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Jangle Fallacy: Is Grit Distinct from Other Psychological Constructs?

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Jangle Fallacy: Is Grit Distinct from Other Psychological Constructs?

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by

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ABSTRACT

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This paper assessed the redundancy of the construct of *grit* (Crede, Tynan, Harms, 2017) compared to other similar constructs using structural equation modeling to remove the effect of measurement error. A series of models regressed grit and its subdomains (*passion* and *perseverance of effort*) on self-control, conscientiousness, achievement striving, and resilience. The R-squared values for these models ranged from 0.62 to 0.89. It is concluded that the concept of grit is mostly redundant with other constructs and is therefore an example of a Jangle fallacy (Kelley, 1927). The unique aspect of grit is mostly related to its *passion* subdomain. The latent correlation between the passion and perseverance of effort subdomains was r = 0.19. Further, it was found that several popular measures failed to conform to their intended factor structure.

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Chapter 1. Introduction

The term "grit" has become a popular construct in recent years. Hochanadel and Finamore (2015), Bashant (2014), and Pappano (2103) all discuss ways in which teachers in K-12 classrooms can foster, teach, and improve students' grit. Author Laila Sanguras wrote a popular book on how educators can create an environment that fosters grit for their students (Sanguras, 2007). Author Lee Daniels lays out 16 steps to develop grit in his book, and in the second edition explains why children should develop grit and advises parents on questions to ask to help them develop it (Daniels, 2017). Perkins-Gough's (2013) conversation with Angela Duckworth – the researcher who introduced grit to the scientific literature – has been cited 209 times (at the time of this manuscript, 2020). In that conversation, Duckworth mentions collaborating with researcher Carol Dweck to develop an intervention intended to increase students' grit. (The effectiveness of this intervention has not yet been demonstrated). Despite the lack of research evidence showing that grit is manipulable or teachable, K-12 educators have shown great interest in it, and the market has responded with books, professional development, and other products targeted at teachers and administrators. Nationally recognized talk show host and head tennis coach at Eastern Washington University, Dr. Steve Clark, quotes Duckworth on his blog, laying out steps that develop grit within youth (Clark, 2019). Dr. Steve Clark suggests that grit is a teachable skill that can be coached and instilled in young college athletes. The steps that Dr. Clark describes may or may not effectively enhance grit, but they do bear strong similarity to the process of deliberate practice (Ericsson, 2008). The only intervention intended to improve grittiness that has been empirically evaluated investigated deliberate practice to improve math test scores in 5th graders (Eskreis-Winkler et al., 2016). The aim of this study was to examine if nonexperts could be motivated to engage in deliberate practice and thereby improve their online math performance. There was no main effect of the intervention but the

authors suggested that the intervention did have an effect on low achieving students, b= -0.37, SE = 0.14, t(197)= -2.65, p=0.1. Results from this study also revealed a significantly negative effect of treatment for high-achieving students (high achieving students were defined as having scored >1.78 *SD* above average on the pretest). The cut point for defining high achieving students was not clearly stated prior to data analysis.

It appears that pop psychology's embracement of grit has far outstripped the science, particularly regarding intervention efforts. For example, Hochandel and Finamore (2015) wrote, "Duckworth and Dweck collaborated…. Duckworth concluded that having a growth mindset could develop grit" (p. 48). Yet, there are no empirical studies in the literature that Duckworth and Dweck ever collaborated on, nor are there studies showing that people who endorse an incremental view of ability (e.g., a "growth mindset") have higher levels of grit. The notion of grit as a teachable concept may have originated with Perkins-Gough's (2013) conversation with Duckworth, in which she speculated that grit might be teachable. The notion that grit is teachable was also promoted by Laura Pappano, an influential education journalist, in a 2013 Harvard Education article. These popular accounts of grit further outstrip the psychological science by stating or implying that grit is not just a sufficient condition for success, but a necessary one. In reality, neither of these statements are supported by the evidence. The literature has merely indicated that highly qualified individuals who are also high in grit achieve at higher rates (Duckworth & Gross, 2014; Duckworth & Kern, 2011; Duckworth et al., 2007). Nowhere has it been found that grit alone, in the absence of other qualifications, is sufficient for success, nor has it been found that grit is required for high achievement; some people achieve in spite of apparently possessing a low level of grit.

The most common hypothesized method of how grit can be increased is via engagement in deliberate practice (Eskreis-Winkler et al., 2016). At the annual Arizona State University (ASU) and Global Silicon Valley (GSV) Summit in 2018, Dr. Duckworth argued in a keynote talk that deliberate practice is a crucial component in grit. Education administrators from Orange County, Florida attended the summit and indicated that they will be implementing a grit-enhancing program based on Duckworth's research at the middle school level (Jacobson, 2018). This talk given by Duckworth at ASU + GSV inspired the planning of an upcoming summit, to be led by teachers, which will promote grit and grit-enhancing interventions in schools. These examples illustrate the hype that grit is receiving in education as well as the unfortunate chasm between the state of the psychological science on grit, how it is understood by laypersons, and how this lay understanding is affecting consequential decisions of educational policy.

Grit Survey Development

Grit was first proposed and investigated as a psychological construct by Angela Duckworth (2007), in which she developed a measure of grit and used it to predict persistence in a series of studies. The initial validation results for the grit survey relied on samples of elite individuals: West Point cadets, Scripps National Spelling Bee contestants, gifted students, and military special operation personnel. This initial research inspired a series of research studies investigating grit as a hypothesized personality trait and important predictor of success in challenging circumstances (Bazelais et al., 2016; Eskreis-Winker et al., 2014; Ivcevic & Brackett, 2014; Lucas et al., 2015; Mueller et al., 2017; Rimfeld et al., 2016; Smith, 2014). More recently, however, studies have shown grit to only be moderately correlated (correlational ranges between -0.07-0.30) with academic performance and academic retention (Crede et al., 2017; Dahl, 2016; Ivcevic, & Brackett, 2014; Jachimowicz et al., 2017; Rimfeld et al., 2016).

Crede et al. (2017) conducted a meta-analysis examining the relationships between grit and academic performance, retention, conscientiousness, and cognitive ability. With 584 effect sizes from 88 independent samples (66,807 individuals) the results show interventions for increasing grit have weak effects on performance and success. The relation between the overall grit score and academic performance yielded the following results, k^1=39, N=13,141, r_{obs}=.15, p=.18 (population correlation coefficient), SD_p=.11 with an 80% credibility interval of [0.04-0.31]. The relation between overall grit and conscientiousness results were, k=22, N=18,826, r_{obs}=.66, p=.84 (population correlation coefficient), SD_p=.07, with an 80% credibility interval for rho of [0.75-0.92]. The researchers called into question the construct validity of grit, suggesting that the grit construct primarily functions because of the perseverance of effort facet. In their conclusion, they argued that additional research examining the relationship of grit with other psychological constructs is needed (Crede et al., 2017). The current study was conceived as a response to this call.

Though grit has received great attention both in scientific psychology and in the popular imagination, certain core aspects of grit remain unresolved. One such issue is the fundamental question of whether grit as a concept is sufficiently distinct from other more established personality constructs. A well-known issue in psychological research is the "jangle fallacy", which is defined as the assumption that two identical constructs are different only because they have different names (Kelley, 1927).

Grit's relation to conscientiousness has been a focus since the survey development began, with Duckworth (2007) herself noting that grit was highly correlated with conscientiousness but claiming that grit predicted success measures over and beyond conscientiousness. Resilience, the

[1] where *k* is the number of studies

ability to mentally recover from adversity, has also been studied alongside grit to predict successful academic outcomes (Arouty, 2015). In an interview with Duckworth on the difference between grit and resilience, Duckworth stated that if someone had a high level of grit, one was also expected to be resilient, but resilience is not the only thing needed to be gritty (Perkins-Gough, 2013). Crede et al. (2017) found that grit is correlated with the Big-5 construct of conscientiousness at $\rho=0.84, N=18,826$ suggesting that it may simply be "old wine in a new bottle" (p. 14).

Self-control, the ability to regulate one's self in the face of temptation, is also highly correlated with grit, r=0.6 (Duckworth et al., 2007). The argument made in relation to the separation between constructs is that there are highly self-controlled people who only live "undistinguishable lives," never finding a life-long passion (Duckworth & Gross, 2014, p. 320). Duckworth claims that there is "mounting evidence" for this theory but no cited sources other than previous works during the grit scale validation and her proposed (not empirically tested) hierarchical goal framework (Duckworth & Gross, 2014). Duckworth and Gross (2014) suggested that longitudinal studies are required to understand grit's uniqueness and to measure "superordinate goals of such compelling personal significance that they inspire lifelong allegiance" (p.323) despite setbacks. Longitudinal studies may be greatly beneficial, but statements such as, "compelling personal significance," and "undistinguishable lives" must be operationally defined (p. 323). What is Duckworth's definition of success and what qualifies as a lifelong allegiance?

Need for achievement is a desire to master skills and succeed through accomplishments (McClelland et al., 1953). By definition, this construct is similar to grit and one could argue that one must also possess a certain level of need for achievement in order to achieve at very high

levels (e.g., national competitions), a quality likely demonstrated by the SCRIPPS participants and West point cadets that Duckworth and colleagues (2009; 2007) used to validate the Grit-O and Grit-S scales. Duckworth et al.'s (2007) conception of the difference was that people who are high in the need for achievement but not grit would not necessarily pursue a task over many years of intense effort. This distinction between grit and need for achievement, however, has not been empirically evaluated, nor is it reflected in the composition of the grit scale items.

Cross (2014) understands grit to be a combination of constructs that together create the concept of grit, stating that "through the combination of persistence, self-control, and more broadly conscientious, emerges grit" (p. 5). Others, (e.g., Crede et al., 2017; Muenks et al., 2017; Ivcevic & Brackett, 2014, Westin, 2014) have suggested that grit could be a lower facet of conscientiousness, similar to how self-control is seen as a facet of conscientiousness (Roberts et al., 2005). The current research is not aimed to examine grit as a subdomain of other psychological constructs, but to investigate the jangle fallacy. Is grit the same as other psychological traits with a new name?

Another major issue in grit research is the drastically mixed evidence regarding its salience in predicting outcomes. In contrast with Duckworth's early research showing grit to be a dominant factor in determining success or failure for elite populations in exceptional circumstances (Duckworth & Seligman, 2005; Duckworth et al., 2007; Duckworth & Quinn, 2009), later work that has found that grit plays a much more modest role in predicting performance, particularly for more typical populations in more prosaic settings (e.g., K-12 students' mathematics grades; Weston, 2014). In fact, that this huge variation in claimed effect sizes may have a very simple explanation; Crede and colleagues (2017) argued that Duckworth and Quinn's (p.171, 2009) claim that each standard deviation increase in grit is associated with a

99% increase in the probability of success results from a misinterpretation of effects estimated on the logit scale. The correct interpretation of her estimated effect is that a one standard deviation increase in grit was associated with the probability of success changing from 94% to 99%, a 5% increase, not a 99% increase. Therefore, a proper interpretation of results may indicate more consistency in the estimated effect size of grit on outcomes, and especially a much more modest influence of grit on outcomes, than has previously been assumed.

One thing seems clear: translational applications of grit in education and other areas, particularly with regard to developing interventions to increase grit, are wildly premature given the scientific status of the construct. For example, if grit is just another label for conscientiousness as Crede (2017) suggested, then grit interventions are doomed to fail because conscientiousness is a stable characteristic that is highly resistant to change (Cobb-Clark & Schurer, 2012). Therefore, it is important both from a scientific and from an applied point of view to understand the nature of grit.

Current Study

The purpose of this study was to examine grit's distinguishability from other conceptually-related psychological constructs, including resilience, need for achievement, self-control, and conscientiousness. The general approach involved regressing grit on a set of related constructs and latent variables via structural equation modeling. The R^2 statistic was interpreted as a metric of distinguishability, as described in Table 3. An R^2 value of one means that grit is fully explainable in terms of these constructs, and therefore completely redundant. An R^2 value of zero means that grit is not at all explainable. In addition, the current study's hypothesis was pre-registered on as-predicted.org. This pre-registration is public and can be found at https://aspredicted.org/tz83v.pdf, or see Appendix B. The current study aimed to answer the

following question: Is grit distinct from other psychological constructs? I hypothesized that grit will not be distinguishable from resilience, need for achievement, self-control and conscientiousness, $R^2 > 0.9$.

Chapter 2. Literature Review

Grit is conceptualized as a psychological trait that is defined as a person's level of "perseverance combined with passion for a specific, long-term goal" (Duckworth et al., 2007 p. 1087). This perseverance of effort is the driving force behind overcoming obstacles or challenges to obtain those long-term goals and accomplishments. Equally as important, the passion subdomain is a person's level of interest toward a very clear objective or goal (e.g. college graduation or achieving tenure in academia). Grit is hypothesized as a distinct construct but has obvious similarities with other constructs in the field of psychology such as resilience, ambition, and conscientiousness (Crede et al., 2017).

Grit was initially conceptualized as a psychological construct by Dr. Angela Duckworth (Duckworth et al., 2007). Duckworth began her career as a teacher, which is where she initially formed the belief that work ethic was more indicative of academic achievement than innate ability. Duckworth hypothesized that the best predictor of success may not be inborn talent, but a special blend of resilience and single-mindedness (Duckworth, 2016). Duckworth was determined to succeed and spent her youth excelling in academics. As an adult, her fascination with this idea led her to become a psychologist, and studying grit became a focus of her research agenda (Duckworth, 2016). This led her to create the Character Lab at the University of Pennsylvania, which specializes in studying grit. Duckworth's hypothesis regarding the centrality of grit in achievement was initially tested in elite settings, such as West Point cadets and Scripps National Spelling Bee contestants. It was in these settings that she first validated a grit questionnaire as a measure of determination and persistence (Duckworth et al., 2007). Duckworth's measure was administered to West Point cadets as they approached one of the more grueling aspects of their training known as the "Beast Barracks", which numerous cadets do not complete. Duckworth found that it was not physical fitness, intelligence, military credentials, or

leadership that predicted completion of their training. Rather, grit was the most accurate predictor of which cadets would finish beast barracks or quit, β=0.48, OR=1.62, $p<.001$ (Duckworth et al., 2007). This was suggested that cadets who scored one standard deviation above average on the grit survey had an odds ratio of 1.62, which was stronger than the effect of the Whole candidate score, β=.09, OR= 1.09 (a combined score the military uses to assess entrance into West Point) or self-control, β=0.41, OR=1.50, $p<0.01$ (Duckworth et al., 2007).

Literature Comparison

Intelligence has long been assessed in education to predict an individual's future potential for academic achievement (Poropat, 2009). It comes as no surprise that some individuals will prevail over others, even when intelligence is equal. This question has been a perpetual one in psychology (Barchard, 2003; Duckworth & Seligman, 2005; Duckworth & Quinn, 2009; Pearl et al., 1980). This question was posed by William James in 1907: "Why do some prevail more so than others with equal intelligence"? (p. 324). Intelligence tests alone account for only a moderate proportion of variance in academic achievement (Zaboski II et al., 2018). As a result, investigation has turned to nonintellectual constructs such as motivation, self-discipline, grit, and conscientiousness. Duckworth and Seligman (2005) conducted a study of 164 eight-graders, testing the effect of self-discipline on GPA. After controlling for IQ, self-discipline outperformed IQ in predicting academic performance. This indicates that eighth-graders who had higher scores on the self-discipline measure were expected to have a higher GPA, after controlling for IQ and 1st marking GPA. Chamorro-Premuzic and Furnham (2003) investigated the Big Five personality assessment and its predictive capability on exam scores. The Big Five traits were significantly correlated with exams scores, but only account for 13% (adjusted r^2) of the variance. Research on psychological traits as predictors of success (e.g. academic performance/ retention, career

success), is ongoing with many questions still unanswered. However, non-cognitive traits like those assessed on the Big Five personality assessment do add significant contribution to understanding achievement outcomes after controlling for ability.

