



Validation of the short grit scale (Grit-S) in Chinese physical education teachers

Yongqing Du^{1,2} · Cheng-Kui Yao³ · Siqi Chang⁴ · Xiaojin Zeng⁴ · Jie Luo³ 

Accepted: 22 August 2023 / Published online: 31 August 2023
© The Author(s) 2023

Abstract

The Short Grit Scale (Grit-S) is a popular instrument used to assess trait-level perseverance and passion for long-term goals in students and/or professional populations. This study examined the psychometric properties and construct validity of the Grit-S in a survey sample of Chinese physical education teachers ($N=256$, 26.6% females, $M_{\text{age}} = 33.96$ years, $SD_{\text{age}} = 6.04$ years). Confirmatory factor analysis indicated that the Grit-S scores supported the proposed two-factor model, comprising consistency of interest and perseverance of effort as subscales. Moreover, as expected, the Grit-S subscale scores showed acceptable internal consistency as well as satisfactory convergent and criterion validity, correlating with scores of external criteria variables (e.g., Big Five personality traits, self-control, and work burnout). These findings suggest that the Grit-S is an effective instrument for assessing grit in Chinese physical education teachers.

Keywords Personality trait · Grit · Grit-S · Construct validity · Chinese physical education teachers

Introduction

Grit, as a non-cognitive construct and personality trait, has been operationalized as trait-level passion and perseverance for long-term goals (Duckworth et al., 2007), and has been shown to predict one's achievement and life outcomes (Duckworth et al., 2007; Duckworth & Quinn, 2009). Extensive research has indicated that grit is correlated with constructs including but not limited to the Big Five personality traits (Duckworth & Quinn, 2009; He et al., 2021; Ivcevic and Brackett, 2014; Rimfeld et al., 2016), self-control (Duckworth & Gross, 2014; Vazsonyi et al., 2018; Werner et al., 2019), life satisfaction (Khan & Khan, 2017; Li et al.,

2018a), and burnout syndrome (Mullen & Crowe, 2018; Zhong et al., 2018).

Grit differs from similar psychological constructs (e.g., conscientiousness, and self-control), and can be distinguished from the traditionally measured facets of Big Five Conscientiousness by its focus on stamina. Grit reflects one's ability to maintain interest in and put effort into projects that might take months or even years to accomplish. People with a higher level of grit do not stray from their goals, even if they do not receive positive feedback encouraging them to continue (Duckworth & Quinn, 2009). Existing literature has noted an essential difference between grit and self-control (Duckworth & Gross, 2014; Duckworth & Quinn, 2009) in that grit is best understood as an ability to pursue long-term goals and is related to the approach motivation system, while self-control entails one's abilities to sustain focus on a current task and resist distractions, which is more consistent with avoidance systems (Duckworth & Gross, 2014).

Grit has become a popular topic of study in personality psychology over the past decade. Studies have shown that people with a higher level of grit are more likely to attain a higher educational level, perform better in their studies and workplace, live a healthier lifestyle, achieve better life satisfaction, and have more positive affect but less negative affect, as well as lower risk of mental disorders or problematic behaviors (e.g., Credé et al., 2017; Datu, 2021;

Yongqing Du and Cheng-Kui Yao are co-first authors.

✉ Jie Luo
luojiegznu@163.com

- ¹ School of Physical Education, Chengdu Sport University, Chengdu, China
- ² Basic Department, Guizhou Vocational Technology College of Electronics & Information, Kaili City, China
- ³ School of Psychology, Guizhou Normal University, Guiyang, China
- ⁴ School of Physical Education, Guizhou Normal University, Guiyang, China

Fernández et al., 2020; Wang et al., 2022). More specifically, students with more grit are more likely to have higher levels of academic achievement at all levels of study, including university (e.g., Akos & Kretchmar, 2017; Duckworth et al., 2007; Duckworth & Quinn, 2009; Saunders-Scott et al., 2018), high school (e.g., Datu et al., 2016; Li et al., 2018b; Schmidt et al., 2019), secondary education (e.g., Hagger & Hamilton, 2019; Park et al., 2018; Tovar-García, 2017), and primary school (O’Neal et al., 2018). Likewise, adults with higher levels of grit are more likely to demonstrate higher levels of work performance, particularly in the context of novice teachers (Duckworth et al., 2009; Robertson-Kraft & Duckworth, 2014), entrepreneurs (Mueller et al., 2017), insurance employees (Zhong et al., 2018), practicing school counselors (Mullen & Crowe, 2018), nurses (He et al., 2021), and sports athletes (Atkinson & Martin, 2020; Larkin et al., 2015; Martin et al., 2015).

Currently, most research on grit has focused on students rather than professionals. It is therefore necessary to extend the existing findings on grit into professional populations (e.g., teachers). Teachers, as people who play important roles in the lives of students, have an effect on students’ development, and the personality traits of teachers have been shown to play an important role in the academic progress, mental health, social development, and personality of their students (Kim & MacCann, 2016; Tahir & Shah, 2012). Studies have indicated that some teachers are much more effective than others at motivating their students, and that these differences can have lasting effects on student learning (Rivkin et al., 2005; Rockoff, 2004; Sanders & Rivers, 1996). The rigors of teaching suggest that positive traits that determine commitment and resilience in the face of adversity might play an important role in determining teacher effectiveness (Stanford, 2001). It is easy to see the relevance of the concept of grit – passion and perseverance for long-term goals – to a career such as teaching, which involves both the pursuit of achievements as well as confronting challenges, setbacks, and difficulties, particularly as a role requiring long-term persistence. There is no doubt that teaching is extremely challenging work, and therefore grit may have an important supportive effect on teachers’ performance. Indeed, research has already demonstrated that grit predicts effectiveness and retention among American novice teachers in low-income public schools (Duckworth et al., 2009; Robertson-Kraft & Duckworth, 2014). However, while findings from a Western cultural context do suggest that grit should be considered in the selection and training of teachers, evidence from non-Western cultures is still limited. Considering that the understanding of grit may differ depending on cultural background (Datu & McInerney, 2017; Datu et al., 2017), this study focused on the grit of teachers working in Mainland China.

