait variable and one contextual (i.e., health or limitations) variable, but not seen between two trait or between two trait-facet variables. Perhaps the fact that there were no statistically significant results across the three samples with regard to trait by trait or facet by facet interactions is itself a consistency in that traits/facets do not necessarily work together to influence

physical activity engagement without the input of contextual, environmental factors. It may be that rather than working in conjunction with one another, broad traits and trait facets more often work within the constraints of the physical environment or one's confidence to influence engagement in physical activity. These findings indicate that contextualized factors and beliefs (self-efficacy) serve a prominent role in the process of eliciting physical activity behaviors in that they might modulate these behaviors based on the major trait at play.

Of all the interactions found, there were only two, separate (i.e., not replicated) three-way interactions that reached the $p < .01$ level. In Sample 2, a three-way interaction was found whereby high extraversion, high neuroticism, and low limitations predicted the highest level of mild physical activity engagement, as measured by the GLTEQ. The interaction form between high extraversion and high neuroticism might be described as a dispositional profile of *energetic vigilance*, which is enhanced by having fewer physical limitations, thereby enabling engagement in a greater number of mild physical activities. For such individuals, engaging in physical activity may be a way to satisfy a high level of behavioral exploration and a search of experiences that lead to immediate rewards (in the case of physical activity, release of endorphins), which may also reduce high levels of emotional instability. Furthermore, from a cybernetic perspective, in the presence of heightened levels of error information signaling and evaluating of one's health status (i.e., high neuroticism), engaging in behavioral exploration (i.e., high extraversion) through physical activity engagement may be a way to alleviate future health error concerns if one is also physically able. At a bivariate level, neuroticism was negatively related to physical activity, but when functioning interdependently with high extraversion, the effect was more positive. This finding further supports Friedman's (2009) idea of the healthy neurotic, who has the tendency to anxiously monitor his health. Furthermore, this finding aligns well with the idea that there are both

independent and interdependent costs and benefits associated with each trait, depending on how they coalesce (Nettle, 2006). As such, the cost associated with one trait might turn into a benefit when understood as part of the context for the expression of another trait, and vice versa.

The other three-way interaction found was in Sample 3, whereby high activity (facet), low industriousness, and high health levels predicted the highest levels of strenuous physical activity engagement, as measured by the IPAQ. While a profile of energetic persistence (high extraversion/activity facet and high conscientiousness/industriousness), was expected, due to consistent evidence linking high levels of both of these traits to greater physical activity, this was not the case in the present study. What was found, instead, was that individuals with high levels of the activity facet and *low* levels of the industriousness facet, who also had good health tended to engage in more strenuous most physical activity. Compared with the same combination of traits, an individual with poor health engages in much lower levels of strenuous physical activity engagement – a difference that could be as much as 250 minutes per week. Within this profile, health status seems to be the critical contextual driving factor. It is also interesting to note in this interaction, that at levels of high industriousness, physical activity levels tend to hover between 100-200 minutes of weekly strenuous physical activity (in between the highest and lowest levels of physical activity observed here), regardless of levels of the activity facet or health status. This amount of physical activity lies above the guideline of 75 minutes of strenuous physical activity per week, as recommended by the U.S. Department of Health and Human Services (USDHHS, 2008). This observation in the interaction pattern may somewhat speak to the stabilizing effect of industriousness and the cybernetic function of its broader trait of conscientiousness.

Of course, these explanations and findings regarding the observed interactive effects are speculative. Given the present findings, it seems unlikely these interaction effects warrant further

research, as none of the observed interaction effects were directly replicated across the three samples with either the GLTEQ or the IPAQ (although the correlational results were mostly consistent when using the GLTEQ to measure physical activity). In terms of a conceptual replication (i.e., across physical activity measures) there were only partial replications with regard to correlational results and again, no replication for the observed interaction effects.

As Maxwell and colleagues (2015) stated regarding replication studies, the difficulty now lies in determining whether to use the observed interaction effects or whether to discard these results in favor of the null effects in the other samples. They suggested that even when adequately powered, the failure to replicate should not lead to an immediate conclusion that any previously obtained results cannot be trusted. Instead, it was recommended that a meta-analytic approach from multiple studies would be the most reasonable way to establish the validity of a statistically significant result or null finding (Maxwell, Lau, & Howard, 2015).

Despite some of the null effects and the failure to replicate, it is suggested that the present study marks a starting point in the examination of the mechanistic Cybernetic Big Five model. Admittedly, an investigation of a mechanistic model of personality and behavior requires examination over a period of time to enable an unfolding of the overall process. Due to the cross-sectional nature of the present study, it would not be fitting to discuss how these interdependent effects may hold or change across different time spans. Moreover, perhaps the results of the present study indicate that examining moderation effects may not be the best method of testing the Cybernetic Big Five Theory. It is possible that mediation is a better way to examine how the traits work together to affect physical activity engagement. Because the five regulatory stages/steps of the CB5T suggest a feedback system, another way to examine this theory may be via a temporal

and mediational process. Longitudinal studies examining the Big Five traits and engagement in physical activity may be able to more thoroughly test these temporal effects across time.

Within CB5T, another level exists that is distinct from traits (but are certainly affected by them) – is that of characteristic adaptations (DeYoung, 2015). CB5T posits that traits are embedded within situations and their expression is dependent on certain types of stimuli. The expression of these traits within situations and at different points in a person's life are manifested in characteristic adaptations that comprise of goals, interpretations, and strategies. Goals refer to a future desired state; interpretations refer to the evaluation of the current state; and strategies refer to plans, actions, skills (both cognitive and behavioral) that are employed to turn the current state into the desired state.

Any behavior that is enacted at any given time is dependent on the complex and multidimensional interactions of the characteristic adaptations, the environment, and the underlying mechanisms of the presently interactive traits, which might inhibit or facilitate behaviors (DeYoung, 2015). Across time, the changes in the different categories of characteristic adaptations allow individuals to be more well-adapted across the life course in accordance with variable life circumstances. From a Cybernetic Big Five Theory (CB5T) perspective, physical activity engagement is a process that might be reflective of a characteristic adaptation (e.g., being an "exerciser, runner, health nut," etc.) that is influenced by the interaction of personality traits and one's environment and beliefs. As such, perhaps a discussion of engagement in physical activity necessitates a discussion of time and certain changes throughout time.

Although not definitive, the findings of the current study enable us to home in on certain interactive effects (such as those among neuroticism, extraversion, and limitations or among the activity facet, the industriousness facet, and health status). These interactive effects may be

examined in future longitudinal or experimental studies to examine whether they might hold for physical activity engagement in the context of these studies and/or across time. The ability to examine specific interactive effects may allow an examination of how the interactions between traits and contextual factors may influence decisions to engage in physical activity as individuals go through varying life transitions and form different characteristic adaptations.

Limitations

Despite the large samples used in the present study and the efforts to overcome them, several limitations should be noted. For example, recruitment from an online site where participants are paid to complete surveys and other tasks might raise questions/concerns regarding participant (in)attentiveness and poor-quality data. However, a study comparing participant responses from traditional college student face-to-face interactions, MTurk participants, and social media sites (e.g., Twitter, Reddit, Facebook) participants showed that results obtained from these groups were not different from one another, but MTurk participants were more diverse in terms of socio-economic status and ethnicity (Casler, Bickel, & Hackett, 2013). In response to the above-stated concerns, a more recent study found that MTurk participants were more attentive to instructions and that their responses to a text manipulation showed larger effect sizes than those of college students (Hauser & Schwarz, 2016). These findings indicate that recruitment from MTurk does not necessarily have drawbacks in terms of data quality and may also confer some advantages over the traditional subject pool (also see Chandler, Mueller, & Paolacci, 2014).

In anticipation of these possible drawbacks, oversampling occurred by a little more than 10% (as mentioned above) to compensate for missing data due to possible participant inattentiveness. To check for and prevent participant inattentiveness, items such as “Please choose strongly agree for this question” were randomly inserted into different parts of the survey in the

present study. Participants who failed at least two of the three attention checks were removed from participation in the study.

One possible reason there was not much replication in even the correlational results for the IPAQ, is that for individuals who are not used to thinking about their physical activity levels on a daily basis, it could be more difficult to quantify physical activity in terms of number of minutes per day and number of days per week, as asked by the IPAQ (as opposed to the number of times, as asked in the GLTEQ). Moreover, it should be noted that the leisure time physical activity items of the IPAQ were taken from a list of 27 questions, which included questions about several different types of physical activity engagement, including for work, household chores, and transportation. Although only the leisure-time physical activity items of the IPAQ were used for the analyses in the present study, it may be possible that when answering these questions, a number of participants had thought about their physical activity engagement as a whole, rather than separating these answers into their own "leisure-time" category.

