Chapter 6
Personality and Physical Activity

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Chapter Overview

Physical activity levels vary from person to person. Some of this variability comes from demographic differences (gender, age), or environmental differences (access to resources), but much of it goes unexplained. In this chapter, we explore the evidence that personality may influence how active people are. We explore the nature of personality, the relationship it has with physical activity, and the possible reasons or mechanisms underlying those relationships. Personality has been linked to physical activity behavior, as well as to social cognitions specific to physical activity like motivation, intention, and preferences. There is also evidence of shared genetic links between personality and physical activity. Personality has even been shown to predict the relationship between physical activity and common mental health outcomes, like symptoms of anxiety and depression. By the end of this chapter, readers should have a strong understanding of what personality is, how it relates to physical activity, and what are some of the causal mechanisms that might explain this relationship. The reader should also have a good understanding of how they might utilize these relationships in their efforts to help others adopt and maintain an active lifestyle.

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Introduction

Physical activity is often the focus of public health initiatives as physical inactivity is a risk factor for chronic conditions (European Union Sport and Health Working Group, 2008; Haskell et al., 2007; Office of Disease Prevention and Health Promotion, 2017; Rhodes et al., 2017; WHO, 2010, p. 325). In addition to the protective effects of physical activity against physical illnesses, a wide body of evidence supports the benefits of physical activity on mental health and quality of life (Bize et al., 2007; Teychenne et al., 2020). Despite this, very few people engage in recommended levels of physical activity. In fact, less than 20% of US adults and adolescents engage in recommended levels of physical activity (Piercy et al., 2018), a trend observed across developed nations (Guthold et al., 2018; Hallal et al., 2012). A key to developing effective and sustainable physical activity promotion initiatives is an understanding of behavioral antecedents to physical activity, which can range from very narrow personal characteristics of individuals to broad environmental and policy factors (Bauman et al., 2012).

One personal factor that has received much attention and has the potential for broad reaching adaptations to current practice is personality. Understanding how personality and physical activity are related could be of great practical value in explaining systematic variability in physical activity behaviors, as well as the impact of behavioral interventions with respect to population reach and effectiveness. Relationships between personality and physical activity may also explain systematic variability in the affective response to behavioral enactment, self-regulation and adherence, preferences for different types of physical activities, and psychological and physiological outcomes of acute or chronic exercise. The use of an integrative framework of the personality system can inform the adaptation of current practice to account for relevant individual differences which influence the way people respond to exposures relevant to physical activity and exercise promotion (Coulter et al., 2016; Ferguson, 2013; Wilson, 2019). The purpose of this chapter is to provide students and practitioners with an overview of the evidence linking physical activity and personality, and to set the stage for continued work towards personality tailored approaches to exercise programming and physical activity promotion.

What is Personality?

The American Psychological Association defines personality as “individual differences in characteristic patterns of thinking, feeling and behaving” (American Psychological Association, 2020). Overall, personality traits represent enduring and consistent individual differences across the lifespan (McCrae et al., 2000; Roberts et al., 2006).

Personality differences originate from fundamental dispositions in early childhood, called temperaments (Rothbart, 2007). These fundamental dispositions influence the way people respond to environmental stimuli emotionally, cognitively, and/or behaviorally. Personality development is a continuous process beginning at an early age (Denissen et al., 2011). While individual expressions of personality are generally considered culturally conditioned manifestations of several factors (Eysenck, 1970; Funder, 2001; McCrae et al., 2000), personality is moderately to highly heritable (Bouchard & Loehlin, 2001; de Moor et al., 2012), suggesting an evolutionary and biological basis (Gray, 1991; Zuckerman, 2005). Biological theories present varying postulates regarding the underlying neurobiology from which personality arises, though none have been universally supported. Common themes that have emerged, however, include individual differences in arousal (tonic neural activity), reactivity (stimulus/response threshold), and self-regulation (recovery from evoked responses; Depue & Collins, 1999; Gray & McNaughton, 2000; Zuckerman, 2005).

Personality theory dates back to the classical theory of the four humours (sanguine, phlegmatic, choleric, and melancholic), put forth by Hippocrates (460 BC) in his treatise “On the Nature of Man”. The ideas put forth were further endorsed by Galen during the second century AD in his famous treatise “On the Natural Faculties”, which preceded his work “On Temperaments” in which he describes an optimal

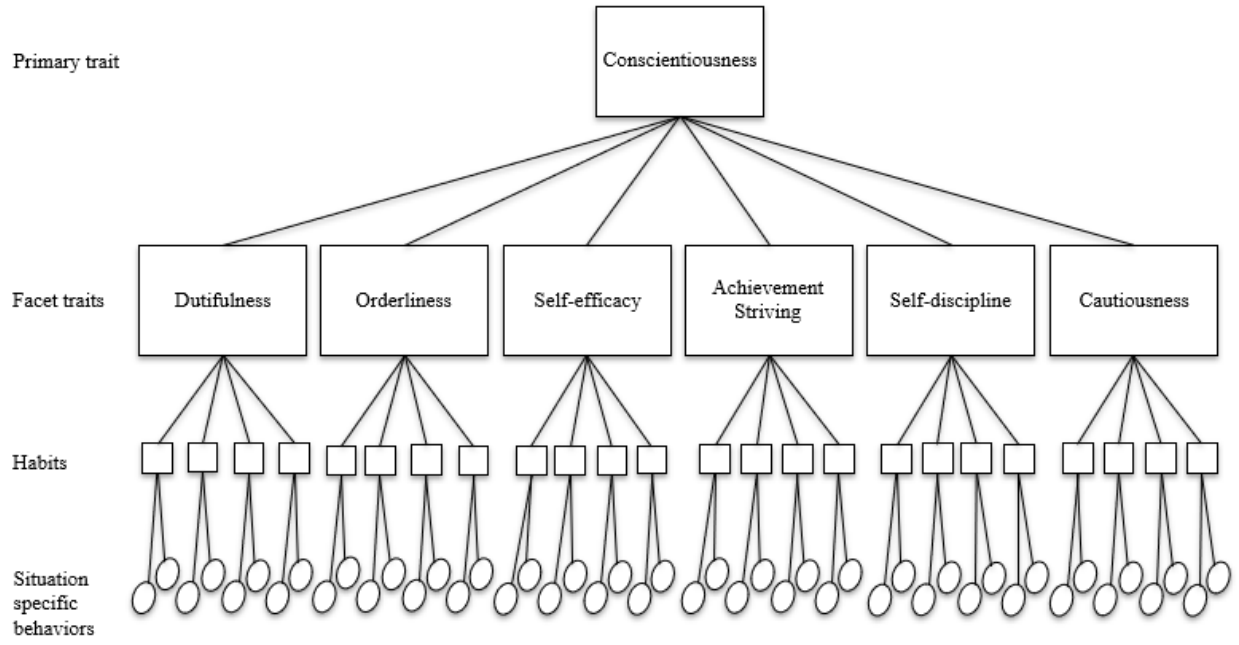
temperament in which all four humours are in balance without any quality being in excess (Stelmack & Stalikas, 1991). The theory of the humours and the resultant fourfold typology of temperament/personality persisted through the middle ages into the Renaissance. With advances in medical science during Medieval times, the physiological models elaborated by Hippocrates were disproven and the psychological postulates were also presumed falsified; ultimately, the theory fell out of favor. Remnants of the fourfold typology were later observed in the writings of Immanuel Kant (1789) and Willhelm Wundt, the "father of psychology" (Stelmack & Stalikas, 1991). The theory put forth a number of ideas that remain important to our current thinking. Specifically, a) the fourfold typology resulted from consistently observed patterns in the person's emotions and behavior; b) it was linked to human physiology as it was understood at the time; and c) it was related to psychopathology.

Early work in psychology reiterated the notion of personality "types" reflected in the personality types and somatotypes described by Carl Jung and William Sheldon, respectively (Jung, 1923; Sheldon & Stevens, 1942). However, an overwhelming body of factor analytic and psychobiological research has nullified the perspective of personality as "types". Nevertheless, these theories made important contributions to considerations for personality moving forward. For example, though Sheldon's theory of somatotypes (i.e. the idea that body types had a causal relationship with personality) has been logically and scientifically refuted (e.g., Hammond, 1957; Lerner, 1969; Slaughter, 1970), significant associations between body type and personality do exist (Sutin & Terracciano, 2016) and highlight relationships between psychological individual differences in health behaviors contributing to body composition and overall health (Ferguson, 2013). Though the work of Carl Jung has received its fair share of criticism, his was the first theory to highlight Extraversion/Introversion as a primary personality factor and his ideas about four functions or modes of operation for personality (i.e. thinking, sensing, intuition, and feeling) persist in popular culture as reflected in the widely used Myers-Briggs type indicator (Barbuto, 1997). Despite the theoretical and scientific advances since these early perspectives, their imprint on contemporary thought is undeniable. Much progress has been made since this early work to understand the structure of human personality and it should go without saying that our current perspectives differ markedly from those in the early 20th century.

Our current view of personality follows a common higher-order trait taxonomy, in which primary traits act as determinants of lower-order sub-traits which are used to describe individuals with greater specificity and detail, but which are also subject to greater influence by external factors (see Figure 6.1). Thus, primary personality traits represent the peak of a conceptual hierarchy, with the most stable, biologically based traits at the top and individual level behaviors at the bottom, with narrow facet traits linking biological individual differences to situation specific individual level behavior. Factor analytic work by scholars throughout the 20th century (e.g., Cattell, 1947; Digman, 1990; Eysenck, 1947; Goldberg, 1993; Thurstone, 1934; Tupes & Christal, 1961; Webb, 1915) provided a top-down template for classifying personality as intercorrelations between descriptive terms. This body of work leveraged the lexical hypothesis (ca. 1884), which states that those personality characteristics that are most important in peoples' lives will eventually become part of their language; thus, terms for personality traits are identifiable across cultures through analysis of their descriptive words for individuals (i.e., trait terms; Allport, 1927; Allport & Odbert, 1936). This work, conducted in tandem with the pioneering work by Hans Eysenck elaborating biological models of Extraversion and Neuroticism (Eysenck, 1970), has helped bridge the gap between specific sub-traits and more general personality factors that resulted in a previously disparate field of study (Digman, 1990; Goldberg, 1993).

Figure 6.1

Visual Representation of the Hierarchical Nature of Personality Depicted Across Levels of the Primary Trait Conscientiousness.



Currently, the dominant contemporary taxonomy used by scholars worldwide is the Five Factor Model (FFM) of personality (McCrae & Costa, 2008; Revelle et al., 2011), or similar variants of this model. This widely supported system postulates that the core personality of all people can be classified on five bipolar dimensions: (1) *Extraversion* / Introversion; (2) *Neuroticism* / Emotional Stability; (3) *Conscientiousness* / Undirectedness; (4) *Openness* / Closedness; and (5) *Agreeableness* / Antagonism. Though it is recognized that these terms each reflect one extreme end of the respective bipolar dimension, the trait terms listed here in italics are those typically used to discuss each dimension within the literature. Their counterparts are seldom called out by name, rather, scholars often refer to individuals as scoring either high or low for Extraversion, for example. Nevertheless, it is important to recognize the continuous nature of these dimensions, and to keep in mind that all people can be classified according to their respective scores on each of the Big Five personality dimensions. Descriptions of dispositions or tendencies displayed for high and low ends of each dimension are listed in Table 6.1. Notably, though there are some sub-traits (e.g., sub-traits of Neuroticism) and trait clusters, such as the dark triad (i.e., narcissism, Machiavellianism, and psychopathy), that do represent trait indicators of psychopathology, all Big Five are generally considered to have some evolutionary utility, and to be normal variations of fundamental, biologically based personality traits across the general population.

Table 6.1

Characteristic Tendencies of Individuals Scoring on the High or Low End of Each Bipolar Dimension of the Big Five personality Factors

Trait dimension	High (+) / Low (-) Anchor Labels	Characteristic Tendencies
Extraversion	(+) Extravert	Sociable; assertive; energetic; excitement seeking; affectionate; talkative; friendly; warm; spontaneous; active; propensity towards positive affect.
	(-) Introvert	Reclusive; reserved; aloof; quiet; inhibited; passive; cold; propensity toward negative affect under conditions of high stimulation.
Neuroticism	(+) Neurotic	Emotionally reactive/unstable; anxious; self-conscious; vulnerable; high-strung; worrying; insecure.
	(-) Emotionally stable	Calm; emotionally stable; secure; relaxed; self-satisfied; comfortable; unperturbed.
Conscientiousness	(+) Conscientious	Orderly; dutiful; self-disciplined; achievement oriented; reliable; persevering; hardworking; punctual; neat; careful; well-organized.
	(-) Undirected	Disorganized; negligent; undependable; poor time management/planning skills; lacking self-discipline.
Openness	(+) Open-minded	Reflective; perceptive; creative; welcoming; unconventional; non-traditional; intellectual; original; imaginative; daring; complex; independent; broad interests.
	(-) Closed-minded	Simple; pragmatic; conforming; traditional; unadventurous; “down to Earth”; conventional; uncreative; narrow interests.
Agreeableness	(+) Agreeable	Lighthearted; easy going; cooperative; kind; optimistic; altruistic; trustworthy; generous; soft-hearted; forgiving; sympathetic; acquiescent; selfless; good-natured; lenient; trusting.
	(-) Antagonistic	Ruthless; vengeful; callous; selfish; irritable; critical; suspicious; argumentative; cynical; competitive.