Previous studies have also indicated that the trait of grit is a good predictor of sport exercise behavior (Reed, 2014) and

sport engagement (Larkin et al., 2015; Martin et al., 2015). Grit may also be an important individual difference trait in exercise behavior, as gritty individuals tend to show more enthusiasm for and persistence in participating in exercise (Reed, 2014). Likewise, gritty players spend more time in sport-specific activities (e.g., competition, training, play, or indirect involvement), and gritty players perform better than less gritty players on assessments of decision-making and situational probability (Larkin et al., 2015). Sports are generally characterized by hardship, fatigue, intensity, and tension, requiring intense confrontation, meaning that those who tend towards playing sports therefore require more positive traits, such as grit. Grit has been shown to have a significant positive correlation with athletic performance (Larkin et al., 2015; Reed, 2014), as regardless of how good an athlete is, their career will be limited by age and physical ability. After retirement, many athletes transition into careers which are still related to sports, such as teaching or training, becoming coaches or physical education teachers, where they can pass on their perseverance and passion for sports to their trainees or students. As such, a physical education teacher could be considered to be a synthesis of an ordinary teacher and a retired athlete, both of which are likely to have a high level of grit. It is important to have a valid and reliable instrument available when assessing physical education teachers’ grit, particularly a measure which is confirmed to work in non-Western populations, as this can play a significant role in predicting the effectiveness and retention of teachers (Duckworth et al., 2009; Robertson-Kraft & Duckworth, 2014). Therefore, the current study focused on physical education teachers in China and their trait-level perseverance and passion for long-term goals.

The psychometric properties of the Short Grit Scale (Grit-S)

To date, two instruments have been commonly used to measure the psychological trait of grit: the full 12-item Grit Scale (Duckworth et al., 2007) and the Short Grit Scale (Grit-S; Duckworth & Quinn, 2009), both of which assess one’s passion and perseverance in achieving long-term goals. The Grit-S, as a short version of the full Grit Scale (Duckworth et al., 2007), was developed by Duckworth and Quinn (2009). The Grit-S maintains the proposed two-factor model of the full Grit Scale while using only eight items, and has been found to have improved psychometric properties over the full 12-item Grit Scale (Duckworth & Quinn, 2009). The eight items of the Grit-S measure two factors: consistency of interest (CI) and perseverance effort (PE). The CI subscale measures one’s tendency to not change goals and interests frequently, and the PE factor refers to one’s tendency to work hard even in the face of setbacks. Following the original work of Duckworth et al. (2009), some studies have

asserted a unidimensional construct (e.g., Gonzalez et al., 2020; Weston, 2014), however the two-factor model of the Grit-S has nonetheless been introduced into other cultural contexts including Japan (Nishikawa et al., 2015), Turkey (Sarıçam et al., 2015), Philippines (Datu et al., 2016), Poland (Wyszyńska et al., 2017), Spain (Arco-Tirado et al., 2018), United States (Mullen & Crowe, 2018), Germany (Schmidt et al., 2019), and China (e.g., Li et al., 2018b; Wang et al., 2017; Zhong et al., 2018). Overall, the two-factor structure of the Grit-S has shown satisfactory psychometric properties in both individualistic and collectivistic cultures. Given that most existing psychometric research has indicated a two lower-order factors model of the Grit-S, and not a second-order factor solution and/or unidimensional model, the current study aimed to test the psychometric properties of the Grit-S within the context of the two first-order factors structure using a Chinese sample.

The Grit-S in China

Following the work of Duckworth and Quinn (2009), psychometric studies of the Chinese version of the Grit-S have validated the measure in Chinese populations (e.g., students and professionals). Two previous studies (Li et al., 2018b; Wang et al., 2017) have supported its two-factor structure in Chinese adolescents, with comparative fit index (CFI) of 0.98, standardized root mean square (SRMR) values of 0.030~0.035, root mean square error of approximation (RMSEA) values of 0.046~0.050, and internal consistency values (Cronbach's α s for the total Grit-S) of 0.80~0.81. Two other studies (He et al., 2021; Zhong et al., 2018) examined the psychometric properties of the Grit-S among Chinese samples of insurance employees (TLI=0.979, CFI=0.986, RMSEA=0.060; α s for the Grit-S subscales were 0.70~0.75; Zhong et al., 2018) and nurses (TLI=0.953, CFI=0.968, SRMR=0.034, RMSEA=0.056; α s for the Grit-S subscales were 0.68~0.72; He et al., 2021). A recent psychometric investigation (Luo et al., 2020) examined the longitudinal properties of the Grit-S in Chinese young adults, and the results suggested that the Grit-S had strict longitudinal measurement invariance across time (e.g., Δ CFIs = -0.008~0.002, Δ TLIs = -0.005~0.006, and Δ RMSEAs = -0.002~0.002). However, the factor structure and internal consistency of the Grit-S in other Chinese populations, such as teachers, have yet to be validated. The current study therefore aimed to investigate the applicability of the Grit-S specifically among Chinese physical education teachers, who can be considered to be a combination of a retired athlete and an ordinary teacher. Given that the aforementioned psychometric research has supported the two-factor solution of the Grit-S scores in cross-sectional (He et al., 2021; Li et al., 2018b; Wang et al., 2017; Zhong et al., 2018) and longitudinal data (Luo et al., 2020), we

hypothesized that the proposed two-factor structure model of the Grit-S would be verified among Chinese physical education teachers.

The current study

The primary purpose of the current study was to examine the psychometric properties and construct validity of the Grit-S scores in a sample of Chinese primary and middle school physical education teachers. First, confirmatory factor analysis (CFA) was used to test and compare the factor structure models of the Grit-S. Considering the findings of previous psychometric studies (He et al., 2021; Mullen & Crowe, 2018; Zhong et al., 2018), we expected that the proposed two-factor model of the Grit-S would be verified in the sample of Chinese physical education teachers. Next, we examined the internal consistency indices of the Grit-S subscales using Cronbach's α , McDonald's ω , and mean inter-item correlations (MIC). Finally, following the procedures of previous studies (e.g., He et al., 2021; Mullen & Crowe, 2018), the convergent and criterion validity of the Grit-S subscales were tested by computing the Pearson's correlation between the Grit-S subscale scores and external criterion measures (i.e., Big Five personality traits and self-control; Duckworth et al., 2007; He et al., 2021), as well as work burnout (e.g., Mullen & Crowe, 2018; Zhong et al., 2018). The convergent validity of the Grit-S scores was measured by computing the association between the Grit-S subscale scores with those of Big Five trait conscientiousness and self-control (Credé et al., 2017; Duckworth et al., 2007; He et al., 2021), while the criterion validity of the Grit-S scores was tested by correlating the Grit-S scores to other Big Five personality traits (e.g., neuroticism, agreeableness, extraversion, and openness) and burnout (Mullen & Crowe, 2018; Zhong et al., 2018). Based on previous research findings (e.g., Duckworth et al., 2007; He et al., 2021; Mullen & Crowe, 2018), we hypothesized that the Grit-S subscale scores would be related to the Big Five personality trait scores, self-control, and burnout.