Grit Survey Development

The grit survey was developed by Duckworth and colleagues (2007). The first attempt to measure grit was the Grit-O, which was comprised of 12 items, six items were related to passion and the other six measured perseverance of effort. The results of a two-factor confirmatory factor analysis of the internal construct validity of the Grit-0 based on n=773, were as follows: CFI= .83, RMSE=.11 and a Cronbach's alpha of .85 for the overall scale, for the Passion subscale α=.85, and for the Perseverance subscale α=.78. Despite the poor fit indices from the CFA analysis, Duckworth and colleagues (2007) concluded that the Grit-O is comprised of a hierarchical structure with two lower level facets, passion and perseverance effort, r=.45. The 12 items are anchored on a 5-point Likert scale, from "not like me" to "very much like me". In this development paper Duckworth et al. (2007) also tested six additional hypotheses. Results showed that grit only accounted for an average of 4% of the variance within educational attainment, GPA, retention at West Point, and ranking in the Scripps National Spelling Bee. In 2009 Duckworth and Quinn developed the Short Grit Scale (Grit-S). The new scale still consisted of a 2-factor structure (passion and effort subscales) but with 8 items instead of 12. To validate the shortened version of the grit scale, researchers used the same participants, from the same dataset obtained in Duckworth et al. 2007. The internal consistency resulted in a range of Cronbach's alpha .73 to .83 across all samples. For each subscale the range of Cronbach's alpha levels were .73 to .79 for passion, and .60 to .78 for perseverance of effort (Duckworth & Quinn,

2009). Confirmatory Factor analysis yielded the following fit indices, χ^2=106.36, p<.001; RMSEA=.061, CFI=.95.

Another major critique of grit in the contemporary literature focus on the psychometric properties of the various grit scales proposed by Duckworth and colleagues (2007, 2009, 2014). Duckworth et al. (2007) developed the Grit-0 survey and validated it using the same sample of participants. This same sample was apparently recycled in the development and validation of the Grit-S (Duckworth & Quinn, 2009) measure two years later. This is problematic because it does not follow rigorous scientific guidelines, as one should not appraise a model using the same sample that was employed to construct it. This can create false evidence for the psychometric quality of a model in phenomenon known as "overfitting" (McDonald & Ho, 2002). Boateng et al. (2018) recommended best practices for developing and validating measures, which should be conducted in the following order: item generation, content validation, pre-testing of questions, survey administration, item reduction, factor analysis, reliability estimation, and finally tests of validity. The final test of validity requires new data collection from other independent research teams. During the pre-testing of questions phase, it is suggested that expert judges (others knowledgeable in the specific domain) and/or target population judges (those who would potentially use the measurement) evaluate measurement items in relation to the domain of interest (Augustine et al., 2012; Haynes et al., 1995; Lawshe, 1975; Lynn, 1986; Linstone, 1975). This step is important because it avoids potential researcher bias and, if implemented correctly in the pre-testing question phase, could also identify potential jangle fallacies. Unfortunately, it appears that the pre-testing of questions step, along with several others, were skipped in the creation of the various grit scales. Despite this abbreviated instrument development and

validation cycle, the grit instrument was still used to predict outcomes like school success, academic retention, military retention, marriage commitment, among others.

Current Applications of the Grit Scale

The grit scale has been used in a wide range of applied fields. Robertson-Kraft and Duckworth (2014) showed that teachers with high grit were more likely to stay in the current job and were more effective as opposed to those who were less gritty and left the practice (teachers retained, or teachers who resigned, d=.79).

Eskreis-Winkler et al. (2014) used the grit scale to predict longevity within marriage, suggesting grittier people would persist in remaining married. The relationship between grit and marriage persistence was only found to be significant for men and not women (male average grit scores, M=3.47, SD=0.69, and females M=3.47, SD=0.70. Results were dervied from a sample of n=6,362, 64% were female of those 80% were married and 20% were widowed or divorced.

Crede et al. (2017) argues that Duckworth's (2007) paper may have contain an error in which odds ratios were confused with probabilites. This leads to incorrect conclusions about the overall effect size. Eskreis-Winkler et al. (2014) also follows this lead by reporting only odds ratios and specifcally state "Grit, extraversion and emotional stability were not significantly associated with martial status" (p. 8). Given the nonsignificant results, the researchers tested a gender by grit interaction and, reported a significant simple effect which they report in males as, OR= 1.17 (Eskreis-Winkler et al., 2014). Since this study wasn't preregistered, readers cannot know whether the gender x grit interaction was hypothesized in advance or rather emerged from a series of unplanned post hoc analyses which are not to be trusted due to the high false positive rate (Simmons et al., 2011).

Lucas et al. (2015) conducted a study (n=426) to see if the perseverance of effort subscale of grit was related to risk tolerance in a laboratory setting. They wanted to see if "gritter" individuals would persist when given the opportunity to receive monetary rewards for answering correct answers or if they would not take the risk of losing the reward if they answered incorrectly ($1 to exit, $2 to continue and answer correctly). The authors found that participants who scored higher on the grit subscale perseverance of effort measure were more likely to risk losing the reward than those who scored lower on grit, p=0.01 (Lucas et al., 2015).

Ray and Brown (2015) suggested adding characteristics that predict student success such as distance traveled, hardiness, and grit to the medical and graduate school admissions process. The goal here was to increase diversity by reducing the challenges experienced by disadvantaged students (those with low SES as well as minority students) as they transition into higher education by taking into account a student's level of grit, how far they would potentially have to travel, and their hardniess level. Ray and Brown's paper did not inlcude results from this suggested new admissions criteria.

Ivcevic and Brackett (2014) studied 213 undergraduates to test the incremental predictive validity of grit after accounting for two other psychological predictors, conscientiousness, and emotion regulation. Using the Big Five personality traits like conscientiousness, researchers were only ably to predict 8%-20% of the variance in school outcomes (rule violation, recognitions, academic honors, and GPA). Grit is reported as not explaining any additional variance in excess of these personality variables, and emotional regulation ability explained an additional 5% in GPA. Rimfeld et al. (2016) found similar results. They used a United Kingdom sample of 4,642 16-year-old twin pairs. When compared to conscientiousness, grit added very little to the prediction of academic success. Conscientiousness accounted for 6% of the variance in grades.

Weston (2014) conducted a replication of prior Duckworth studies (Duckworth et al., 2007; Duckworth & Quinn, 2009). Weston studied low-income, ethnic minority students at an Upward Bound program and found that grit was not significantly related to GPA, though the correlation at least had the expected sign, r=.25, p=.164. However, grit was significantly negatively correlated with literacy r= -.37, p=.036. Weston reported a much lower internal consistency than what was described by Duckworth and Quinn (2009). Duckworth and Quinn noted grit had a Cronbach's alpha range of .73- .85, but Weston (2014) reported an alpha of .56 for the full grit scale, .47 for the passion subscale, and .49 for the perseverance of effort subscale. The small sample size of n=33 is a serious limitation of Weston's (2014) master thesis, and this should be noted when considering the results. Lucas et al. (2015) reported an internal consistency more similar to Duckworth et al. (2007) original findings (n=426, Cronbach alpha =.73).

Grit Related to other Psychological Constructs

The *jangle fallacy* (Kelley, 1927) is the belief that two things are different simply because they have different names. Grit could possibly suffer from the jangle fallacy. Is grit distinctly different from conscientiousness, resilience, or need for achievement, or is it simply an old idea with a new name? Confusion about the naming and boundaries of psychological constructs is not new, as noted by Kelley (1927). Sport and exercise psychology have a similar concern with resilience and critiques of resilience in relation to other constructs such as coping and mental toughness (Fletcher & Sarkar, 2013; Rutter, 1987; Walsh, 2015). The main question whether constructs are dissimilar can be rephrased in terms of discriminant and convergent validity (Fogarty & Perera, 2016). The construct neuroticism suffered from similar problems until researchers expanded the concept to include self-esteem, neuroticism, locus of control, and generalized self-efficacy; this expanded construct is now referred to as general neuroticism

(Judge et al., 2002). Researchers have now since called for formal studies to investigate the discriminant validity of grit relative to other constructs, such as resilience, motivation, self-control, need for achievement, and conscientiousness, because much is still unknown about the construct grit and its ability to predict academic performance (Crede et al., 2017; Weston, 2014), and previous results have shown that grit is highly similar to conscientiousness. Distinguishing between closely related constructs is a necessary step toward conceptual clarification of grit.

Conscientiousness

Grit has been compared to conscientiousness, one of the Big Five Personality traits, defined as an inclination toward being responsible, hard-working, and organized (Maddi et al., 2012). Duckworth and Quinn (2009) in their validation study of the Short Grit Scale (Grit-S) conducted a study to examine the correlation between grit and conscientiousness and found the two constructs to be highly correlated ($r=.77$, $p<.001$). However, they also reported that grit still was a significant predictor of educational attainment beyond conscientiousness, $OR=1.31$, $p<.001$. Duckworth and Quinn (2009) suggest that grit could be a separate construct, unrelated to conscientiousness, but Crede et al. (2017) suspect that the relation between grit and conscientiousness may be stronger than Duckworth and colleagues have considered, especially since both constructs are highly correlated. Some researchers have acknowledged that grit is related to conscientiousness but suggest that grit is different because grit is the courage to push through adversity (Maddie et al., 2012), while others suggest that grit is a "lower-level personality trait in the domain of conscientiousness" (Ivcevic & Brackett, 2014).

Some conscientiousness-measuring items on the International Personality Item Pool (IPIP, Goldberg, 1999) are extraordinarily similar to items on the Grit-S subscale perseverance (Crede et al., 2017). The Grit-S includes questions such as, "I finish whatever I begin," which is

highly similar to the IPIP item, “I carry out my plans” and the Grit-S, “I am a hard worker” is similar to IPIP item “I work hard.” The jangle fallacy occurs when “new” psychological constructs are proposed and promoted without regard for similar constructs that already exist. There is reason to suspect that grit is merely a subdomain of conscientiousness.

Resilience

During an interview (Perkins-Gough, 2013), Duckworth was asked if there was a specific difference between grit and resilience. Resilience is the ability to recover from adversity (Reivich & Seligman, 2011). Resilience is not a new concept, but it was highlighted when the Army invested in a new program for its soldiers and military spouses called the Ready and Resilient Campaign, also known as the Comprehensive Solider and Family Fitness (CSF2). This program seeks to teach soldiers and their families resilience skills in order to promote healthy relationships and decrease the risk of mental disorders (suicide). Resilience skills include cognitive coping skills like those related to cognitive behavior therapy: “Thinking Traps”, teaches individuals to acknowledge the type of inner thoughts one has after a specific event (i.e. getting stopped at a red light might produce a negative thought that then determines how that person emotionally responds (Reivich & Seligman, 2011). The goal of resilience training is to highlight the inner thoughts, and by doing so enable a person to change those thoughts to directly control their emotional response. In relation to grit, Duckworth suggests that grit can potentially strengthen resilience when faced with stress and willingness to give up (Duckworth et al., 2007; Duckworth & Quinn, 2009). Researchers Luthar, Doernbernberger & Zigler (1993) define resilience as a dynamic process that exists on a continuum. According to Duckworth, “Grit is related because part of what it means to be gritty is to be resilient” (Perkins-Gough, 2013, p.1). Duckworth goes on to say that by this relation, it only is part of what grit is, with the other part

being passion. She is claiming that grit is distinct from resilience because grit also attempts to measure passion, but without empirical evidence that grit is distinguishable from similar constructs researchers can't know for certain. She is also perhaps suggesting in this statement that grit and resilience overlap in measuring persistence. The resilience measure used and discussed later has three subdomains, including negativity bias, emotional resilience, and social skills, none of which directly measure perseverance of effort.

Self-Control

Self-control is defined as the ability to manage one's own emotion, thoughts, and behaviors (Diamond, 2013). Tangney et al. (2004) suggest that individuals who can maintain a high level of self-control could be considered the happiest due to the balance between regulation of ones' self and "fitting" into their environment. People who surrender to antisocial behaviors could in return have a difficult time adjusting to their environment in a prosocial manner. How does self-control potentially relate to grit? MacCann and Roberts (2010) investigated the relationship of time management, grit and self-control in relation to academic achievement. They found high correlations between all of these variables and argued that all of them could be subdomains of conscientiousness. Self-control predicted student life satisfaction after accounting for conscientiousness (MacCann & Roberts, 2010). Stewart (2015) also investigated the relationship of grit and self-control as a means to predict academic performance (GPA). They concluded that grit showed no utility for predicting college GPA, but self-control did have a significant relationship with it.

Vazsonyi and colleagues (2019) conducted a confirmatory factor analysis to investigate the discriminate validity between grit and self-control. Grit and self-control had a correlation of r=.81 (Vazsonyi et al., 2019). Evidence for high collinearity caused the standard errors with the

structural model to inflate creating "nonsensical estimates" (p. 220). It was concluded that comparing grit and self-control in this manner were next to impossible, leading them to believe that grit and self-control strongly overlap.

Duckworth and Gross (2014) explain that grit is highly correlated with self-control, but it is not a perfect correlation meaning grit is still a unique, separate construct. Grit is the passion and perseverance toward long term goals, whereas self-control does not include a facet that includes the desire to obtain a superordinate goal. Duckworth's claim that grit is distinct from self-control is an empirical claim that requires further scientific investigation.

Need for Achievement

The concept of "need for achievement" is defined by a person's interest to succeed in his or her accomplishments and master skills (McClelland et al., 1976). It was suggested by David McClellend (1985) that there are three main types of motives: need for achievement, affiliation and power. Need for achievement theory tries to explain why some are motivated to achieve more than others. There is enough conceptual similarity between need for achievement and grit to suspect that these are highly overlapping concepts (Crede et al., 2017), though others have argued that grit is distinct from need for achievement (Cross, 2014; Duckworth et al., 2007; Duckworth & Quinn, 2009; Perkins-Gough, 2013). Again, this is a claim that could benefit from empirical investigation.

Aims of this Study

Does grit depend on the specific goal and vary across time? Is it a stable trait like other personality measures, such as conscientiousness? Is it even distinguishable from other constructs? Weston (2014) describes the trait as a dynamic process rather than a stable trait. Weston (2014) also stated that grit's relation to academic achievement might not be clear

cut as previously claimed, stating that "grit has gotten ahead of itself" (p. 1), concluding that grit's construct validity should be investigated. To date, no one has tested the discriminant validity of grit versus other similar constructs, such as resilience, need for achievement, self-control, and conscientiousness in a combined structural model. This study is the first to conduct such an investigation.

Given the widespread interest in grit among psychologists and educators, there is an urgent need for additional investigation of the construct and its relation to similar constructs (Crede et al., 2017). The purpose of this study will be to examine the degree to which grit is a distinguishable construct from conscientiousness, resilience, self-control, and need for achievement. If grit really is an example of a jangle fallacy, then that would imply that grit as an independent entity does not really exist. If grit is just conscientiousness, as suggested by Crede and colleagues (2017), and conscientiousness is a stable trait, interventions to improve, foster, or teach grit will not be successful.

To achieve the primary aim of the present study, I first established separate baseline measurement models for each construct using structural equation modeling, modifying the models as necessary to achieve acceptable fit. I proceeded by fitting a simultaneous measurement model for all constructs with free covariances between the latent variables. The final step added structural paths from the constructs to the grit latent variable. Since grit was the outcome variable there was a direct path to grit from resilience, self-control, conscientiousness, and need for achievement. There are many fit statistics that determine the goodness-of-fit for measurement models in confirmatory factor analysis. However, the r-squared value (the percent of variance explained) was the statistic the current study interpreted to determine whether grit

can be considered a separate construct or whether it is redundant with other psychological constructs.

Chapter 3. Methods

Participants

For confirmatory factor analysis, one suggested rule of thumb for the minimum sample size is 10 per indicator variable (Kline, 2016). The final structural model to be fitted contains sixty observed variables. Accordingly, the preregistration stipulated the data collection would continue until a minimum sample of 600 was reached or until Dec 2nd, 2020. Data collection continued from September 26th to December 2nd online via Survey Monkey and terminated with n=952 complete survey responses. Participants were recruited from the psychology department pool at East Tennessee State University, as well as from social media sites (e.g., Facebook groups APSU Psychology Club, Alpha Gamma Delta- Theta Psi Alumnae, Fort Campbell SMRT, AGD Rose Sisters, Fort Campbell FRG Network, Clarksville Chive, Instagram, and Twitter) (see, Appendix A for the advertisement used to recruit participants). A total of 86 cases were dropped for completing the survey battery (a total of 68 questions) in under five minutes. This meant that participants who spent at least four seconds per item were retained in the analysis dataset. This exclusion criteria was not pre-registered, but was chosen after investigating the patterns of missing responses, because many of the respondents who spent less than five minutes on the survey only responded to the first item. The final analytic sample consisted of 866 participants. See Table 1 for the breakdown of participants by age and race.