This widely supported taxonomy emerged organically through decades of factor analytic work (Digman, 1990). Further, the Big Five are observed to be moderately heritable (Jang et al., 1996; Riemann et al., 1997), are related to childhood temperament (Ahadi & Rothbart, 1994; Rothbart et al., 2000), follow a stable and predictable trajectory of change over the lifespan (Roberts et al., 2006), and are significantly related to several indices of physical health and psychological well-being (Ferguson, 2013; Steel, Schmidt, & Shultz, 2008). The Big Five are considered to be the core dimensions of personality, and to interact with one's environmental exposures resulting in the expression of more specific sub-traits, (Goldberg et al., 2006; McCrae & Costa, 1995). For example, individuals high in Extraversion may express this higher order trait through excitement seeking, sociability, a positive outlook, or energetic activity under circumstances that facilitate such an expression, whereas these traits would not manifest under the same circumstance for an individual low in Extraversion (i.e. high in introversion). Most theorists agree that primary traits interact with external factors to produce narrower, more contextualized social cognitive and motivational characteristics which strongly influence behavioral action (Ajzen, 1991; Bogg et al., 2008; McCrae & Costa, 1999; Mischel & Shoda, 1999; Rhodes, 2006). A detailed elaboration of this integrative perspective of the personality system is detailed in the Five Factor Theory (McCrae & Costa, 1999, 2008), and a contextualization of these concepts to physical activity and exercise behaviors was recently published for consideration by health professionals interested in using personality to maximize physical activity and exercise outcomes (Wilson, 2019). Generally, integrative theories of the personality system indicate that the way one responds to any external or internal stimulus is moderated by their underlying core personality (which is reflective of individual differences in neurobiological arousal and reactivity in relevant neural networks). Personality is therefore expected to moderate the environmental influences on cognitions, affect, and behavior, making it a salient source of systematic variation in outcomes of interest to a wide-range of behavioral interventionists (Ferguson, 2013).

Personality Measurement

Personality assessment can be approached via self- or proxy-report survey, behavioral observation, or the measurement of psychophysiological correlates (de Geus & Neumann, 2008; Lanyon & Goodstein, 1997). Most frequently, personality is assessed using a validated self-report measure. Survey assessments ask people to rate how well an adjective or sentence describes themselves or someone they know. Common proxy respondents include teachers, parents, or close friends of the individual being assessed. Validated survey instruments often allow users to compute summary scores for traits measured, though reports of normative scores for personality are uncommon, making interpretations of sample representativeness difficult. Surveys are generally easy to implement, low cost, and low burden for the researcher and participant, though they do have some notable limitations. Primarily, survey assessments are vulnerable to response bias (e.g., socially desirable responding or experimental demand). To minimize this possibility, some surveys use "distractor" items that do not ask about personality characteristics, attempting to conceal the purpose of the survey from the participant. Another common approach is to mix the personality assessment items in with items from other surveys in a single question block. Both approaches aim to reduce the potential of response bias resulting from participants deducing what the survey is attempting to assess and tailoring their answers in some way. Some commonly used, well-supported surveys for assessing the Big Five traits include the Big Five Inventory (John et al., 1991), and the NEO-PI-R (Costa Jr & McCrae, 2008). Another resource that many find especially useful is the International Personality Item Pool (IPIP). The IPIP is a free resource in the public domain including more than 3,000 items from over 250 personality scales which are available to be copied, edited, translated or otherwise used for any purpose without seeking permission or paying a fee for use (Goldberg, 1999; Goldberg et al., 2006). Interested readers are encouraged to go to https://ipip.ori.org/ to explore the resource and its applicability for their assessment needs.

Unlike survey assessments, behavioral observations and psychophysiological measures are uninfluenced by participant response bias. Behavioral observations involve coding and analysis of observations made in-person or via video recording. This approach is time-consuming and carries a substantial researcher burden. Coding observations requires careful consideration and control for external conditions, as low inter-rater reliability commonly results from the influence of environmental and situational variables (Rowe & Kamphaus, 2008). To date, observational assessments of personality are rarely used in the exercise and physical activity literature.

Finally, psychophysiological correlates of personality can be used as a proxy measure for biologically based traits. Significant relationships are consistently reported between psychophysiological reactivity and self-reported measures of personality (de Geus & Neumann, 2008). Individual differences in sensory stimulus response of localized brain activity are related to personality as observed in studies using functional magnetic resonance imaging and electroencephalography. Personality modulates responses such as evoked asymmetry and event-related potentials (e.g., error-related negativity, contingent negative variation; Canli et al., 2001; Coan et al., 2006; Pailing & Segalowitz, 2004). For example, individual differences in cerebral blood flow have been observed between introverts and extraverts using positron emission tomography such that introverts are reported to have greater cerebral blood flow in the frontal cortex at rest than extraverts (Johnson et al., 1999). Additionally, indicators of autonomic nervous system responses (e.g., electrodermal conductivity, heart rate variability, pre-pulse inhibition and magnitude modification of the startle reflex) to stressors and emotional stimuli may be useful indicators of personality differences, though evidence to date has been mixed (de Geus & Neumann, 2008). Like behavioral observation, the assessment of psychophysiological correlates of personality in the exercise and physical activity literature has been underutilized.

Personality and Physical Activity

Currently the cumulative evidence supports a modest relationship between personality and physical activity (Rhodes & Smith, 2006; Wilson & Dishman, 2015), as well as physical inactivity, and sedentary behavior (Sutin et al., 2016). These relationships appear robust across the lifespan (de Moor et al., 2006), and some evidence suggests that associations are bidirectional (Stephan, Sutin, et al., 2014). Most of the evidence on personality and physical activity is derived from cross-sectional and longitudinal observations.

Cross-sectional Associations

The relationship between personality and physical activity has received intermittent attention over the past 50 years. Since the elaboration of the FFM, several reviews and meta-analyses have summarized the relationship between physical activity and personality (McEachan, 2004; Rhodes & Pfaeffli, 2012; Rhodes & Smith, 2006; Sutin et al., 2016; Wilson & Dishman, 2015). The first meta-analysis in this area reported small positive associations between Extraversion (r = .23) and Conscientiousness (r = .20) and physical activity and a small negative relationship between physical activity and Neuroticism (r = -.11) among 35 samples (Rhodes & Smith, 2006). Though these effect sizes are small based on traditional standards (Cohen, 1988), more recent guidelines for psychological sciences indicate that effects sizes of about .10 should be judged as relatively small, and of .20 to be considered typical (Gignac & Szodorai, 2016). Concurrent narrative analysis of potential effect moderators revealed that sex, age, and study design did not appear to affect the findings, though it was observed that European studies reported weaker associations between Extraversion and physical activity compared to North American studies.

More recent meta-analyses corroborate and extend these findings. Wilson and Dishman (2015) conducted a meta-analysis of 64 studies on the application of the FFM and physical activity, and Sutin

and colleagues (2016) conducted a more selected meta-analysis of 16 population samples. Both studies reported positive associations between physical activity and Extraversion (both *r* = .11), and Conscientiousness (both *r* = .10) in the small effect size range. Though statistically significant, all other associations were of a trivial effect size by standards for individual differences research (Cohen, 1992; Gignac & Szodorai, 2016). Formal assessment of study design and sample characteristics as possible effect moderators revealed that Conscientiousness was linked more to the frequency of activity (*r* = .21) than other types of assessment such as general quantity (*r* = .06) or volume (*r* = .07), and the association between Extraversion and physical activity appears intensity dependent, as effects were stronger for effects examined for quantity of moderate-to-vigorous physical activity (*r* = .13) than for quantity of mild-to-moderate physical activity (*r* = .04; Wilson & Dishman, 2015). Moderator analyses also corroborated the narrative review by Rhodes and Smith (2006) such that effects between physical activity and Extraversion, as well as Neuroticism, were significantly stronger in samples from North American compared to samples from Europe (Wilson & Dishman, 2015). Notably, these analyses highlight areas where more work is needed, as most of the work has been limited to healthy, North American adults. Studies are needed to further our understanding of these relationships in population subgroups that have received less attention (e.g., older adults, Central American, South American, and Asian populations, clinical samples).

Based on the cumulative evidence, we can conclude that self-reported physical activity has a reliable, yet small positive association with Extraversion and Conscientiousness. Also, Neuroticism appears to have a negative relationship with self-reported physical activity. Importantly, these analyses indicate that, together, Extraversion, Conscientiousness, and Neuroticism account for 7-10% of the variance in physical activity in the population, highlighting the possibility that approaches to physical activity promotion can leverage individual differences to maximize physical activity outcomes, such as adoption and adherence. Consistent relationships between personality and physical activity underscore the possibility of using personality to identify those who may be at risk for inactivity or poor exercise adherence. With respect to the Big Five primary personality traits, Neuroticism appears to signal risk for inactivity, whereas increments of Conscientiousness and Extraversion may protect against inactivity. Studies have yet to determine the degree to which interactions between traits within-subjects influence relationships between traits and activity level. More work is needed to test the utility of personality as a tailoring variable for physical activity interventions and exercise programming.

Though relationships between personality and self-reported physical activity are highly consistent, there is relative paucity of evidence reporting on these relationships using objective measures (e.g., pedometers, accelerometers) of physical activity. Considering the modest relationships between self-reported and objectively measured physical activity in general, it is important to examine whether physical activity measurement impacts observed relationships between personality and physical activity. For example, one study examining cross-sectional relationships between personality factors and physical activity in a sample (*n* = 298) of female undergraduates reported differential relationships dependent on physical activity measurement (Wilson et al., 2015). Specifically, Wilson and colleagues observed Extraversion to be significantly related to self-reported physical activity only, while Neuroticism was related to objectively measured physical activity only. These results were recently corroborated in a large sample (*n* = 1,098) of middle-aged women; Neuroticism was negatively associated with leisure time moderate-to-vigorous physical activity as measured by both self-report and accelerometry, whereas Extraversion was positively related to self-reported physical activity only (Kekäläinen et al., 2020). Such discrepancies also appear present in older adult samples. One sample (*n* = 3,094) of older adults (age > 65 years) responded to self-report items for personality and physical activity conceptualized as participating in exercise for more than 30 minutes at least twice per week (Takatori et al., 2019). Significant, but small (*r* = .08 to .13), correlations were reported for physical activity and Extraversion, Conscientiousness, Agreeableness, and Openness. Another study of older

adults (*n* = 271; age > 79 years) used the activPAL activity monitor (a tri-axial inclinometer) to assess sedentary time and physical activity relative to personality traits, and found no significant associations between personality and physical activity measured as step count, but significant negative associations between sedentary time and Agreeableness, Conscientiousness, and Openness (Čukić et al., 2019). Observations in these and other studies (e.g., Hearon & Harrison, 2020) contrast with bivariate relationships reported in meta-analyses. This might be due to differences in physical activity assessment, as direct measures (e.g., accelerometers) capture all types of physical activity, including incidental movement throughout the day, whereas indirect measures (i.e., physical activity self-reports) are more likely to capture purposeful exercise and memorable bouts of physical activity (Troiano et al., 2014). Another possibility is the presence of a common method bias favoring self-report assessments in the observed associations with personality. Consequently, these inconsistent observations highlight the need to use direct and indirect measures of physical activity concurrently to understand what portion of the covariance may be related to response bias versus true association.

Correlational Associations: Personality and Physical Inactivity

In addition to association between personality and physical activity, the focused meta-analysis by Sutin and colleagues (2016) estimated population effect sizes relationships between personality and physical inactivity, and sedentary behavior (e.g., time spent sitting, hours watching TV). In examining relationships between traits and a dichotomous inactivity variable (i.e. inactive or not inactive), data suggest that for every standard deviation (*SD*) unit increase in Extraversion, Conscientiousness, or Openness, there is about a 10-15% decrease in risk for inactivity. In contrast, for every *SD* increase in Neuroticism, there is a 10% increase in risk for inactivity. Further, Neuroticism appears consistently positively related, and Conscientiousness consistently negatively related, with total time spent sedentary. Finally, Sutin et al. report that evidence for associations between sedentary behaviors and Extraversion and Openness is mixed, and Agreeableness appears unrelated to sedentary behavior. However, additional work highlights the mixed nature of these effects. For example, Extraversion is observed to be negatively associated with total sitting time and, along with Conscientiousness, total leisure screen time in a large sample of young adults in Australia (Burnett et al., 2016). A more recent report indicated that among a sample (*n* = 64) of young adults, sedentary time measured by accelerometry was not significantly related to any of the Big Five personality traits (Hearon & Harrison, 2020). Conversely, self-reported time spent sitting was inversely related to Extraversion and Conscientiousness cross-sectionally, but positively associated with Openness prospectively with follow-up measures taken at 5-months in a sample (*n* = 126) of young adults (mean age = 21.6 years; Joyner et al., 2019). Overall, the associated evidence on personality and sedentary behavior is still in its infancy. Continued work in this area is needed to support our understanding of how personality relates to sedentary behaviors, and whether any of the covariance significantly explains relevant health outcomes.

Longitudinal Associations

Most of the evidence linking physical activity and personality describes bivariate associations observed in cross-sectional or very brief longitudinal investigations (e.g., 8 weeks). Overall, results from subgroup analyses in the Wilson & Dishman meta-analysis indicate that relationships between personality and physical activity from prospective studies are similar to those from cross-sectional studies. The exception to this was observed for effects between Conscientiousness and physical activity; associations from prospective studies were nearly twice as large as those from cross-sectional studies (Wilson & Dishman, 2015). This was later corroborated in a sample (*n* = 126) of college students in which Conscientiousness was observed to significantly predict moderate-to-vigorous physical activity at a 5-month follow-up assessment; no relationships were observed for the other four primary personality traits (Joyner & Loprinzi, 2018). These observations may reflect the propensity of individuals with

increasing levels of Conscientiousness to possess a greater aptitude for developing and sticking with a plan. Individuals with higher scores for Conscientiousness demonstrate greater self-discipline and sense of duty for executing plans and reaching goals than those who score low for Conscientiousness. Other primary traits are characterized by qualities that speak to their propensity for behaviors in the present, rather than the likelihood of engaging in future behavior. This quality may explain why longitudinal associations between physical activity and Conscientiousness are statistically significant, while those of other traits are not.