Method

Participants

Participants in the current study were attending a physical education teacher training program for primary and secondary schools, and were recruited from Guizhou Province. The training program is intended to improve the professional skills and psychological competence of physical education teachers working in primary and secondary schools. A total of 256 physical education teachers participated in the study, of which 68 were female (26.6%) and 188 were

male (73.4%); 150 teachers (58.6%) were of Han ethnicity and 41.0% were mixed ethnic minorities ($N=105$). Information regarding participants' age, length of time working as a teacher, educational level, and professional title is shown in Table 1.

Procedure

The current study was approved by the Human Subjects Review Committee at the corresponding author's university. The teachers who were undergoing training were invited to participate in the study by their lecturers (who included the researchers), and participants completed the online questionnaire during class while attending their teaching program, submitting the questionnaire through the school's online management system. Participants were informed as to the study's nature, goal, confidentiality, and anonymity, and were told that their responses or participation would not affect their training program performance. Participants were told that their answers would remain anonymous, and they were invited to ask questions regarding the study at any point. All participants provided their informed consent online prior to their participation in the study. The study questionnaire took between 20 and 30 min to complete.

Measures

The Short Grit Scale (Grit-S)

The Grit-S (Duckworth & Quinn, 2009) measures two factors (i.e., CI and PE) and assesses respondents' trait-level

passion and perseverance for long-term goals. Each factor is assessed using four items, and each item is rated on a five-point scale which ranges from 1 (not at all like me) to 5 (very much like me); higher scores indicate a higher corresponding trait-level (Duckworth & Quinn, 2009). The Chinese version of the Grit-S has been validated previously in adolescents (Li et al., 2018b; Wang et al., 2017), young adults (Luo et al., 2020), insurance employees (Zhong et al., 2018), and nurses (He et al., 2021). In the present study, the coefficient α s for the CI and PE scales were 0.71 and 0.74, respectively.

The Chinese Big Five Personality Inventory-15

The Chinese Big Five Personality Inventory-15 (CBF-PI-15; Zhang et al., 2019) is a brief version of the Chinese Big Five Personality Inventory (Wang et al., 2010a, b) which was developed to assess the Big Five personality traits: extraversion, agreeableness, conscientiousness, neuroticism, and openness. Each personality domain in the CBF-PI-15 is measured using three items, and each item is rated on a six-point scale ranging from 1 (strongly disagree) to 6 (strongly agree). In the current study, the coefficient α s for extraversion, agreeableness, conscientiousness, neuroticism, and openness were 0.81, 0.79, 0.74, 0.83, and 0.84, respectively.

The Brief Self-Control Scale

The Brief Self-Control Scale (BSCS; Tangney et al., 2004) is a short version of the Total Self-Control Scale (Tangney et al., 2004) which measures respondents' level of self-control. The BSCS is has a unidimensional structure comprising 13 items, with nine items reverse-scored. Each item is rated on five-point scale, ranging from 1 (not at all like me) to 5 (very much like me). The Chinese version of the BSCS has been validated in Chinese populations (Chen et al., 2022). In the present study, the coefficient α for the BSCS was 0.77.

The Job Burnout Inventory-15

The Job Burnout Inventory-15 (JBI-15; Li & Li, 2006; Li et al., 2005) measures three components (i.e., exhaustion, depersonalization, and reduced personal accomplishment), and is designed to assess job burnout of individuals based on Maslach's model of burnout. Each factor is assessed using five items, and each item is rated on a seven-point scale, ranging from 1 (very unlike me) to 7 (very much like me). In the present study, the coefficient α s for exhaustion, depersonalization, and reduced personal accomplishment were 0.78, 0.84, and 0.85, respectively.

Table 1 Demographic information for the present study ($N=256$)

Variables	Data (percentage)
Age, <i>M</i> , <i>SD</i> (P_{25} , P_{50} , P_{75})	33.96 \pm 6.04 (28, 35, 39)
Length of time spent as a teacher, <i>M</i> , <i>SD</i> (P_{25} , P_{50} , P_{75})	11.27 \pm 5.76 (6, 11, 16)
Gender: female	68 (26.6%)
Educational level	
High school or below	2 (0.8%)
Junior college degree	5 (2.0%)
Bachelor degree	224 (87.5%)
Graduate degree	25 (9.8%)
Grades taught	
Primary	72 (28.1%)
Intermediate	131 (51.2%)
Senior	40 (15.6%)
Missing information	13 (5.1%)

Note. *M* = mean; *SD* = standard deviation; P_{25} = 25th percentile; P_{50} = 50th percentile; P_{75} = 75th percentile

Data Analysis

First, descriptive statistics (i.e., mean, standard deviation, skewness, kurtosis) for the Grit-S subscale scores were calculated using SPSS 22.0 (IMB Corp, 2013). Then, corrected item-total correlations (CITC) for each item's respective subscale, as well as inter-item correlations within each factor, were computed for item analysis of the Grit-S scale. Item-total correlations ≥ 0.50 are satisfactory, and ≥ 0.40 are acceptable; inter-item correlations ≥ 0.30 are good and ≥ 0.20 are acceptable (Hair et al., 2014).