Finally, another aspect of this study that warrants mention is that although the present study examined physical activity engagement, it is important to note that many participants in the study are probably sedentary for most of the work that they do, such that many people may be answering surveys and participating in experiments on MTurk to at least partially supplement their incomes. Indeed, descriptive statistics showed that roughly half of the participants in each sample reported little to no engagement in leisure-time physical activity (as measured by both the GLTEQ and the IPAQ). Therefore, this context should be taken into consideration when examining the results of the present study.

Implications and Conclusion

Although there were few definitive findings taken from the present study, they nonetheless

underscore the importance of examining and understanding the interplay of personality traits and contextual factors in the prediction of health-related behaviors, such as physical activity. The present study raises questions about the most fitting way to measure leisure-time physical activity engagement (and teasing it apart from daily physical activity). Of course, given the resources and face-to-face interactions, use of objective measurement tools such as accelerometers and pedometers during structured leisure-time physical activity may be the ideal, but these options are not always feasible. Considering some of these practical limitations, it is important to be cautious in distinguishing leisure-time physical activity from overall daily physical activity, given that leisure-time physical activity has positive implications for health while work-related physical activity (especially strenuous level activity) may have negative implications for health (Coenen et al., 2018). Additionally, the unsuccessful conceptual replication showed that quantifying physical activity in different (i.e., frequency vs. number of minutes) ways may lead to different results; as such, it is important that researchers use caution when examining and combining results from studies that use different physical activity measures.

Despite the lack of consistent trait by trait and trait by contextual factor interactions that reached significance levels of $p < .01$, however, the present study provides support for extraversion and the activity facet as two of the most robust personality-related predictors of physical activity engagement. The stabilizing function of industriousness in physical activity engagement was also examined in the three-way interaction with the activity facet and health status. Additionally, there seemed to be a positive effect of having a high level of neuroticism when working in conjunction with a high level of behavioral exploration (i.e., high extraversion) and low levels of physical limitations. Although the two observed three-way interaction effects were different, and each was found in a separate sample, they might provide some direction as to which specific interaction to

test in a possible experimental study regarding leisure-time physical activity choices and personality traits.

Undoubtedly, an examination and test of a mechanistic model to understand *how* something *works* requires longitudinal investigations that are tested across time (and possibly major life transitions) to see how the main and interactive effects of traits and contextual factors might function together and how these processes might unfold over time. Regarding the interactive effects of traits and contextual factors in the prediction of physical activity engagement, the inconsistent findings signify that there is much more work to be done to tease apart these effects. When taken as a whole, there are multiple ways that the CB5T can be tested. Thus, having an informative starting point, such as the interactions found in the present study, presents a more manageable way of understanding how one part of the overall personality system may work to influence health-related behaviors. In this sense, the results of the present study suggest that looking at cross-sectional interaction effects is not the best way to examine and/or test the CB5T. The serial and looping mechanisms depicted in the CB5T perhaps indicates that it might not be possible to see any replicable effects at just one point in time. Moreover, it is possible that the personality interactions would only be observable when individuals are actively making choices in the moment regarding physical activity engagement, as opposed to a recall of previous patterns of physical activity. Future studies might integrate cross-sectional results with experimental studies to observe how individuals with certain personality structures might react (e.g., choosing to engage in physical activity as opposed to a more sedentary type of activity) to goal-related or goal-directed situations.

In light of the null results for replications of the observed interactions in the present study, it is suggested that researchers attempt to replicate other interaction effects as well when there is

observed moderation. Overall, the present study demonstrate the need for more replicable studies involving interaction effects, as the inability to fully replicate results is not unique to the present study. It is important to note that not all replication failures are bad but should be expected as part of the scientific process (Diener & Biswas-Diener, 2018). As such, the present study marks an appropriate starting point in the scientific process for enhancing an understanding of how personality traits may or may not work together and with the surrounding environment to influence health-related behaviors, such as leisure-time physical activity.

Table 1. Descriptive statistics of study variables across three samples

Variable (range)	Sample 1 (N = 967) Mean (SD) or %	Sample 2 (N = 963) Mean (SD) or %	Sample 3 (N = 949) Mean (SD) or %
Age (18-98)	37.90 (12.60)	37.00 (12.29)	36.97 (12.05)
Sex (males = 1; females = 2)	36 %	38 %	40 %
Education (1-14)	5.80 (1.27)	5.86 (1.27)	5.81 (1.26)
Income (continuous)	57929.19 (42624.28)	59844.02 (44513.13)	62562.82 (71826.35)
BMI (continuous)	28.05 (8.59)	27.84 (7.46)	28.33 (8.91)
Health (1-5)	3.20 (0.95)	3.21 (0.92)	3.24 (0.97)
Limitations (sum of 10)	1.98 (2.77)	2.07 (2.84)	2.16 (2.91)
TTM Stage of Change	3.26 (1.44)	3.29 (1.48)	3.28 (1.47)
Self-efficacy	2.68 (0.94)	2.64 (0.95)	2.64 (0.92)
Conscientiousness (1-5)	3.90 (0.71)	3.84 (0.70)	3.85 (0.72)
Agreeableness (1-5)	3.84 (0.70)	3.80 (0.68)	3.79 (0.67)
Neuroticism (1-5)	2.79 (0.95)	2.81 (0.93)	2.80 (0.97)
Openness (1-5)	3.66 (0.68)	3.64 (0.69)	3.63 (0.67)
Extraversion (1-5)	2.97 (0.89)	2.91 (0.88)	2.96 (0.87)
Industriousness Facet (1-5)	3.91 (0.71)	3.84 (0.68)	3.86 (0.70)
Anxiety Facet (1-5)	2.89 (0.90)	2.91 (0.89)	2.91 (0.92)
Ingenuity Facet (1-5)	3.76 (0.71)	3.71 (0.72)	3.70 (0.71)
Activity Facet (1-5)	3.20 (0.59)	3.14 (0.57)	3.17 (0.59)
Exercise - GLTEQ (weekly)			
Total Exercise (weighted # of times)	36.10 (40.33)	35.67 (35.50)	40.30 (61.34)
Strenuous Exercise (continuous # of times)	1.43 (0.88)	1.51 (1.92)	1.49 (1.93)
Moderate Exercise (continuous # of times)	2.93 (5.90)	2.65 (3.53)	2.98 (3.90)
Mild Exercise (continuous # of times)	4.29 (7.46)	4.41 (9.12)	5.99 (24.61)
Exercise - IPAQ (weekly)			
Total MET Exercise (weighted # of minutes)	1347.12 (2490.02)	1335.32 (2831.41)	1199.37 (1864.81)
Strenuous Exercise (continuous # of minutes)	73.50 (180.47)	81.59 (265.11)	66.74 (154.60)
Moderate Exercise (continuous # of minutes)	76.62 (216.52)	73.65 (233.63)	62.34 (148.96)
Mild Exercise (continuous # of minutes)	137.18 (270.33)	117.57 (221.18)	126.09 (236.09)