A few studies have examined the interconnected relationship between personality and physical activity across extended periods of time. Repeated measures over time allow for an assessment of the direction of effects between variables, and the stability of these effects over time. Indeed, the existing longitudinal evidence indicates that relationships between personality and physical activity are, for the most part, stable across the lifespan. A population based study using the Netherlands Twin Registry assessed survey data from adolescent and adult twins and their families collected every two years from 1991 to 2002 and demonstrated that regular exercisers were significantly more extroverted and generally more emotionally stable (low Neuroticism) than non-exercisers across age categories from early adolescence (10–15 years) to old age (> 60 years; de Moor et al., 2006). Overall, this provides strong evidence for the stability of associations between personality and physical activity across adulthood.

Repeated measures also provide the opportunity to distinguish between-person from within-person effects. In other words, we are better able to understand differences in how personality differences between people impact change in physical activity over time, and also how the natural flux of personality over time within an individual impacts change in physical activity over time. For example, Mõttus et al. (2017) showed that while Extraversion and Conscientiousness predict between-person physical activity, differences in Neuroticism within-people over time were also predictive of physical activity. This is important preliminary evidence for investigators aiming to adjust behavioral techniques according to personality traits to enhance physical activity interventions or utilize physical activity as a therapeutic tool for individuals according to personality. This is an area ripe for investigation, as scholars are just now beginning to apply personality to focused efforts in health promotion (Ferguson, 2013; Wilson, 2019).

Evidence also exists to suggest that the relationships between personality and physical activity behavior may be bidirectional. It has been observed that personality is predictive of changes in physical activity levels across several decades (Kern et al., 2010), and conversely, that physical activity levels are predictive of the stability (or instability) of personality as we age (Stephan, Boiché, et al., 2014; Stephan et al., 2018; Stephan, Sutin, et al., 2014). One longitudinal trial spanning 40 years revealed predictive qualities of Extraversion and Neuroticism on physical activity changes, specifically, though over time higher physical activity was associated with higher levels of Extraversion and lower levels of Neuroticism. However, these personality traits were associated with a greater decline in physical activity among adult males compared to those who scored low for Extraversion and/or high for Neuroticism at baseline (Kern et al., 2010). This effect between personality and change in physical activity over time was not observed in females. Longitudinal associations between Openness and Agreeableness with physical activity change were not significant.

Interestingly, some evidence supports a beneficial effect of physical activity on personality change over time. A recent report showed that lower physical activity was associated with declines in Conscientiousness, Openness, Extraversion, and Agreeableness over the course of 20 years, although the effect sizes were very small (Stephan et al., 2018). Similarly, change in personality traits was reduced among adults classified as physically active in two large longitudinal cohort studies. Specifically, adults in the Health and Retirement study (n = 3,774) and the Midlife in the United States study (n = 3,758) were followed for 4 and 10 years, respectively. Those who were physically active at baseline had significantly

greater intra-individual stability of primary personality traits in both studies (Stephan, Sutin, et al., 2014). Further, research examining lower level personality traits has demonstrated a beneficial effect of physical activity on sub-traits of Neuroticism, possibly due to the documented anxiolytic and anti-depressive effect of activity.

Despite these compelling observations, more work is needed to test plausible biological and cognitive mechanisms of these relationships. Additionally, little has been done to understand the impact of trait-trait interactions on physical activity behavior within people using multivariate techniques to understand these relationships more comprehensively. Though the existing longitudinal research is encouraging, the hypothesis of bidirectionality has mixed support, highlighting the need for further investigation (Allen et al., 2017).

Genetic Links between Personality and Physical Activity

The cumulative associative evidence begs the question of genetic overlap between personality and physical activity level. Heritability estimates for the Big Five traits range from 41% to 61% (Jang et al., 1996; Riemann et al., 1997; Vukasovic & Bratko, 2015), and physical activity is heritable in the range of 48% to 71% (de Moor & de Geus, 2012; Stubbe et al., 2006). Early assessments support rather strong genetic links between personality traits and physical activity. Analysis of a large longitudinal dataset from a sample of 10,105 twins surveyed from 1991 to 2009 indicated common genetic pleiotropy (the existence of a single gene that impacts more than one apparently unrelated or distantly related qualities) between physical activity and Neuroticism, and a combination of genetic pleiotropy and causal effects of Extraversion on physical activity responsible for the small phenotypic associations described in the observational literature (de Moor & de Geus, 2018). In other words, the association between Neuroticism and physical activity was observed to be the result of a shared genetic source, whereas the association between Extraversion and physical activity was partly due to shared genes, but also partly due to a causal impact of Extraversion on physical activity behavior. For instance, higher levels of Extraversion may predispose individuals to more frequent opportunities for physical activity due to the propensity to seek out stimulating environments. The genetic association between Extraversion and physical activity was again corroborated in a sample (n = 373) of adolescent and young adult twins (Schutte et al., 2019). This cutting-edge research begins the process of teasing apart causal effects and shared genetic variance in the physical activity and personality relationship. Additional research is needed to test the reproducibility and generalizability of these compelling observations in more diverse samples, but early results suggest a common genetic etiology between physical activity behavior and primary traits Neuroticism and Extraversion.

Personality, Physical Activity, and Social Cognitions

Though describing direct relationships between personality and physical activity is an important first step, it is important to specify how personality may affect physical activity behavior. Specifically, the influence of personality is hypothesized to be indirect, working through social cognitions (e.g., perceptions, attitudes, norms, self-efficacy), habits, or social and environmental access to behavioral resources (Ajzen, 1991; Bogg et al., 2008; McCrae & Costa, 1995; Rhodes, 2006). Several studies have examined social cognitive theories as mediators of the personality–physical activity relationship (Rhodes & Pfaeffli, 2012; Rhodes & Wilson, 2020; Wilson, 2019). Most of these investigations examined Ajzen's (1991) theory of planned behavior as the intermediary (see Chapter 5; Delli Paoli, 2021).

Theory of Planned Behavior as a Mediator

Rhodes and Pfaeffli (2012) conducted a systematic review and reported that personality was related to theory of planned behavior constructs, and that personality and social cognitive constructs were related to physical activity. However, the test of full mediation (i.e., that the link between

personality and physical activity was actually through social constructs) was only supported in two samples (Bryan & Rocheleau, 2002; Hagan et al., 2009). In one case, the effect of Extraversion on physical activity was fully mediated through perceived behavioral control (Bryan & Rocheleau, 2002). A more complex analysis subsequently revealed that a sub-trait of Extraversion, the activity trait, accounted for the observed relationship between Extraversion and social cognitive constructs. Hagan et al. (2009) reported that the activity trait mediated the relationship between Extraversion and theory of planned behavior constructs, and that attitude and perceived behavioral control mediated the relationship between the activity trait and physical activity behavior (Hagan et al., 2009). All other studies only supported partial mediation, as personality had significant direct effects on physical activity. The finding is interesting because it shows that personality may have another route on behavior beyond reflective social cognitions (e.g., intention, attitude, perceived control). For example, dual-process theories (Deutsch & Strack, 2006) propose that behavior is the result of a combination of planned "cold" operations and impulsive "hot" drives (also see Chapter 2, Rebar et al., 2021; Chapter 4, Brand & Ekkekakis, 2021). This may help explain why observations vary between investigations examining behavior in the context of social cognitive theories which lack an affective component. It is plausible that the relationship between Extraversion and impulsivity, or Extraversion and the affective response to heightened arousal, for example, partially influences physical activity behavior beyond the observed relationships between Extraversion and social cognitive constructs (Rhodes & Wilson, 2020). More work is needed which integrates a wider range of cognitive and affective theories into our understanding of how personality impacts physical activity. There is too little evidence at present to make conclusive statements about which traits (at primary or facet levels) have the strongest influence on behavioral antecedents, and which social cognitive and affective factors are best at ultimately transferring the impact of personality differences to predictable differences in behavior (Rhodes & Boudreau, 2017; Wilson, 2019).

Personality and Intentions

Much attention has been given specifically to the relationships between primary personality traits and physical activity intention. Given that intention is considered the proximal determinant of behavior in most social cognition models (Conner & Norman, 2015), investigations have examined the possibility of moderation and mediation in the context of multivariate models including personality, social cognitions, and behavioral intention. Cumulative associative evidence points to moderation of the intention-behavior gap by personality traits, specifically Conscientiousness. Two systematic reviews have concluded that Conscientiousness interacts with intention to impact physical activity level (Rhodes & Dickau, 2013; Wilson & Dishman, 2015). A recent meta-analysis examined moderation according to whether or not participants were asked how active they intended to be prior to an impending physical activity measurement, and found that associations between Conscientiousness and physical activity were twice as large in studies that asked about intention compared to those that did not (Wilson & Dishman, 2015). Moreover, a review of moderators of the physical activity intention-behavior gap concluded that Conscientiousness significantly moderates the intention-behavior relationship, such that higher levels of Conscientiousness are associated with stronger positive intention-behavior relationships (Rhodes & Dickau, 2013). Conner and Abraham (2001) were among the first researchers to test this association and theorized that the disposition toward organization and achievement keeps conscientious individuals from slipping in their original physical activity goals.

More recently, Smith et al. (2017) demonstrated that Conscientiousness interacts with competency to set exercise goals (conceptually similar to intention setting) to predict objectively measured physical activity over two weeks in a sample (n = 94) of adults aged 21 to 65 years. Those who scored low for Conscientiousness and reported poor goal setting skills appear to be at risk for inactivity compared to others. Conversely, those scoring low for Conscientiousness who reported excellent goal

setting skills were significantly more active than those with poor goal setting skills, and similarly active to those who scored high for Conscientiousness (for whom goal setting skill did not significantly influence physical activity level). These observations indicate that goal setting skills may be particularly important for those scoring low for Conscientiousness, and that strategies targeting goal setting may not be very useful among those scoring high for Conscientiousness.

Less work has been done to understand these relationships in the context of other primary traits, though there is some evidence that Extraversion moderates the intention-behavior relationship with extraverts more likely to follow-through on intentions than introverts (Rhodes & Dickau, 2013). Rhodes and colleagues (2002) have suggested that individuals high on Extraversion may facilitate their intentions through gravitating toward more active environments than introverted individuals. Neuroticism has also been evaluated as a moderator of the intention-behavior relationship though results are mixed (Hoyt et al., 2009; Rhodes, Courneya, & Hayduk, 2002; Rhodes et al., 2005).

It is plausible that mixed results represent the influence of confounding variables. Theorists agree that traits should work through increasingly narrow and contextualized social cognitions to impact proximal determinants of behavior, such as intention (Ajzen, 1991; McCrae & Costa, 1999; Montano & Kasprzyk, 2015). This expectation of mediation has been tested in a few studies (Bogg, 2008; McEachan et al., 2010; Rhodes & Courneya, 2003; Rhodes, Courneya, & Hayduk, 2002; Rhodes et al., 2004). In a sample (n = 397) of postgraduate students at a large UK University, Conscientiousness impacted intention directly, and indirectly through affective attitude about physical activity, and perceived behavioral control. Conversely, Extraversion did not significantly contribute to physical activity intention or behavior after controlling for social cognitive variables (McEachan et al., 2010). This is an interesting observation when compared to results of moderator analyses in the Wilson & Dishman (2015) meta-analysis; bivariate associations between Extraversion and physical activity were significantly stronger among North American samples than European, and were significantly stronger for effects observed after participants were asked how active they intended to be over the measurement period. Taken together with the results from McEachan and colleagues, evidence points to the possibility that the moderating role of Extraversion on the intention-behavior gap may also be dependent on the cultural background of participants (McEachan et al., 2010; Wilson & Dishman, 2015). More research is required before any definitive conclusions about mediation and/or moderation can be drawn.

Self-Efficacy

Personality and physical activity have also been examined in the context of their common relationships with self-efficacy. In a population cohort (n = 3,471), general self-efficacy was observed to partially mediate the relationships between all of the Big Five personality factors and self-reported moderate-to-vigorous physical activity and leisure time inactivity (Ebstrup et al., 2013). Observed relationships between personality and physical activity were consistent with previous meta-analyses (Rhodes & Smith, 2006; Wilson & Dishman, 2015), but when general self-efficacy was added to the prediction model a significant relationship between Agreeableness and physical activity, not previously supported, was revealed. Mediation by self-efficacy was also observed in a sample of older adults (n = 876; $\geq$ 60 years). Again, the direction and strength of relationships between personality and exercise were consistent with the cumulative literature, but Yasunaga and Yaguchi (2014) found that exercise self-efficacy partially mediated the relationships of Extraversion and Openness, and fully mediated the relationships of Neuroticism, Agreeableness, and Conscientiousness with exercise participation. There is also some evidence demonstrating that self-efficacy to overcome barriers interacts with Neuroticism to predict physical activity (Smith, Williams, O'Donnell, & McKechnie, 2016). In a sample of 94 adults, barrier self-efficacy significantly negatively impacted steps per day (measured by pedometer) to a greater degree among those who scored high for Neuroticism than those who did not. This interaction could indicate that strategies for increasing low barrier self-efficacy may be particularly important for

individuals scoring high on Neuroticism. More work is needed to confirm this interpretation. For more discussion on self-efficacy, especially in the context of sport psychology, see Chapter 26 (Hepler et al., 2021)

Motives and Barriers

Another possible explanation for the relationships between personality and physical activity is through its effect upon exercise barriers and motives. Though sparse, existing evidence does indicate that Neuroticism is positively related, and Conscientiousness and Extraversion are negatively related to exercise barriers like fear of embarrassment, lack of motivation, and/or lack of energy (Courneya & Hellsten, 1998). In a multinational sample of adults, personality was observed to differentiate whether motives for exercise were more physical or psychological. Higher levels of Agreeableness and Conscientiousness were related to greater physical, rather than psychological, motivation for exercise, whereas higher levels of Emotional Stability (i.e. lower levels of Neuroticism), Extraversion, and Openness were related to greater psychological motivation for exercise (Courneya & Hellsten, 1998). This is partially in contrast to another report that indicated Neuroticism to be related to exercise motives focused on enhancing physical appearance and/or losing weight, while Extraversion, Conscientiousness, and Openness were reportedly related to exercise motives focused on health and fitness, or stress reduction and enjoyment (Courneya & Hellsten, 1998; Ingledew & Markland, 2008). Work by Lochbaum and colleagues (2013) suggests that the relationship between Extraversion and exercise participation is fully mediated by approach oriented goals to achieve skill mastery, whereas the relationship between Neuroticism and exercise participation was only partially mediated by approach/avoidance goals related to performance compared to others (Lochbaum et al., 2013). Differences in the way that motivations and barriers are conceptualized across this limited body of evidence make conclusive interpretations difficult and point to a need for strategic approaches to understanding how personality relates to motives and barriers to exercise and physical activity participation.