Second, following a procedure similar to those used in previous studies (Gonzalez et al., 2020; He et al., 2021), a series of CFAs were conducted to test and compare the factor structure models (e.g., unidimensional, two-factor) of the Grit-S using Mplus 7.0 (Muthén & Muthén, 1998). As the skewness and kurtosis values of certain items (i.e., Item 4, Item 8) were not within the -1 to $+1$ range (see Table 2), we applied the maximum likelihood estimation with a mean-adjusted chi-square (MLM) that was robust to non-normality. The model fit indices of the CFA included the CFI, the TLI, the SRMR, and the RMSEA. If CFI and TLI values were higher than 0.90, with SRMR and RMSEA values less than 0.08, this indicated an adequate model fit; however, if CFI and TLI values were above 0.95, with SRMR and RMSEA values less than 0.05, this suggested an excellent model fit (Marsh et al., 2004; Schermelleh-Engel et al., 2003).

Third, the internal consistency coefficients of the Grit-S subscale scores were calculated using Cronbach's α , McDonald's ω , and the MIC. According to Barker et al. (1994), a Cronbach's α from 0.70 to 0.79 is acceptable, 0.80 to 0.89 is good, and above 0.90 is excellent. A McDonald's ω greater than 0.70 is considered acceptable (Hair et al., 2014). We also calculated the MICs independent of the scale length;

an MIC from 0.15 to 0.50 was considered acceptable (Clark & Watson, 1995).

Finally, the validity of the Grit-S was validated using Pearson's correlations against the CBF-PI-15, BSCS, and JBI-15. The convergent validity was tested by calculating the correlation between the Grit-S scores with those of Big Five trait conscientiousness and self-control, and the criterion validity was examined by computing the relationship between the Grit-S scores and those of the other Big Five personality traits (e.g., neuroticism, agreeable, extraversion, and openness) and burnout. According to Cohen (1988), correlation coefficients ≤ 0.30 are weak, between 0.30 and 0.50 are moderate, and ≥ 0.50 are strong.

Results

Descriptive statistics

Descriptive statistics of the Grit-S scores are shown in Table 2, which includes the mean, standard deviation, skewness, and kurtosis for each item.

The CITC with each item's respective subscale ranged from 0.44 to 0.63, and the inter-item correlations within each Grit-S subscale were above 0.25 (see Table 3).

Factor structure of the Grit-S

The eight-item model fit values of the one-factor model were poor ($\chi^2 = 123.418$, $df = 20$, CFI = 0.821, TLI = 0.750, SRMR = 0.078, RMSEA = 0.121). However, the model fit indices of the two-factor structure were adequate ($\chi^2 = 43.953$, $df = 19$, CFI = 0.958, TLI = 0.938, SRMR = 0.046, RMSEA = 0.060). The latent correlation between the Grit-S subscales was strong ($r = 0.59$,

Table 2 Descriptive statistics of the Grit-S scores

Item	Range	<i>M</i>	<i>SD</i>	<i>SK</i>	<i>KU</i>
Grit-S 1: New ideas and projects sometimes distract me from previous ones.	4	3.49	0.92	-0.39	0.00
Grit-S 3: I have been obsessed with a certain idea or project for a short time but later lost interest.	4	3.82	0.90	-0.62	0.18
Grit-S 5: I often set a goal but later choose to pursue a different one.	4	4.07	1.02	-0.93	0.19
Grit-S 6: I have difficulty maintaining my focus on projects that take more than a few months to complete.	4	3.62	1.11	-0.61	-0.09
Consistency of interest	16	15.00	2.89	-0.60	0.64
Grit-S 2: Setbacks don't discourage me.	4	3.71	1.31	-0.59	-0.87
Grit-S 4: I am a hard worker.	4	4.42	0.88	-1.59	2.20
Grit-S 7: I finish whatever I begin.	4	4.06	1.07	-0.83	-0.38
Grit-S 8: I am diligent.	4	4.20	1.01	-1.03	0.03
Perseverance of effect	12	16.39	3.22	-0.46	-0.80

Note. *M* = mean; *SD* = standard deviation; *SK* = skewness; *KU* = kurtosis.

Table 3 Correlation coefficients for all items of the Grit-S

Item	CITC	Item-item correlation							
		Item 1	Item 3	Item 5	Item 6	Item 2	Item 4	Item 7	Item 8
Item 1	0.44	1.00							
Item 3	0.55	0.34	1.00						
Item 5	0.56	0.43	0.48	1.00					
Item 6	0.45	0.28	0.42	0.36	1.00				
Item 2	0.46	0.25	0.20	0.28	0.05	1.00			
Item 4	0.52	0.19	0.31	0.36	0.10	0.39	1.00		
Item 7	0.57	0.29	0.30	0.35	0.14	0.32	0.42	1.00	
Item 8	0.63	0.31	0.32	0.27	0.13	0.41	0.43	0.62	1.00

Note. CITC=corrected item-total correlations with each item’s respective factor

$p < 0.001$). All items’ factor loadings for the two first-order factors solution are presented in Fig. 1.

Internal consistency of the Grit-S

In terms of the internal consistency values, the Cronbach’s α of the Grit-S subscale scores were acceptable ($\alpha > 0.70$), with the Cronbach’s α for the CI and PE subscales 0.71 and 0.74, respectively. The McDonald’s ω indices also showed that the Grit-S scores had satisfactory internal consistency, with ω values for the CI and PE subscales 0.72 and 0.76, respectively. Finally, the MIC values for the CI and PE subscales were 0.39 and 0.43, respectively.

Validity of the Grit-S

Pearson’s correlation coefficients were used to test the validity of the Grit-S, assessing the Grit-S subscale scores against the scores of the chosen external measures (i.e., CBF-PI-15, BSCS, and JBI-15; see Table 4). As expected, both Grit-S subscale scores correlated significantly with the three chosen criterion measures. Specifically, the Grit-S subscale scores had a significant positive correlation with the scores for extraversion, agreeableness, conscientiousness, openness, and self-control, while significant negative correlations were found between the Grit-S subscale scores and neuroticism and burnout (i.e., exhaustion,

Fig. 1 Measurement model and standardized factor loadings of the Grit-S scores. Note. CI=consistency of interest; PE=perseverance of effort