Table 2. Correlations among study variables for Sample 1 and Sample 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1. Age	--	.07*	.04	.05	.08*	-.05	.17**	.02	-.08**	.24**	.20**	-.20**	.05	.09**	.12**	-.16**	.03	.03	-.13**	-.21**	-.03	-.03	-.11**	-.09**	-.08*	-.07*
2. Sex	.07*	--	-.05	-.02	.01	-.07*	.11**	-.12**	-.11**	.04	.09**	.15**	-.05	.03	.11**	.21**	-.06	.07*	-.09**	-.20**	-.04	.06	-.11**	-.12**	-.04	-.03
3. Education	.05	-.04	--	.22**	-.05	.17**	-.10*	.15**	.07*	.08*	-.03	-.06	.11**	.08*	.16**	-.02	.10**	.16**	.06*	.10**	.01	.02	.04	.04	.00	.03
4. Income	.02	-.06	.30**	--	-.08**	.24**	-.12**	.15**	.07*	.06	.02	-.08*	.01	.08*	.06	-.06	.04	.14**	.06	.14**	-.01	-.01	.04	.06	-.01	.00
5. BMI	.05	.05	-.10**	-.07*	--	-.32**	.25**	-.17**	-.18**	-.07*	-.04	.08*	-.05	.00	-.03	.07*	-.03	-.03	-.14**	-.19**	-.07*	-.03	-.09**	-.07*	-.09**	-.03
6. Health	-.04	-.09**	.16**	.17**	-.30**	--	-.39**	.31**	.29**	.32**	.14**	-.30**	.12**	.20**	.23**	-.27**	.15**	.21**	.22**	.34**	.13**	-.03	.19**	.17**	.12**	.10**
7. Limitations	.19**	.06	-.07*	-.17**	.21**	-.42**	--	-.30**	-.20**	-.20**	-.04	.17**	-.07*	-.06	-.16**	.15**	-.11**	-.12**	-.17**	-.24**	-.13**	.02	-.12**	-.10**	-.09**	-.08*
8. TTM	-.03	-.10**	.11**	.14**	-.19**	.34**	-.27**	--	.48**	.22**	.15**	-.22**	.15**	.16**	.20**	-.21**	.19**	.26**	.40**	.57**	.27**	-.03	.28**	.23**	.18**	.18**
9. Self-efficacy	.00	-.11**	.10**	.06	-.15**	.27**	-.17**	.43**	--	.15**	.06	-.16**	.18**	.17**	.17**	-.20**	.19**	.22**	.33**	.46**	.21**	.00	.19**	.16**	.12**	.11**
10. Conscientiousness	.22**	.03	.05	.04	-.12**	.32**	-.15**	.21**	.17**	--	.46**	-.53**	.16**	.28**	.64**	-.45**	.26**	.47**	.09**	.09**	.09**	.00	.03	.04	.02	-.03
11. Agreeableness	.17**	.11**	-.06	-.05	-.02	.18**	-.09*	.11**	.08*	.41**	--	-.47**	.11**	.24**	.37**	-.38**	.21**	.19**	.05	.06	.03	.02	-.01	-.01	.03	-.03
12. Neuroticism	-.21**	.27**	-.05	-.07*	.12**	-.37**	.18**	-.25**	-.22**	-.48**	-.44**	--	-.11**	-.38**	-.32**	.87**	-.19**	-.24**	-.10**	-.16**	-.08*	.03	-.07*	-.07*	-.05	-.02
13. Openness	.07*	-.03	.06	-.05	-.06	.09**	-.06*	.11**	.15**	.22**	.18**	-.16**	--	.26**	.37**	-.14**	.82**	.25**	.13**	.09**	.12**	.04	.09**	.07*	.08*	.05
14. Extraversion	.06	-.02	-.03	.02	-.06	.22**	-.03	.17**	.17**	.30**	.26**	-.38**	.31**	--	.31**	-.37**	.33**	.39**	.15**	.14**	.11**	.04	.12**	.10**	.08**	.07*
15. Industriousness Facet	.11**	.03	.06*	.06	-.06	.21**	-.15**	.20**	.18**	.65**	.33**	-.27**	.36**	.29**	--	-.29**	.49**	.60**	.13**	.10**	.11**	.05	.00	.01	.01	-.03
16. Anxiety Facet	-.14**	.28**	-.01	-.04	.08*	-.30**	.17**	.22**	-.27**	-.36**	-.38**	.86**	-.17**	-.36**	-.22**	--	-.21**	-.22**	-.11**	-.17**	-.08*	.02	-.09**	-.06*	-.10**	-.03
17. Ingenuity Facet	.04	-.07*	.03	.01	-.05	.15**	-.08*	.12**	.16**	.30**	.23**	-.24**	.79**	.38**	.51**	-.24**	--	.36**	.15**	.12**	.13**	.06	.08*	.07*	.07*	.01
18. Activity Facet	.04	.03	.08*	.14**	-.10**	.24**	-.14**	.25**	.17**	.45**	.19**	-.22**	.23**	.39**	.58**	-.18**	.36**	--	.19**	.19**	.14**	.05	.09**	.08*	.06	.04
19. Total exercise†	-.09**	-.10**	.08*	.01	-.05	.15**	-.15**	.35**	.19**	.08**	.05	-.13**	.06*	.10**	.10**	-.11**	.08*	.13**	--	.58**	.76**	.65**	.27**	.22**	.17**	.20**
20. Strenuous exercise†	-.23**	-.26**	.09**	.11**	-.15**	.32**	-.23**	.49**	.36**	.08**	.00	-.19**	.03	.13**	.10**	-.18**	.05	.17**	.47**	--	.22**	-.03	.37**	.37**	.18**	.14**
21. Moderate exercise†	.01	.00	.06	-.01	.01	.04	-.07*	.20**	.08*	.05	.05	-.05	.06	.05	.07*	-.05	.07*	.07*	.85**	.09**	--	.31**	.16**	.10**	.14**	.15**
22. Mild exercise†	.00	.05	-.02	-.07*	.03	-.02	-.01	-.01	-.06	.04	.04	-.02	.03	.03	.02	.01	.02	.02	.51**	-.04	.21**	--	.02	-.03	.03	.11**
23. Total exercise‡	-.11**	-.14**	.01	.01	-.08*	.19**	-.06	.35**	.24**	.06	.04	-.16**	.02	.13**	.05	-.14**	.04	.13**	.21**	.37**	.07*	.01	--	.90**	.58**	.53**
24. Strenuous exercise‡	-.09**	-.15**	.02	.02	-.05	.18**	-.07*	.33**	.22**	.07*	.06	-.15**	.03	.13**	.06	-.12**	.05	.12**	.18**	.42**	.02	-.03	.88**	--	.25**	.26**
25. Moderate exercise‡	-.08**	-.11**	-.01	.00	-.06	.12**	.00	.24**	.14**	.02	-.02	-.11**	-.01	.09**	.01	-.12**	.01	.09**	.16**	.24**	.08*	.02	.74**	.51**	--	.25**
26. Mild Exercise ‡	-.08*	-.04	-.01	.01	-.08**	.11**	-.04	.20**	.17**	.05	.05	-.11**	.02	.06	.03	-.09**	.03	.07*	.14**	.12**	.09**	.06	.66**	.35**	.26**	--

Note: $^{**}p \leq .01$; $^{*}p \leq .05$. Correlations below the diagonal refer to Sample 1 and correlations above the diagonal refer to Sample 2. † = exercise variables from the GLTEQ; ‡ = exercise variables from the IPAQ.

Table 3. Correlations among study variables for Sample 3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1. Age	--																									
2. Sex	.04	--																								
3. Education	.11**	-.04	--																							
4. Income	.07*	-.06	.21**	--																						
5. BMI	.09**	.02	-.10**	-.06	--																					
6. Health	-.05	-.08**	.21**	.14**	-.32**	--																				
7. Limitations	.12**	.11**	-.14**	-.07*	.23**	-.42**	--																			
8. TTM	-.04	-.06	.13**	.11**	-.21**	.32**	-.23**	--																		
9. Self-efficacy	.02	-.11**	.09**	.08*	-.17**	.28**	-.16**	.41**	--																	
10. Conscientiousness	.24**	.04	.07*	.06	-.10**	.27**	-.20**	.19**	.21**	--																
11. Agreeableness	.19**	.13**	-.03	.00	.03	.13**	-.10*	.09**	.07*	.41**	--															
12. Neuroticism	-.21**	.20**	-.10**	-.09**	.05	-.33**	.17**	-.16**	-.20**	-.52**	-.40**	--														
13. Openness	.11**	-.02	.08*	-.03	-.05	.08*	-.09*	.10**	.12**	.20**	.20**	-.12**	--													
14. Extraversion	.07*	-.08*	.09**	.11**	-.06	.27**	-.13**	.16**	.17**	.27**	.24**	-.38**	.29**	--												
15. Industriousness Facet	.14**	.11**	.09**	.04	-.09**	.18**	-.15**	.15**	.21**	.61**	.35**	-.24**	.39**	.29**	--											
16. Anxiety Facet	-.17**	.22**	-.06	-.09**	.05	-.31**	.16**	-.15**	-.22**	-.45**	-.31**	.87**	-.15**	-.38**	-.23**	--										
17. Ingenuity Facet	.11**	-.03	.04	-.02	-.01	.08*	-.09*	.09**	.10**	.28**	.24**	-.18**	.79**	.36**	.53**	-.22**	--									
18. Activity Facet	.01	.04	.08*	.09**	-.08*	.27**	-.21**	.20**	.28**	.49**	.22**	-.27**	.29**	.46**	.57**	-.27**	.37**	--								
19. Total exercise†	-.04	-.01	.00	.00	-.08*	.19**	-.12**	.16**	.15**	.11**	.01	-.10**	.07*	.07*	.11**	-.08*	.06	.15**	--							
20. Strenuous exercise†	-.18**	-.17**	.10**	.08*	-.21**	.37**	-.25**	.51**	.35**	.15**	.05	-.17**	.03	.18**	.14**	-.17**	.05	.21**	.29**	--						
21. Moderate exercise†	-.03	.04	.03	.01	-.07*	.18**	-.12**	.23**	.14**	.07*	-.02	-.07*	.02	.06	.07*	-.03	.01	.13**	.62**	.14**	--					
22. Mild exercise†	.03	.03	-.05	-.04	.00	.03	-.02	-.06*	.00	.06	.01	-.04	.07*	-.01	.06	-.03	.05	.06	.90**	-.04	.33**	--				
23. Total exercise‡	-.04	-.05	.01	-.01	-.04	.25**	-.12**	.36**	.28**	.12**	.07*	-.11**	.11**	.12**	.11**	-.12**	.12**	.14**	.24**	.44**	.16**	.08*	--			
24. Strenuous exercise‡	-.05	-.08*	.02	.01	-.06	.25**	-.10*	.34**	.27**	.10**	.06	-.10**	.06	.11**	.08*	-.11**	.07*	.12**	.14**	.50**	.08*	-.03	.84**	--		
25. Moderate exercise‡	-.04	-.01*	.05	-.02	-.09**	.19**	-.10**	.24**	.17**	.11**	.08*	-.10**	.12**	.06	.10**	-.11**	.13**	.11**	.38**	.21**	.21**	.31**	.63**	.35**	--	
26. Mild Exercise ‡	-.03	-.00	-.05	-.02	.07**	.07**	-.06	.14**	.11**	.05	.01	-.04	.09**	.06	.05	-.03	.09**	.07*	.06	.10**	.10**	.00	.58**	.16**	.18**	--