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Personality, Physical Activity, and Affect

Another pathway through which personality might impact physical activity participation is through affective responses to exercise itself (see Chapter 4, Brand & Ekkekakis, 2021; Chapter 11, Jones

& Zenko, 2021; and Chapter 12, Zenko & Ladwig, 2021). Personality has close direct relationships with the propensity to experience positive and negative affect, and to enhance affective responses to a wide range of stimuli. Affective responses to physical activity and expectations of enjoyment are both reliable correlates of future physical activity behavior (Rhodes et al., 2010; Rhodes & Kates, 2015). The fundamental basis for personality development, as discussed previously, lies in temperament (individual differences in tonic arousal, reactivity, and self-regulation). From this perspective, it is intuitive that personality differences might impact how one responds affectively to the uniquely arousing stimulus of exercise. Indeed, there is some evidence to indicate that personality traits are related to physical activity enjoyment. Smith et al. (2016) reported that, in a sample of 94 adults, enjoyment of physical activity has a small negative association with Neuroticism, and a small positive association to Agreeableness. In contrast, Lochbaum & Lutz (2005) reported moderate relationships between exercise enjoyment and Conscientiousness in (*ES* = .67) and Neuroticism (*ES* = -.68) in a sample (*n* = 187) of college-aged females. Another study in a small sample (*n* = 53) of undergraduates reported a moderate positive relationship between physical activity enjoyment and Extraversion only (Baldwin et al., 2016). These mixed results may be the result of sample characteristics, or differences in the conceptualization and measurement of enjoyment (Williams et al., 2019). More work is needed in larger, more diverse samples to understand how personality relates to enjoyment of physical activity and exercise, and the potential moderators of these relationships. Nevertheless, what evidence does exist points to significant relationships between primary personality traits and physical activity enjoyment.

There is some evidence for the biological plausibility of trait level influence on the affective responses to exercise. As discussed earlier, the underlying biological basis for personality lies in temperamental differences in physiological reactivity and self-regulation in stimulus response. Recent studies among adolescents report high (88% to 91%) heritability of physiological recovery from exercise (Nederend et al., 2016), and low-to-moderate (12% to 37%) heritability of affective responses during and following exercise (Schutte et al., 2016). Some evidence indicates that personality interacts with exercise intensity to influence ratings of affect and perceived exertion during exercise (Hall et al., 2005; Schneider & Graham, 2009), and with motivational state to influence the autonomic responses to exercise (Kuroda et al., 2015). On the other hand, Big Five personality traits have been reported to be unrelated to feeling state during high-intensity exercise in a small (*n* = 48) international sample of healthy adults, whereas preferences for higher intensity exercise were related (Jones et al., 2018). Unfortunately, there is a relative paucity of research linking psychological and physiological responses to exercise with personality. Too few studies have been reported to make conclusive statements about the possible relationships between personality and the affective response to exercise.

Personality, Physical Activity, and Mental Health

An emerging area of interest is the multivariate relationship between personality, physical activity and mental health. Affective disorders, such as anxiety and depression, have been the focus of exercise psychologists for decades but only recently have scholars begun to examine these relationships in the context of personality differences. Across the recent investigations in this area, scholars have tested whether personality moderates the mental health impact of physical activity, and whether physical activity mediates the relationships between personality and mental health.

One of the earliest investigations in this area examined relationships between physical activity, personality and general symptoms of anxiety and depression in a sample (*n* = 298) of female undergraduates (Wilson et al., 2016). Moderate-to-vigorous physical activity, measured by accelerometry, was observed to interact with Extraversion and Neuroticism to predict symptoms of mental distress such that physical activity had a protective effect among neurotic-introverts, whereas physical activity did not seem to impact mental health symptoms among extraverts. Taken in context of earlier reports that neurotic-introverts are at risk for mental distress (Steel et al., 2008), these results

suggest that inactivity may increase risk for mental distress. In contrast, another study examining interactive effects between personality and self-reported physical activity on symptoms of anxiety among undergraduates (*n* = 200) reported no such interaction (Joyner & Loprinzi, 2017). These effects were more recently examined in the context of subjective well-being in a sample (*n* = 349) of older adults (> 50 years old). Self-reported leisure time physical activity interacted with personality to impact subjective well-being such that higher levels of Extraversion and Openness enhanced the positive effect between physical activity and well-being (Chan et al., 2018). Another study reported that cardiorespiratory fitness moderated the relationship between Neuroticism and depression in a sample of 1,588 adolescents, such that fitness had a protective effect against increased symptoms of depression with increasing levels of Neuroticism (Yeatts et al., 2017). These compelling observations indicate that the relationships between general symptoms of mental distress and physical activity are dependent on personality characteristics, and individuals with personality profiles that put them at higher risk for mental distress may benefit from greater levels of fitness and physical activity participation. It is possible that outcome differences reflect sample or design characteristics influencing observed effects. These discrepancies point to the need for further study.

Examining the relationships between personality, physical activity, and mental health has been limited to non-clinical populations until just recently. An analysis by McDowell et al. (2020) found that physical activity partially mediated the relationships between primary personality and incident generalized anxiety disorder in a large cohort (*n* = 4,582) of adults in the Irish Longitudinal Study on Aging. In contrast to earlier reports, however, physical activity transmitted the positive effect of Extraversion and Conscientiousness to the benefit of reduced clinical incidence, rather than protecting against the negative impact of Neuroticism. Notable distinctions between studies that may account for some of these discriminant findings include characteristics of the sample, the severity of the outcomes (i.e. generalized symptoms vs clinical diagnosis), and the nature of the study design (i.e. cross-sectional vs longitudinal observation). In light of recent advances in mental health practice (i.e., the endorsement of exercise as a frontline strategy for individuals with mild depression; American Psychiatric Association Steering Committee on Practice Guidelines, 2010) and the frequent comorbidity of mental illness with chronic disorders like cancer and cardiovascular disease (Chan et al., 2015; Watkins et al., 2013), investigations among samples with clinical mental health disorders are paramount. Advancing our understanding of the role of personality in the effectiveness of physical activity and exercise for easing mental distress among clinical populations is an important corollary to this effort, and an area ripe for further investigation. For more discussion on exercise and depression, see Chapter 15 (Brush & Burani, 2021). For more discussion on exercise and anxiety, see Chapter 16 (Schuch et al., 2021). For more discussion on physical activity and severe mental illness, see Chapter 17 (Fibbins et al., 2021).

Personality and Physical Activity Preferences

Relationships between personality and physical activity are likely confounded by the way physical activity is conceptualized within studies. Indeed, physical activity is a complex concept and cannot be captured comprehensively with any one measurement method. Different physical activities are characterized with different skill requirements and energy expenditure demands (Ainsworth et al., 2011; Pate et al., 1995). Taken together, the body of evidence on individual differences in preferences supports robust relationships between personality traits and specific attributes of physical activities, such as aesthetics and social qualities (e.g., social, outdoor/indoor), structure (exercise vs. spontaneous activity), extreme energy requirements (intensity), competitiveness, and skill. In a landmark study, Courneya & Hellsten (1998) elaborate on relationships between primary personality traits and a wide range of physical activity preferences. For example, they report that Extraversion is related to preferences for exercising with others (e.g., group or supervised exercise). They also observed that increasing increments of trait Openness are related to preferences for outdoor (rather than home or

gym), recreational (rather than competitive), unsupervised, and spontaneous (rather than scheduled) exercise, and a preference for walking rather than modes like skating or weight-training. Furthermore, Conscientiousness was related to a preference for scheduled activity, and high-intensity exercise, rather than moderate-intensity exercise. Those who preferred high intensity to moderate intensity also scored low for Neuroticism. Finally, those who scored higher for Agreeableness preferred aerobics to weight-training (Courneya & Hellsten, 1998). It is important to note, however, that these observations are limited to a sample of 264 undergraduate students.

Additional work has been done to understand how personality relates to preference for different modes of activity. For example, in their systematic review of personality and physical activity, Rhodes and Smith (2006) outlined five studies that explored personality with a particular mode or modes of physical activity. They observed that Neuroticism was negatively associated, and Extraversion was positively associated, with participation in aerobic activity. In a more focused assessment of preferences for physical activity modes according to personality, Howard et al. (1987) found that, in a sample (*n* = 31) of middle-aged men, extraverts were more likely to engage in swimming, aerobic conditioning, dancing, and tennis than introverts; whereas introverts were more inclined to engage in gardening, and home improvement. There was no association between Extraversion and walking, jogging, golf, and cycling. A more recent study replicated and extended these results, reporting no relationship with Neuroticism, Extraversion or Conscientiousness and leisure-time walking (Rhodes et al., 2007). A recent meta-analysis highlighted significant positive relationships between Extraversion, and facet traits impulsivity and sensation seeking, with participation in high-risk sports like skydiving, mountain climbing, surfing, or hang-gliding, among others (McEwan et al., 2019). Participation in these types of activities was also negatively associated with Neuroticism, unsurprisingly. Conversely, self-reported minutes of participation in mindfulness meditation and/or exercise is reported to be positively related to Openness and negatively related to Neuroticism (Barrett et al., 2019). As noted throughout the chapter, studies are needed in larger, more diverse samples to enhance our understanding in this area. Understanding physical activity preferences in the context of personality may help exercise practitioners identify types of activities that new clients may be likely to enjoy, assisting in the effort to promote exercise adherence (e.g., Newsome et al., 2021).

Differences in preferences for exercise intensity are theoretically expected for Extraversion specifically, as extraverts are expected to experience positive hedonic tone at greater stimulus intensities than those who are more introverted (Eysenck et al., 1982). Though not a direct assessment of self-reported intensity preference, perhaps the most robust support for this hypothesis is evident through moderator analyses performed in the Wilson & Dishman meta-analysis (2015). They observed that the relationship between Extraversion and physical activity is weaker in studies that reported physical activity as the amount of mild-to-moderate intensity physical activity than it was when physical activity was conceptualized in any other way. Further, effects were strongest when physical activity was captured as volume of moderate-to-vigorous intensity activity, supporting the postulate that the relationship between Extraversion and physical activity might be intensity dependent. One might expect, based on this finding, that Extraversion predicts naturalistic participation in higher intensity activities, but is less useful for predicting participation in lower intensity activities. Introverted individuals would therefore be less likely to regularly participate in moderate-to-vigorous intensity activities such as those endorsed in national physical activity recommendations (U.S. Department of Health and Human Services, 2018). These observations are in agreement with a more recent report linking more frequent participation in vigorous intensity activity with increasing increments of Extraversion in adult women (Karvonen et al., 2020), though the relationship was not significant among men.

Intensity preference differences according to personality were further elaborated in a large (*n* = 4,649) sample of Danish adults. Observations supported increasing increments of Conscientiousness, Extraversion, Neuroticism, and Openness to predict increasing intensities of leisure time physical activity

expressed in METs, measured by validated self-report (Petersen et al., 2018). Analyses also demonstrated a significant positive influence of Extraversion on self-reported physical activity duration, and a social-class dependent association between Conscientiousness and duration such that increasing increments of Conscientiousness predicted greater duration only for individuals within a low occupational social class (i.e., "unskilled" workers, or workers in positions requiring 1.5 years of training at most). Beyond these observations, evidence linking personality to physical activity duration preferences and practices is non-existent. Nonetheless, observations on preferences for different qualities of physical activity (i.e., different intensities, modes, durations) highlight the potential importance of physical activity promotion approaches to target preferences according to these salient individual differences. However, to date, personality targeted physical activity promotion efforts have yet to be reported.

Considerations for Personality in the Promotion of Physical Activity

Evidence suggests that personality may be a useful tool for professionals who are attempting to reduce the risk of disease by increasing physical activity level. Personality appears related to physiological health outcomes of exercise, including body mass index (Sutin & Terracciano, 2016), and cardiovascular and metabolic fitness (Terracciano et al., 2013), and is associated with health outcomes related to physical activity, including mental health (Klein et al., 2011; Steel et al., 2008), allostatic load (Milad & Bogg, 2020), and risk for chronic diseases (Compare et al., 2014; Jokela et al., 2014). Further, personality is significantly related to treatment adherence (Christensen & Smith, 1995).

Associations between personality and physical activity represent a potentially challenging obstacle and not a target for change. Personality resembles other intractable demographic correlates of physical activity such as age, disability status, or gender. Thus, health promoters need to consider interventions adapted to maximize outcomes according to personality differences. Little is known how personality impacts intervention reach (i.e., the effectiveness of strategies designed to attract people to exercise programs) and effectiveness (Glasgow et al., 1999). Personality might also predict which people are likely to succeed in the adoption and maintenance of a new behavior, such as physical activity, and who may be at risk for dropout or poor behavioral maintenance.

Some early evidence suggests that motivational traits interact with promotional message content to influence how that content is perceived. In a large sample (n = 800) of undergraduates, messages about physical activity that were presented in a gain-framed format (i.e. presenting the positive outcomes of a physically activity lifestyle) were perceived significantly more positively by individuals who scored high for approach motivation (conceptually similar to a profile of high Extraversion and low Neuroticism). On the other hand, loss-framed messages, presenting the negative outcomes of a sedentary lifestyle, were perceived significantly more negatively by people who scored high for avoidance motivation (conceptually similar to high Neuroticism and low Extraversion; Wilson & Estabrooks, 2020). Such differences could plausibly translate to an enhanced or reduced likelihood to volunteer for programs such as those being promoted in selected messages. Another study found that messages designed to target affect (i.e., "enjoyable" messages) were more effective in increasing walking behavior among conscientious individuals than messages targeting knowledge (i.e. "instrumental" messages), and that walking behavior increased under this messaging condition to a greater extent than for their less conscientious counterparts (Why et al., 2010).