Table 1.

Demographic Descriptive Statistics

Age	African American	American Indian	Asian	Caucasian	Hispanic
18-34	36	23	170	200	34
35- 54	16	2	44	191	20
55 +	4	0	1	43	1

Measurements

Grit Scale

The Grit-0 (Duckworth, & Quinn, 2007; see Appendix C) consists of 12 items and is measured on a 5-point Likert scale (α=0.81). The instrument was created to have a hierarchical structure with two lower level subscales, passion and perseverance of effort, each defined by six items. Example items include, "Setbacks don't discourage me" and "I am hard worker." Scores are summed and then divided by twelve to get an overall grit score. The maximum score on this scale is 5 (extremely gritty) and the lowest score on the scale is 1 (not gritty at all).

Factor III Conscientiousness

The conscientiousness 10-item International Personality Item Pool (IPIP) is a representation of the Goldberg (1992) markers for the Big-Five factor structure (see Appendix D). The Factor III Conscientiousness measure is a subscale from the Big-Five Factor Marker assessment. It is comprised of 10-items measuring a single construct (α=0.85). Items are rated on a 5-point Likert scale (1 = *very inaccurate*, 2 = *moderately inaccurate*, 3 = *neither inaccurate nor accurate*, 4 = *moderately accurate*, and 5 = *very accurate*). Example items include, "Get

chores done right away" and "Often forget to put things back in their proper place" (reverse coded).

Achievement Striving

Achievement-striving, 6FPQ is a representation of the Goldberg (1992) markers for the Big-Five factor structure as a subdomain of conscientiousness (see Appendix E). The 6FPQ is a brief assessment for need for achievement. This scale is from the International Personality Item Pool, specifically from the Six Factor Personality Questionnaire (α=0.86). It has 10 items measuring a single construct, five of which are reverse coded. Items are rated on a 5-point Likert scale from (1 = *very inaccurate*, 2 = *moderately inaccurate*, 3 = *neither inaccurate nor accurate*, 4 = *moderately accurate*, and 5 = *very accurate*. Examples of some of the items include, "Do more than what's expected of me," and "Find it difficult to get down to work".

Brief Risk- Resilience Index for Screening

The Brief Risk- Resilience Index for Screening (BRISC) is a 15-item self-report measure of self-regulation of emotions (Rush, 2012; see Appendix F) (α=0.75). It measures three core domains: negative bias (5 items; one's hypersensitivity to stress and anticipation of negative outcomes' e.g., "I tended to overreact to situations"), emotional resilience (5 items; one's capacity for self-efficacy; e.g., "I felt very satisfied with the way I look and act"), and social skills (5 items; one's capacity to engage in social situations and seek support; e.g., "I enjoyed socializing and chatting with other people"). Negativity bias is concerned with risk for negative emotional states, whereas emotional resilience and social skills concern regulatory responses to negative emotional states. Each item is rated on a 5-point Likert scale, with greater values representing higher functioning and better coping. The scale is anchored at 1 for *strongly disagree* and 5 for *strongly agree*.

Brief Self-Control Scale

The Brief Self-Control Scale (Brief SCS) is a 13-item survey of general trait self-control (Tangney et al., 2004; see Appendix G) (α=0.87). Items are rated on a 5-point Likert scale from 1 (*not at all*) to 5 (*very much*). Examples of some of the items include, "I am good at resisting temptation", and "I have a hard time breaking bad habits" (which is reverse coded). The average score across all items would indicate a person's level of self-control, with higher scores indicating greater general self-control.

Procedure

Approval from East Tennessee State University Institution Review Board, IRB# c0919.25e, was obtained prior to data collection and the guidelines set forth by the IRB for protection of human subjects were followed (see Appendix H for approval letter). Participants who signed up to participate in the study were directed to an online survey site that presented all of the questionnaires. The participants first encountered the consent form. They were then directed to start the study by taking the surveys in the following order: Grit-O Scale, Brief Risk-Resilience Index for Screening, Conscientiousness, Achievement Striving (assessing need for achievement), and the Brief Self-Control Scale. After completion of those surveys, participants provided basic demographic including age, sex, and race. Participants were debriefed following completion of the study.

Chapter 4. Results

Data Preparation

All data preparation and analysis were performed using R statistical software version 3.6.1 (R Core Team, 2019). Data were imported from Survey Monkey via a csv file. The exclusion criteria were applied, and appropriate variable names were assigned. Negatively worded items were reverse coded using the recode() function from the car package (Fox, 2019), including items 1, 4, 6, 9, 10, and 12 from the Grit-0 survey, items 1, 3, 4, 7, 9 from the achievement striving, items 2, 3, 4, 5, 7, 9, 10, 12, 13 from the Brief Self-Control Scale, and items 1,4, 5, 6, 7, 10 from the Conscientiousness scale.

Descriptive Statistics

Scale-level descriptive statistics for each survey questionnaire are shown in Table 2. Item descriptive analysis revealed there were no outliers and the distributions were within an acceptable range for skewness and kurtosis (Gravetter & Wallnau, 2014). For a complete list of survey item descriptive statistics, see Tables IA-IE in Appendix I.

Table 2.

Construct Descriptive Statistics

Construct variable	N	Mean	St. Dev	Min	Max	Cronbach's α
Grit	811	3.3	0.6	1.8	4.9	0.81
Resilience	811	3.3	0.5	1	5	0.75
Achievement Striving	810	3.5	0.7	1.1	5	0.86
Conscientiousness	810	3.6	0.7	1.6	5	0.85
Self-Control	810	3.3	0.7	1.2	5	0.87

The average inter-item correlation for the achievement-striving, self-control, grit, and conscientiousness scales were within Piedmont's (2014) recommended range of 0.20-0.40, implying that the items are homogenous but still contain unique variance. The average inter-item correlation for the resilience scale was just below this suggested range, 0.19. The Cronbach's alphas for each scale were deemed acceptable.

Data Analysis

Confirmatory Factor Analysis (CFA) with the maximum likelihood (ML) estimator was used to analyze the data via the R package lavaan version 0.6-5 (Rosseel, 2012). CFA was used for three main reasons: the ability to assess (rather than assume) measurement model fit, the estimation of structural relationships between constructs that are purged of measurement error, and the flexibility to model hierarchical factor structure. Instead of assuming that the factors automatically "fit" within the higher order, the structure can be tested and changed before proceeding to the next step of analysis. Cases with missing data were included via the use of full-information maximum likelihood estimation (FIML; Enders & Bandalos, 2001). The analysis R code is publicly posted along with the raw data on the Open Science Framework website (https://osf.io/dn2jb/), including all supplemental material (e.g., fit summaries for Models 1-14).

The following criteria for assessing fit statistics were used to determine whether the model sufficiently fit the data (Jackson et al., 2009).

Chi Square (χ^2) assesses the overall fit and indicates significant model misfit when $p < 0.05$ (Kline, 2016). However, this test becomes excessively powerful when n is large or in models with many degrees of freedom and rejects the null of exact fit even for tiny departures. Therefore, the following approximate fit indices will be considered in addition.

Comparative Fit Index (CFI) measures the fit improvement of the target model versus an empty (null) model and has a range of 0-1. The closer to 1 the better the fit. A CFI score of .95 is considered acceptable (Kline, 2016).

Standardized Root Mean Square Residual (SMRM) is the standardized difference of observed and model implied covariance matrices. A SMRM of zero would indicate perfect fit but is acceptable when it is at or below 0.08 (Kline, 2016).

Root Mean Square Error of Approximation (RMSEA) estimates the amount of misfit per degree of freedom by looking at the difference between the hypothesized model and the population covariance matrix (Hooper et al., 2008). It has a range of 0-1. The smaller the value the better. A score of 0.06 or less is considered acceptable (Kline, 2016).

R squared (R^2) is only applicable to endogenous variables in structural models; it is the percent of variance explained of a particular endogenous construct. It has a range of 0-1; the closer to 1 the value is, the better the construct can be predicted from the model (Kline, 2016). Table 3 provides the hypothesized R^2 interpretation for the final structural model's outcome variable grit.

Interpretation Guidelines for R^2

Hair et al. (2011) argued that if the goal of a structural model is to explain the endogenous latent variables' variance, then the R^2 value should be high. They provided the following guidelines for interpreting R^2 for endogenous latent variables: 0.75+ is "substantial," 0.50 is "moderate," and 0.25 is "weak" (Hair et al., 2013; 2011). Falk and Miller (1992) suggested R^2 values equal to or greater than 0.10 to be deemed a minimally adequate amount of explained variance in a particular endogenous construct. Chin (1998) suggests the following guidelines for R^2: 0.67 "substantial," 0.33 "moderate," and 0.19 "weak. Cohen (1988) has similar

guidelines as Chin (1998). The fact is, there are no objective criteria at which the interpretation of a continuous statistic changes from one conclusion to another. Criteria need to be judged in the scientific experimental context. Slavish adherence to common rules and interpretation guidelines neglects context and scientific expertise. I have considered these guidelines, as well as prior literature, in reaching my own standards for interpretation in the context of this study as articulated in Table 3.

Table 3.

R^2 metric of distinguishability scale

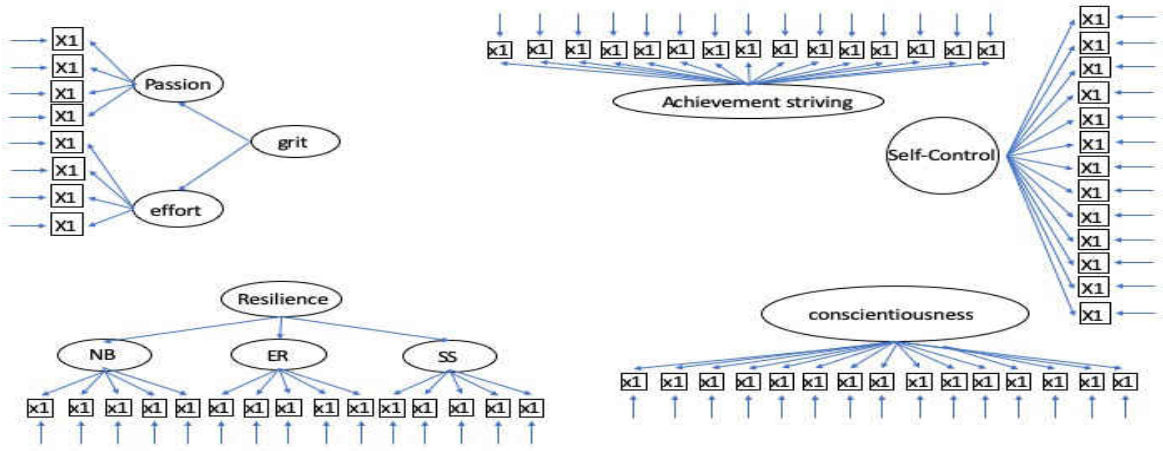
R^2 value	Interpretation
$R^2 = 0.9 +$	Grit is not distinguishable from other constructs
$R^2 = 0.8\text{-}0.89$	Grit's distinguishability from other constructs is questionable
$R^2 = 0.6\text{-}0.79$	Grit is distinguishable but substantially related
$R^2 = 0\text{-} 0.59$	Grit is clearly distinguishable

Sequence of Analysis

1. Fit individual measurement models (see Figure 1) for each construct, making reasonable modifications as needed (e.g., freeing residual correlations between items) until adequate fit is achieved.
2. Fit a full measurement model for all constructs simultaneously with free correlations between the latent variables.
3. Fit a structural model regressing latent grit on latent conscientiousness, achievement-striving, self-control, and resilience. The R^2 from this model is the focal statistic for interpretation.

Figure 1.

Measurement Model. Each latent construct was fitted separately. Grit (Model 1), Resilience (Model 4), Achievement Striving (Model 7), Self-Control (Model 9), Conscientiousness (Model 11).



Measurement Models

Measurement models were fitted (see Figure 1) for each construct individually.

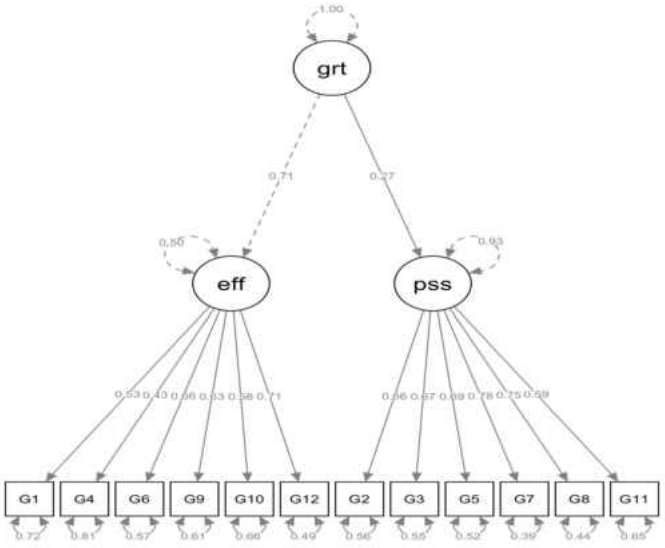
Grit-0 Measurement Model

The Grit-O measure was structured to measure two subdomains: passion and perseverance of effort. Passion and perseverance of effort each contain six observed items. This hypothesized measurement model for grit (Model 1) was a hierarchical factor model with the higher order latent variable grit and two second order factors (passion and perseverance of effort), each of which influences item responses. The hypothesized model did not include any cross-loadings or residual covariances between items. In order for the proposed model to converge, certain restrictions were required because a hierarchical factor analysis model with two subfactors was not identified (Crede et al., 2017). The model was parameterized such that the factor variances (or factor residual variances for the subfactors) were fixed to one so that all

loadings could be freely estimated. Additionally, one of the two loadings for the subfactors on grit (e.g., perseverance of effort or passion) had to be fixed to one; without this constraint the theorized model would not converge. Fixing either of these loadings to one produces equivalent model fit. In this grit measurement model, I fixed the factor loading of the perseverance of effort latent variable on grit to one. This model did produce acceptable fit, $\chi^2(52, N=811) = 231.11$, $p<.001$; RMSEA=0.065 [90% CI: 0.057-0.074]; CFI= 0.937; SRMR=0.054. (Figure 2). However, the choice of which subfactor loading is fixed to one alters the interpretation and definition of the higher-order grit latent variable, causing it to either become mostly identical to perseverance of effort or to passion. Crede and colleagues (2017) also noted this problematic structure of grit. For this reason, alternative measurement models were considered. For the complete factor loadings table for Model 1 see Table 4.

Figure 2.

Model 1 Grit hierarchical structure. The factor loading for perseverance of effort is fixed to one.



Note: Numbers presented in the figure are fully standardized. The dashed factor loading was fixed to one on the unstandardized scale.

Table 4.

Grit Model 1 Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	Beta
effort	G1	0.35	0.02	14.31	< .001	0.53
effort	G4	0.33	0.03	11.39	< .001	0.43
effort	G6	0.44	0.02	18.62	< .001	0.66
effort	G9	0.42	0.02	17.45	< .001	0.63
effort	G10	0.44	0.03	15.94	< .001	0.58
effort	G12	0.47	0.02	20.49	< .001	0.71
passion	G2	0.66	0.03	19.06	< .001	0.66
passion	G3	0.64	0.03	19.01	< .001	0.67
passion	G5	0.73	0.04	20.16	< .001	0.69
passion	G7	0.84	0.04	23.39	< .001	0.78
passion	G8	0.83	0.04	22.54	< .001	0.75
passion	G11	0.61	0.04	16.4	< .001	0.59
grit	effort	1	0			0.71
grit	passion	0.28	0.07	4.27	< .001	0.27

The first alternative measurement model for grit (Model 2) allowed all twelve observed items to load directly on a single latent variable, grit. This model produced unacceptable fit indices, $\chi^2(54, N=811) = 1139.65$, $p<.001$; RMSEA=0.157 [90% CI: 0.15-0.16]; CFI= 0.62; SRMR=0.145. A second alternative model with two correlated factors and no hierarchical structure (Model 3) was tested. Items were allowed to load on the subdomains (passion and perseverance of effort) as separate constructs with a free covariance between latent variables (see Figure 3). The model was parameterized such that each factor variance was fixed to one, the latent constructs were allowed to correlate, and none of the indicator variables loadings were set

to one, allowing all loadings to be freely estimated. The fit for this model was identical to the fit of the first model (with one additional degree of freedom), $\chi^2(53, N=811) = 231.11$, $p<.001$; RMSEA=0.06 [90% CI: 0.05-0.07]; CFI= 0.938; SRMS=0.054. The correlation between passion and perseverance effort was 0.19. For the full factor loadings table for Model 3, see Table 5.