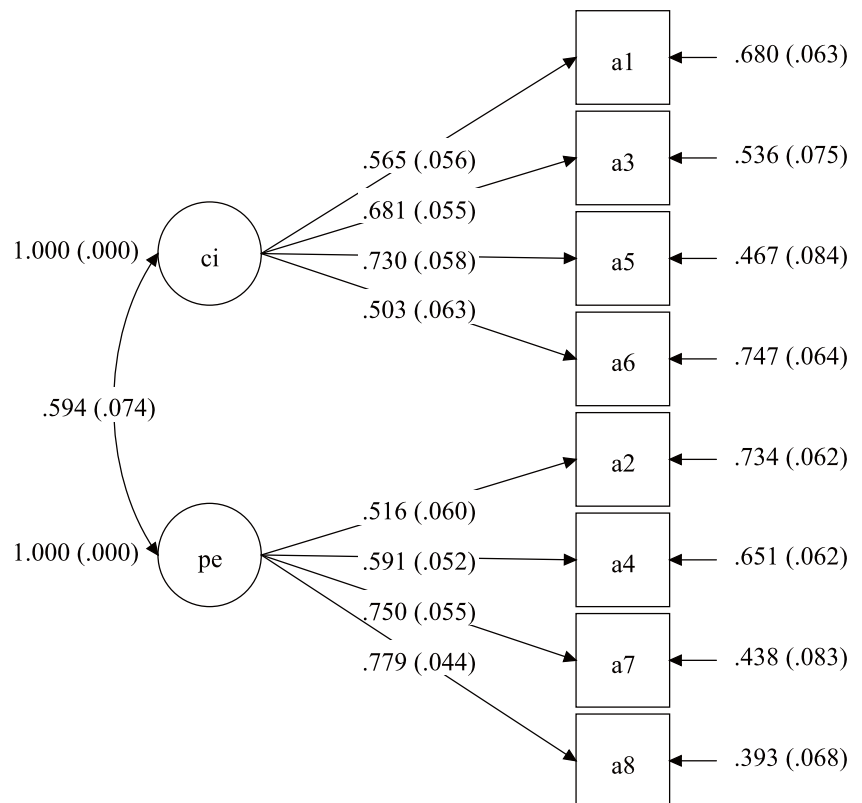


Table 4 Correlations between Grit-S scores and external measures

Variables	$M \pm SD$	alpha	CI	PE	E	A	C	N	O	BSCS	EXH	DEP	RPA
CI	15.00 ± 2.89	0.71	1										
PE	16.39 ± 3.22	0.74	0.42**	1									
E	12.71 ± 3.76	0.81	0.29**	0.50**	1								
A	15.02 ± 3.10	0.79	0.29**	0.50**	0.42**	1							
C	14.50 ± 2.69	0.74	0.40**	0.64**	0.41**	0.65**	1						
N	7.64 ± 3.79	0.83	-0.44**	-0.43**	-0.44**	-0.35**	-0.29**	1					
O	12.75 ± 3.72	0.84	0.28**	0.52**	0.63**	0.44**	0.53**	-0.27**	1				
BSCS	46.51 ± 6.81	0.77	0.61**	0.57**	0.43**	0.42**	0.53**	-0.53**	0.41**	1			
EXH	14.60 ± 6.86	0.78	-0.35**	-0.22**	-0.29**	-0.18**	-0.14*	0.48**	-0.22**	-0.44**	1		
DEP	9.53 ± 5.77	0.84	-0.38**	-0.32**	-0.19**	-0.36**	-0.30**	0.40**	-0.17**	-0.44**	0.49**	1	
RPA	12.21 ± 6.51	0.85	-0.31**	-0.43**	-0.30**	-0.43**	-0.50**	0.36**	-0.34**	-0.35**	0.03	0.30**	1

Note. CI=consistency of interest; PE=perseverance of effort; E=extraversion; A=agreeableness; C=conscientiousness; N=neuroticism; O=openness; BSCS= Brief Self-Control Scale; EXH=exhaustion; DEP=depersonalization; RPA=reduced personal accomplishment. * $p < .05$; ** $p < .01$

depersonalization, and reduced personal accomplishment) at the zero-order level.

Discussion

The main purpose of this study was to test the psychometric properties and construct validity of the Grit-S (Duckworth & Quinn, 2009), a popular tool used to assess trait-level passion and perseverance for long-term goals of students and/or professional populations. The current study used a sample Chinese primary and middle school physical education teachers, specifically. Our results indicate that the proposed two-factor structure model of the Grit-S, comprising two subscales measuring CI and PE, fit the data well. Furthermore, the Grit-S and its subscales showed acceptable internal consistency, and satisfactory convergent and criterion validity. Overall, our findings suggest that the Grit-S is effective in assessing grit in Chinese physical education teachers.

Consistent with the findings of previous studies in Chinese contexts regarding students (e.g., Luo et al., 2020; Wang et al., 2017) and professionals (e.g., He et al., 2021; Zhong et al., 2018), the proposed two-factor structure model of the Grit-S was also supported by the current study's sample of physical education teachers. Likewise, our overall results are consistent with those of studies done in Western samples (e.g., Arco-Tirado et al., 2018; Duckworth & Quinn, 2009; Schmidt et al., 2019). It appears that the two-factor structure of the Grit-S is common and universal across different populations (students and professionals) and cultures (Western and non-Western). Prior studies have revealed that grit increases monotonically with age (Duckworth et al., 2007), and that grit scores vary across age groups (e.g., Duckworth et al., 2007, 2009), while the two-factor model

of grit has been shown to be consistent and stable across age groups (e.g., students and professionals). Existing findings have also shown that grit can predict one's achievements despite challenging circumstances over and beyond one's level of talent (Duckworth et al., 2007; Duckworth & Quinn, 2009).

The Grit-S (Duckworth & Quinn, 2009) is a revised version of the original Grit scale (Grit-O; 12 items; Duckworth et al., 2007) and maintains the originally proposed two-factor structure of the Grit-O, but does so using four fewer items while having better psychometric properties than the Grit-O (Duckworth & Quinn, 2009). While the Grit-S has been shown to have satisfactory psychometric properties not only in student populations, but also in professional samples, as well the latter including practicing school counselors (Mullen & Crowe, 2018), insurance employees (Zhong et al., 2018), and nurses (He et al., 2021), no studies have examined its validity in Chinese teacher populations. Therefore, the present study extended the applicable population of the Grit-S, verifying the two-factor structure of the measure in a sample of Chinese physical education teachers.