Though the proposal for personality-matched interventions has appeal, there is very limited research on this approach at present. What evidence there is, is mixed. Rhodes and Matheson (2008) attempted a planning intervention for individuals low in Conscientiousness aimed at improving physical activity. Physical activity did not differ between the intervention and control group, however. Importantly, this null result may have reflected an ineffective intervention approach, as most of the

participants reported that they did not complete the planning worksheet, highlighting the issue of participant compliance with intervention protocols. This may especially be true for people scoring low for Conscientiousness, as they are characterized by low adherence to instructions and an absent sense of duty to comply. More recently, a planning intervention was observed to significantly impact the translation of intention for physical activity into successful performance of the behavior in a sample of 136 adults in cardiac rehabilitation, but only for those with high levels of Conscientiousness (Lippke et al., 2018). This echoes the observational evidence discussed previously with regard to intention, personality, and physical activity, and underscores the importance of identifying methods to assist individuals with low levels of Conscientiousness in following through on behavioral intentions.

Evidence linking personality to preference for, or responsiveness to, specific behavior change techniques could inform the continued efforts towards intervention adaptions according to personality. One study assessed ratings of behavioral techniques applied in mobile apps promoting physical activity among a sample of Dutch adults. Belmon and colleagues found that Agreeableness was related to a preference for goal setting and goal reviewing techniques, and Neuroticism was related to negative ratings of feedback and self-monitoring techniques (Belmon et al., 2015). Some evidence suggests that individual differences in Extraversion and Neuroticism may impact how effective different social strategies are for influencing behavior change. Extraverts and those scoring higher on Neuroticism were found to increase physical activity in response to a mobile app intervention under a condition of social comparison, but not peer pressure (Lepri et al., 2016). Another study examined personality in the context of behavior change when participants were provided a wearable physical activity tracker for a 35-day period. Among a sample (n = 52) of adults, step count increased significantly more over time with increasing increments of Conscientiousness, as well as among individuals with a combination of high scores for Conscientiousness and Neuroticism (Stieger et al., 2020). Interestingly, personality may also impact how using a wearable physical activity tracker makes them feel. Some evidence suggests that increasing increments of Openness and Conscientiousness are positively related to experiencing positive affect while wearing a physical activity tracker (Ryan et al., 2019). It should be noted that the opposite of positive affect is the absence of positive affect, rather than negative affect (Watson et al., 1999; Watson & Tellegen, 1999; but see Russell & Carroll, 1999; Chapter 12, Zenko & Ladwig, 2021). That is to say, the corollary to these observations is that with decreasing increments of Openness and Conscientiousness, we might expect no effect of wearables on positive affect. Encouragingly, there were no associations between personality and negative affect related to wearing a physical activity tracker. These early results underscore the importance of considering personality in the context of selecting behavior change techniques and suggest that targeted approaches based on personality may be helpful to maximize intervention effectiveness. Continued work is needed to ascertain the utility of personality-matched intervention.

Though emerging evidence is encouraging, direct tests of strategies targeting individual differences in personality have yet to be reported for interventions aiming to increase physical activity. Table 6.2 presents considerations derived from the body of evidence reviewed herein. An earlier iteration of these considerations is presented by Newsome et al., (in press). These preliminary considerations are presented with the intent to inform the application of personality psychology to physical activity promotion, and to provide a basis from which personality tailored or targeted approaches may be developed and tested with rigorous study design. It should be emphasized that this list of considerations has not been fully empirically tested and reflects the expertise and interpretations of the limited body of evidence discussed herein by the authors. Further, use of these considerations may be particularly challenging as they focus on individual traits. It is likely that individuals will present with high or low scores on multiple traits, complicating the application of these considerations. Everyone expresses individual differences on each of the Big Five factors; in other words, we are all classifiable according to this model and each of us present characteristics along each of these five

dimensions. As an example of the challenge presented, imagine two individuals who both score high for Extraversion. These two individuals, however, score significantly differently for another trait, like Openness. This very likely influences the types of behavioral strategies that will work best for each person. Practitioners may be able to combine considerations to accommodate for these unique interactions. For example, because extraverts like being active with others, and open individuals prefer unsupervised, outdoor activities (Courneya & Hellsten, 1998), one might recommend joining an unsupervised, socially supported (i.e., recruit a walking buddy), outdoor walking program to an open, extraverted patient. As is standard in physical activity programming, practitioners should always include the client in the development of a physical activity program. Considerations listed here should be viewed only as a potential starting point for discussion around program development.

Table 6.2

Considerations for Physical Activity Promotion and Exercise Programming for People with High or Low Scores on the Big Five Personality Dimensions

Trait expression	Promotion and Programming Considerations
(+) Extravert	Preferences include moderate-to-vigorous intensity, and activity with others. Motivated to exercise for enjoyment. May tend to go "too hard, too fast"; emphasize safe progression and recovery.
(-) Introvert	Likely to have an initial preference for lower intensities. Tend to avoid exposure to excessive sensory stimuli; recommend restorative and mindful activities. Likely to enjoy exercise alone or with a close friend. Outdoor or home exercise settings may enhance activity enjoyment.
(+) Neurotic	More likely to remain inactive due to embarrassment. Primary exercise motives related to appearance. Derive less enjoyment from exercise than others. Likely to benefit from strategies to enhance self-efficacy to overcome barriers related to physical activity/exercise, and programming to focus on short term, realistic goals. Focusing on the mental health benefit of exercise as a motivator may enhance adherence.
(-) Emotionally Stable	Pay attention to self-reported goals and logical program progression. Provide a means for feedback and self-monitoring.
(+) Conscientious	Very good at setting short- and long-term goals and creating action plans for success. Recommend long-term adherence as a focused goal. Self-monitoring techniques are typically well implemented, and feedback appreciated. May prefer higher intensity activities.
(-) Undirected	High risk for drop out, especially during times of high stress. Poor planning and goal setting skills. Be mindful of upcoming life events that may disrupt normal participation. Not motivated by tracking or feedback techniques. Social accountability with an important other is advisable. Try to identify activities that are challenging yet enjoyable to promote adherence.

Table 6.2 (continued)

(+) Open-minded	Variety may help facilitate adherence. May prefer outdoor and adventure activities. Make programming suggestions but promote autonomy in program development.
(-) Closed-minded	May challenge new ideas or unusual approaches (not likely to adopt the latest trend). Stick to traditional exercise programming. Highlight the evidence supporting programming development.
(+) Agreeable	Generally cooperative and easy going. Likely to take instruction well. May benefit from motivational interviewing to understand exercise preferences.
(-) Antagonistic	Likely to enjoy competition with oneself or others, and to be achievement oriented. Include progress checks and feedback while working towards short and long-term goals.

Conclusion

Physical activity has many antecedents that range from the individual to environmental and social policy. One personal factor that has received much attention and has the potential for broad reaching adaptations to current physical activity theory and practice is personality. Personality theory has one of the longest and richest traditions in psychology; currently, the dominant taxonomy used by scholars worldwide is the FFM. This model has also been used extensively to understand the role of personality in physical activity.

Currently the cumulative evidence supports a modest relationship between personality and physical activity. In particular, self-reported physical activity has a reliable, yet small positive association with Extraversion and Conscientiousness and a small negative relationship with Neuroticism. Much of the research to support these relationships is cross-sectional, yet there is a growing evidence base to show that personality can affect physical activity over time using longitudinal designs. Interestingly, some evidence even supports a beneficial effect of physical activity on personality change over time.

How personality may influence physical activity has also seen considerable research attention. There is a body of evidence that personality traits may play a role in social cognitive constructs such as attitudes, enjoyment, self-efficacy, barriers/motives, and intention. Conscientiousness, in particular, has been shown to influence whether people are likely to follow through with intentions, and may contribute to what is known as the intention-behavior gap. Similarly, personality may moderate the affective response to physical activity, thus influencing more impulsive determinants of behavior beyond social cognitions. Personality is also linked to physical activity choices and preferences. For example, it has been established that higher intensity aerobic activities are more likely to be performed by extraverts.

The relationships between general symptoms of mental distress and physical activity are dependent on personality characteristics. Individuals with personality profiles that put them at higher risk for mental distress may benefit from greater levels of fitness and physical activity participation. Less work has been done among populations with clinical mental disorders, which are frequently comorbid with chronic illness, highlighting the need for continued work in this direction.

Finally, research is starting to explore how personality may be used to improve physical activity interventions. Associations between personality and physical activity represent a potentially challenging obstacle rather than a target for change. Thus, health promoters may need to consider interventions

adapted to personality to maximize program reach and effectiveness. Preliminary considerations for the application of personality psychology to physical activity promotion provided herein (Table 6.2) should inform practitioners and interventionists aiming to maximize physical activity and exercise programming with the goal of adherence through personalized approaches.

In summary, much evidence exists on the relationships between personality and physical activity, though more work is required to understand genetic, cognitive, and affective mechanisms, developmental associations across extended periods of time, and the development and implementation of personality adapted physical activity promotion strategies. Lastly, rigorous measurement of physical activity with concurrent direct and indirect measures is needed to understand the differential observations of association between physical activity and personality to better inform application moving forward.

Learning Exercises

1. What is personality? Define personality in one sentence.
2. Describe the relationships between primary personality traits and physical activity in terms of direction and strength.
3. What are some social cognitive variables that have been studied in the context of personality and physical activity? How do these variables relate to personality and physical activity?
4. Based on what you know about the primary personality dimensions, what are some programming recommendations you would make for someone who is extremely extraverted? Introverted?
5. Have a friend complete one of the five factor personality measures available on the ipip website. Create exercise recommendations for them based on their survey responses.

Further Reading

Wilson, K. (2019). Personality and physical activity. In M. H. Anshel & S. J. Petruzzello (Eds.), *APA's Handbook of sport and exercise psychology* (Vol. 2, pp. 219–239). American Psychological Association. https://doi.org/10.1037/0000124-012

Rhodes, R. E., & Wilson, K. (2020). Personality and Physical Activity. In R. J. Schinke & D. Hackfort (Eds.), *The Routledge international encyclopedia of sport and exercise psychology* (Vol. 1, pp. 413–425). Taylor and Francis.

Rhodes, R. E., & Boudreau, P. (2017). Physical activity and personality traits. In *Oxford Research Encyclopedia of Psychology*. https://doi.org/10.1093/acrefore/9780190236557.013.210

Rhodes, R. E., & Pfaeffli, L. A. (2012). Personality and physical activity. In E. O. Acevedo (Ed.), *The Oxford handbook of exercise psychology* (pp. 195–223). Oxford University Press.

Newsome, A. N., Kilpatrick, M., Mastrofini, G., & Wilson, K. (2021). Personality traits and physical activity: Helping exercise professionals maximize client outcomes. *ACSM's Health & Fitness Journal.*

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References

Ainsworth, B. E., Haskell, W. L., Herrmann, S. D., Meckes, N., Bassett, D. R., Tudor-Locke, C., Greer, J. L., Vezina, J. W., Whitt-Glover, M., & Leon, A. S. (2011). 2011 compendium of physical activities. *Medicine & Science in Sports & Exercise*, *43*(8), 1575–1581. https://doi.org/10.1249/MSS.0b013e31821ece12

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/http://dx.doi.org/10.1016/0749-5978(91)90020-T

Allen, M. S., Magee, C. A., Vella, S. A., & Laborde, S. (2017). Bidirectional associations between personality and physical activity in adulthood. *Health Psychology*, *36*(4), 332–336.. https://doi.org/10.1037/hea0000371

Allport, G. W. (1927). Concepts of trait and personality. *Psychological Bulletin*, *24*(5), 284–293. https://doi.org/10.1037/h0073629

Allport, G. W., & Odbert, H. S. (1936). Trait-names: A psycho-lexical study. *Psychological Monographs*, *47*(1), i. https://doi.org/10.1037/h0093360

American Psychiatric Association Steering Committee on Practice Guidelines. (2010). *Practice Guideline for the Treatment of Patients With Major Depressive Disorder* (L. J. Fochtmann, Ed. 3 ed.). American Psychiatric Association. http://www.psychiatry.org/psychiatrists/practice/clinical-practice-guidelines

American Psychological Association. (2020). *Personality*. American Psychological Association. Retrieved 08/14/2020 from www.apa.org/topics/personality/

Baldwin, D., Datta, S., Bassett, D., Overstreet, B., & Schweighart, P. (2016). Feel better but exercise less: An examination of exercise enjoyment, personality and physical activity in young adults. *Acta Psychopathologica*, *2*(1), 1–7.