Figure 3.

An alternative model, perseverance of effort and passion as separate but correlated latent variables Model 3.

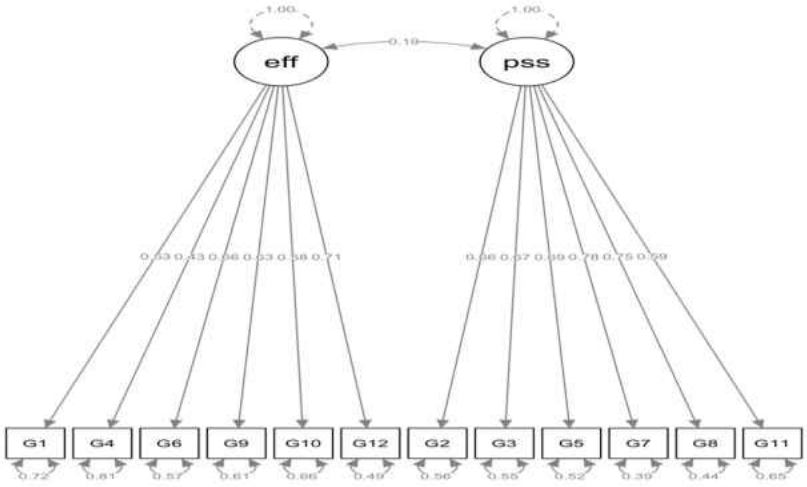


Table 5.

Grit Model 3 Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	Beta
effort	G1	0.49	0.03	14.31	< .001	0.53
effort	G4	0.47	0.04	11.39	< .001	0.43
effort	G6	0.62	0.03	18.62	< .001	0.66
effort	G9	0.6	0.03	17.45	< .001	0.63
effort	G10	0.62	0.04	15.94	< .001	0.58
effort	G12	0.67	0.03	20.49	< .001	0.71
passion	G2	0.69	0.03	19.86	< .001	0.66

passion	G3	0.66	0.03	20.03	< .001	0.67
passion	G5	0.76	0.04	21.08	< .001	0.69
passion	G7	0.87	0.04	24.79	< .001	0.78
passion	G8	0.86	0.04	23.45	< .001	0.75
passion	G11	0.63	0.04	17.15	< .001	0.59

BRIEF Risk-Resilience Scale Measurement Model

The BRIEF resilience measure was constructed to measure three subdomains: negativity bias, emotional resilience, and social skills. Each subdomain consists of five items. The hypothesized measurement model for resilience (Model 4) was a hierarchical factor model with a superordinate resilience latent variable and three subordinate factors (e.g., negativity bias, emotional resilience, and social skills), each of which influences item responses. The hypothesized model did not include any cross-loadings or residual covariances between items. The model was parameterized such that the factor variances or factor residual variances were fixed to one so that all loadings could be freely estimated. This model exhibited extremely poor fit, $\chi 2(90, N=811) =1213.19$, $p<.001$; RMSEA=0.12 [90% CI 0.12-0.13]; CFI= 0.69; SRMR=0.23 and was deemed to be unacceptable. As a result, alternative measurement models were considered.

The first alternative measurement model for resilience (Model 5) allowed all observed items to load directly on a single latent variable. This model converged; however, its fit was even worse than the original model, $\chi^2(90, N=811) = 1938.73$, $p<.001$; RMSEA=0.160 [90% CI: 0.153-0.166]; CFI= 0.495; SRMR=0.172. As a result, this model was also deemed unacceptable.

A third measurement model (Model 6) was tested. The top level of the hierarchical structure of resilience was removed and items were allowed to load on the subdomains

(negativity bias, social skills, and emotional resilience, as theorized) as separate constructs with free covariances (see Figure 4). This model produced the best fit of those considered, though it remained somewhat poor, $\chi^2(87, N=811) = 682.31$, $p<.001$; RMSEA=0.09 [90% CI: 0.09-0.10]; CFI= 0.84; SRMR=0.09. This was, however, the model retained for the remainder of analysis. The correlation between negativity bias and emotional resilience was -0.32; the correlation between negativity bias and social skills was -0.11; and the correlation between emotional resilience and social skills was 0.79. For the complete factor loadings for Model 6, see Table 6.

Figure 4.

Resilience Model 6. An alternative model, with negativity bias, emotional resilience, and social skills were structured as single latent variables.

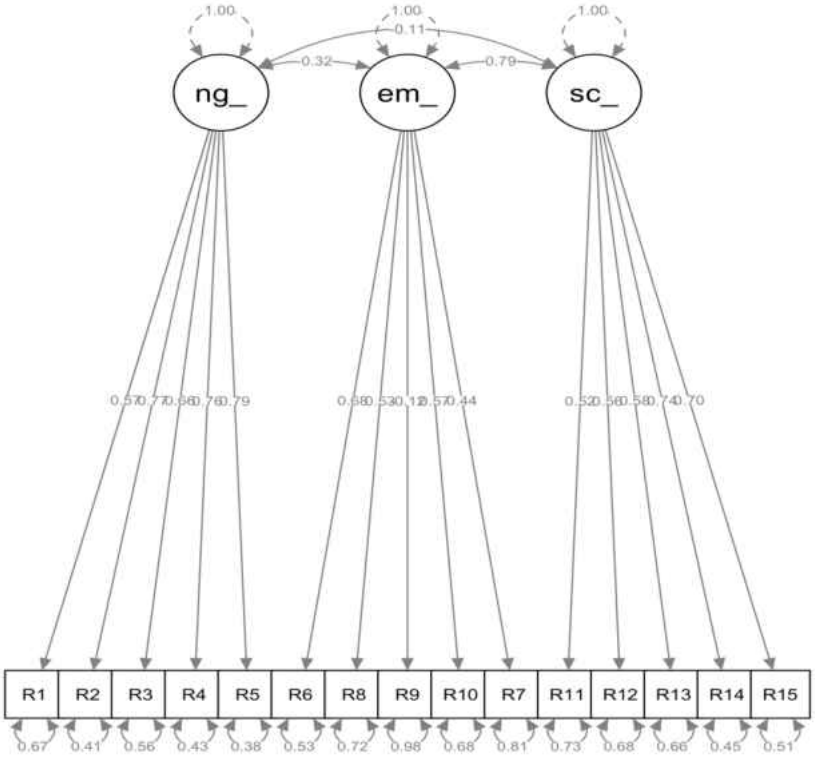


Table 6.

Resilience Model 6 Factor Loadings

Latent Factor	Indicator	B	SE	Z	p-value	Beta
negativity_bias	R1	0.67	0.04	16.42	< .001	0.57
negativity_bias	R2	0.89	0.04	24.21	< .001	0.77
negativity_bias	R3	0.75	0.04	19.89	< .001	0.66
negativity_bias	R4	0.9	0.04	23.58	< .001	0.76
negativity_bias	R5	1.01	0.04	24.89	< .001	0.79
emotional_resilience	R6	0.7	0.04	18.49	< .001	0.68
emotional_resilience	R8	0.53	0.04	13.89	< .001	0.53
emotional_resilience	R9	-0.15	0.05	-2.92	0.003	-0.12
emotional_resilience	R10	0.52	0.03	15.22	< .001	0.57
emotional_resilience	R7	0.4	0.04	11.23	< .001	0.44
social_skills	R11	0.5	0.04	13.8	< .001	0.52
social_skills	R12	0.56	0.04	15.21	< .001	0.56
social_skills	R13	0.66	0.04	16.3	< .001	0.58
social_skills	R14	0.75	0.03	21.57	< .001	0.74
social_skills	R15	0.76	0.04	20.27	< .001	0.7

Achievement-Striving Measurement Model

The achievement striving measurement was constructed to measure all observed items loading directly on a single unobserved latent construct. The hypothesized measurement model (Model 7) for achievement striving had a unidimensional structure with a single latent variable that influences item responses. The hypothesized measurement model did not impose any constraints on the model and all observed item responses were allowed to be freely estimated, meaning the first indicator variable was not fixed to one. This model exhibited extremely poor

fit, $\chi^2(35, N=816) = 1335.015$, $p<.001$; RMSEA=0.213 [90% CI: 0.204-0.223]; CFI= 0.63; SRMR=0.17. This measurement model of achievement striving was therefore deemed unacceptable and alternative measurement models were considered using exploratory factor analysis (EFA) techniques.

Results from a scree plot, a plot that shows how many factors to retain within the measurement model (Brown, 2009), revealed that at least two separate factors were present. Items 1, 3, 4, 7, and 9 were loaded onto a single latent variable referred to as Ach 1 and the remaining observed indicator items were loaded onto a single latent variable referred to as Ach 2 with free covariances. This model (Model 8) had the following fit statistics $\chi^2(34, N=816) = 142.44$, $p<.001$; RMSEA=0.063 [90% CI: 0.052-0.073]; CFI= 0.97; SRMR=0.04 (Figure 5); and this model was retained for further analyses. The correlation between Ach 1 and Ach 2 was 0.30. Normally this technique would not be used during confirmatory factor analysis, but it is acceptable in this case as the purpose of this study is not to test a measurement model but rather to fit and interpret the coefficients of a structural model describing the relationship between constructs, which requires that the measurement model fit the data reasonably well in order to produce meaningful results (Ullman & Bentler, 2003). For the complete factor loadings table for Model 8, see Table 7.

Figure 5.

Achievement-striving Model 8. An alternative model, Ach 1, Ach 2 were structured as separate, correlated latent variables.

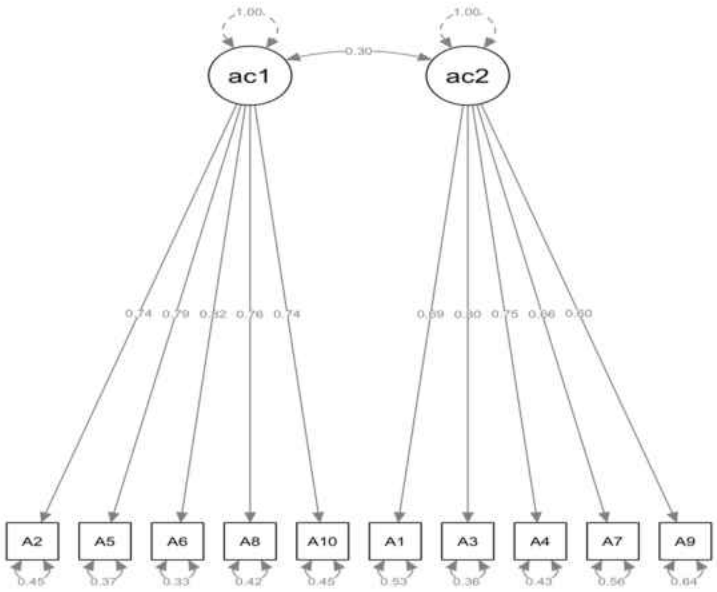


Table 7.

Achievement-striving Model 8 Factor loading

Latent Factor	Indicator	B	SE	Z	p-value	Beta
ach1	A2	0.85	0.04	23.52	< .001	0.74
ach1	A5	0.98	0.04	25.97	< .001	0.79
ach1	A6	0.97	0.04	27.06	< .001	0.82
ach1	A8	0.89	0.04	24.47	< .001	0.76
ach1	A10	0.92	0.04	23.67	< .001	0.74
ach2	A1	0.62	0.03	20.65	< .001	0.69
ach2	A3	0.73	0.03	25.16	< .001	0.80
ach2	A4	0.69	0.03	23.42	< .001	0.75
ach2	A7	0.65	0.03	19.65	< .001	0.66
ach2	A9	0.65	0.04	17.38	< .001	0.60

Brief Self-Control Scale Models

The brief self-control measure was constructed to measure a single latent variable. The hypothesized measurement model for self-control (Model 9) therefore had a unidimensional structure with a single latent variable that influences item responses. The model was parameterized such that the factor residual variance was fixed to one so that all loadings could be freely estimated. This measurement model had the following fit statistics, $\chi 2(65, N=810) = 857.1$, $p<.001$; RMSEA=0.123 [90% CI: 0.115-0.130]; CFI= 0.75; SRMR=0.08. The fit indices indicate poor model fit and therefore this was viewed as unacceptable. Researchers have found similar results using the Brief Self-Control Scale during investigation with confirmatory factor analysis (Vazsonyi et al., 2019).

To improve model fit, an exploratory factor analysis was conducted to help determine the factor structure of the item responses. The scree plot revealed that at least two separate factors were present in this sample. Vazsonyi et al. (2019) found a similar two-factor structure. The two-factor model suggested by the EFA was tested via CFA, with items 2, 3, 4, 5, 7, 9, and 10 loaded onto a latent variable referred to as Self 1 and the remaining items loaded onto a latent variable referred to as Self 2 with a free covariances between factors (see Figure 6). The alternative model (Model 10) had the following fit indices $\chi^2(34, N=810) = 304.84$, $p<.001$; RMSEA=0.098 [90% CI: 0.088-0.108]; CFI= 0.87; SRMR=0.05. The correlation between Self 1 and Self 2 was 0.48. This model produced the best fit of those considered (though it remained somewhat poor) and was therefore retained for further analysis. For the complete factor loadings, see, Table 8.

Figure 6.

Self-control Model 10. An alternative model, Self 1, Self 2 were structured as single latent variables.

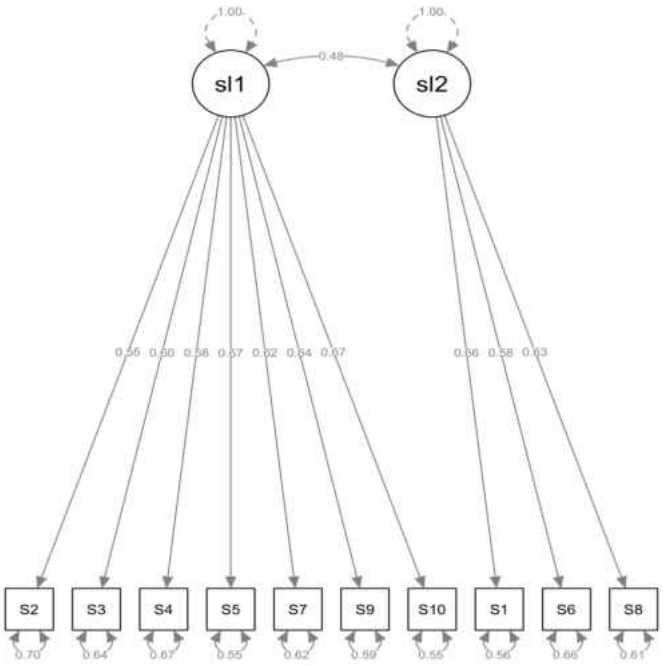


Table 8.

Self-control Model 10 Factor loadings

Latent Factor	Indicator	B	SE	Z	p-value	Beta
self1	S2	0.7	0.04	15.53	< .001	0.55
self1	S3	0.69	0.04	17.12	< .001	0.6
self1	S4	0.69	0.04	16.14	< .001	0.58
self1	S5	0.78	0.04	19.35	< .001	0.67
self1	S7	0.77	0.04	17.75	< .001	0.62
self1	S9	0.77	0.04	18.42	< .001	0.64
self1	S10	0.81	0.04	19.44	< .001	0.67
self2	S1	0.78	0.05	16.07	< .001	0.66
self2	S6	0.71	0.05	14.22	< .001	0.58

self2	S8	0.74	0.05	15.37	< .001	0.63

Conscientiousness Measurement Models

The conscientiousness scale (Model 11) was constructed to measure a single construct. The hypothesized measurement model for conscientiousness therefore contained a unidimensional structure in which all items loaded on a single latent variable. The loadings for all items were freely estimated, meaning the loading for the first indicator variable was not fixed to one. This model did not have acceptable fit, $\chi^2(35, N=810) = 1253.62$, $p<.001$; RMSEA=0.207 [90% CI: 0.198-0.217]; CFI= 0.59; SRMR=0.17. Alternative models were considered using exploratory factor analysis techniques.