Note: $^{**}p \leq .01$; $^{*}p \leq .05$. Correlations below the diagonal refer to Sample 1 and correlations above the diagonal refer to Sample 2. † = exercise variables from the GLTEQ; ‡ = exercise variables from the IPAQ.

Table 4. Sample 1 regression models for predicting physical activity via broad traits

	GLTEQ				IPAQ			
	Total	Strenuous	Moderate	Mild	Total	Strenuous	Moderate	Mild
	(R = .476; r^2 = .227)	(R = .554; r^2 = .307)	(R = .343; r^2 = .117)	(R = .188; r^2 = .035)	(R = .428; r^2 = .183)	(R = .419; r^2 = .176)	(R = .327; r^2 = .107)	(R = .279; r^2 = .078)
	β	β	β	β	β	β	β	β
Age	-.14**	-.23**	-.03	-.02	-.10**	-.11**	-.09**	-.07
Sex	-.10**	-.18**	-.05	.03	-.03	-.11**	-.09**	.05
Education	.05	.02	.06	.01	.03	.02	.00	.04
Income	-.03	.05	-.09**	-.09**	.01	.03	-.03	-.02
BMI	.03	-.02	-.03	-.01	-.07	-.01	-.05	-.06
Health	.11	.18**	.08	-.03	.15**	.16**	.12**	.06
Limitations	-.12**	-.05	-.10**	-.07	-.01	-.03	.03	-.01
Self-efficacy	.25**	.27**	.19**	-.04	.23**	.22**	.15**	.13**
Conscientiousness (C)	.02	-.01	.03	.02	.02	.00	.01	-.01
Neuroticism (N)	-.03	-.03	.03	.02	-.07	-.02	-.05	-.10
Openness (O)	.03	-.04	.07	.09**	.04	.01	.02	.05
Extraversion (E)	.09**	.08	.08	.08	.07	.08	.08	.05
C x E	-.05	-.04	-.03	.00	.02	.05	-.06	.00
C x O	.03	.01	.00	.04	.01	-.01	.01	.01
N x E	-.02	-.03	-.02	.02	-.04	-.04	-.06	-.04
N x O	.06	.03	.06	.07	.06	.02	-.01	.07

Note: Standardized weights; $^{**}p \leq .01$

Table 5. Sample 1 regression models for predicting physical activity via trait facets

	GLTEQ				IPAQ			
	Total	Strenuous	Moderate	Mild	Total	Strenuous	Moderate	Mild
	(R = .479; r^2 = .230) β	(R = .559; r^2 = .312) β	(R = .342; r^2 = .117) β	(R = .172; r^2 = .030) β	(R = .428; r^2 = .183) β	(R = .426; r^2 = .181) β	(R = .327; r^2 = .107) β	(R = .268; r^2 = .072) β
Age	-.13**	-.23**	-.02	-.02	-.10**	-.11**	-.08	-.06
Sex	-.12**	-.19**	-.04	.03	-.03	-.12**	-.08	.05
Education	.05	.02	.06	.01	.03	.01	.00	.04
Income	-.05	.04	-.11**	-.10**	-.01	.01	-.04	-.03
BMI	-.03	-.02	-.03	-.02	-.07	-.01	-.05	-.07
Health	.12**	.18**	.07	-.02	.15**	.16**	.12**	.06
Limitations	-.12**	-.04	-.10**	-.07	-.01	-.03	.04	-.01
Self-efficacy	.26**	.27**	.19**	-.03	.22**	.22**	.15**	.13**
Industriousness (Ind)	-.01	.00	-.02	-.01	.01	-.01	-.05	.00
Anxiety (Anx)	-.01	-.03	.03	.02	-.07	.00	-.07	-.09
Ingenuity (Ing)	.01	-.06	.06	.09	.05	-.01	.03	.06
Activity (Act)	.13**	.11**	.10**	.05	.09	.14**	.11**	.04
Ind X Act	-.04	.01	-.05	-.03	.03	.04	-.02	.01
Ind X Ing	.04	.00	.01	.02	-.02	-.01	-.01	.00
Anx X Act	-.02	-.01	-.01	-.04	.01	.03	.00	-.01
Anx X Ing	.06	.03	.03	.07	.01	-.02	-.02	.04

Note: Standardized weights; $^{**}p \leq .01$

Table 6. Sample 2 regression models for predicting physical activity via broad traits

	GLTEQ				IPAQ			
	Total	Strenuous	Moderate	Mild	Total	Strenuous	Moderate	Mild
	(R = .527; r^2 = .278) β	(R = .582; r^2 = .339) β	(R = .375; r^2 = .141) β	(R = .209; r^2 = .044) β	(R = .457; r^2 = .209) β	(R = .459; r^2 = .211) β	(R = .337; r^2 = .113) β	(R = .250; r^2 = .062) β
Age	-.12**	-.18**	-.02	.00	-.08	-.13**	-.07	.01
Sex	-.07	-.12**	-.03	.05	-.01	-.07	-.01	.02
Education	-.01	.04	-.03	-.05	.03	.02	.01	.04
Income	.02	.07	-.03	-.03	.04	.07	-.01	-.01
BMI	-.06	-.05	-.07	-.06	-.05	-.04	-.06	-.03
Health	.10**	.16**	.04	-.03	.11**	.15**	.08	.04
Limitations	-.08	-.05	-.10**	-.01	-.11**	-.07	-.05	-.09
Self-efficacy	.35**	.35**	.23**	.05	.28**	.25**	.21**	.14**
Conscientiousness (C)	.00	-.04	.03	.02	-.06	-.06	-.04	-.05
Neuroticism (N)	-.01	-.07	.02	.03	-.01	.01	-.03	-.02
Openness (O)	.06	-.01	.09**	.15**	.03	.03	.02	.03
Extraversion (E)	.08**	.05	.08	.05	.11**	.09**	.08	.09
C x E	-.03	-.05	.04	-.01	-.02	-.01	.03	-.04
C x O	-.02	.01	-.06	-.01	-.04	-.03	-.02	-.03
N x E	-.04	-.05	.03	-.03	-.04	-.02	-.03	-.05
N x O	-.03	-.01	-.03	-.04	.01	-.05	.00	.04

Note: Standardized weights; $^{**}p \leq .01$

Table 7. Sample 2 regression models for predicting physical activity via trait facets

	GLTEQ				IPAQ			
	Total	Strenuous	Moderate	Mild	Total	Strenuous	Moderate	Mild
	(R = .544; r^2 = .296)	(R = .586; r^2 = .344)	(R = .387; r^2 = .150)	(R = .240; r^2 = .058)	(R = .459; r^2 = .211)	(R = .461; r^2 = .212)	(R = .344; r^2 = .118)	(R = .262; r^2 = .069)
	β	β	β	β	β	β	β	β
Age	-.11**	-.18**	-.01	.00	-.08	-.12**	-.07	.01
Sex	-.08	-.13**	-.03	.04	.00	-.06	.01	.02
Education	-.02	.02	-.04	-.06	.03	.02	.01	.03
Income	.01	.06	-.05	-.04	.03	.06	-.02	-.02
BMI	-.07	-.05	-.08	-.07	-.05	-.04	-.06	-.04
Health	.10	.16**	.04	-.04	.12**	.15**	.07	.05
Limitations	-.07	-.04	-.09**	-.01	-.10**	-.06	-.05	-.08
Self-efficacy	.34**	.34**	.22**	.04	.28**	.26**	.20**	.13**
Industriousness (Ind)	-.03	-.06	-.03	.05	-.13**	-.11**	-.12**	-.09
Anxiety (Anx)	.00	-.04	.00	.03	-.03	.01	-.08	-.03
Ingenuity (Ing)	.06	.00	.09	.11**	.04	.04	.03	.00
Activity (Act)	.16**	.13**	.13**	.08	.14**	.11**	.11**	.15**
Ind X Act	-.07	-.04	-.05	-.08	-.02	-.03	-.03	-.01
Ind X Ing	-.02	.01	-.04	.05	-.04	-.02	-.02	-.06
Anx X Act	-.06	-.05	-.01	-.07	-.06	-.04	-.05	-.07
Anx X Ing	.00	.02	-.01	-.04	.00	-.04	-.02	.03