Barbuto, J. E. (1997). A critique of the Myers-Briggs Type Indicator and its operationalization of Carl Jung's psychological types. *Psychological Reports*, *80*(2), 611–625. https://doi.org/10.2466/pr0.1997.80.2.611

Barrett, B., Torres, E. R., Meyer, J., Barnet, J. H., & Brown, R. (2019). Predictors of mindfulness meditation and exercise practice, from MEPARI-2, a randomized controlled trial. *Mindfulness*, *10*(9), 1842–1854. https://doi.org/10.1007/s12671-019-01137-3

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J., Martin, B. W., & Lancet Physical Activity Series Working Group (2012). Correlates of physical activity: Why are some people physically active and others not? *The Lancet*, *380*(9838), 258–271. https://doi.org/10.1016/S0140-6736(12)60735-1

Belmon, L. S., Middelweerd, A., te Velde, S. J., & Brug, J. (2015). Dutch young adults ratings of behavior change techniques applied in mobile phone apps to promote physical activity: A cross-sectional survey. *JMIR mHealth and uHealth*, *3*(4), e103. https://doi.org/10.2196/mhealth.4383

Bize, R., Johnson, J. A., & Plotnikoff, R. C. (2007). Physical acitvity level and health-related quality of life in the general adults population: A systematic review. *Preventive Medicine*, *45*, 401–415. https://doi.org/10.1016/j.ypmed.2007.07.017

Bogg, T. (2008). Conscientiousness, the transtheoretical model of change, and exercise: A Neo-socioanalytic integration of trait and social-cognitive frameworks in the prediction of behavior. *Journal of Personality*, *76*(4), 775–802. https://doi.org/10.1111/j.1467-6494.2008.00504.x

Bogg, T., Voss, M. W., Wood, D., & Roberts, B. W. (2008). A hierarchical investigation of personality and behavior: Examining neo-socioanalytic models of health related outcomes. *Journal of Research in Personality*, *42*, 183–207. https://doi.org/10.1016/j.jrp.2007.05.003

Bouchard, T. J., & Loehlin, J. C. (2001). Genes, evolution, and personality. *Behavior Genetics*, *31*(3), 243–273. https://doi.org/10.1023/A:1012294324713

Brand, R., & Ekkekakis, P. (2021). Exercise behavior change revisited: Affective-reflective theory. In Z. Zenko & L. Jones (Eds.), *Essentials of exercise and sport psychology: An open access textbook* (pp. 62–92). Society for Transparency, Openness, and Replication in Kinesiology. https://doi.org/10.51224/B1004

Brush, C. J., & Burani, K. (2021). Exercise and physical activity for depression. In Z. Zenko & L. Jones (Eds.), *Essentials of exercise and sport psychology: An open access* textbook (pp. 338–368). Society for Transparency, Openness, and Replication in Kinesiology. https://doi.org/10.51224/B1015

Bryan, A. D., & Rocheleau, C. A. (2002). Predicting aerobic versus resistance exercise using the theory of planned behavior. *American Journal of Health Behavior*, *26*, 83–94. https://doi.org/10.5993.AJHB.26.2.1

Burnett, C. M., Allen, M. S., & Vella, S. A. (2016). Personality and sedentary behaviour in Australian adults. *International Journal of Sport and Exercise Psychology*, 1–6. https://doi.org/10.1080/1612197X.2016.1212083

Butkovic, A., Vukasovic Hlupic, T., & Bratko, D. (2017). Physical activity and personality: A behaviour genetic analysis. *Psychology of Sport & Exercise*, *30*, 128–134. https://doi.org/10.1016/j.psychosport.2017.02.005

Canli, T., Zhao, Z., Desmond, J. E., Kang, E., Gross, J., & Gabrieli, J. D. (2001). An fMRI study of personality influences on brain reactivity to emotional stimuli. *Behavioral Neuroscience*, *115*(1), 33. https://doi.org/10.1037/0735-7044.115.1.33

Cattell, R. B. (1947). Confirmation and clarification of primary personality factors. *Psychometrika*, *12*(3), 197–220. https://doi.org/10.1007/BF02289253

Chan, B. C. L., Luciano, M., & Lee, B. (2018). Interaction of physical activity and personality in the subjective wellbeing of older adults in Hong Kong and the United Kingdom. *Behavioral Sciences*, *8*(8), 71. https://doi.org/10.3390/bs8080071

Chan, C. M. H., Ahmad, W., Azman, W., MD Yusof, M., Ho, G. F., & Krupat, E. (2015). Effects of depression and anxiety on mortality in a mixed cancer group: a longitudinal approach using standardised diagnostic interviews. *Psycho-Oncology*, *24*(6), 718–725. https://doi.org/10.1002/pon.3714

Christensen, A. J., & Smith, T. W. (1995). Personality and patient adherence: correlates of the five-factor model in renal dialysis. *Journal of Behavioral Medicine*, *18*(3), 305–313. https://doi.org/10.1007/BF01857875

Coan, J. A., Allen, J. J., & McKnight, P. E. (2006). A capability model of individual differences in frontal EEG asymmetry. *Biological Psychology*, *72*(2), 198–207. https://doi.org/10.1016/j.biopsycho.2005.10.003

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge Academic.

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*, 155–159. https://dio.org/10.1037/0033.2909.112.1.155

Compare, A., Mommersteeg, P. M., Faletra, F., Grossi, E., Pasotti, E., Moccetti, T., & Auricchio, A. (2014). Personality traits, cardiac risk factors, and their association with presence and severity of coronary artery plaque in people with no history of cardiovascular disease. *Journal of Cardiovascular Medicine*, *15*(5), 423–430. https://doi.org/10.245/JCM.0b013e328365cd8c

Conner, M., & Abraham, C. (2001). Conscientiousness and the theory of planned behavior: Toward a more complete model of the antecedents of intentions and behavior. *Personality and Social Psychology Bulletin*, *27*, 1547–1561. https://doi.org/10.1177/01461672012711014

Conner, M., & Norman, P. (2015). *Predicting health behaviour: Research and practice with social cognition models*. Open University Press. https://doi.org/10.1080/1612197X.2015.1016085

Costa Jr, P. T., & McCrae, R. R. (2008). *The Revised NEO Personality Inventory (NEO-PI-R)*. Sage Publications, Inc. https://doi.org/10.4135/9781849200479.n8

Coulter, T. J., Mallett, C. J., Singer, J. A., & Gucciardi, D. F. (2016). Personality in sport and exercise psychology: Integrating a whole person perspective. *International Journal of Sport and Exercise Psychology*, *14*(1), 23–41. https://doi.org/10.1080/1612197X.2015.1016085

Courneya, K. S., & Hellsten, L.-A. M. (1998). Personality correlates of exercise behavior, motives, barriers and preferences: An application of the five-factor model. *Personality and Individual Differences*, *24*(5), 625–633. https://doi.org/10.1016/s0191-8869(97)00231-6

Čukić, I., Gale, C. R., Chastin, S. F., Dall, P. M., Dontje, M. L., Skelton, D. A., Deary, I. J., & Team, S. U. (2019). Cross-sectional associations between personality traits and device-based measures of step count and sedentary behaviour in older age: the Lothian Birth Cohort 1936. *BMC geriatrics*, *19*(1), 302. https://doi.org/10.1186/s12877-019-1328-3

de Geus, E., & Neumann, D. L. (2008). Psychophysiological measurement of personality. In G. J. Boyle, G. Matthews, & D. H. Saklofske (Eds.), *The SAGE handbook of personality theory and assessment, Vol 2: Personality measurement and testing.* (pp. 313–333). Sage Publications, Inc. https://doi.org/10.4135/9781849200479.n15

Delli Paoli, A. G. (2021). Predictors and correlates of physical activity and sedentary behavior. In Z. Zenko & L. Jones (Eds.), *Essentials of exercise and sport psychology: An open access textbook* (pp. 93–113). Society for Transparency, Openness, and Replication in Kinesiology. https://doi.org/10.51224/B1005

de Moor, M., Beem, A. L., Stubbe, J. H., Boomsma, D. I., & de Geus, E. J. C. (2006). Regular exercise, anxiety, depression and personality: A population-based study. *Preventive Medicine*, *42*(4), 273–279. https://doi.org/10.1016/j.ypmed.2005.12.002

de Moor, M., Costa, P. T., Terracciano, A., Krueger, R. F., de Geus, E. J. C., Toshiko, T., Penninx, B. W. J. H., Esko, T., Madden, P. A. F., Derringer, J., Amin, N., Willemsen, G., Hottenga, J. J., Distel, M. A., Uda, M., Sanna, S., Spinhoven, P., Hartman, C. A., Sullivan, P., … Boomsma, D. I. (2012). Meta-analysis of genome-wide association studies for personality. *Mol Psychiatry*, *17*(3), 337–349. https://dx.doi.org/10.1038%2Fmp.2010.128

de Moor, M., & de Geus, E. (2018). Causality in the associations between exercise, personality, and mental health. In H. Budde & M. Wegner (Eds.), *The exercise effect on mental health* (pp. 67–99). Routledge.

de Moor, M., & de Geus, E. J. (2012). Genetic influences in exercise behavior. In J. M. Rippe (Ed.), *Lifestyle medicine* (pp. 1367–1378). Taylor and Francis.

Denissen, J. J. A., van Aken, M. A. G., & Roberts, B. W. (2011). Personality development across the life span. In T. Chamorro-Premuzic, S. von Stumm, & A. Furnham (Eds.), *The Wiley Blackwell handbook of individual differences* (pp. 77–100). John Wiley & Sons, Ltd.

Depue, R. A., & Collins, P. F. (1999). Neurobiology of the structure of personality: Dopamine, facilitation of incentive motivation, and extraversion. *Behavioral and Brain Sciences*, *22*, 491-517. https://doi.org/10.1017/S0140525X99002046

Deutsch, R., & Strack, F. (2006). Duality models in social psychology: From dual processes to interacting systems. *Psychological Inquiry*, *17*, 166–172. https://doi.org/10.1207/s15327965pli1703_2

Digman, J. M. (1990). Personality structure: Emergence of the five-factor model. *Annual Review Of Psychology*, *41*(1), 417–440. https://doi.org/10.1146/annurev.ps.41.020190.002221

Ebstrup, J. F., Aadahl, M., Eplov, L. F., Pisinger, C., & Jørgensen, T. (2013). Cross-sectional associations between the five factor personality traits and leisure-time sitting-time: The effect of general self-efficacy. *Journal of Physical Activity & Health, 10*(4), 572–580. https://doi.org/10.1123/jpah.10.4.572

European Union Sport and Health Working Group. (2008). *European Union physical activity guidelines*.

Eysenck, H. J. (1947). *Dimensions of personality*. Praeger.

Eysenck, H. J. (1970). *The structure of human personality* (Third ed.). Methuen. https://doi.org/10.1037/h0052161

Eysenck, H. J., Nias, D. K. B., & Cox, D. N. (1982). Sport and Personality. *Advances in Behaviour Research and Therapy*, *4*, 1–56. https://doi.org/10.1016/0146-6402(82)90004-2

Ferguson, E. (2013). Personality is of central concern to understand health: Towards a theoretical model for health psychology. *Health Psychology Review*, *7*(sup1), S32–S70. https://doi.org/10.1080/17437199.2010.547985

Fibbins, H., Lederman, O., & Rosenbaum, S. (2021). Physical activity and severe mental illness. In Z. Zenko & L. Jones (Eds.), *Essentials of exercise and sport psychology: An open access textbook* (pp. 385–408). Society for Transparency, Openness, and Replication in Kinesiology. https://doi.org/10.51224/B1017

Funder, D. C. (2001). Personality. *Annual Review of Psychology*, *52*, 197–221.

Gignac, G. E., & Szodorai, E. T. (2016). Effect size guidelines for individual differences researchers. *Personality and Individual Differences*, *102*, 74–78. https://doi.org/10.1016/j.paid.2016.06.069

Glasgow, R. E., Vogt, T. M., & Boles, S. M. (1999). Evaluating the public health impact of health promotion interventions: the RE-AIM framework. *American Journal of Public Health*, *89*(9), 1322–1327. https://doi.org/10.2105/AJPH.89.9.1322

Goldberg, L. R. (1993). The structure of phenotypic personality traits. *American Psychologist*, *48*(1), 26–34. https://doi.org/10.1037/0003-066X.48.1.26

Goldberg, L. R. (1999). A broad-bandwidth, public-domain, personality inventory measuring the lower-level facets of several five-factor models. In I. Mervielde, I. Deary, F. De Fruyt, & F. Ostendorf (Eds.), *Personality psychology in Europe* (Vol. 7, pp. 7–28). Tilburg University Press.

Goldberg, L. R., Johnson, J. A., Eber, H. W., Hogan, R., Ashton, M. C., Cloninger, C. R., & Gough, H. G. (2006). The international personality item pool and the future of public-domain personality measures. *Journal of Research in Personality*, *40*(1), 84–96. https://doi.org/10.1016/j.jrp.2005.08.007

Gray, J. A. (1991). The neuropsychology of temperament. In J. Strelau & A. Angleitner (Eds.), *Explorations in temperament* (pp. 105–128). Plenum Press. https://doi.org/10.1007/978-1-4899-0643-4_8

Gray, J. A., & McNaughton, N. (2000). *The neuropsychology of anxiety: An enquiry into the funtions of the septo-hippocampal system* (2nd ed.). Oxford University Press. https://doi.org/10.1017/S000712500011373X

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: A pooled analysis of 358 population-based surveys with 1·9 million participants. *The Lancet Global Health*, *6*(10), e1077–e1086. https://doi.org/10.1016/S2214-109X(18)30357-7

Hagan, A. L., Rhodes, R. E., Hausenblas, H., & Giacobbi, P. R. (2009). Integrating five-factor model facet level traits with the theory of planned behavior and exercise. *Psychology of Sport & Exercise*, *10*, 565–572. https://doi.org/10.1016/j.psychsport.2009.02.008

Hall, E. E., Ekkekakis, P., & Petruzzello, S. J. (2005). Is the relationship of RPE to psychological factors intensity-dependent? *Medicine & Science in Sports & Exercise*, *37*(8), 1365–1373. https://doi.org/10.1249/01.mss.0000174897.25739.3c

Hallal, P. C., Andersen, L. B., Bull, F. C., Guthold, R., Haskell, W., Ekelund, U., & Group, L. P. A. S. W. (2012). Global physical activity levels: surveillance progress, pitfalls, and prospects. *The Lancet*, *380*(9838), 247–257. https://doi.org/10.1016/50140-6736(12)60646-1

Hammond, W. (1957). The status of physical types. *Human biology*, *29*(3), 223–241. https://www.jstor.org/stable/41449137

Haskell, W. L., Lee, I.-M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., Macera, C. A., Heath, G. W., Thompson, P. D., & Bauman, A. (2007). Physical activity and public health: Updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation*, *116*(9), 1081–1093. https://doi.org/10.1161/circulationaha.107.185649

Hearon, B. A., & Harrison, T. J. (2020). Not the exercise type? Personality traits and anxiety sensitivity as predictors of objectively measured physical activity and sedentary time. *Journal of Health Psychology*. https://doi.org/10.1177/1359105320906242

Hepler, T. J., Hill, C. R., Chase, M. A., & Feltz, D. L. (2021). Self, relational, and collective efficacy in athletes. In Z. Zenko & L. Jones (Eds.), *Essentials of exercise and sport psychology: An open access textbook* (pp. 643–663). Society for Transparency, Openness, and Replication in Kinesiology. https://doi.org/10.51224/B1027

Howard, J. H., Cunningham, D. A., & Rechnitzer, P. A. (1987). Personality and fitness decline in middle-aged men. *International Journal of Sport Psychology*, *18*, 100–111.