The scree plot results for item responses in the conscientiousness measurement revealed at least two separate factors present. Indicator items 1, 4, 5, 6, 7, and 10 were loaded onto a single latent variable referred to as Con 1 and the remaining observed items were loaded onto a single latent variable referred to as Con 2 with a free correlation between latent variables (see Figure 7). This measurement model (Model 12) produced acceptable fit indices, $\chi^2(34, N=810) = 179.56$, $p<.001$; RMSEA=0.071 [90% CI: 0.061-0.082]; CFI= 0.95; SRMR=0.04. The correlation between Con 1 and Con 2 was 0.32. Model 12 was retained for further proceedings given the acceptable fit. For the complete factor loadings table, see Table 9. Table 10 summaries each retained model's fit indices that were used in the structural model analysis.

Figure 7.

Conscientiousness Model 12. An alternative model, Self 1, Self 2 were structured as single latent variables.

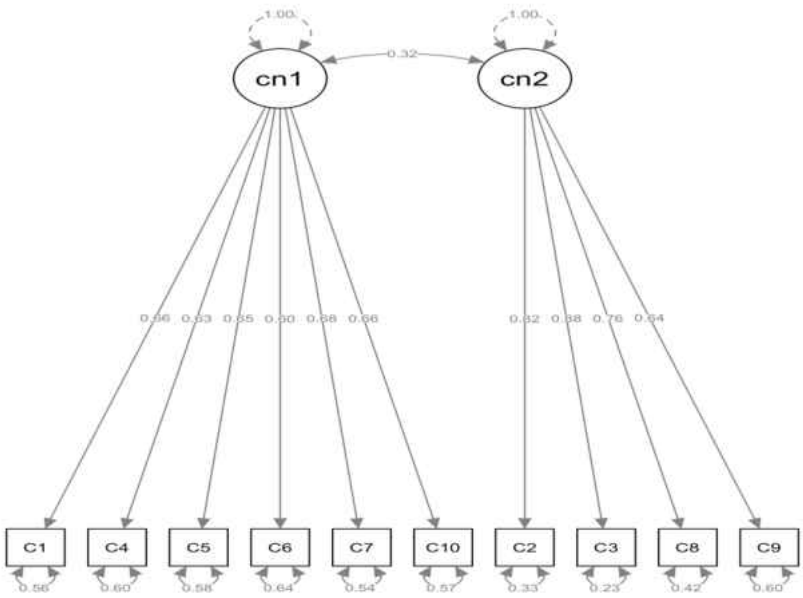


Table 9.

Conscientiousness Model 12 Factor loadings

Latent Factor	Indicator	B	SE	Z	p-value	Beta
con1	C1	0.59	0.03	19.39	< .001	0.66
con1	C4	0.62	0.03	18.07	< .001	0.63
con1	C5	0.69	0.04	18.81	< .001	0.65
con1	C6	0.6	0.04	17.07	< .001	0.6
con1	C7	0.62	0.03	19.83	< .001	0.68
con1	C10	0.61	0.03	19	< .001	0.66
con2	C2	1.01	0.04	27.01	< .001	0.82
con2	C3	1.06	0.04	29.77	< .001	0.88
con2	C8	0.95	0.04	24.13	< .001	0.76
con2	C9	0.76	0.04	19.06	< .001	0.64

Table 10.

Model fit statistics for each retained model

Model	χ^2	DF	N	P	RMSEA [90% CI]	SRMR	CFI
Model 1 (grit)	232.08	53	817	<0.001	0.064[0.056-0.073]	0.05	0.94
Model 6 (resilience)	682.31	87	811	<0.001	0.091[0.085-0.098]	0.09	0.84
Model 8 (achievement striving)	145.33	34	810	<0.001	0.063[0.052-0.073]	0.04	0.97
Model 10 (self-control)	304.84	34	810	<0.001	0.098[0.088-0.108]	0.05	0.87
Model 12 (conscientiousness)	179.56	34	810	<0.001	0.071[0.061-0.082]	0.04	0.95

Note. In Model 1 (grit) the factor loading for the latent variable perseverance of effort on grit is fixed to one. The same fit indices were obtained when the latent variable passion is fixed to one and when the higher order latent variable grit is removed leaving passion and perseverance of effort as single latent variable models.

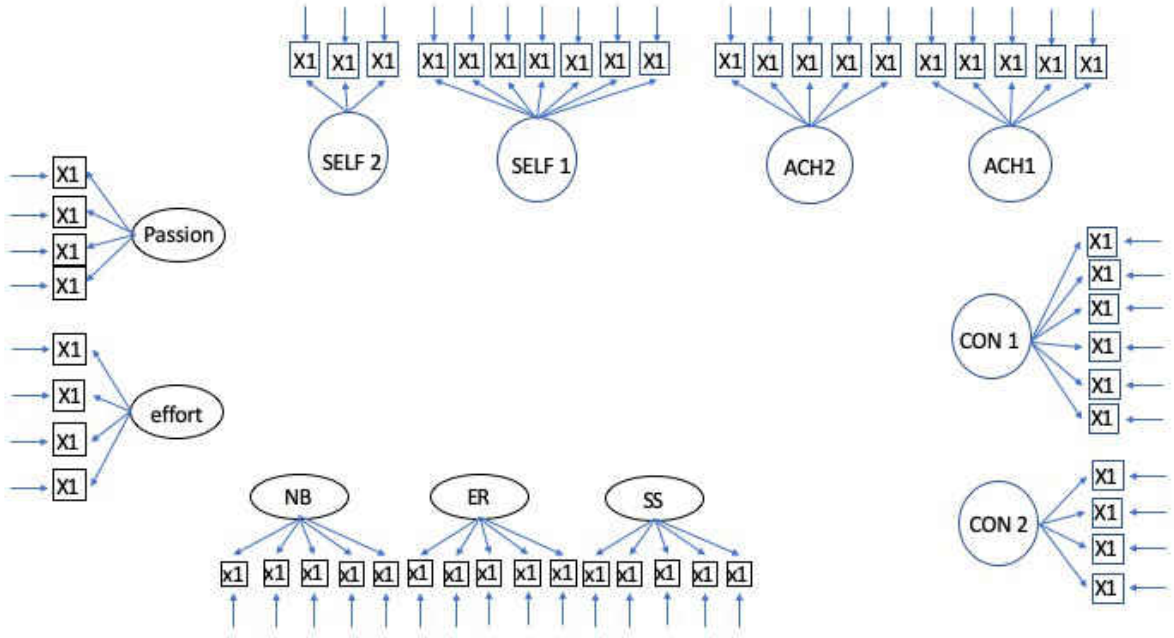
Full Measurement Model

Once all individual measurement models were deemed to have acceptable fit, a full measurement model was fit to the data. The full measurement model included fitting all single latent constructs simultaneously with free correlations between exogenous latent variables. The higher-order grit latent variable was removed for this phase of testing because when passion and perseverance of effort are retained as single latent variables without the hierarchical structure, the same fit indices are produced. The justification for this removal was to not impose assumptions on the model that assumed that either passion or perseverance of effort accounted for more of the variance in grit when fixed to one. A structural model with grit as a hierarchical latent variable

was tested and will be discussed later. The full model (Model 13) was identified with 60 observed variables, 399 observations, and 186 parameters. The full measurement model (Model 13) had the following fit statistics, $\chi^2(1484, N=817) = 4817.87$, $p<.001$; RMSEA=0.052 [90% CI: 0.051-0.054]; CFI= 0.84; SRMR=0.07 (see Figure 8). This fit was deemed marginal but was considered to be good enough to justify continuing to the final phase, testing the structural model with regression pathways. For a complete factor loading table, see Table JA Appendix J.

Figure 8.

Full Measurement Model 13. Note: correlations between latent variables were included in the model but are not represented in this figure for clarity.



Structural Models

The final phase of analysis consisted of fitting a series of four structural models to obtain an overall R^2 value for each outcome variable. The four outcome variables in each structural model were as follows: 1) passion (grit subfactor), 2) perseverance of effort (grit subfactor), 3)

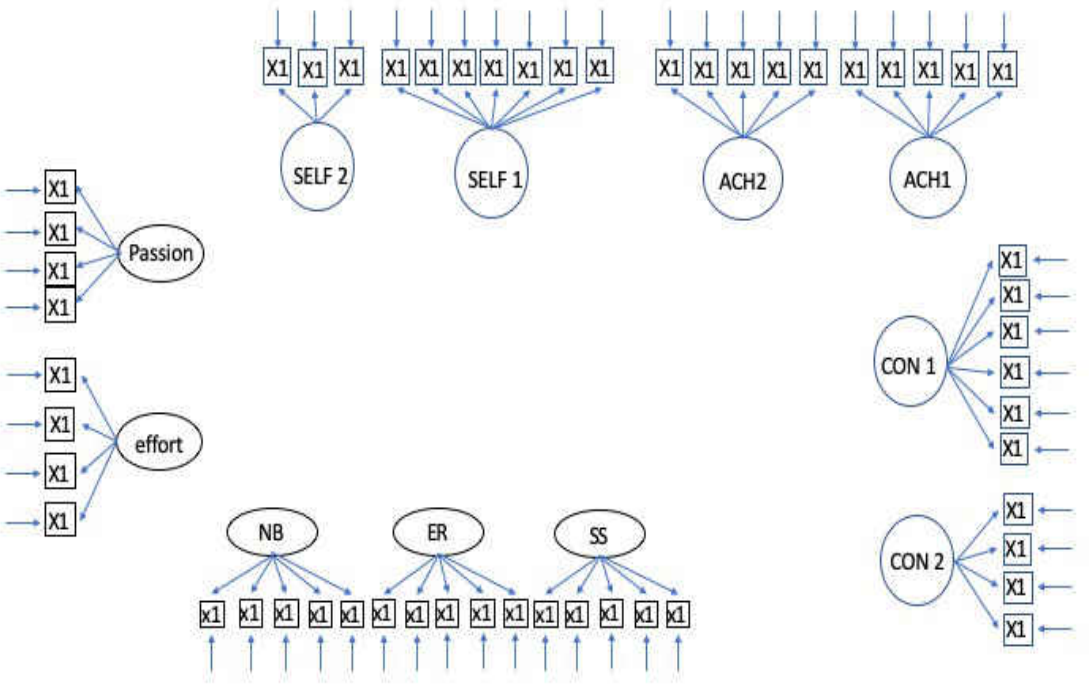
grit (with the perseverance of effort latent variable factor loading fixed to one), and 4) grit (with the passion latent variable factor loading fixed to one.

First Structural Model

The first structural model was constructed with the grit subordinate latent variable passion as the outcome variable. Passion was the outcome variable being predicted by the other constructs, which include negative bias, social skills, emotional resilience, Ach 1, Ach 2, Self 1, Self 2, Con 1, and Con 2. All latent variable variances and residual variances were fixed to one, allowing factor loadings to be freely estimated (see Figure 9). The resulting R^2, the variance accounted for by the predictor variables, was the focus of interpretation after fit indices were evaluated. This structural model converged normally with the following fit statistics, $\chi^2(1179, N=817) = 4066.72$, $p<.001$; RMSEA=0.055 [0.053-0.057]; CFI= 0.85; SRMR=0.07. As the model fit was deemed acceptable, the variance accounted for was evaluated. The R^2 value for passion was 0.62, meaning 62% of the variance in passion is accounted for through the other latent variables in the structural model. For a complete factor loadings table see, Table KA Appendix K.

Figure 9.

Structural Model for the grit subdomain latent variable passion as the outcome variable.

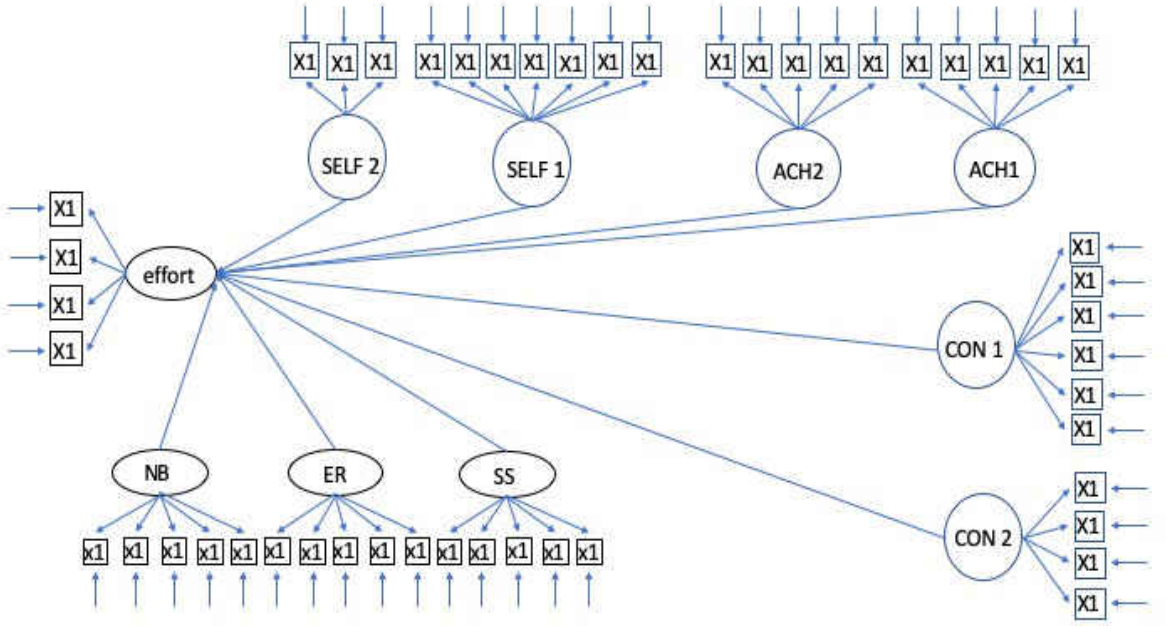


Second Structural Model

The second structural model was constructed identically to the previous model but with the grit subdomain latent variable perseverance of effort as the outcome variable, as shown in Figure 10. Each latent variable's variance (or residual variance) was fixed to one, allowing all factor loadings to be freely estimated. Model fit was assessed, $\chi^2(1130, N=817) = 4060.17$, $p<.001$; RMSEA=0.056 [90% CI:0.054-0.058]; CFI= 0.84; SRMR=0.07. Eighty percent of the variance in perseverance of effort was accounted for by the model. For a complete factor loadings table see, Table LA, Appendix L.

Figure 10.

Model 14: Structural Model for the grit subdomain latent variable perseverance of effort as the outcome variable.