Following a similar procedure to those of existing studies (e.g., Barker et al., 1994; Hair et al., 2014), the Cronbach's α and McDonald's ω values were calculated, and all indices indicated that the Grit-S subscales had acceptable internal consistency, which is in line with prior findings using samples of professionals (e.g., He et al., 2021; Zhong et al., 2018). Furthermore, the MIC values were also acceptable for the Grit-S scores. Overall, our findings suggest that the Grit-S and its subscales have acceptable internal consistency when used in samples of Chinese teachers.

The convergent and criterion validity of the Grit-S and its subscales were verified by calculating the Pearson's correlations between the Grit-S scores and external criteria measures

(i.e., CBF-PI-15, BSCS, and JBI-15). We had expected to find a correlation between the Grit-S scores with the relevant concept-related and overlapping measures (i.e., conscientiousness and self-control; Duckworth et al., 2007; Duckworth & Quinn, 2009), which would be consistent with the findings of a prior study using a sample of nurses (He et al., 2021). Our results demonstrated that the Grit-S has acceptable convergent validity, supported by the correlation between grit with both conscientiousness and self-control. The Grit-S scores also had significant correlations with the other Big Five personality traits of extraversion, agreeableness, neuroticism, and openness. Considering that grit appears to be a powerful personality trait, the relationship between grit and the most popular Big Five personality traits is not surprising (Duckworth et al., 2007; He et al., 2021), and it is unsurprising that the correlation between grit and conscientiousness is slightly higher than between grit and any of the other Big Five personality traits. Finally, also consistent with previous findings (Ceschi et al., 2016; Mullen & Crowe, 2018; Zhong et al., 2018), we found that the Grit-S scores had a significantly negative correlation with burnout, suggesting that teachers with higher grit scores will generally have lower burnout scores. Individuals who are better prepared to deal with the challenges faced while working towards a goal are also less likely to experience burnout (Maslach, 2003). If, according to Duckworth et al. (2007), grit relates to one's perseverance through difficulties and boredom while striving to accomplish long-term goals, it seems likely that individuals with higher grit will also experience less burnout (Mullen & Crowe, 2018; Zhong et al., 2018).

The findings of this study have some important implications for both theoretical and practical research settings. First, our results support the two-factor structure solution of the Duckworth et al. (2007) grit traits model in a Chinese professional population. Moreover, our study shows that the Grit-S can serve as a valid and reliable measurement among Chinese physical education teachers, expanding the ability to assess grit in different populations and providing support for its use in cross-cultural research.

Limitation and future directions

The current study does have some limitations, and our findings should be considered in light of these. First, our study participants were recruited predominantly from Southwest China, so our results might not extend to other geographic regions or cultures; future research should attempt to replicate and expand the findings of the current study to other regions of China. Second, the current study only tested the factor model, internal consistency, and convergent and criterion validity of the Grit-S in Chinese teachers due to the fact that the demographic variables were somewhat unbalanced,

particularly in gender; future research should examine the measurement invariance of the Grit-S across demographic variables (e.g., gender) in teacher samples. Finally, although the convergent and criterion validity of the Grit-S and its subscales were supported by the expected correlations with the Big Five personality traits, self-control, and work burnout measures (i.e., CBF-PI-15, BSCS, and JBI-15, respectively), the correlations between the Grit-S scores and other criteria (e.g., teacher's work performance, teaching effectiveness, job retention) should also be considered in future research (Datu, 2021; Robertson-Kraft & Duckworth, 2014).

Despite these shortcomings, the present study nonetheless expands and confirms the applicable professional populations which can be measured using the Grit-S, particularly in a Chinese context, and has verified the psychometric properties of the Grit-S among Chinese physical education teachers. Our findings suggest that the Grit-S is a valid instrument for use in assessing grit in Chinese physical education teachers.

Data availability The data supporting the conclusions of this article are available upon request to correspondence author.

Declarations

Ethical approval This study was approved by the Human Subjects Review Committee at the corresponding author's university. In order to protect privacy, all of the participants' responses were anonymous.

Informed consent All participants provided their online informed consent prior to participation in this study.

Conflict of interest The authors declare that this research was conducted in the absence of any commercial or financial relationships that could be construed as potential conflicts of interest.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Akos, P., & Kretchmar, J. (2017). Investigating grit at a non-cognitive predictor of college success. *The Revue of Higher Education*, 40, 163–186. <https://doi.org/10.1353/rhe.2017.0000>
- Arco-Tirado, J. L., Fernández-Martín, F. D., & Hoyle, R. H. (2018). Development and validation of a Spanish version of the Grit-S scale. *Frontiers in Psychology*, 9, 96. <https://doi.org/10.3389/fpsyg.2018.00096>