Hoyt, A. L., Rhodes, R. E., Hausenblas, H., & Giacobbi, P. R. (2009). Integrating five-factor model facet level traits with the theory of planned behavior and exercise. *Psychology of Sport & Exercise*, *10*, 565–572. https://doi.org/10.1016/j.psychsport.2009.02.008

Ingledew, D. K., & Markland, D. (2008). The role of motives in exercise participation. *Psychology & Health*, *23*(7), 807–828. https://doi.org/10.1080/08870440701405704

Jang, K. L., Livesley, W. J., & Vernon, P. A. (1996). Heritability of the big five personality dimensions and their facets: a twin study. *Journal of Personality*, *64*, 577–591. https://doi.org/10.1111/j.1467-6494.1996.tb00522.x

John, O. P., Donahue, E. M., & Kentle, R. L. (1991). Big five inventory. *Journal of Personality and Social Psychology*. https://doi.org/10.1037/t07550-000

Johnson, D. L., Wiebe, J. S., Gold, S. M., Andreasen, N. C., Hichwa, R. D., Watkins, G. L., & Boles Ponto, L. L. (1999). Cerebral blood flow and personality: A positron emission tomography study. *American Journal of Psychiatry*, *156*(2), 252–257.

Jokela, M., Pulkki-Råback, L., Elovainio, M., & Kivimäki, M. (2014). Personality traits as risk factors for stroke and coronary heart disease mortality: Pooled analysis of three cohort studies. *Journal of Behavioral Medicine*, *37*(5), 881–889. https://doi.org/10.1007/s10865-013-9548-z

Jones, L., Hutchinson, J. C., & Mullin, E. M. (2018). In the zone: An exploration of personal characteristics underlying affective responses to heavy exercise. *Journal of Sport and Exercise Psychology*, *40*(5), 249–258. https://doi.org/10.1123/jsep.2017-0360

Jones. L., & Zenko, Z. (2021). Strategies to facilitate more pleasant exercise experiences. In Z. Zenko & L. Jones (Eds.), *Essentials of exercise and sport psychology: An open access textbook* (pp. 242–270). Society for Transparency, Openness, and Replication in Kinesiology. https://doi.org/10.51224/B1011

Joyner, C., Biddle, S. J., & Loprinzi, P. D. (2019). Association of personality on changes in weekday sitting time: cross-sectional and prospective evaluation. *Journal of Lifestyle Medicine*, *9*(1), 60. https://doi.org/10.15280/jlm.2019.9.1.60

Joyner, C., & Loprinzi, P. D. (2017). The association of personality on anxiety: Moderation considerations of physical activity. *Journal of Behavioral Health*, *6*(2), 89–92. https://doi.org/10.5455/jbh.20170103051957

Joyner, C., & Loprinzi, P. D. (2018). Longitudinal effects of personality on physical activity among college students: Examining executive function as a potential moderator. *Psychological Reports*, *121*(2), 344–355. https://doi.org/10.1177/0033294117726076

Jung, C. G. (1923). *Psychological types; or, The psychology of individuation*. Paul, Trench, Trubner.

Karvonen, J., Törmäkangas, T., Pulkkinen, L., & Kokko, K. (2020). Associations of temperament and personality traits with frequency of physical activity in adulthood. *Journal of Research in Personality*, *84,* 103887. https://doi.org/10.1016/j.jrp.2019.103887

Kekäläinen, T., Laakkonen, E. K., Terracciano, A., Savikangas, T., Hyvärinen, M., Tammelin, T. H., Rantalainen, T., Törmäkangas, T., Kujala, U. M., & Alen, M. (2020). Accelerometer-measured and self-reported physical activity in relation to extraversion and neuroticism: A cross-sectional analysis of two studies. *BMC geriatrics*, *20*(1), 1–11. https://doi.org/10.1186/s12877-020-01669-7

Kern, M. L., Reynolds, C. A., & Friedman, H. S. (2010). Predictors of physical activity patterns across adulthood: A growth curve analysis. *Personality and Social Psychology Bulletin*, *36*(8), 1058–1072. https://doi.org/10.1177/0146167210374834

Klein, D. N., Kotov, R., & Bufferd, S. J. (2011). Personality and depression: Explanatory models and review of the evidence. *Annual review of clinical psychology*, *7*, 269–295. https://doi.org/10.1146/annurev-clinpsy-032210-104540

Kuroda, Y., Hudson, J., & Thatcher, R. (2015). Motivational state and personality in relation to emotion, stress, and HRV responses to aerobic exercise. *Journal of Psychophysiology, 29*(4), 147–160. https://psycnet.apa.org/doi/10.1027/0269-8803/a000146

Lanyon, R. I., & Goodstein, L. D. (1997). *Personality assessment*. John Wiley & Sons.

Lepri, B., Staiano, J., Shmueli, E., Pianesi, F., & Pentland, A. (2016). The role of personality in shaping social networks and mediating behavioral change. *User-Model User Adaptation Interface*, *26*, 143–175. https://doi.org/10.1007/s11257-016-9173-y

Lerner, R. M. (1969). The development of stereotyped expectancies of body build-behavior relations. *Child Development*, 137–141. https://doi.org/10.2307/1127162

Lippke, S., Pomp, S., & Fleig, L. (2018). Rehabilitants' conscientiousness as a moderator of the intention–planning-behavior chain. *Rehabilitation Psychology*, *63*(3), 460. https://doi.org/10.1037/rep0000210

Lochbaum, M. R., Litchfield, K., Podlog, L., & Lutz, R. (2013). Extraversion, emotional instability, and self-reported exercise: The mediating effects of approach-avoidance achievement goals. *Journal of Sport and Health Science*, *2*, 176–183. https://doi.org/http://dx.doi.org/10.1016/j.jshs.2012.08.002

Lochbaum, M. R., & Lutz, R. (2005). Exercise enjoyment and psychological response to acute exercise: The role of personality and goal cognitions. *Individual Differences Research*, *3*(3), 153–161.

McCrae, R. R., & Costa, J., P.T. (1999). A five-factor theory of personality. In L. A. Pervin & O. P. John (Eds.), *Handbook of personality: Theory and research* (2nd ed., pp. 139-153). The Guilford Press.

McCrae, R. R., & Costa, J., P.T. (2008). The five-factor theory of personality. In O. P. John, R. W. Robins, & L. A. Pervin (Eds.), *Handbook of personality: Theory and research* (3rd ed., pp. 159–181). The Guilford Press.

McCrae, R. R., & Costa, P. T. (1995). Trait explanations in personality psychology. *European Journal of Personality*, *9*, 231–252. https://doi.org/10.1002/per.2410090402

McCrae, R. R., Costa, P. T., Ostendorf, F., Angleitner, A., Hrebickova, M., Avia, M. D., Sanz, J., Sanchez-Bernardos, M. L., Kusdil, M. E., Woodfield, R., Saunders, P. R., & Smith, P. B. (2000). Nature over nurture: Temperament, personality, and life-span development. *Journal of Personality & Social Psychology*, *78*, 173–186. https://doi.org/10.1037/0022-3514.78.1.173

McDowell, C. P., Wilson, K. E., Monroe, D. C., McCrory, C., Kenny, R. A., & Herring, M. P. (2020). Physical activity partially mediates associations between "Big" personality traits and incident generalized anxiety disorder: Findings from the irish longitudinal study on ageing. *Journal of Affective Disorders*, *277*, 46–52. https://doi.org/https://doi.org/10.1016/j.jad.2020.07.124

McEachan, R. R. C. (2004). The role of personality in predicting exercise behaviour: A systematic review. *Health Psychology Update*, *13*, 14–18.

McEachan, R. R. C., Sutton, S., & Myers, L. (2010). Mediation of personality influences on physical activity within the theory of planned behaviour. *Journal of Health Psychology*, *15*(8), 1170–1180. https://doi.org/10.1177/1359105310364172

McEwan, D., Boudreau, P., Curran, T., & Rhodes, R. E. (2019). Personality traits of high-risk sport participants: A meta-analysis. *Journal of Research in Personality*, *79*, 83–93. https://doi.org/10.1016/j.jrp.2019.02.006

Milad, E., & Bogg, T. (2020). Personality traits, coping, health-related behaviors, and cumulative physiological health in a national sample: 10 year prospective effects of conscientiousness via perceptions of activity on allostatic load. *Annals of Behavioral Medicine*. https://doi.org/10.1093/abm/kaaa024

Mischel, W., & Shoda, Y. (1999). Integrating dispositions and processing dynamics within a unified theory of personality: The cognitive-affective personality system. In *Handbook of personality: Theory and research* (Vol. 2, pp. 197–218).

Montano, D. E., & Kasprzyk, D. (2015). Theory of reasoned action, theory of planned behavior, and the integrated behavioral model. In K. Glanz, B. L. Rimer, & K. Viswanath (Eds.), *Health behavior: Theory, research, and practice*. John Wiley & Sons, Ltd.

Mõttus, R., Epskamp, S., & Francis, A. (2017). Within- and between individual variability of personality characteristics and physical exercise. *Journal of Research in Personality*, *69*, 139–148. https://doi.org/10.1016/j.jrp/2016.06.017

Nederend, I., Schutte, N. M., Bartels, M., ten Harkel, A. D., & de Geus, E. J. (2016). Heritability of heart rate recovery and vagal rebound after exercise. *European Journal of Applied Physiology*, *116*(11-12), 2167–2176. https://doi.org/10.1007/s00421-016-3459-y

Newsome, A. N., Kilpatrick, M., Mastrofini, G., & Wilson, K. (in press). Personality traits and physical activity: Helping exercise professionals maximize client outcomes. *ACSM's Health & Fitness Journal.*

Office of Disease Preventon and Health Promotion. (2017). *Physical activity guidelines*. https://health.gov/paguidelines/

Pailing, P. E., & Segalowitz, S. J. (2004). The error-related negativity as a state and trait measure: Motivation, personality, and ERPs in response to errors. *Psychophysiology*, *41*(1), 84–95. https://doi.org/10.1111/1469-8986.00124

Pate, R. R., Pratt, M., Blair, S., Haskell, W. L., Macera, C. A., & Bouchard, C. (1995). Physical activity and public health: A recommendation from the Centers of Disease Control and Prevention and the American College of Sports Medicine. *Journal of the American Medical Association*, *273*, 402–-407. https://doi.org/10.1001/jama.1995.03520290054029

Petersen, G. L., Mortensen, E. L., Rod, N. H., Lange, T., Flensborg-Madsen, T., Hansen, Å. M., & Lund, R. (2018). Occupational social class and personality traits in relation to leisure-time physical activity level: Cross-sectional results from the Copenhagen Aging and Midlife Biobank. *Journal of Aging and Health*, *30*(8), 1263–1283. https://doi.org/10.1177/0898264317714928

Piercy, K. L., Troiano, R. P., Ballard, R. M., Carlson, S. A., Fulton, J. E., Galuska, D. A., George, S. M., & Olson, R. D. (2018). The physical activity guidelines for Americans. *JAMA*, *320*(19), 2020–2028. https://doi.org/10.1001/jama.2018.14854

Rebar, A. L., Alfrey, K.-L., & Gardner, B. (2021). Theories of physical activity motivation. In Z. Zenko & L. Jones (Eds.), *Essentials of exercise and sport psychology: An open access textbook* (pp. 15–36). Society for Transparency, Openness, and Replication in Kinesiology. https://doi.org/10.51224/B1002

Revelle, W., Wilt, J., & Condon, D. (2011). Individual differences and differential psychology: A brief history and prospect. In T. Chamorro-Premuzic, S. von Stumm, & A. Furnham (Eds.), *The Wiley Blackwell handbook of individual differences* (pp. 3–38). John Wiley & Sons, Ltd.

Rhodes, R. E. (2006). The built-in environment: the role of personality and physical activity. *Exercise and Sport Science Reviews*, *34*(2), 83–88.