Third and Fourth Structural Models

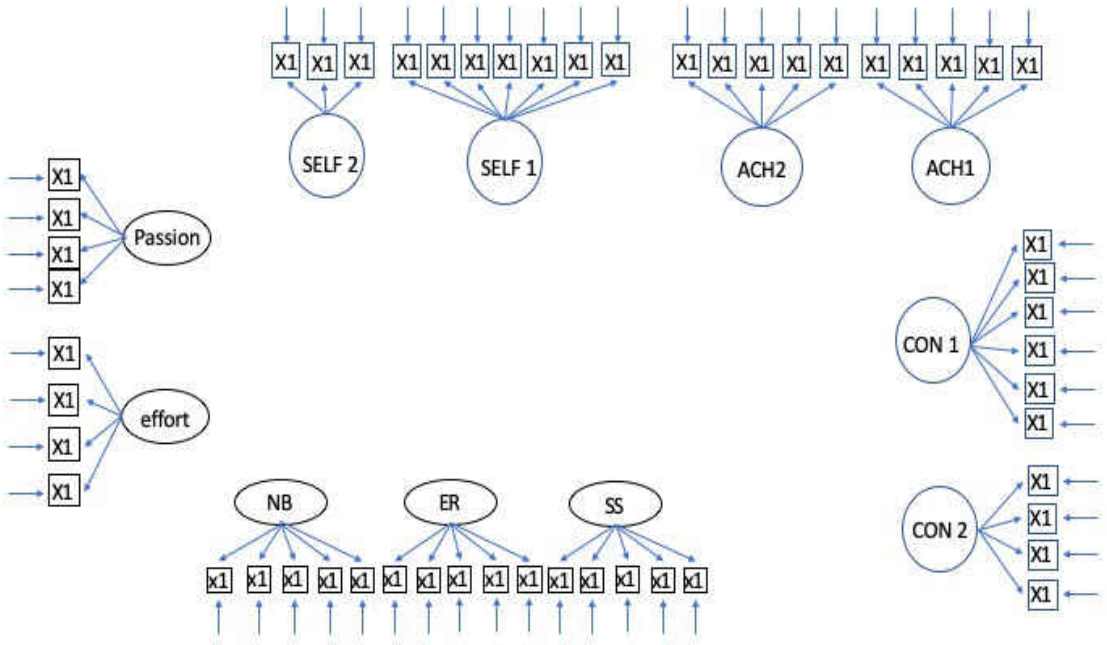
The third and fourth structural models tested were constructed with the higher-order latent variable grit as the outcome. Grit was constructed as a hierarchical structural model with two subordinate latent variables, passion and perseverance of effort (see Figure 11). As described in the section on the hierarchical measurement model for grit, identification required either one of the two factor loadings from grit to the grit subdomains to be fixed to one. The choice of which subdomain loading was fixed strongly alters the meaning of the superordinate grit latent variable. Briefly, if the perseverance of effort loading was fixed to one, the loading for passion was much weaker. Therefore, "grit" was mostly defined by the latent variable perseverance of effort. Conversely, if the passion loading was fixed to one, the freely-estimated perseverance of

effort loading was weak, and "grit" was mostly defined by passion. This choice, while arbitrary, strongly affects the R2 value obtained.

In the first of these models, the perseverance of effort loading was fixed to one. Model fit was as follows: $\chi^2(1493, N=817) = 5289.08$, $p<.001$; RMSEA=0.056 [90% CI: 0.054-0.057]; CFI= 0.81; SRMR=0.09 and passion fixed to one produced the following, $\chi^2(1493, N=817) = 5432.15$, $p<.001$; RMSEA=0.057 [90% CI: 0.055-0.058]; CFI= 0.81; SRMR=0.09. When the perseverance of effort loading was fixed to one, the R^2 value for grit was 0.89, meaning nearly 90% of the variance in grit is explained by the other psychological constructs. When the grit subordinate latent variable passion factor loading was fixed to one, the R^2 value for grit was 0.76. For the complete factor loadings table for each of these models, see Tables MA and NA in Appendices M-N.

Figure 11.

Structural model with hierarchical structure of grit as the outcome variable.



Chapter 5. Discussion

The main objective for the current study was to investigate grit's distinguishability from the other personality constructs of conscientiousness, resilience, self-control, and need for achievement. Although Duckworth and colleagues consistently argue that grit is distinguishable from constructs like conscientiousness (Cooper, 2014; Duckworth et al., 2007; Duckworth & Quinn, 2009), other independent researcher teams have presented evidence that grit and conscientiousness are highly related (e.g. Collaco, 2018; Crede et al., 2017; Ivcevic & Brackett, 2014). Crede and colleagues (2017) concluded in their meta-analysis that the hierarchical structure of grit has not been confirmed to be reliable, that the subdomain perseverance of effort has a stronger validity than passion, and that grit was strongly correlated with conscientiousness. This study reaches a similar conclusion finding a lack of evidence for grit as a hierarchical structure with two lower order subdomains. This study also concludes that grit (especially the perseverance of effort subdomain) is almost completely redundant with other similar psychological constructs. Both of these findings are discussed below.

Structural Models

To test the distinguishability hypothesis, structural equation modeling was used to examine the variance in grit and its subdomains that could be explained in terms of other similar constructs. The overall structural model with passion as the outcome variable and conscientiousness, need for achievement, negativity bias, social skills, emotional resilience and self-control as predictor variables resulted in an R^2 value of 0.62. According to my interpretation guidelines (Table 3), I interpreted this to mean that passion could be distinguishable but substantially related to the other constructs. The second structural model was constructed with perseverance of effort as the outcome and the same predictors, resulted in an R^2 value of 0.80.

This value was interpreted to mean that the distinguishability of perseverance of effort from the other constructs is questionable.

The structural model with grit as the outcome variable and the subdomain effort factor loading fixed to one had an R^2 value of 0.89, which fell to R^2=0.76, when the subdomain passion factor loading was fixed to one. My interpretation guidelines held that an R^2 value between 0.8-0.9 would be interpreted as grit's distinguishability being questionable, while an R^2 value of 0.9 would have an interpretation of grit is not distinguishable from other constructs. My hypothesis was not exactly supported with grit having an R^2 greater than 0.90. This was mainly due to the highly flexible hierarchical structure of grit, based on which latent factor loading was fixed to one (passion or perseverance of effort). The overall variance accounted for shifted drastically from 0.89 to 0.76 depending on which latent factor loading was fixed to one. The results indicate that the psychological construct of grit is an example of the jangle fallacy given the large R^2 values across all four structural models.

In addition, since the effort subcomponent of grit is mostly redundant, any uniqueness of the grit concept simply results from the inclusion of passion. However, the perseverance of effort subcomponent of grit could be the driving force behind its association with academic success outcomes as well as its strong correlations with other psychological constructs since it is redundant with other concepts which are known to be correlated with positive achievement outcomes.

Duckworth's empirical argument for the distinguishability of grit is based on a claim of incremental validity - that grit is not redundant because it predicts achievement outcomes even after controlling for other constructs. For example, Duckworth has argued that "grit predicts over and beyond conscientiousness" (Duckworth et al., 2007, p. 1087) and that grit predicts over and

beyond self-control (Duckworth & Gross, 2009), Westfall and Yarkoni (2016) demonstrated, however, that incremental validity claims have a false positive rate approaching 100% when constructs are measured with error (as they always are). Using a classic correlation-is-not-causation example used in many introductory statistical courses (ice cream sales, and swimming pool deaths), they show that when researchers control for a version of the confounding variable (in this example, "heat") that is measured with error, the correlation between ice cream and drownings fails to completely disappear. They conclude that findings of incremental validity, which are extremely common in psychology, do not actually provide evidence for the independence of effects. Given this example, the results of Duckworth et al.'s studies and others that use the same argumentative structure fail to provide any evidence that grit offers any incremental value beyond the other constructs measured. Conscientiousness, self-control, need for achievement, and resilience could all be confounding of the grit-academic performance relationship, but it may appear to naïve researchers that grit is predictive "over and beyond" those constructs. Although this study did not follow traditional analysis procedures for testing discriminant validity, one could still conclude that if a significant proportion of variance can be explained by other psychological constructs, the construct in question would not appear to have discriminant validity. The method used in this study provides a far more direct and diagnostic test of the actual discriminant validity of grit, enabling potential jingle-jangle fallacies to be evaluated empirically.

Measurement Models

An incidental finding of this study was the poor replicability of claimed factor structures and psychometric properties of some seemingly well-established instruments. The hierarchical measurement model for grit did produce good fit consistent with previous literature (Duckworth

et al. 2007). However, the hierarchical measurement model required consequential constrains for identification. The constraint placed on the grit measurement model fixed the lower level latent variable perseverance of effort's loading on grit to one, causing this subdomain to dominate the composition of the higher-order grit variable. This conceptually contradicts how a grit score is ultimately obtained by users of the scale, who produce a total score by averaging across all item responses. This classical scoring procedure produces grit scores that are an equal combination of perseverance of effort and passion. Since removing the higher-order construct grit and allowing observed items to load onto the subordinate latent variables as single constructs produced the exact same fit indices, this model was carried forward to the structural analysis.

The grit measurement scale was not the only construct whose measurement proved to be problematic. The resilience instrument mini-BRISC, which was designed to measure three lower level latent variables (negativity bias, social skills, and emotional resilience) did not produce acceptable fit when the hypothesized measurement model was fit to the data. An alternative model removing resilience as the higher order latent variable produced the best fit. This could imply that there is a lack of evidence for the hierarchical structure of resilience. The aim here though was not, however, to confirm the dimensionality of resilience, but to proceed with a good fitting model. The need for achievement measure, intended to be a unidimensional scale, also produced unacceptable fit when such a model was fitted to the data. Exploratory factor analysis (EFA) was used to identify a two-factor model that did exhibit acceptable fit. EFA was used for the other measurements, conscientiousness and self-control, both of which did not produce acceptable fit statistics with a unidimensional structure. It was within this exploration phase that a two-structure factor was found for both constructs.

To understand results such as these one has to think about the scale development process and the methods used to assess dimensionality such as confirmatory factor analysis (CFA). The scale development process for the other psychological constructs are briefly discussed, as this is beyond the scope of this manuscript. The Factor III Conscientiousness scale used was obtained from the International Personality Item Pool (International Personality Item Pool, n.d.). This scale is a representation of Goldberg's Big-Five (1992). The IPIP scale construction was accomplished by correlating the available IPIP items with the original scale of interest and rank ordering items with the absolute value correlations. The highest correlated negatively worded items and positively worded items were selected with the desired number of items for the final scale. A reliability analysis was conducted by removing any item that lowers the coefficient alpha. This process was continued until a reasonable high alpha was obtained. The achievement striving 6FPQ was also obtained from the IPIP and is a representation of the six-factor personality questionnaire (Jackson et al., 2000). The IPIP version followed the same scale construction as noted with the conscientiousness IPIP scale. The two IPIP scales used in this study may have not had the same unidimensionality as the original scales they were made from. Schmitt (1996) suggested that high alpha levels, one of the methods used to assess the IPIP scales, does not measure or test the structure of the scale, meaning a high alpha coefficient should not be interpreted as evidence for unidimensionality.

The mini-Brief Risk Resilience Index Scale (Williams et al., 2012) used in the study is a shorten version of the full 45 item Brief Risk Resilience Index Scale (Williams et al., 2012). This original scale was developed using principal component analysis and validated with behavioral measures (e.g. clinical assessment; psychologist was blind to BRISC scores). However, the proposed factor structure was never replicated or tested with confirmatory factor analysis

procedures. This manuscript, that I know of, is the first to empirically evaluate the theorized factor dimensionality.

The self-control scale (Tangney et al., 2004) was developed with college students (N=351, N=255). Using item-total correlations scale items were cut from 93 to 36. The dimensionality of the scale was tested using Exploratory factor analysis with varimax and oblique rotations (Tangeny et al., 2004). Scree plot results revealed five factors. However, varimax and oblique results revealed little correlation variation with the five factors which lead the researchers to focus on a total self-control score with no regard to the scree plot results and potential underlining factors. The published self-report scale is theorized to have a unidimensional structure despite the evidence from the scree plot.

In general, during any scale development it is difficult to rule out a two-factor structure using a single cross-sectional data collection occasion. VanderWeele (2018) showed that two factors that mutually cause one another over time can manifest as a single factor in a non-longitudinal design. Researchers commonly validate instruments by using one wave of data collection and, if there is evidence for unidimensional structure to explain most of the variance between scale items then researchers stop there and publish the results. The evidence for this type of structure is likely due to only using one round of data collection (VanderWeele, 2018).

Hoi Suen (1990) referring to test scores explained in the book Principles of Test Theories that for "test scores to truthfully reflect quantities of a characteristic of interest involves a huge inferential leap" (p. 5). This idea although referring to test scores can also be applied to the way we think about psychological measurements, especially with unobserved latent constructs, meaning scale development researchers are also taking a giant inferential leap. This problem is made worse when scale development processes are abbreviated and or not replicated by other

independent researchers before implementation. Replication by other independent researcher teams is a crucial step because excellent fit for proposed construct models does not necessarily confirm a theory or confirm a unidimensional structure (Fried, 2020).

The other explanation for the lack of evidence towards proposed factor structure as some have argued (Marsh et al., 2010) could be due to the methods used to assess structure, such as Confirmatory Factor Analysis (CFA). Marsh et al., argued allowing one indicator variable to load on one latent factor, a common method in CFA studies is "too restrictive for personality research" (p. 472). They conclude that exploratory structural equation modeling, which combines CFA and EFA methods, shows better structural fit similar to theorized big five factor models. On the contrary, researchers Gignac, Bates, and Jang (2006) suggest rather than concluding a problem within CFA researchers should investigate the evidence for model misfit. The field of educational psychology among other fields find it appropriate to use CFA techniques to assess model fit and confirm measurement structure (e.g., Keith & Reynolds, 2018; Li et al., n.d.; McCoach, 2002; Steinmetz et al., 2009)

In conclusion, model misfit within social and personality research is not uncommon (Flake et al., 2017; Gignac et al., 2006). Therefore, it is suggested for personality scale development, researchers follow best practices, (e.g. Costello & Osborne, 2005; Flake et al., 2017; Worthington & Whittaker, 2006) have independent researcher teams validate the measure and, validate dimensionality before implementation in applied settings.

Limitations of Study

This study was not without limitations. First, a majority (59%) of the participants were aged 18-34. This is not surprising the study was primarily advertised through Sona, a psychology department participant pool recruitment tool. In an attempt to correct for the type of bias that

may be evident with this convenience sample, advertisements were placed on social media sites. That said, the majority of the data were from undergraduate students. In addition, there is no way of truly determining which participants came directly from the psychology department pool and which ones from the social media sites within the current study. As a result, it is suggested that future studies with this type of data collection procedure should add an additional item in the demographics section to dissect the two types of participants, such as "are you currently enrolled in college?" or "where did you learn of this research opportunity?" However, this method of data collection will still be considered a convenience sample as opposed to a probability sample that is representative of a population.

Another limitation of the study was the scales used to assess the constructs measured. The scales selected had acceptable Cronbach's alpha levels and the responses to most items appeared to be approximately normal. Several of the measurement models, however, did not produce acceptable model fit, as noted prior and, as a result made it difficult to achieve the aim of this study. That is, the need for achievement, conscientiousness, and self-control scales did not have a unidimensional structure, as theorized in previous studies, according to the results from exploratory factor analysis within the current study, specifically displayed through a scree plot, and verified using CFA.

Future Research

Where do we go from here? There have been many important findings in relation to grit, such as the meta analytic review (Crede et al. 2017), and the multivariate analysis using multiple grit scales (Collaco, 2018), all of which state that grit is highly correlated with other well-known psychological constructs. However, there has also been a continued push from Duckworth that grit is unique and predictive over and beyond conscientiousness, self-control, and cognitive

ability (Duckworth, 2013; Duckworth et al., 2007). The evidence provided in the current study suggests that grit, specifically the lower level latent variables passion and perseverance of effort, are not sufficiently distinguishable from other psychological constructs. As the result, the age-old question of why some individuals prevail while others do not cannot currently be answered through the personality trait of grit. Does this mean that grit is not a personality trait? Not necessarily, but the evidence presented here suggests that the items observed in the grit scale may actually be measuring conscientiousness, among other constructs.

Currently, the grit construct does not have the supporting evidence required for implementation or curriculum changes within school districts. The research evidence presented by Duckworth has major shortcomings. 1. The abbreviated scale development (e.g. not consulting other experts for item selections. 2. Validating the Grit-S measure using the same sample used to validate the Grit-O. 3. The grit scale items are strikingly similar between other construct measurements. 4. The hierarchical structural of grit is not identified (Kline, 2016). Due to these shortcomings grit is not distinguishable from other psychological constructs.

Other researcher teams have also stated similar conclusions (Collaco, 2018; Crede et al., 2017; Cross, 2014; Dahl, 2016; Ivcevic, & Brackett, 2014; Jachimowicz et al., 2017; Rimfeld et al., 2016). It is important to note however, that one failed replication does not warrant that the grit phenomenon does not exist, but when multiple independent research teams report results that indicate high correlations between constructs as well as the high R^2 values presented in this paper, it does indicate that there is construct overlap (Block, 2000) which means the construct in question does not have discriminant validity and is an example of a jangle fallacy. Jangle fallacies are problematic for researchers because it creates confusion within the literature.