Note: Standardized weights; **$p \leq .01$

Table 8. Sample 3 regression models for predicting physical activity via broad traits

	GLTEQ				IPAQ			
	Total	Strenuous	Moderate	Mild	Total	Strenuous	Moderate	Mild
	(R = .493; r^2 = .243)	(R = .539; r^2 = .291)	(R = .347; r^2 = .120)	(R = .197; r^2 = .039)	(R = .425; r^2 = .180)	(R = .429; r^2 = .184)	(R = .346; r^2 = .120)	(R = .256; r^2 = .066)
	β	β	β	β	β	β	β	β
Age	-.15**	-.22**	-.08	-.01	-.01	-.07	.03	.03
Sex	-.02	-.12**	.07	.06	-.02	-.08	.00	.03
Education	.00	.04	.01	-.05	.01	.02	.02	-.01
Income	-.01	.02	-.01	-.01	-.04	-.01	-.03	-.05
BMI	-.04	-.06	-.01	-.09**	-.02	.01	-.04	-.03
Health	.16**	.19**	.15**	-.06	.17**	.20**	.16**	.07
Limitations	-.12**	-.07	-.09	-.05	-.09	-.06	-.04	-.07
Self-efficacy	.25**	.25**	.17**	.04	.25**	.25	.18**	.12**
Conscientiousness (C)	.05	.06	-.03	.04	.06	.07	.03	.02
Neuroticism (N)	-.01	-.01	-.05	-.01	.03	.06	-.01	.02
Openness (O)	.03	-.04	.02	.10**	.10**	.01	.09**	.12**
Extraversion (E)	.10**	.09**	.05	.05	.02	.04	-.03	.02
C x E	.00	.01	-.02	.01	.04	.06	.03	.04
C x O	.06	.04	.06	-.04	-.01	-.02	.03	-.04
N x E	-.02	.00	-.05	-.01	.03	.05	.03	.03
N x O	.08	.06	.08	.00	-.01	-.02	-.05	.01

Note: Standardized weights; $^{**}p \leq .01$

Table 9. Sample 3 regression models for predicting physical activity via trait facets

	GLTEQ				IPAQ			
	Total	Strenuous	Moderate	Mild	Total	Strenuous	Moderate	Mild
	(R = .493; r^2 = .243)	(R = .535; r^2 = .287)	(R = .337; r^2 = .114)	(R = .221; r^2 = .049)	(R = .429; r^2 = .184)	(R = .430; r^2 = .185)	(R = .340; r^2 = .116)	(R = .266; r^2 = .071)
	β	β	β	β	β	β	β	β
Age	-.14**	-.21**	-.07	.02	.00	-.07	.03	.04
Sex	-.05	-.12**	.05	.04	-.02	-.08**	.00	.02
Education	.00	.04	.01	-.05	.01	.02	.02	-.01
Income	-.01	.02	-.01	-.02	-.04	-.01	-.04	-.05
BMI	-.05	-.06	-.01	-.09**	-.02	.01	-.04	-.02
Health	.17**	.20**	.16**	-.05	.17**	.20**	.15**	.09
Limitations	-.11**	-.07	-.08	-.05	-.09	-.05	-.03	-.07
Self-efficacy	.24**	.24**	.17**	.04	.25**	.25**	.18**	.13**
Industriousness (Ind)	.06	.07	-.03	.04	.06	.05	.01	.05
Anxiety (Anx)	.00	-.03	.00	.02	.02	.02	-.02	.04
Ingenuity (Ing)	-.01	-.03	.00	.07	.09**	.02	.08	.10
Activity (Act)	.10**	.04	.07	.07	.00	.02	.02	-.01
Ind X Act	-.04	-.04	-.02	-.01	.03	.02	-.01	.07
Ind X Ing	-.01	.05	-.02	-.08	-.05	-.05	-.03	-.05
Anx X Act	-.02	-.02	-.01	.00	-.01	-.01	.00	.01
Anx X Ing	.00	.02	-.02	.00	.01	-.02	-.03	.06

Note: Standardized weights; **$p \leq .01$

Table 10. Three-way interactions predicting physical activity as measured by the IPAQ

	IPAQ (Sample 1) Mild ($R = .293$; $r^2 = .086$) β		IPAQ (Sample 1) Strenuous ($R = .433$; $r^2 = .187$) β		IPAQ (Sample 2) Strenuous ($R = .471$; $r^2 = .221$) β		IPAQ (Sample 3) Strenuous ($R = .444$; $r^2 = .197$) β
Age	-.07		-.11**		-.13**		-.07
Sex	.05		-.12**		-.06		-.09**
Education	.04		.01		.02		.02
Income	-.01		.01		.07		.00
BMI	-.05		-.02		-.04		.01
Health	.06		.15**		.15**		.23**
Limitations	-.02		-.03		-.07		-.06
Self-efficacy	.14**		.22**		.26**		.26
C / Ind	-.01		-.01		-.12**		.06
N / Anx	-.11		.00		.02		.02
O / Ing	.06		-.01		.04		.02
E / Act	.04		.13**		.11**		.04
C x E / Ind x Act	.01		.04		-.04		-.02
C x O / Ind x Ing	.01		-.01		-.01		-.05
N x E / Anx x Act	-.05		.04		-.04		.01
N x O / Anx x Ing	.07		-.02		-.04		-.02
C x Self-efficacy	**-.10****	Anx x Limitations	.01	Anx x Limitations	.00	Ind x Health	-.04
E x Self-efficacy	.00	Act x Limitations	**-.08****	Act x Limitations	**-.09****	Act x Health	**.12****
C x E x Self-efficacy	-.01	Anx x Act x Limitations	.04	Anx x Act x Limitations	.05	Ind x Act x Health	**-.10****

Note: Standardized weights; $^{**}p < .01$; C = conscientiousness, N = neuroticism, O = openness, E = extraversion, Ind = industriousness, Act = activity, Ing = ingenuity, Anx = anxiety

Table 11. Three-way interactions with limitations and health predicting physical activity as measured by the GLTEQ

	GLTEQ (Sample 2) Strenuous (R = .587; r^2 = .345) β		GLTEQ (Sample 2) Mild (R = .228; r^2 = .052) β		GLTEQ (Sample 3) Moderate (R = .362; r^2 = .131) β		GLTEQ (Sample 3) Moderate (R = .363; r^2 = .132) β
Age	-.18**		-.01		-.09**		-.08
Sex	-.12**		.05		.07		.07
Education	.04		-.05		.01		.01
Income	.07		-.03		-.01		-.01
BMI	-.05		-.06		.00		-.01
Health	.15**		-.03		.15**		.14**
Limitations	-.07		-.04		-.07		-.09
Self-efficacy	.35**		.05		.17**		.17**
Conscientiousness (C)	-.05		.02		-.03		-.02
Neuroticism (N)	-.07		.02		-.05		-.06
Openness (O)	-.01		.15**		.02		.02
Extraversion (E)	.04		.06		.06		.06
C x E	-.05		-.02		-.01		-.02
C x O	-.01		-.01		.06		.07
N x E	-.04		-.04		-.06		-.10
N x O	.00		-.05		.07		.09
C x Limitations	-.03	N x Limitations	-.01	N x Limitations	-.02	C x Health	.02
O x Limitations	**-.07****	E x Limitations	.00	E x Limitations	**-.09****	E x Health	**-.12****
C x O x Limitations	.00	N x E x Limitations	**-.10****	N x E x Limitations	.03	C x E x Health	-.02

Note: Standardized weights; $^{**}p < .01$

Table 12. Three-way interactions with self-efficacy predicting physical activity measured by GLTEQ in Sample 1