Rhodes, R. E., & Boudreau, P. (2017). Physical activity and personality traits. In *Oxford Research Encyclopedia of Psychology*. https://doi.org/10.1093/acrefore/9780190236557.013.210

Rhodes, R. E., & Courneya, K. S. (2003). Relationships between personality, an extended theory of planned behaviour model and exercise behaviour. *British Journal of Health Psychology*, *8*(1), 19. https://doi.org/10.1348/135910703762879183

Rhodes, R. E., Courneya, K. S., Blanchard, C. M., & Plotnikoff, R. C. (2007). Prediction of leisure-time walking: an integration of social cognitive, perceived environmental, and personality factors [Article]. *International Journal of Behavioral Nutrition & Physical Activity*, *4*, 51–61. https://doi.org/10.1186/1479-5868-4-51

Rhodes, R. E., Courneya, K. S., & Hayduk, L. A. (2002). Does personality moderate the theory of planned behavior in the exercise domain? *Journal of Sport and Exercise Psychology*, *24*, 120–132. https://doi.org/10.1123/jsep.24.2.120

Rhodes, R. E., Courneya, K. S., & Jones, L. W. (2002). Personality, the Theory of Planned Behavior, and Exercise: A Unique Role for Extroversion's Activity Facet. *Journal of Applied Social Psychology*, *32*(8), 1721–1736. https://doi.org/10.1111/j.1559-1816.2002.tb02772.x

Rhodes, R. E., Courneya, K. S., & Jones, L. W. (2004). Personality and social cognitive influences on exercise behavior: adding the activity trait to the theory of planned behavior. *Psychology of Sport and Exercise*, *5*(3), 243–254. https://doi.org/10.1016/s1469-0292(03)00004-9

Rhodes, R. E., Courneya, K. S., & Jones, L. W. (2005). The theory of planned behavior and lower-order personality traits: Interaction effects in the exercise domain. *Personality and Individual Differences*, *38*(2), 251–265. https://doi.org/10.1016/j.paid.2004.04.005

Rhodes, R. E., & Dickau, L. (2013). Moderators of the intention-behaviour relationship in the physical activity domain: a systematic review. *British Journal of Sports Medicine*, *47*(4), 215–225. https://doi.org/10.1136/bjsports-2011-090411

Rhodes, R. E., Fiala, B., & Conner, M. (2010). A Review and Meta-Analysis of Affective Judgments and Physical Activity in Adult Populations. *Annals of Behavioral Medicine*, *38*(3), 180–204. https://doi.org/10.1007/s12160-009-9147-y

Rhodes, R. E., Janssen, I., Bredin, S. S., Warburton, D. E., & Bauman, A. (2017). Physical activity: Health impact, prevalence, correlates and interventions. *Psychology & Health*, *32*(8), 942–975. https://doi.org/10.1080/08870446.2017.1325486

Rhodes, R. E., & Kates, A. (2015). Can the affective response to exercise predict future motives and physical activity behavior? A systematic review of published evidence. *Annals of Behavioral Medicine*, *49*(5), 715–731. https://doi.org/10.1007/s12160-015-9704-5

Rhodes, R. E., & Matheson, D. H. (2008). Does personality moderate the effect of implementation intentions on physical activity? *Annals of Behavioral Medicine*, *35,* S209.

Rhodes, R. E., & Pfaeffli, L. A. (2012). Personality and physical activity. In E. O. Acevedo (Ed.), *The Oxford handbook of exercise psychology* (pp. 195–223). Oxford University Press.

Rhodes, R. E., & Smith, N. E. I. (2006). Personality correlates of physical activity: A review and meta-analysis. *British Journal of Sports Medicine*, *40*, 958–965. https://doi.org/10.1136/bjsm.2006.028860

Rhodes, R. E., & Wilson, K. (2020). Personality and physical activity. In R. J. Schinke & D. Hackfort (Eds.), *The Routledge international encyclopedia of sport and exercise psychology* (Vol. 1, pp. 413–425). Taylor and Francis.

Riemann, R., Angleitner, A., & Strelau, J. (1997). Genetic and environmental influences on personality: A study of twins reared together using the self- and peer report NEO-FFI scales. *Journal of Personality*, *65*, 449–475. https://doi.org/10.1111/j.1467-6494.1997.tb00324.x

Roberts, B. W., Walton, K. E., & Viechtbauer, W. (2006). Patterns of mean-level change in personality traits across the life course: a meta-analysis of longitudinal studies. *Psychological Bulletin*, *132*, 1–25. https://doi.org/10.1037/0033-2909.132.1.1

Rothbart, M. K. (2007). Temperament, development, and personality. *Current Directions in Psychological Science*, *16*, 207–212. https://doi.org/10.1111/j.1467-8721.2007.00505.x

Rowe, E. W. P., Alyssa M., & Kamphaus, R. W. (2008). Behavioral measures of personality in children. In G. J. Boyle, G. Matthews, & D. H. Saklofske (Eds.), *The SAGE handbook of personality theory and assessment* (Vol. 2, pp. 547–565). SAGE Publications Ltd.

Russell, J. A., & Carroll, J. M. (1999). On the bipolarity of positive and negative affect. *Psychological Bulletin, 125*(1), 3–30. https://doi.org/10.1037/0033-2909.125.1.3

Ryan, J., Edney, S., & Maher, C. (2019). Anxious or empowered? A cross-sectional study exploring how wearable activity trackers make their owners feel. *BMC Psychology*, *7*(1), 42. https://doi.org/10.1186/s40359-019-0315-y

Schneider, M. L., & Graham, D. J. (2009). Personality, physical fitness, and affective response to exercise among adolescents. *Medicine & Science in Sports & Exercise*, *41*(4), 947–955. https://doi.org/10.1249/MSS.0b013e31818de009

Schuch, F. B., Stubbs, B., & Kandola, A. (2021). Physical activity and exercise for the prevention and management of anxiety. In Z. Zenko & L. Jones (Eds.), *Essentials of exercise and sport psychology: An open access textbook* (pp. 369–384). Society for Transparency, Openness, and Replication in Kinesiology. https://doi.org/10.51224/B1016

Schutte, N. M., Nederend, I., Bartels, M., & de Geus, E. J. (2019). A twin study on the correlates of voluntary exercise behavior in adolescence. *Psychology of Sport and Exercise*, *40*, 99–109. https://doi.org/10.1016/j.psychsport.2018.10.002

Schutte, N. M., Nederend, I., Hudziak, J. J., Bartels, M., & de Geus, E. J. C. (2016). Heritability of the affective response to exercise and its correlation to exercise behavior. *Psychology of Sport and Exercise, 31,* 139–148. http://dx.doi.org/10.1016/j.psychsport.2016.12.001

Sheldon, W. H., & Stevens, S. S. (1942). *The varieties of temperament; A psychology of constitutional differences.* Harper.

Slaughter, M. (1970). An analysis of the relationship between somatotype and personality traits of college women. *Research Quarterly. American Association for Health, Physical Education and Recreation*, *41*(4), 569–575. https://doi.org/10.1080/10671188.1970.10615017

Smith, G., Williams, L., O'Donnell, C., & McKechnie, J. (2017). The influence of social-cognitive constructs and personality traits on physical activity in healthy adults. *International Journal of Sport and Exercise Psychology*, *15*, 540–555. https://doi.org/10.1080/1612197X.2016.1142459

Steel, P., Schmidt, J., & Shultz, J. (2008). Refining the relationship between personality and subjective well-being. *Psychological Bulletin*, *134*(1), 138–161. https://doi.org/10.1037/0033-2909.134.1.138

Stelmack, R. M., & Stalikas, A. (1991). Galen and the humour theory of temperament. *Personality and Individual Differences*, *12*(3), 255–263. http://dx.doi.org/10.1016/0191-8869(91)90111-N

Stephan, Y., Boiché, J., Canada, B., & Terracciano, A. (2014). Association of personality with physical, social, and mental activities across the lifespan: Findings from US and French samples. *British Journal of Psychology*, *105*(4), 564–580. https://doi.org/10.1111/bjop.12056

Stephan, Y., Sutin, A. R., Luchetti, M., Bosselut, G., & Terracciano, A. (2018). Physical activity and personality development over twenty years: Evidence from three longitudinal samples. *Journal of Research in Personality*, *73*, 173–179. https://doi.org/10.1016/j.jrp.2018.02.005

Stephan, Y., Sutin, A. R., & Terracciano, A. (2014). Physical activity and personality development across adulthood and old age: Evidence from two longitudinal studies. *Journal of Research in Personality*, *49*, 1–7. https://doi.org/10.1016/j.jrp.2013.12.003

Stieger, M., Robinson, S. A., Bisson, A. N., & Lachman, M. E. (2020). The relationship of personality and behavior change in a physical activity intervention: The role of conscientiousness and healthy neuroticism. *Personality and Individual Differences*, *166*. https://doi.org/10.1016/j.paid.2020.110224

Stubbe, J. H., Boomsma, D. I., Vink, J. M., Cornes, B. K., Martin, N. G., Skytthe, A., & de Geus, E. J. (2006). Genetic influences on exercise participation in 37,051 twin pairs from seven countries. *PLoS One,*, *1*, e22. https://doi.org/10.1371/journal.pone.0000022

Sutin, A. R., Stephan, Y., Luchetti, M., Artese, A., Oshio, A., & Terracciano, A. (2016). The five-factor model of personality and physical inactivity: A meta-analysis of 16 samples. *Journal of Research in Personality*, *63*, 22–28. http://dx.doi.org/10.1016/j.jrp.2016.05.001

Sutin, A. R., & Terracciano, A. (2016). Personality traits and body mass index: Modifiers and mechanisms. *Psychology & Health*, *31*(3), 259–275. https://doi.org/10.1080/08870446.2015.1082561

Takatori, K., Matsumoto, D., Miyazaki, M., Yamasaki, N., & Moon, J.-S. (2019). The difference between self-perceived and chronological age in the elderly may correlate with general health, personality and the practice of good health behavior: A cross-sectional study. *Archives of gerontology and geriatrics*, *83*, 13–19. https://doi.org/10.1016/j.archger.2019.03.009

Terracciano, A., Schrack, J. A., Sutin, A. R., Chan, W., Simonsick, E. M., & Ferrucci, L. (2013). Personality, Metabolic Rate and Aerobic Capacity. *PLoS One*, *8*(1), e54746. https://doi.org/10.1371/journal.pone.0054746

Teychenne, M., White, R. L., Richards, J., Schuch, F. B., Rosenbaum, S., & Bennie, J. A. (2020). Do we need physical activity guidelines for mental health: What does the evidence tell us? *Mental Health and Physical Activity*, *18*, 100315. https://doi.org/10.1016/j.mhpa.2019.100315

Thurstone, L. L. (1934). The vectors of mind. *Psychological Review*, *41*(1), 1. https://doi.org/10.1037/h0075959

Troiano, R. P., McClain, J. J., Brychta, R. J., & Chen, K. Y. (2014). Evolution of accelerometer methods for physical activity research. *British Journal of Sports Medicine*, *48*(13), 1019–1023.

Tupes, E., & Christal, R. (1961). Recurrent personality factors based on trait ratings (Tech. Rep. No. 61-97). *Lackland Air Force Base: USAF ASD Technical Report*. https://doi.org/10.1111/j.1467-6494.1992.tb00973.x

U.S. Department of Health and Human Services. (2018). *Physical activity guidelines for Americans*, *2nd edition.* Washington, DC: U.S. Department for Health and Human Services. https://www.health.gov/sites/defaut/files/2019-09/Physical_Activity_Guidelines_2nd_edition.pdf

Vukasovic, T., & Bratko, D. (2015). Heritability of personality: A meta- analysis of behavior genetic studies. *Psychological Bulletin*, *141*, 769–785. https://doi.org/10.1037/bul0000017

Watkins, L. L., Koch, G. G., Sherwood, A., Blumenthal, J. A., Davidson, J. R., O'Connor, C., & Sketch, M. H. (2013). Association of anxiety and depression with all-cause mortality in individuals with coronary heart disease. *Journal of the American Heart Association*, *2*(2), e000068. https://doi.org/10.1161/JAHA.112.000068

Watson, D., Wiese, D., Vaidya, J., & Tellegen, A. (1999). The two general activation systems of affect: Structural findings, evolutionary considerations, and psychobiological evidence. *Journal of Personality and Social Psychology, 76*(5), 820–838. https://doi.org/10.1037/0022-3514.76.5.820

Watson, D., & Tellegen, A. (1999). Issues in dimensional structure of affect—Effects of descriptors, measurement error, and response formats: Comment on Russell and Carroll (1999). *Psychological Bulletin, 125*(5), 601–610. https://doi.org/10.1037/0033-2909.125.5.601

Webb, E. (1915). *Character and intelligence: An attempt at an exact study of character*. University Press.

WHO. (2010). *Global recommendations on physical activity for health*. World Health Organization.

Why, Y. P., Huang, R. Z., & Sandhu, P. K. (2010). Affective messages increase leisure walking only among conscientious individuals. *Personality and Individual Differences*, *48*, 752–756. https://doi.org/10.1016/j.paid.2010.01.022

Williams, D. M., Rhodes, R. E., & Conner, M. T. (2019). Conceptualizing and intervening on affective determinants of health behaviour. *Psychology & Health, 34*, 1267–1281 https://doi.org/10.1080/08870446.2019.1675659

Wilson, K. (2019). Personality and Physical Activity. In M. H. Anshel & S. J. Petruzzello (Eds.), *APA's handbook of sport and exercise psychology* (Vol. 2, pp. 219–239). American Psychological Association. https://doi.org/10.1037/0000124-012

Wilson, K., Das, B., Evans, E., & Dishman, R. (2016). Structural equation modeling supports a moderating role of personality in the relationship between physical activity and mental health in college women. *Journal of Physical Activity & Health*, *13*, 67–78. https://doi.org/10.1123/jpah.2014-0455

Wilson, K., Das, B. M., Evans, E. M., & Dishman, R. K. (2015). Personality correlates of physical activity in college women. *Medicine & Science in Sports & Exercise*, *47*(8), 1691–1697. https://doi.org/10.1249/MSS.0000000000000570

Wilson, K., & Dishman, R. (2015). Personality and physical activity: A systematic review and meta-analysis. *Personality & Individual Differences*, *72*, 230–242. https://doi.org/10.1016/j.paid.2014.08.023

Wilson, K., & Estabrooks, P. A. (2020). Physical activity promotion message perceptions biased by motivational dispositions. *Applied Psychology: Health and Well Being*, *12*(3), 610–635. https://doi.org/10.1111/aphw.12199

Yasunaga, A., & Yaguchi, K. (2014). Personality traits, self-efficacy for exercise, and exercise levels in older Japanese adults. *健康心理学研究*, *27*(1), 1–11. http://doi.org/10.11560/jahp.27.1_1

Yeatts, P. E., Martin, S. B., & Petrie, T. A. (2017). Physical fitness as a moderator of neuroticism and depression in adolescent boys and girls. *Personality and Individual Differences*, *114*, 30–35. https://doi.org/10.1016/j.paid.2017.03.040

Zenko, Z., & Ladwig, M. A. (2021). Affective responses to exercise: Measurement considerations for practicing professionals. In Z. Zenko & L. Jones (Eds.), Essentials of exercise and sport psychology: An open access textbook (pp. 271–293). Society for Transparency, Openness, and Replication in Kinesiology. https://doi.org/10.51224/B1012

Zuckerman, M. (2005). *Psychobiology of personality* (2nd ed.). Cambridge University Press.

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