Therefore, the meaning of the construct is only interpretable to the specific researcher in which it was developed.

Future research could look to improvement of the psychometric properties of the grit scale by selecting different items or using a different means of measurement other than self-report measures (e.g., a behavioral task measure). Future research could also test the hypothesis that perseverance of effort is the driving force behind the construct of grit by isolating/separating the subdomains of grit, passion and perseverance of effort, and testing each subcomponent's ability to predict academic and other success outcomes. One suggestion is apparent given the results of this study, that more empirical research should be done to validate constructs prior to implementation. One way to accomplish this would be to assess the discriminant validity of the construct in question with other similar established constructs using structural equation modeling as presented in this paper.

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APPENDICES

Appendix A: Participant Recruitment Advertisement

Research participants needed!

What: Research study investigating the personality trait surveys.

When: Online link, estimated time to complete 1 hour or less.

Who: 18 years or older, English speaking and reading fluent, American residents only.

Participation is voluntary

I am a graduate student at ETSU. I am conducting a research study investigating the personality trait grit. I am recruiting individuals from all backgrounds. To participate you must be 18 or older and an American resident. The survey questions will be provided in English, therefore to participate you will need to speak and read English fluently. Please type the link below or copy it and paste it into your browser to view the informed consent to participate in the study: https://www.surveymonkey.com/r/9DRCGV5

If you have any questions, please contact Natasha Godkin (423-439-4464) or Dr. Matthew McBee (423-439-6657).

Appendix B: Pre-Registration

ASPREDICTED

Jangle Fallacy&Grit. Is grit distinct from other psychological constructs? (#35126)

Created: 02/05/2020 03:16 PM (PT)
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Author(s)
Natasha Godkin (East Tennessee State University) - godkin@etsu.edu

1) Have any data been collected for this study already?
It's complicated. We have already collected some data but explain in Question 8 why readers may consider this a valid pre-registration nevertheless.

2) What's the main question being asked or hypothesis being tested in this study?
I hypothesize that grit will not be distinguishable from resilience, need for achievement and conscientiousness or self-control, R2 > 0.9.

3) Describe the key dependent variable(s) specifying how they will be measured.
Grit will be measured with the full 12 item survey (Duckworth, Peterson, Matthews & Kelly, 2007), Resilience will be measured using the Brief Risk-Resilience Index for screening (BRISC, Rush, 2012). Self control will be measured using the SCS brief version (Tangney, Baumeister, & Boone). Conscientiousness (10-item IPIP representation of Goldberg 1992). Achievement striving will be measured using the 6FPQ: Achievement [It1], IPIP representation of the Goldberg 1992.

4) How many and which conditions will participants be assigned to?
There will be only one condition. Every participant will be given the same survey battery.

5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.
Confirmatory Factor Analysis (CFA) will be used to analyze the data. Data will be analyzed using the R statistical software, specially the lavann package (Rosseel, 2012), and the analysis code will be publicly posted along with the raw data on the Open Science Framework website (osf.io). Step 1. Will be to fit individual measurement models for each construct, making reasonable modifications as needed (for example, freeing residual correlations between items) until adequate fit is achieved. 2. Fit a full measurement model for all constructs simultaneously, with free correlations between the latent variables. 3. Fit a structural model regressing latent grit on latent conscientiousness, achievement-striving, resilience and self-control. The r-squared value from this final model is the focal statistic for interpretation.

6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.
Cases with missing data will be included via the use of full-information maximum likelihood estimation (FIML; Enders & Bandalos, 2001).

7) How many observations will be collected or what will determine sample size? No need to justify decision, but be precise about exactly how the number will be determined.
A widely accepted rule of thumb is 10 cases/observations per indicator variable in setting a lower bound of an adequate sample size, 20 observations per indicator variable is more ideal (Kline, 2016). I will aim for the latter, however 10 per observation will be used at the minimum to interpret results adequately. The final model includes 60 latent variables. A sample size needed is 600 with an ideal amount being 1200.

8) Anything else you would like to pre-register? (e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)
Data collection has begun. However, prior to data collection an as predictor was filled out, Sep 9th 2019 at 10:55AM, I have a screen shot of this that I emailed to my mentor for proof reading. After a success defense of my research proposal my committee suggested I add in a self-control measurement. I failed to come back to as predicted and complete my pre-registration prior to having my survey battery live for data collection to include the updated self-control variable. Everything else has and will be the same.

Appendix C: Grit-O Scale

Directions for taking the Grit Scale: Here are a number of statements that may or may not apply to you. For the most accurate score, when responding, think of how you compare to most people -- not just the people you know well, but most people in the world. There are no right or wrong answers, so just answer honestly!

1.I have overcome setbacks to conquer an important challenge.

Very much like me, Mostly like me, Somewhat like me, Not much like me, Not like me at all

2.New ideas and projects sometimes distract me from previous ones.

Very much like me, Mostly like me, Somewhat like me, Not much like me, Not like me at all

3.My interests change from year to year.

Very much like me, Mostly like me, Somewhat like me, Not much like me, Not like me at all

4.Setbacks don't discourage me.

Very much like me, Mostly like me, Somewhat like me, Not much like me, Not like me at all

5.I have been obsessed with a certain idea or project for a short time but later lost interest.

Very much like me, Mostly like me, Somewhat like me, Not much like me, Not like me at all

6.I am a hard worker.

Very much like me, Mostly like me, Somewhat like me, Not much like me, Not like me at all

7.I often set a goal but later choose to pursue a different one.

Very much like me, Mostly like me, Somewhat like me, Not much like me, Not like me at all

8.I have difficulty maintaining my focus on projects that take more than a few months to complete.

Very much like me, Mostly like me, Somewhat like me, Not much like me, Not like me at all

9.I finish whatever I begin.

Very much like me, Mostly like me, Somewhat like me, Not much like me, Not like me at all

10.I have achieved a goal that took years of work.

Very much like me, Mostly like me, Somewhat like me, Not much like me, Not like me at all

11.I become interested in new pursuits every few months.

Very much like me, Mostly like me, Somewhat like me, Not much like me, Not like me at all

12.I am diligent.

Very much like me, Mostly like me, Somewhat like me, Not much like me, Not like me at all

Scoring:

1.For questions 1, 4, 6, 9, 10 and 12 assign the following points:

5 = Very much like me

4 = Mostly like me

3 = Somewhat like me

2 = Not much like me

1 = Not like me at all

2.For questions 2, 3, 5, 7, 8 and 11 assign the following points:

1 = Very much like me

2 = Mostly like me

3 = Somewhat like me

4 = Not much like me

5 = Not like me at all

Add up all the points and divide by 12. The maximum score on this scale is 5 (extremely gritty), and the lowest score on this scale is 1 (not at all gritty).

Duckworth, A.L., Peterson, C., Matthews, M.D., & Kelly, D.R. (2007). Grit: Perseverance and passion for long-term goals. Journal of Personality and Social Psychology, 9, 1087-1101

Appendix D: Factor III Conscientiousness

10-item scale (Alpha = .79)

+ keyed	Am always prepared.
	Pay attention to details.
	Get chores done right away.
	Like order.
	Follow a schedule.
	Am exacting in my work.
– keyed	Leave my belongings around.
	Make a mess of things.
	Often forget to put things back in their proper place.
	Shirk my duties.

Appendix E: Achievement-Striving

(6FPQ: Achievement [IT1])

+ keyed	Do more than what's expected of me.
	Accomplish a lot of work.
	Excel in what I do.
	Plunge into tasks with all my heart.
	Do a lot in my spare time.
– keyed	Do just enough work to get by.
	Hang around doing nothing.
	Shirk my duties.
	Find it difficult to get down to work.
	Need a push to get started.

Appendix F: Brief Risk-Resilience Index for Screening (BRISC)

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
1. I was often stressed and on edge	☐	☐	☐	☐	☐
2. I lost hope and felt like giving up when something went wrong	☐	☐	☐	☐	☐
3. I tended to over-react to situations	☐	☐	☐	☐	☐
4. I felt down or sad	☐	☐	☐	☐	☐
5. I felt like I'm not worth anything	☐	☐	☐	☐	☐
6. I felt good about the way I looked and acted	☐	☐	☐	☐	☐
7. I responded best when I got positive feedback	☐	☐	☐	☐	☐
8. If I got negative feedback, I still found the positive in those comments	☐	☐	☐	☐	☐
9. Sometimes people couldn't rely on me as much as they should've been able to	☐	☐	☐	☐	☐
10. I was always successful at	☐	☐	☐	☐	☐

completing my tasks, even if I had more to do than others					
11. I could sense the emotions of others and found a way to respond, even if they were unspoken	□	□	□	□	□
12. Other told me that I am a sensitive and understanding person	□	□	□	□	□
13. I usually took the lead in introducing myself to new people rather than waiting on others to make the introduction	□	□	□	□	□
14. I tried to build close relationships with people	□	□	□	□	□
15. I enjoyed socializing and chatting with other people	□	□	□	□	□

Appendix G: Brief Self-Control Scale

Please indicate how much each of the following statements reflects how you typically are.

1 2 3 4 5

Not at all Very much

____ 1. I am good at resisting temptation.

____ 2. I have a hard time breaking bad habits.

____ 3. I am lazy.

____ 4. I say inappropriate things.

____ 5. I do certain things that are bad for me, if they are fun.

____ 6. I refuse things that are bad for me.

____ 7. I wish I had more self-discipline.

____ 8. People would say that I have iron self-discipline.

____ 9. Pleasure and fun sometimes keep me from getting work done.

____ 10. I have trouble concentrating.

____ 11. I am able to work effectively toward long-term goals.

____ 12. Sometimes I can't stop myself from doing something, even if I know it is wrong.

____ 13. I often act without thinking through all the alternatives.

Scoring:

Add up items; Reverse-score items 2, 3, 4, 5, 7, 9, 10, 12, 13

Appendix I: Survey Item Descriptive Statistics for each Measurement

Table IA.

Descriptive Statistics for Grit-O

Item	N	Mean	St. Dev.	Min	Max
G1	817	3.8	0.9	1	5
G2	817	2.7	1	1	5
G3	817	2.6	1	1	4
G4	817	3.3	1.1	1	5
G5	817	2.8	1.1	1	5
G6	817	4.2	0.9	1	5
G7	817	2.9	1.1	1	5
G8	817	3	1.1	1	5
G9	817	3.8	1	1	5
G10	817	3.8	1.1	1	5
G11	817	2.7	1.1	1	5
G12	817	3.9	0.9	1	5
average	817	3.3	0.6	1.8	4.9

Table IB.

Descriptive Statistics for Conscientiousness

Item	N	Mean	St. Dev.	Min	Max
C1	808	3.7	0.9	1	5
C2	806	3.2	1.2	1	5
C3	808	3.4	1.2	1	5
C4	805	3.7	1	1	5
C5	807	3.4	1.1	1	5

C6	804	3.8	1	1	5
C7	806	3.8	0.9	1	5
C8	806	3.3	1.3	1	5
C9	806	3.5	1.2	1	5
C10	808	4.1	0.9	1	5
average	810	3.6	0.7	1.6	5

Table IC.

Descriptive Statistics for Achievement-striving

Item	N	Mean	St. Dev.	Min	Max
A1	806	3.7	0.9	1	5
A2	806	3.4	1.2	1	5
A3	807	3.8	0.9	1	5
A4	808	3.8	0.9	1	5
A5	807	3.5	1.2	1	5
A6	803	3.3	1.2	1	5
A7	806	3.7	1	1	5
A8	804	3.2	1.2	1	5
A9	806	3.5	1.1	1	5
A10	806	3.3	1.2	1	5
average	810	3.5	0.7	1.1	5

Table ID.

Descriptive Statistics for the Brief Risk-Resilience Screening

Statistic	N	Mean	St. Dev	Min	Max
R1	813	3	1.2	1	5
R2	814	2.8	1.2	1	5
R3	814	2.9	1.1	1	5
R4	813	3.1	1.2	1	5
R5	814	2.7	1.3	1	5
R6	813	3.4	1	1	5
R7	815	3.9	0.9	1	5
R8	809	3.3	1	1	5
R9	813	2.9	1.2	1	5
R10	811	3.7	0.9	1	5
R11	810	3.6	1	1	5
R12	812	3.7	1	1	5
R13	812	3.2	1.1	1	5
R14	808	3.6	1	1	5
R15	811	3.5	1.1	1	5
average	817	3.3	0.5	1	5

Table IE.

Descriptive Statistics for Self-control

Statistic	N	Mean	St. Dev.	Min	Max
S1	805	3.4	1.2	1	5
S2	809	3.1	1.3	1	5
S3	802	3.7	1.1	1	5

S4	809	3.6	1.2	1	5
S5	808	3.4	1.2	1	5
S6	807	3.2	1.2	1	5
S7	808	2.8	1.2	1	5
S8	806	3	1.2	1	5
S9	806	3.2	1.2	1	5
S10	806	3.4	1.2	1	5
S11	806	3.6	1	1	5
S12	806	3.4	1.2	1	5
S13	805	3.5	1.2	1	5
average	810	3.3	0.7	1.2	5

Appendix J: Factor Loadings for the Full Measurement Model

Table JA.

Full Measurement Model for all latent constructs, Factor loadings

Latent Factor	Indicator	B	SE	Z	p-value	Beta
effort	G1	0.49	0.03	15.11	< .001	0.53
effort	G4	0.49	0.04	12.36	< .001	0.45
effort	G6	0.63	0.03	20.49	< .001	0.68
effort	G9	0.6	0.03	18.3	< .001	0.62
effort	G10	0.62	0.04	16.66	< .001	0.57
effort	G12	0.65	0.03	21.1	< .001	0.69
passion	G2	0.69	0.03	20.2	< .001	0.66
passion	G3	0.65	0.03	19.87	< .001	0.66
passion	G5	0.75	0.04	21.27	< .001	0.69
passion	G7	0.86	0.03	24.98	< .001	0.77
passion	G8	0.88	0.04	24.73	< .001	0.77
passion	G11	0.62	0.04	17.11	< .001	0.58
negativity_bias	R1	0.66	0.04	16.06	< .001	0.56
negativity_bias	R2	0.89	0.04	24.6	< .001	0.77
negativity_bias	R3	0.75	0.04	20.12	< .001	0.66
negativity_bias	R4	0.87	0.04	23.02	< .001	0.74
negativity_bias	R5	1.04	0.04	26.05	< .001	0.81
emotional_resilience	R6	0.62	0.04	16.32	< .001	0.61
emotional_resilience	R8	0.48	0.04	12.56	< .001	0.48
emotional_resilience	R9	-0.32	0.05	-6.11	< .001	-0.27
emotional_resilience	R10	0.57	0.03	17.29	< .001	0.62

emotional_resilience	R7	0.38	0.03	10.99	< .001	0.43
social_skills	R11	0.49	0.04	13.55	< .001	0.51
social_skills	R12	0.55	0.04	14.99	< .001	0.55
social_skills	R13	0.67	0.04	16.71	< .001	0.59
social_skills	R14	0.76	0.03	22.01	< .001	0.75
social_skills	R15	0.76	0.04	20.43	< .001	0.7
ach1	A2	0.87	0.04	24.42	< .001	0.75
ach1	A5	0.97	0.04	26.4	< .001	0.79
ach1	A6	0.98	0.03	27.98	< .001	0.82
ach1	A8	0.9	0.04	25.18	< .001	0.77
ach1	A10	0.9	0.04	23.34	< .001	0.73
ach2	A1	0.62	0.03	20.96	< .001	0.68
ach2	A3	0.72	0.03	25.31	< .001	0.78
ach2	A4	0.7	0.03	24.69	< .001	0.77
ach2	A7	0.65	0.03	20.48	< .001	0.67
ach2	A9	0.67	0.04	18.55	< .001	0.62
self1	S2	0.68	0.04	15.3	< .001	0.53
self1	S3	0.74	0.04	19.03	< .001	0.64
self1	S4	0.66	0.04	15.91	< .001	0.55
self1	S5	0.71	0.04	17.65	< .001	0.61
self1	S7	0.74	0.04	17.43	< .001	0.6
self1	S9	0.77	0.04	18.83	< .001	0.64
self1	S10	0.88	0.04	22.32	< .001	0.72
self2	S1	0.79	0.04	18.09	< .001	0.67
self2	S6	0.65	0.05	13.83	< .001	0.53
self2	S8	0.79	0.04	17.72	< .001	0.66
con1	C1	0.61	0.03	21.32	< .001	0.69

con1	C4	0.6	0.03	17.88	< .001	0.61
con1	C5	0.69	0.04	19.55	< .001	0.65
con1	C6	0.55	0.03	15.76	< .001	0.55
con1	C7	0.63	0.03	21.1	< .001	0.69
con1	C10	0.63	0.03	20.53	< .001	0.67
con2	C2	0.94	0.04	24.61	< .001	0.77
con2	C3	1.01	0.04	28.2	< .001	0.84
con2	C8	0.97	0.04	25.27	< .001	0.77
con2	C9	0.88	0.04	23.08	< .001	0.73

Appendix K: Factor Loadings for the Structural Model 1

Table KA.