	GLTEQ (Sample 1) Total ($R = .488$; $r^2 = .238$) β		GLTEQ (Sample 1) Strenuous ($R = .566$; $r^2 = .321$) β		GLTEQ (Sample 1) Moderate ($R = .357$; $r^2 = .128$) β
Age	-.13**		-.24**		-.02
Sex	-.12**		-.20**		-.04
Education	.04		.01		.06
Income	-.05		.03		-.10**
BMI	-.03		-.03		-.03
Health	.11**		.17**		.07
Limitations	-.11**		-.04		-.09**
Self-efficacy	.24**		.25**		.20**
Industriousness (Ind)	-.02		-.01		-.02
Anxiety (Anx)	-.01		-.03		.02
Ingenuity (Ing)	.01		-.06		.07
Activity (Act)	.12**		.12**		.09
Ind X Act	-.04		.00		-.05
Ind X Ing	.04		-.02		.02
Anx X Act	-.03		.01		-.04
Anx X Ing	.06		.04		.03
Ind X Self-efficacy	**.11****	Ind X Self-efficacy	**.12****	Ind X Self-efficacy	.04
Act X Self-efficacy	**-.11****	Act X Self-efficacy	-.04	Act X Self-efficacy	**-.13****
Ind X Act X Self-efficacy	.04	Ind X Act X Self-efficacy	.05	Ind X Act X Self-efficacy	-.01

Note: Standardized weights; $^{**}p \leq .01$

Table 13. Three-way interactions with self-efficacy predicting physical activity measured by GLTEQ in Sample 3

	GLTEQ (Sample 3) Total ($R = .503$; $r^2 = .253$) β		GLTEQ (Sample 3) Moderate ($R = .351$; $r^2 = .123$) β		GLTEQ (Sample 3) Mild ($R = .249$; $r^2 = .062$) β
Age	-.13**		-.06		.02
Sex	-.05		.05		.04
Education	-.01		.01		-.06
Income	-.01		.00		-.01
BMI	-.05		-.01		-.09**
Health	.17**		.16**		-.05
Limitations	-.11**		-.09		-.05
Self-efficacy	.22**		.17**		.03
Industriousness (Ind)	.07		-.03		.04
Anxiety (Anx)	.01		.01		.03
Ingenuity (Ing)	-.02		.00		.06
Activity (Act)	.10**		.07		.07
Ind X Act	-.04		.00		.00
Ind X Ing	-.02		-.03		-.09
Anx X Act	-.03		-.03		-.03
Anx X Ing	.01		-.01		.01
Ind X Self-efficacy	**.12****	Ind X Self-efficacy	.07	Ind X Self-efficacy	.09
Act X Self-efficacy	**-.12****	Act X Self-efficacy	**-.13****	Act X Self-efficacy	**-.16****
Ind X Act X Self-efficacy	.03	Ind X Act X Self-efficacy	.02	Ind X Act X Self-efficacy	.04

Note: Standardized weights; $^{**}p \leq .01$

Figure 1. Figure of hypothesized interactions among broad-level traits of the Stability and Plasticity components and contextual moderators

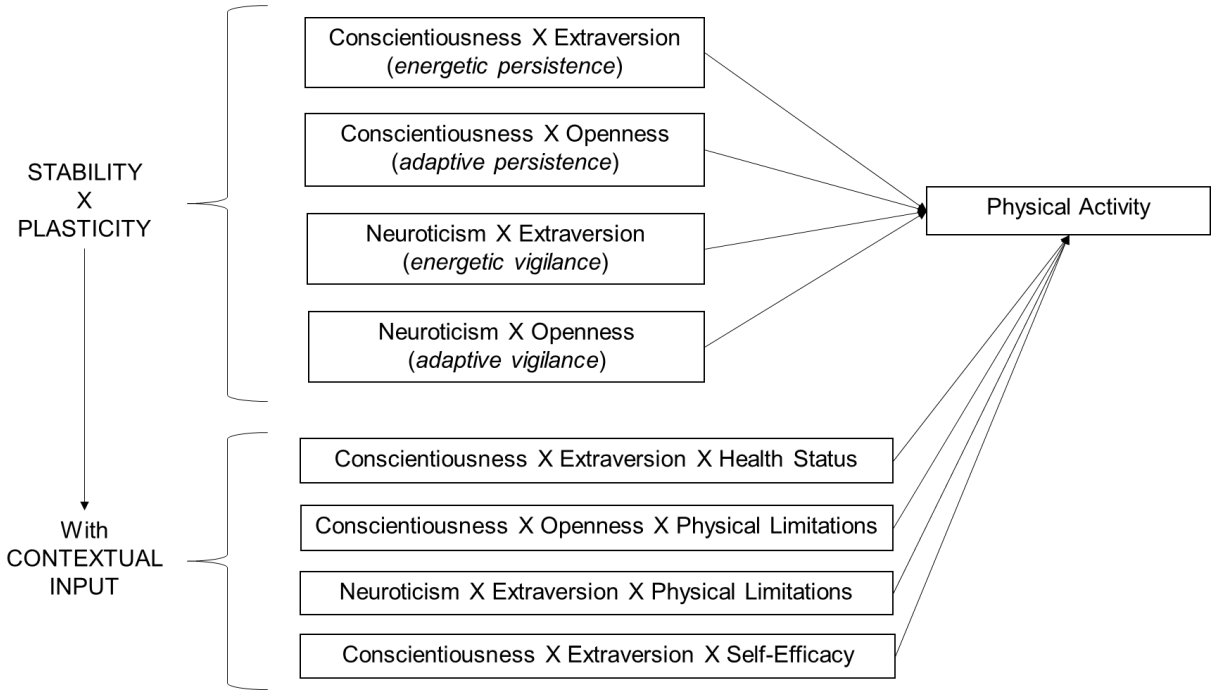


Figure 2. Figure of hypothesized interactions among trait facets and contextual moderators