- Atkinson, F., & Martin, J. (2020). Gritty, hardy, resilient, and socially supported: A replication study. *Disability and Health Journal*, 13(1), 100839. <https://doi.org/10.1016/j.dhjo.2019.100839>
- Barker, C., Pistrang, N., & Elliot, R. (1994). *Research methods in clinical and counselling psychology*. Wiley.
- Ceschi, A., Sartori, R., Dickert, S., & Costantini, A. (2016). Grit or honesty humility? New insights into the moderating role of personality between the health impairment process and counterproductive work behavior. *Frontiers in Psychology*, 7, 1799. <https://doi.org/10.3389/fpsyg.2016.01799>
- Chen, W., Zhang, G., Tian, X., & Zhao, S. (2022). Factor structure and longitudinal measurement invariance of the Tangney's brief self-control scale in chinese adolescents. *Frontiers in Public Health*, 10, 802448. <https://doi.org/10.3389/fpubh.2022.802448>
- Clark, L. A., & Watson, D. (1995). Constructing validity: Basic issues in objective scale development. *Psychological Assessment*, 7, 309–319. <https://doi.org/10.1037/1040-3590.7>
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.
- Corp, I. B. M. (2013). *IBM SPSS for Windows, Version 22.0*. IBM Corp.
- Credé, M., Tynan, M. C., & Harms, P. D. (2017). Much ado about grit: A meta-analytic synthesis of the grit literature. *Journal of Personality and Social Psychology*, 113(3), 492–511. <https://doi.org/10.1037/pspp0000102>
- Datu, J. A. D. (2021). Beyond passion and perseverance: Review and future research initiatives on the science of grit. *Frontiers in Psychology*, 11, 545526. <https://doi.org/10.3389/fpsyg.2020.545526>
- Datu, J. A. D., & McInerney, D. M. (2017). *Does culture matter for grit? Mapping cross-cultural directions in grit Research Programs*. Information Age Publishing.
- Datu, J. A. D., Valdez, J. P. M., & King, R. B. (2016). Perseverance counts but consistency does not! Validating the short grit scale in a collectivist setting. *Current Psychology*, 35, 121–130. <https://doi.org/10.1007/s12144-015-9374-2>
- Datu, J. A. D., Yuen, M., & Chen, G. (2017). Grit and determination: A review of literature with implications for theory and research. *Journal of Psychologists and Counsellors in Schools*, 27(2), 168–176. <https://doi.org/10.1017/jgc.2016.2>
- Duckworth, A., & Gross, J. J. (2014). Self-control and grit related but separable determinants of success. *Current Directions in Psychological Science*, 23(5), 319–325. <https://doi.org/10.1177/0963721414541462>
- 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*, 92(6), 1087–1101. <https://doi.org/10.1037/0022-3514.92.6.1087>
- Duckworth, A. L., & Quinn, P. D. (2009). Development and validation of the short grit scale (Grit-S). *Journal of Personality Assessment*, 91(2), 166–174. <https://doi.org/10.1080/00223890802634290>
- Duckworth, A. L., Quinn, P. D., & Seligman, M. E. P. (2009). Positive predictors of teacher effectiveness. *The Journal of Positive Psychology*, 4(6), 540–547. <https://doi.org/10.1080/17439760903157232>
- Fernández, F. D., Arco, J. L., & Hervás, M. (2020). Grit as a predictor and outcome of educational, professional, and personal success: A systematic review. *Psicología Educativa*, 26, 163–173. <https://doi.org/10.5093/psed2020a11>
- Gonzalez, O., Canning, J. R., Smyth, H., & MacKinnon, D. P. (2020). A psychometric evaluation of the short grit scale: A closer look at its factor structure and scale functioning. *European Journal of Psychological Assessment*, 36, 646–657. <https://doi.org/10.1027/1015-5759/a000535>
- Hagger, M., & Hamilton, K. (2019). Grit and self-discipline as predictors of effort and academic attainment. *British Journal of Educational Psychology*, 89(2), 324–342. <https://doi.org/10.1111/bjep.12241>
- Hair, J. F., Jr., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). *Multivariate data analysis* (7th.). Pearson Education Limited.
- He, C., Wu, D., Yang, L., Yang, L., & Yue, Y. (2021). Psychometric properties of the Grit-S in chinese nurses. *Frontiers in Psychology*, 12, 766055. <https://doi.org/10.3389/fpsyg.2021.766055>
- Ivcevic, Z., & Brackett, M. (2014). Predicting school success: Comparing conscientiousness, grit, and emotion regulation ability. *Journal of Research in Personality*, 52, 29–36. <https://doi.org/10.1016/j.jrp.2014.06.005>
- Khan, B. M., & Khan, A. M. (2017). Grit, happiness and life satisfaction among professionals: A correlational study. *Journal of Psychology and Cognition*, 2(2), 123–132.
- Kim, L. E., & MacCann, C. (2016). Student-teacher personality similarity as a predictor of student educational experience and motivation. *Personality and Individual Differences*, 101, 490.
- Larkin, P., O'Connor, D., & Williams, A. (2015). Does grit influence sport-specific engagement and perceptual-cognitive expertise in elite youth soccer? *Journal of Applied Sport Psychology*, 28(2), 129–138. <https://doi.org/10.1080/10413200.2015.1085922>
- Li, J., Fang, M. Y., Wang, W. S., Sun, G., & Cheng, Z. M. (2018a). The influence of grit on life satisfaction: Self-esteem as a mediator. *Psychologica Belgica*, 58(1), 51–66. <https://doi.org/10.5334/pb.400>
- Li, J., Zhao, Y., Kong, F., Du, S., Yang, S., & Wang, S. (2018b). Psychometric assessment of the short grit scale among chinese adolescents. *Journal of Psychoeducational Assessment*, 36(3), 291–296. <https://doi.org/10.1177/0734282916674858>
- Li, Y., & Li, Y. (2006). Development the diagnostic criterion of job burnout. *Psychological Science*, 29(1), 148–150. <https://doi.org/10.16719/j.cnki.1671-6981.2006.01.040>
- Li, Y., Zhang, K., & Zhao, G. (2005). Confirmatory factor analysis of job burnout. *Psychological Exploration*, 25(4), 70–73.
- Luo, J., Wang, M. C., Ge, Y., Chen, W., & Xu, S. (2020). Longitudinal invariance analysis of the short grit scale in chinese young adults. *Frontiers in Psychology*, 11, 466. <https://doi.org/10.3389/fpsyg.2020.00466>
- Marsh, H., Hau, W., & Wen, Z. (2004). In search of golden rules: Comment on hypothesis testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Structural Equation Modeling: A Multidisciplinary Journal*, 11(3), 320–341. https://doi.org/10.1207/s15328007sem1103_2
- Martin, J. J., Byrd, B., Watts, M. L., & Dent, M. (2015). Gritty, hardy, and resilient: Predictors of sport engagement and life satisfaction. *Journal of Clinical Sport Psychology*, 9(4), 345–359. <https://doi.org/10.1123/jcsp.2015-0015>
- Maslach, C. (2003). *Burnout: The cost of caring*. Malor Books.
- Mueller, B. A., Wolfe, M. T., & Syed, I. (2017). Passion and grit: An exploration of the pathways leading to venture success. *Journal of Business Venturing*, 32(3), 260–279. <https://doi.org/10.1016/j.jbusvent.2017.02.001>
- Mullen, P. R., & Crowe, A. (2018). A psychometric investigation of the short grit scale with a sample of school counselors. *Measurement and Evaluation in Counseling and Development*, 51(3), 151–162. <https://doi.org/10.1080/07481756.2018.143519>
- Muthén, L. K., & Muthén, B. O. (1998–2015). *Mplus user's guide* (7th ed.). Muthén and Muthén.
- Nishikawa, K., Okugami, S., & Amemiya, T. (2015). Development of the japanese short grit scale (Grit-S). *The Japanese Journal of Personality*, 24(2), 167–169.
- O'Neal, C. R., Goldthrite, A., Riley, L. W., & Atapattu, R. K. (2018). A reciprocal, moderated mediation model of grit, engagement, and literacy achievement among dual language learners. *Social Development*, 27(3), 665–680. <https://doi.org/10.1111/sode.12288>