Structural Model for the grit subdomain latent variable passion as the outcome variable factor loadings

Latent Factor	Indicator	B	SE	Z	p-value	Beta
passion	G2	0.42	0.03	16.24	< .001	0.66
passion	G3	0.4	0.03	15.79	< .001	0.65
passion	G5	0.46	0.03	16.84	< .001	0.69
passion	G7	0.53	0.03	18.15	< .001	0.78
passion	G8	0.54	0.03	18.7	< .001	0.77
passion	G11	0.38	0.03	14.26	< .001	0.58
negativity_bias	R1	0.66	0.04	16.07	< .001	0.56
negativity_bias	R2	0.89	0.04	24.48	< .001	0.77
negativity_bias	R3	0.75	0.04	20.08	< .001	0.66
negativity_bias	R4	0.88	0.04	23.19	< .001	0.74
negativity_bias	R5	1.04	0.04	25.99	< .001	0.8
emotional_resilience	R6	0.63	0.04	16.57	< .001	0.61
emotional_resilience	R8	0.48	0.04	12.52	< .001	0.48
emotional_resilience	R9	-0.32	0.05	-5.99	< .001	-0.26
emotional_resilience	R10	0.57	0.03	17.21	< .001	0.62
emotional_resilience	R7	0.39	0.03	11.04	< .001	0.43
social_skills	R11	0.49	0.04	13.54	< .001	0.51
social_skills	R12	0.55	0.04	14.98	< .001	0.55
social_skills	R13	0.67	0.04	16.72	< .001	0.59
social_skills	R14	0.76	0.03	22.03	< .001	0.75
social_skills	R15	0.76	0.04	20.43	< .001	0.7
ach1	A2	0.87	0.04	24.42	< .001	0.75
ach1	A5	0.97	0.04	26.33	< .001	0.79

ach1	A6	0.98	0.03	28.01	< .001	0.82
ach1	A8	0.9	0.04	25.14	< .001	0.77
ach1	A10	0.9	0.04	23.33	< .001	0.73
ach2	A1	0.62	0.03	20.87	< .001	0.68
ach2	A3	0.72	0.03	25.29	< .001	0.78
ach2	A4	0.69	0.03	24.04	< .001	0.75
ach2	A7	0.66	0.03	20.39	< .001	0.67
ach2	A9	0.68	0.04	18.77	< .001	0.63
self1	S2	0.68	0.04	15.31	< .001	0.53
self1	S3	0.74	0.04	19.03	< .001	0.64
self1	S4	0.66	0.04	15.93	< .001	0.55
self1	S5	0.71	0.04	17.67	< .001	0.61
self1	S7	0.74	0.04	17.43	< .001	0.6
self1	S9	0.77	0.04	18.82	< .001	0.64
self1	S10	0.87	0.04	22.31	< .001	0.72
self2	S1	0.78	0.04	17.87	< .001	0.67
self2	S6	0.65	0.05	13.85	< .001	0.53
self2	S8	0.79	0.04	17.74	< .001	0.67
con1	C1	0.61	0.03	20.9	< .001	0.68
con1	C4	0.6	0.03	18	< .001	0.61
con1	C5	0.69	0.04	19.5	< .001	0.65
con1	C6	0.56	0.03	16.01	< .001	0.56
con1	C7	0.63	0.03	21	< .001	0.69
con1	C10	0.63	0.03	20.5	< .001	0.68
con2	C2	0.94	0.04	24.6	< .001	0.77
con2	C3	1.01	0.04	28.2	< .001	0.84
con2	C8	0.97	0.04	25.29	< .001	0.77
con2	C9	0.88	0.04	23.07	< .001	0.73

Appendix L: Factor Loadings for the Structural Model 2

Table LA.

Structural Model for the grit subdomain latent variable perseverance of effort as the outcome variable factor loadings

Latent Factor	Indicator	B	SE	Z	p-value	Beta
effort	G1	0.22	0.02	9.58	< .001	0.52
effort	G4	0.21	0.02	8.78	< .001	0.44
effort	G6	0.28	0.03	10.69	< .001	0.68
effort	G9	0.26	0.03	10.21	< .001	0.61
effort	G12	0.29	0.03	10.44	< .001	0.7
negativity_bias	R1	0.66	0.04	16.11	< .001	0.56
negativity_bias	R2	0.89	0.04	24.56	< .001	0.77
negativity_bias	R3	0.75	0.04	20.12	< .001	0.67
negativity_bias	R4	0.87	0.04	23.05	< .001	0.74
negativity_bias	R5	1.04	0.04	26.01	< .001	0.8
emotional_resilience	R6	0.63	0.04	16.45	< .001	0.61
emotional_resilience	R8	0.48	0.04	12.56	< .001	0.48
emotional_resilience	R9	-0.32	0.05	-6.06	< .001	-0.27
emotional_resilience	R10	0.57	0.03	17.29	< .001	0.62
emotional_resilience	R7	0.38	0.03	11	< .001	0.43
social_skills	R11	0.49	0.04	13.6	< .001	0.51
social_skills	R12	0.55	0.04	15.04	< .001	0.56
social_skills	R13	0.67	0.04	16.68	< .001	0.59

social_skills	R14	0.76	0.03	21.97	< .001	0.75
social_skills	R15	0.76	0.04	20.37	< .001	0.7
ach1	A2	0.87	0.04	24.43	< .001	0.75
ach1	A5	0.97	0.04	26.35	< .001	0.79
ach1	A6	0.98	0.03	27.96	< .001	0.82
ach1	A8	0.9	0.04	24.96	< .001	0.76
ach1	A10	0.89	0.04	23.26	< .001	0.73
ach2	A1	0.61	0.03	20.87	< .001	0.68
ach2	A3	0.72	0.03	25.3	< .001	0.78
ach2	A4	0.7	0.03	24.71	< .001	0.77
ach2	A7	0.66	0.03	20.63	< .001	0.67
ach2	A9	0.67	0.04	18.45	< .001	0.61
self1	S2	0.67	0.04	15.16	< .001	0.53
self1	S3	0.74	0.04	19.26	< .001	0.65
self1	S4	0.67	0.04	16.09	< .001	0.56
self1	S5	0.71	0.04	17.66	< .001	0.61
self1	S7	0.74	0.04	17.29	< .001	0.59
self1	S9	0.77	0.04	18.67	< .001	0.63
self1	S10	0.87	0.04	22.06	< .001	0.72
self2	S1	0.8	0.04	18.16	< .001	0.68
self2	S6	0.64	0.05	13.63	< .001	0.52
self2	S8	0.79	0.04	17.55	< .001	0.66
con1	C1	0.61	0.03	21.3	< .001	0.69
con1	C4	0.6	0.03	17.85	< .001	0.61
con1	C5	0.69	0.04	19.55	< .001	0.65
con1	C6	0.55	0.03	15.84	< .001	0.55
con1	C7	0.63	0.03	21.09	< .001	0.69
con1	C10	0.63	0.03	20.48	< .001	0.67
con2	C2	0.94	0.04	24.67	< .001	0.77
con2	C3	1.01	0.04	28.27	< .001	0.84
con2	C8	0.97	0.04	25.21	< .001	0.77
con2	C9	0.88	0.04	22.99	< .001	0.73

Appendix M: Factor Loadings for the Structural Model 3

Table MA.

Factor Loadings: Structural Model for grit when subordinate latent variable effort factor loading was fixed to one

Latent Factor	Indicator	B	SE	Z	p-value	Beta
effort	G1	0.15	0.01	10.39	< .001	0.51
effort	G4	0.15	0.02	9.5	< .001	0.44
effort	G6	0.2	0.02	12.09	< .001	0.68
effort	G9	0.19	0.02	11.5	< .001	0.62
effort	G10	0.2	0.02	11.02	< .001	0.57
effort	G12	0.21	0.02	11.9	< .001	0.69
passion	G2	0.65	0.03	19.5	< .001	0.66
passion	G3	0.61	0.03	19.21	< .001	0.66
passion	G5	0.71	0.03	20.71	< .001	0.69
passion	G7	0.82	0.03	24.09	< .001	0.78
passion	G8	0.81	0.03	23.45	< .001	0.76
passion	G11	0.58	0.04	16.4	< .001	0.58
grit	effort	1	0			0.95
grit	passion	0.13	0.02	6.44	< .001	0.35
negativity_bias	R1	0.66	0.04	16.09	< .001	0.56
negativity_bias	R2	0.89	0.04	24.59	< .001	0.77
negativity_bias	R3	0.75	0.04	20.12	< .001	0.67
negativity_bias	R4	0.87	0.04	23.04	< .001	0.74
negativity_bias	R5	1.04	0.04	26.02	< .001	0.8
emotional_resilience	R6	0.63	0.04	16.55	< .001	0.61
emotional_resilience	R8	0.48	0.04	12.58	< .001	0.48
emotional_resilience	R9	-0.32	0.05	-6.06	< .001	-0.27
emotional_resilience	R10	0.57	0.03	17.3	< .001	0.62

emotional_resilience	R7	0.39	0.03	11.04	< .001	0.43
social_skills	R11	0.49	0.04	13.61	< .001	0.51
social_skills	R12	0.55	0.04	15.05	< .001	0.56
social_skills	R13	0.67	0.04	16.67	< .001	0.59
social_skills	R14	0.76	0.03	21.96	< .001	0.75
social_skills	R15	0.76	0.04	20.38	< .001	0.7
ach1	A2	0.87	0.04	24.44	< .001	0.75
ach1	A5	0.97	0.04	26.37	< .001	0.79
ach1	A6	0.98	0.03	27.98	< .001	0.82
ach1	A8	0.9	0.04	24.97	< .001	0.76
ach1	A10	0.89	0.04	23.27	< .001	0.73
ach2	A1	0.61	0.03	20.86	< .001	0.68
ach2	A3	0.72	0.03	25.4	< .001	0.78
ach2	A4	0.7	0.03	24.64	< .001	0.76
ach2	A7	0.66	0.03	20.5	< .001	0.67
ach2	A9	0.67	0.04	18.56	< .001	0.62
self1	S2	0.67	0.04	15.13	< .001	0.53
self1	S3	0.74	0.04	19.28	< .001	0.65
self1	S4	0.67	0.04	16.06	< .001	0.56
self1	S5	0.71	0.04	17.63	< .001	0.61
self1	S7	0.74	0.04	17.28	< .001	0.59
self1	S9	0.77	0.04	18.68	< .001	0.63
self1	S10	0.87	0.04	22.11	< .001	0.72
self2	S1	0.8	0.04	18.19	< .001	0.68
self2	S6	0.64	0.05	13.67	< .001	0.53
self2	S8	0.79	0.04	17.59	< .001	0.66
con1	C1	0.61	0.03	21.3	< .001	0.69
con1	C4	0.6	0.03	17.9	< .001	0.61

con1	C5	0.69	0.04	19.55	< .001	0.65
con1	C6	0.55	0.03	15.77	< .001	0.55
con1	C7	0.63	0.03	21.11	< .001	0.69
con1	C10	0.63	0.03	20.55	< .001	0.67
con2	C2	0.95	0.04	24.69	< .001	0.77
con2	C3	1.01	0.04	28.3	< .001	0.84
con2	C8	0.97	0.04	25.22	< .001	0.77
con2	C9	0.88	0.04	22.98	< .001	0.73

Appendix N: Factor Loadings for Structural Model 4

Table NA.

Factor Loadings: Structural model for grit when subordinate latent variable passion factor loading was fixed to one.

Latent Factor	Indicator	B	SE	Z	p-value	Beta
effort	G1	0.44	0.03	13.64	< .001	0.52
effort	G4	0.43	0.04	11.1	< .001	0.43
effort	G6	0.57	0.03	18.39	< .001	0.67
effort	G9	0.55	0.03	17.09	< .001	0.63
effort	G10	0.57	0.04	15.29	< .001	0.57
effort	G12	0.62	0.03	19.82	< .001	0.72
passion	G2	0.3	0.02	17.18	< .001	0.66
passion	G3	0.28	0.02	16.48	< .001	0.65
passion	G5	0.33	0.02	17.83	< .001	0.69
passion	G7	0.38	0.02	19.62	< .001	0.78
passion	G8	0.4	0.02	20.46	< .001	0.78
passion	G11	0.27	0.02	14.56	< .001	0.57
grit	effort	0.21	0.03	7.12	< .001	0.4
grit	passion	1	0			0.9
negativity_bias	R1	0.66	0.04	16.06	< .001	0.56
negativity_bias	R2	0.89	0.04	24.49	< .001	0.77
negativity_bias	R3	0.75	0.04	20.09	< .001	0.66
negativity_bias	R4	0.88	0.04	23.18	< .001	0.74
negativity_bias	R5	1.04	0.04	26.01	< .001	0.8
emotional_resilience	R6	0.63	0.04	16.63	< .001	0.61
emotional_resilience	R8	0.48	0.04	12.54	< .001	0.48
emotional_resilience	R9	-0.32	0.05	-6	< .001	-0.26
emotional_resilience	R10	0.57	0.03	17.22	< .001	0.62

emotional_resilience	R7	0.39	0.03	11.05	< .001	0.43
social_skills	R11	0.49	0.04	13.56	< .001	0.51
social_skills	R12	0.55	0.04	14.99	< .001	0.55
social_skills	R13	0.67	0.04	16.71	< .001	0.59
social_skills	R14	0.76	0.03	22.03	< .001	0.75
social_skills	R15	0.76	0.04	20.41	< .001	0.7
ach1	A2	0.87	0.04	24.43	< .001	0.75
ach1	A5	0.97	0.04	26.36	< .001	0.79
ach1	A6	0.98	0.03	28.05	< .001	0.82
ach1	A8	0.9	0.04	25.16	< .001	0.77
ach1	A10	0.9	0.04	23.33	< .001	0.73
ach2	A1	0.62	0.03	20.81	< .001	0.68
ach2	A3	0.72	0.03	25.34	< .001	0.78
ach2	A4	0.69	0.03	24.03	< .001	0.75
ach2	A7	0.66	0.03	20.4	< .001	0.67
ach2	A9	0.68	0.04	18.76	< .001	0.63
self1	S2	0.68	0.04	15.28	< .001	0.53
self1	S3	0.74	0.04	19.07	< .001	0.64
self1	S4	0.66	0.04	15.93	< .001	0.56
self1	S5	0.71	0.04	17.66	< .001	0.61
self1	S7	0.74	0.04	17.41	< .001	0.6
self1	S9	0.77	0.04	18.82	< .001	0.64
self1	S10	0.88	0.04	22.32	< .001	0.72
self2	S1	0.78	0.04	17.92	< .001	0.67
self2	S6	0.65	0.05	13.87	< .001	0.53
self2	S8	0.79	0.04	17.75	< .001	0.67
con1	C1	0.61	0.03	20.9	< .001	0.68
con1	C4	0.6	0.03	18.01	< .001	0.61

con1	C5	0.69	0.04	19.51	< .001	0.65
con1	C6	0.56	0.03	15.99	< .001	0.56
con1	C7	0.63	0.03	20.99	< .001	0.69
con1	C10	0.63	0.03	20.51	< .001	0.68
con2	C2	0.94	0.04	24.61	< .001	0.77
con2	C3	1.01	0.04	28.21	< .001	0.84
con2	C8	0.97	0.04	25.29	< .001	0.77
con2	C9	0.88	0.04	23.06	< .001	0.73

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