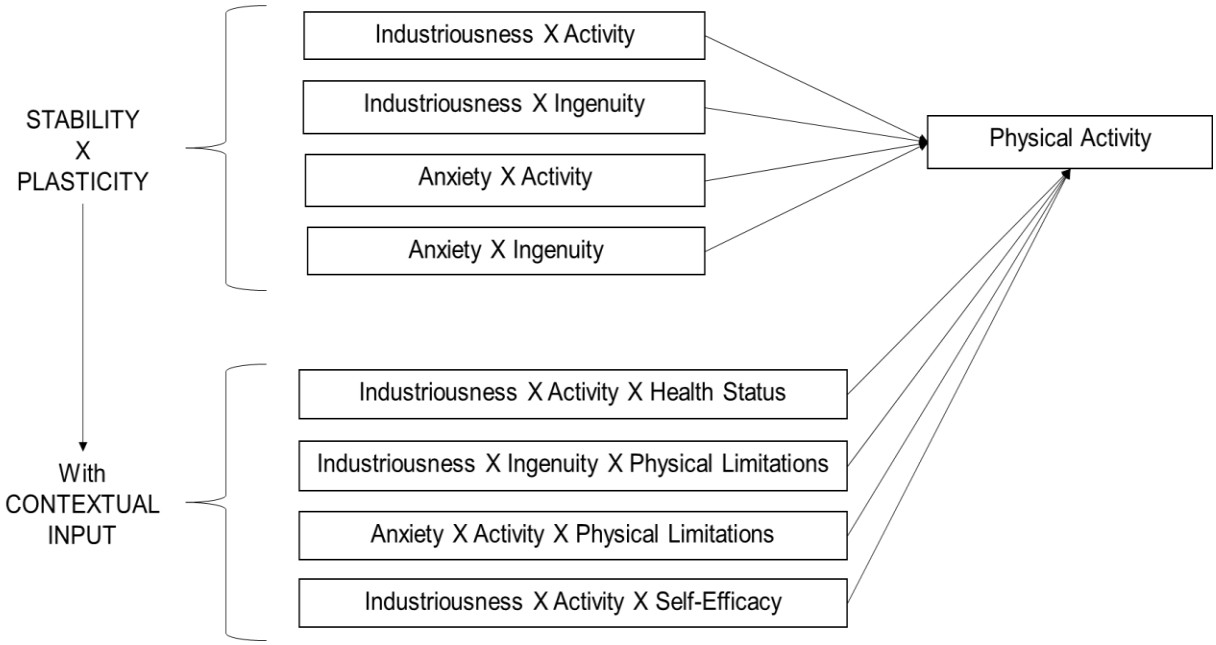
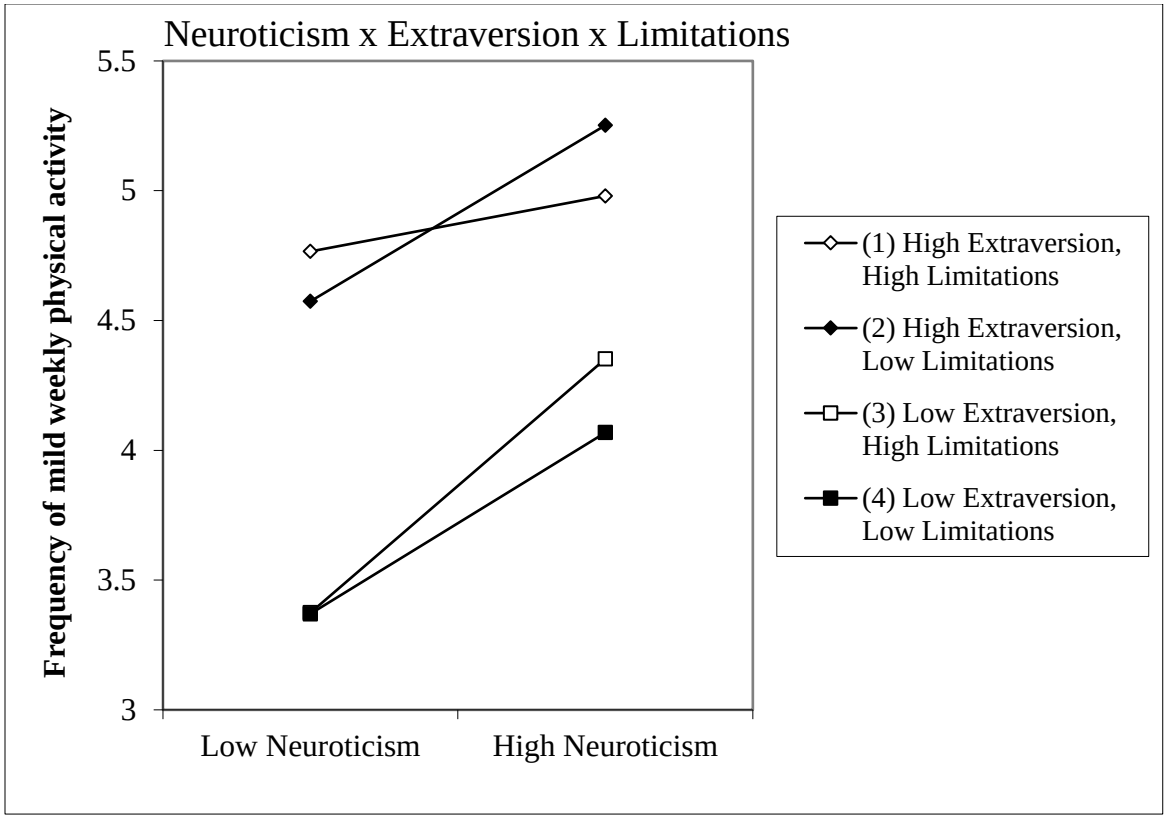
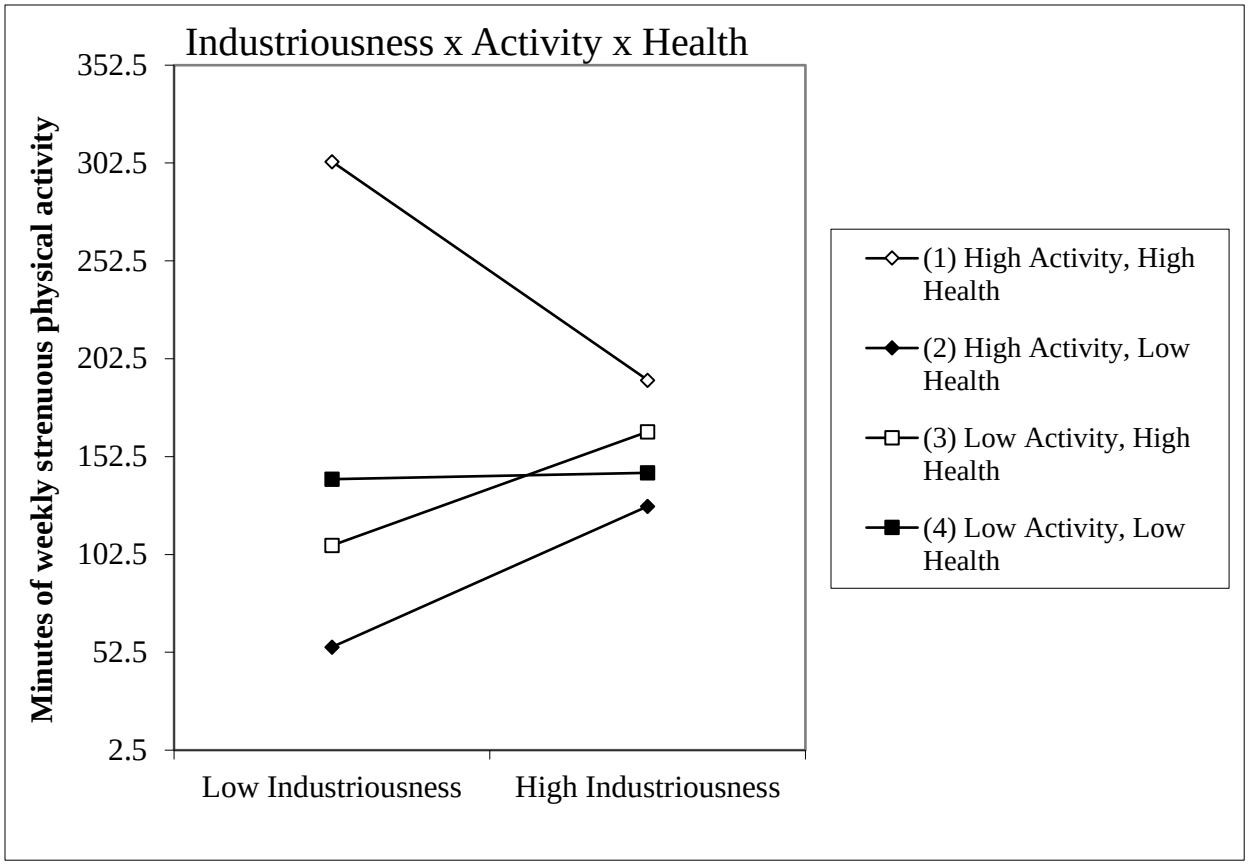


Figure 3. Three-way interaction between neuroticism, conscientiousness, and physical limitations in the prediction of mild physical activity from the GLTEQ in Sample 2



*Note: Untransformed physical activity scores are used for purposes of interpretability.

Figure 4. Three-way interaction between industriousness, activity, and health status in the prediction of strenuous physical activity from the IPAQ in Sample 3



APPENDIX A

Demographics Information

1. ___ Male
   ___ Female

2. Age _____

3. Current weight (lbs) _____

4. Current height (in) _____

5. How would you best describe your ethnic or racial background?
   - ___ African American/Black
   - ___ American Indian/Native American/Alaskan Native
   - ___ Hispanic/Chicano/Mexican American
   - ___ Asian American
   - ___ Native Hawaiian/Other Pacific Islander
   - ___ Caucasian/European American/White
   - ___ Multiracial
   - ___ Other (please specify)

6. Marital Status
   - ___ Single
   - ___ In a committed relationship (e.g., boyfriend/girlfriend)
   - ___ Married
   - ___ Separated
   - ___ Divorced
   - ___Widowed

7. If in a relationship, how long have you been in this relationship/marriage? _____

8. Number of marriages ____

9. Number of children _____

10. Age of youngest child _____

11. Please indicate the highest level of education you have completed.
    ___ Some elementary school
    ___ Some middle school
    ___ Some high school
    ___ High school diploma
    ___ Some college
    ___ College B.A. degree
    ___ Some graduate school
    ___ Masters degree
    ___ PhD, JD, MD, EdD, or any other doctoral degree

12. Are you currently employed?
    ___ Yes, full-time
    ___ Yes, part-time but want full-time
    ___ Yes, part-time by choice
    ___ No, but seeking work
    ___ No, and not seeking work
    ___ No, retired

13. What is your total household income? _____

APPENDIX B

Health Questionnaire

In general, would you say your health is:

___ Poor
___ Fair
___ Good
___ Very Good
___ Excellent

The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

No, not limited at all	Yes, limited a little	Yes, limited a lot
1	2	3

1. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports.
2. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf.
3. Lifting or carrying groceries.
4. Climbing several flights of stairs.
5. Climbing one flight of stairs.
6. Bending, kneeling, or stooping.
7. Walking more than a mile.
8. Walking several blocks.
9. Walking one block.
10. Bathing or dressing yourself.