- Park, D., Yu, A., Baelen, R. N., Tsukayama, E., & Duckworth, A. L. (2018). Fostering grit: Perceived goal-structure predicts growth in grit and grades. *Contemporary Educational Psychology, 55*, 120–128. <https://doi.org/10.1016/j.cedpsych.2018.09.007>
- Reed, J. (2014). A survey of grit and exercise behavior. *Journal of Sport Behavior, 37*(4), 390–405.
- Rimfeld, K., Kovas, Y., Dale, P. S., & Plomin, R. (2016). True grit and genetics: Predicting academic achievement from personality. *Journal of Personality and Social Psychology, 111*(5), 780–789. <https://doi.org/10.1037/pspp0000089>
- Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica, 73*(2), 417–458.
- Robertson-Kraft, C., & Duckworth, A. L. (2014). True grit: Trait-level perseverance and passion for long-term goals predicts effectiveness and retention among novice teachers. *Teachers College Record, 116*(3), 1–27. <https://doi.org/10.1177/016146811411600306>
- Rockoff, J. E. (2004). The impact of individual teachers on student achievement: Evidence from panel data. *American Economic Review, 94*(2), 247–252.
- Sanders, W. L., & Rivers, J. C. (1996). *Cumulative and residual effects of teachers on future student academic achievement*. University of Tennessee Value-Added Research and Assessment Center.
- Sarıçam, H., Çelik, İ., & Oğuz, A. (2015). *Kısa Azim (Sebat) Ölçeğinin Türkçeye Uyarlanması: Geçerlik ve Güvenirlilik Çalışması-Turkish adaptation of the short grit scale (Grit-S): Validity and reliability study*. The International Congress on Curriculum and Instruction.
- Saunders-Scott, D., Braley, M. B., & Stennes-Spidahl, N. (2018). Traditional and psychological factors associated with academic success: Investigating best predictors of college retention. *Motivation and Emotion, 42*, 459–465. <https://doi.org/10.1007/s11031-017-9660-4>
- Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online, 8*(2), 23–74.
- Schmidt, F. T. C., Fleckenstein, J., Retelsdorf, J., Eskreis-Winkler, L., & Möller, J. (2019). Measuring grit: A German validation and a domain-specific approach to grit. *European Journal of Psychological Assessment, 35*, 436–447. <https://doi.org/10.1027/1015-5759/a000407>
- Stanford, B. H. (2001). Reflections of resilient, persevering urban teachers. *Teacher Education Quarterly, 28*(3), 75–87.
- Tahir, A. A., & Shah, A. F. (2012). Relationship of students' perceptions about teacher's personality with academic achievement of students. *Journal of Educational Research, 15*(2), 35–43.
- Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72*(2), 271–324. <https://doi.org/10.1111/j.0022-3506.2004.00263.x>
- Tovar-García, E. D. (2017). The impact of perseverance and passion for long term goals (GRIT) on educational achievements of migrant children: Evidence from Tatarstan, Russia. *Psicologia Educativa, 23*(1), 19–27. <https://doi.org/10.1016/j.pse.2017.02.003>
- Vazsonyi, A. T., Ksinan, A. J., Jiskrova, G., Mikuška, J., Javakhishvili, M., & Cui, G. (2018). To grit or not to grit, that is the question! *Journal of Research in Personality, 78*, 215–226. <https://doi.org/10.1016/j.jrp.2018.12.006>
- Wang, M. C., Dai, X., & Yao, S. (2010a). Development of Chinese big five personality inventory (CBF-PI): Theoretical framework and reliability analysis. *Chinese Journal of Clinical Psychology, 18*(5), 545–548. <https://doi.org/10.16128/j.cnki.1005-3611.2010.05.01230>
- Wang, M. C., Dai, X., & Yao, S. (2010b). Development of the Chinese big five personality inventory (CBF-PI): Validity analysis. *Chinese Journal of Clinical Psychology, 18*(6), 687–690. <https://doi.org/10.16128/j.cnki.1005-3611.2010.06.030>
- Wang, S., Jiang, J., Tang, X., & Lu, F. (2022). Editorial: New advances in grit research: A multidisciplinary perspective. *Frontiers in Psychology, 13*, 967591. <https://doi.org/10.3389/fpsyg.2022.967591>
- Wang, S., Zhou, M., Chen, T., Yang, X., Chen, G., Wang, M., & Gong, Q. (2017). Grit and the brain: Spontaneous activity of the dorso-medial prefrontal cortex mediates the relationship between the trait grit and academic performance. *Social Cognitive and Affective Neuroscience, 12*(3), 452–460. <https://doi.org/10.1093/scan/nsw145>
- Werner, K. M., Milyavskaya, M., Klimo, R., & Levine, S. L. (2019). Examining the unique and combined effects of grit, trait self-control, and conscientiousness in predicting motivation for academic goals: A commonality analysis. *Journal of Research in Personality, 81*, 168–175. <https://doi.org/10.1016/j.jrp.2019.06.003>
- Weston, L. C. (2014). *A replication and extension of psychometric research on the grit scale (Unpublished master's thesis)*. University of Maryland College Park, MD.
- Wyszyńska, P., Ponikiewska, K., Karaś, D., Najderska, M., & Rogoza, R. (2017). Psychometric properties of the Polish version of the short grit scale. *Polish Psychological Bulletin, 48*(2), 229–236. <https://doi.org/10.1515/ppb-2017-0026>
- Zhang, X., Wang, M. C., He, L., Jie, L., & Deng, J. (2019). The development and psychometric evaluation of the Chinese big five personality inventory-15. *PLoS ONE, 14*(8), e0221621. <https://doi.org/10.1371/journal.pone.0221621>
- Zhong, C., Wang, M. C., Shou, Y., Ren, F., Zhang, X., Li, M., & Yang, W. (2018). Assessing construct validity of the Grit-S in Chinese employees. *PLoS ONE, 13*(12), e0209319. <https://doi.org/10.1371/journal.pone.0209319>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.