APPENDIX C

How I am in general

Below are characteristics that may or may not apply to you. Please indicate the extent to which **you agree or disagree with the statements.**

Disagree Strongly 1	Disagree a little 2	Neither agree nor disagree 3	Agree a little 4	Agree Strongly 5

I am someone who…

1. Is talkative
2. Tends to find fault with others
3. Does a thorough job
4. Is depressed, blue
5. Is original, comes up with new ideas
6. Is reserved
7. Is helpful and unselfish with others
8. Can be somewhat careless
9. Is relaxed, handles stress well
10. Is curious about many different things
11. Is full of energy
12. Starts quarrels with others
13. Is a reliable worker
14. Can be tense
15. Is ingenious, a deep thinker
16. Generates a lot of enthusiasm
17. Has a forgiving nature
18. Tends to be disorganized
19. Worries a lot
20. Has an active imagination
21. Tends to be quiet
22. Is generally trusting
23. Tends to be lazy
24. Is emotionally stable, not easily upset
25. Is inventive
26. Has an assertive personality
27. Can be cold and aloof
28. Perseveres until the task is finished
29. Can be moody
30. Values artistic, aesthetic experiences
31. Is sometimes shy, inhibited
32. Is considerate and kind to almost everyone
33. Does things efficiently
34. Remains calm in tense situations
35. Prefers work that is routine
36. Is outgoing, sociable
37. Is sometimes rude to others
38. Makes plans and follows through with them
39. Gets nervous easily
40. Likes to reflect, play with ideas
41. Has few artistic interests
42. Likes to cooperate with others
43. Is easily distracted
44. Is sophisticated in art, music, or literature

APPENDIX D

GLTEQ

Considering a 7-day period (a week), how many times, on average, do you do the following kinds of exercise for more than 20 minutes during your free time (write on each line the number of times)?

A. Strenuous exercise (heart beats rapidly, e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller blading, vigorous swimming, vigorous long-distance bicycling)
_____# of times

B. Moderate exercise (not exhausting, e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine (downhill) skiing, social dancing)
_____# of times

C. Mild exercise (minimal effort, e.g., yoga, archery, fishing, bowling, horseshoes, golf, easy walking)
_____# of times

Considering a 7-day period (a week), during your leisure time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)? Check only one line.

___Often

___Sometimes

___Never/rarely

APPENDIX E

International Physical Activity Questionnaire – Long Form

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

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

PART 1: JOB-RELATED PHYSICAL ACTIVITY

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

1. Do you currently have a job or do any unpaid work outside your home?

   _____ Yes

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

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

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

   _____ **days per week**

   _____ No vigorous job-related physical activity ***Skip to Question 4***

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

   _____ **hours per day**

   _____ **minutes per day**

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

_____ **days per week**

_____ No moderate job-related physical activity ***Skip to Question 6***

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

_____ **hours per day**

_____ **minutes per day**

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

_____ **days per week**

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

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

_____ **hours per day**

_____ **minutes per day**

PART 2: TRANSPORTATION

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

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

_____ **days per week**

_____ No traveling in a motor vehicle ***Skip to Question 10***

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

_____ **hours per day**

_____ **minutes per day**

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

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

_____ **days per week**

_____ No bicycling from place to place ***Skip to Question 12***

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

_____ **hours per day**

_____ **minutes per day**

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

_____ **days per week**

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

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

_____ **hours per day**

_____ **minutes per day**

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

This section is about some of the physical activities you might have done in the last 7 days in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

14. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, chopping wood, shoveling snow, or digging **in the garden or yard**?

_____ **days per week**

_____ No vigorous activity in garden or yard ***Skip to Question 16***

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

_____ **hours per day**

_____ **minutes per day**

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

_____ **days per week**

_____ No moderate activity in garden or yard ***Skip to Question 18***

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

_____ **hours per day**

_____ **minutes per day**

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

_____ **days per week**

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

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

_____ **hours per day**

_____ **minutes per day**

PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY

This section is all about the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

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

_____ **days per week**

_____ No walking in leisure time ***Skip to Question 22***

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

_____ **hours per day**

_____ **minutes per day**

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

_____ **days per week**

_____ No vigorous activity in leisure time ***Skip to Question 24***

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

_____ **hours per day**

_____ **minutes per day**

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

_____ **days per week**

_____ No moderate activity in leisure time ***Skip to PART 5: TIME SPENT SITTING***

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

_____ **hours per day**

_____ **minutes per day**

PART 5: TIME SPENT SITTING

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

26. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?

_____ **hours per day**

_____ **minutes per day**

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

_____ **hours per day**

_____ **minutes per day**

APPENDIX F

Self-Efficacy

This section looks at how confident you are to exercise when other things get in the way. Read the following items and mark responses using the scale below.

Not at all confident 1	Somewhat confident 2	Moderately confident 3	Very confident 4	Extremely confident 5

I am confident I can participate in regular exercise when:

1 2 3 4 5 My exercise partner decides not to exercise that day.

1 2 3 4 5 I don't have access to exercise equipment.

1 2 3 4 5 I have to exercise alone.

1 2 3 4 5 I am traveling.

1 2 3 4 5 I am alone.

1 2 3 4 5 My gym is closed.

1 2 3 4 5 I am busy.

1 2 3 4 5 My friends don't want me to exercise.

1 2 3 4 5 I don't feel like it.

1 2 3 4 5 My significant other does not want me to exercise.

1 2 3 4 5 I feel I don't have the time.

1 2 3 4 5 I am spending time with friends or family who do not exercise.

1 2 3 4 5 I am anxious.

1 2 3 4 5 It's raining or snowing.

1 2 3 4 5 I am depressed.

1 2 3 4 5 It's cold outside.

1 2 3 4 5 I am under a lot of stress.

1 2 3 4 5 The roads or sidewalks are snowy.

APPENDIX G

TTM Staging Questionnaire

The following five statements will assess how much you currently exercise in your leisure time (exercise done outside of work). Regular exercise is *defined two ways*: 1) Any planned *moderate-intensity* physical activity (e.g., brisk walking, jogging, bicycling, swimming, tennis, etc.) performed **five or more days a week for 30 minutes** or more; ***OR*** 2) any planned *vigorous-intensity* physical activity (e.g., jogging, engaging in heavy yard work, participating in high-impact aerobic dancing, swimming continuous laps, bicycling uphill, etc.) performed **three or more days a week for 25 minutes** or more.

Do you exercise regularly according to either definition above?

a. _____No, and I do not intend to begin exercising regularly in the next 6 months.

b. _____No, but I intend to begin exercising regularly in the next 6 months.

c. _____No, but I intend to begin exercising regularly in the next 30 days.

d. _____Yes, I have been, but for less than 6 months.

e. _____Yes, I have been for more than 6 months.

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ABSTRACT

A PRE-REGISTERED MULTI-REPLICATION EXAMINATION OF THE INDEPENDENT AND INTERDEPENDENT EFFECTS OF BIG FIVE TRAITS AND FACETS IN PREDICTING PHYSICAL ACTIVITY VIA A CYBERNETIC FRAMEWORK

by

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Major: Psychology (Social-Personality)

Degree: Doctor of Philosophy

Personality traits are important and reliable predictors of health outcomes and health-related behaviors, yet examining only main effects does not allow an examination of possible synergistic effects of traits (and their related lower-order facets) on health behaviors (Hampson & Friedman, 2008). Guided by Cybernetic Big Five Theory (CB5T; DeYoung, 2015), the present study examined three samples of U.S. adults recruited through Amazon Mechanical Turk (total N = 2879) to test main and moderated effects of broad Big Five traits and trait facets on physical activity while accounting relevant background factors such as age, sex, education, income, body mass index, health status, physical limitations, and self-efficacy. Results showed robust main effects of extraversion and activity facet on physical activity engagement (especially strenuous activity) across all three samples. A multiplicative effect of high levels of extraversion, high levels of neuroticism, and low levels of physical limitations predicted greater levels of engagement in mild physical activity as measured by the Godin Leisure-Time Exercise Questionnaire. A second multiplicative effect of high levels of the activity facet, low levels of the industriousness facet, and good health status predicted greater engagement in strenuous physical activity as measured by the

International Physical Activity Questionnaire. Although interaction effects were not replicated directly (i.e., among the three samples) or conceptually (i.e., across the two measures of physical activity, the present study marks an appropriate starting point for enhancing an understanding of the interactions that connect broad stability and plasticity tendencies of the personality system and their associated effects on health-related behaviors, such as leisure-time physical activity. It is suggested that future research test the CB5T by combining cross-sectional findings with experimental and/or longitudinal data to inform a greater understanding of the mechanistic workings of the personality system and its influence on physical activity engagement.

AUTOBIOGRAPHICAL STATEMENT

Phuong Vo majored in Social-Personality Psychology with a minor in Health Psychology under the direction of Dr. Tim Bogg. She previously graduated from Kalamazoo College in 2009 with a Bachelor of Arts, majoring in Psychology and minoring in Anthropology/Sociology. Her research focuses on examining health-promoting behavioral initiation and maintenance through a personological perspective. She is also interested in understanding how personality, environmental, and genetic factors interact to influence health behaviors, such as physical activity and dietary behaviors. She will continue to expand her research program to include examinations of genetic and biological markers of health and eating behaviors as a postdoctoral scholar with Dr. Kelly Klump at Michigan State University.