NEW ADVANCES IN GRIT RESEARCH: A MULTIDISCIPLINARY PERSPECTIVE

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NEW ADVANCES IN GRIT RESEARCH: A MULTIDISCIPLINARY PERSPECTIVE

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Editorial: New advances in grit research: A multidisciplinary perspective

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Editorial on the Research Topic
New advances in grit research: A multidisciplinary perspective

Grit, a popular research topic in psychology over the past decade, was first introduced in 2007 and defined as a compound personality of perseverance and passion to achieve long-term goals (Duckworth et al., 2007). Many earlier studies have shown the beneficial role of grit in achievement and life outcomes. For instance, higher levels of grit are associated with higher educational attainment, greater school and workplace performance, a healthier lifestyle, better life satisfaction, more positive affect and less negative affect, and lower risks of mental disorders and problematic behaviors (Fernández et al., 2020; Datu, 2021). However, some recent studies have begun to question and re-examine grit, such as the factor structure of grit, its association with other similar constructs, and its predictive ability for outcomes (Tang et al., 2019, 2021; Ponnock et al., 2020; Morell et al., 2021; Jiang et al., 2022). This Research Topic aims to address those controversies and wishes to advance the frontiers of grit research from a multidisciplinary perspective.

He et al. begin this Research Topic with psychometric research on the Short Grit Scale (Grit-S) among 709 Chinese nurses. The authors found that the Grit-S retained the two-factor structure of the original scale, showed adequate internal consistency and test-retest reliability, and had satisfactory convergent validity with the measures of self-control, psychological resilience, and the "big five" personality traits. With regard to the criterion-related validity, the perseverance of effort but not consistency of interest of grit was related to nursing task performance after controlling for age, gender, length of nursing work, and other personality factors. Additionally, the Grit-S exhibited good measurement invariance between nurses in general hospitals and psychiatric hospitals. These results are generally consistent with previous psychometric findings by Grit-S in

other Chinese populations (Li et al., 2018; Zhong et al., 2018; Luo et al., 2020), suggesting the usefulness of Grit-S in Chinese nurses.

Four studies in this volume examined the possible psychosocial mechanism of grit to know how it affects individuals' developmental outcomes. A prospective study by Sulla et al. examined the longitudinal role of grit in university students' achievement in online learning settings during the COVID-19 pandemic. They observed that self-efficacy severed as a mediator between grit and course grades, and psychological distress moderated this mediation pathway. Second, Yang and Wu revealed that grit can influence the meaning of life of nurses in three ways: *via* the mediating role of social support, *via* the mediating role of dispositional hope, and *via* the chain mediating role of social support and dispositional hope. Through a questionnaire survey method looking at 2,602 college students, Zhang et al. found grit had a moderating role in the association between perfectionism and depression symptoms. Concretely, grit partly buffered the effects of negative perfectionism on depression and completely buffered the effects of positive perfectionism on depression. Finally, through two studies on college freshmen students, Yang et al. reported that grit had multiple roles in the relation between interpersonal stress and psychological security. Specifically, grit not only mediated the effect of interpersonal stress on psychological security but also played a moderating role in the link of interpersonal stress with psychological security. In summary, these studies suggest the important role of grit in personal development and wellbeing and show new possible psychosocial mechanisms in explaining the effects of grit.

Another four studies delved into the antecedent factors of grit. First, in 1,871 college students from 12 geographically diverse universities in China, Cheung et al. found that grit was negatively predicted by adverse childhood experiences, and the most strongly predictive factors were emotional neglect and abuse and sexual abuse. Second, Imafuku et al. probed the role of maternal grit and parenting style in the development of grit among children aged 3–6 years. Their findings indicated that mothers' grit levels but not parenting styles (i.e., responsiveness and control) were predictive of individual differences in the grit of children. Third, based on 2,839 students across 21 middle schools in Chiang Mai of Thailand, Tangmunkongvorakul et al. investigated the association between social connectedness and grit; they identified a battery of social connectedness factors linked to grit, including parental support, having been told by parents that they had done something bad, having been asked by parents to do homework, interest in school and satisfactory relationship with teachers. Fourth, from a perspective of transpersonal psychology, Agrawal et al. systematically explored the antecedents and consequences of grit in a sample of employed adults. The authors observed that several transpersonal factors (i.e., metacognition, empathy, optimism, and flow) were linked to grit, which in turn enhanced job performance and job satisfaction. Taking those four studies together, they have deepened our understanding of the antecedents of grit, which may be helpful for possible grit intervention designs.

Additionally, an electroencephalography study by Aguerre et al. investigated the neurobiological substrates of grit in 120 young adults with diverse work experiences and educational backgrounds. The study found that participants with higher grit showed lower frontal theta/beta ratios during a learning task involving top-down control processes. Moreover, perseverance of effort was found to be associated with entropy during a task, indicating the task may require more effort and engagement. Importantly, these findings persisted after controlling for demographic variables and impulsiveness, a self-control-related construct that is highly linked with grit (Pan et al., 2021). In line with the previous neural findings on grit (Wang and Li, 2021), those studies suggest that grit may share some unique neurobiological markers.

Finally, Yu et al. focused on a type of domain-specific grit (i.e., math-specific grit) and tested its possible mediating role in the relation between math anxiety and math achievement. In study 1 based on 222 10th-grade students, the authors observed that math-specific grit but not domain-general grit can mediate the linkage of math anxiety with math achievement. This finding was replicated in study 2 in another group of 465 11th-grade students; furthermore, math-specific grit and math-specific procrastination showed serial mediating effects on the relationship between math anxiety and math achievement. Since recent literature has shown that domain-specific grit outperforms domain-general grit in predicting academic achievement (Clark and Malecki, 2019; Schmidt et al., 2019), this research may ignite more studies of domain-specific grit.

As a whole, the papers in this Research Topic take multidisciplinary approaches and provide valuable insights into understanding grit in different research fields. It has to be noted that given the limited data in this volume, it may be premature to draw a conclusion about the major controversies on grit. However, we hope that this volume will stimulate more scientific investigations on grit and hope many of its controversies can be resolved. The findings of this volume also advance the development of psychoradiology, a burgeoning field at the intersection of psychology, psychiatry and radiology (Canario et al., 2021; Lai et al., 2022; Suo et al., 2022; Zhang et al., 2022).

Author contributions

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Conflict of interest

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Passion and Persistence: Investigating the Relationship Between Adverse Childhood Experiences and Grit in College Students in China

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Adverse childhood experiences (ACEs) are known to have deleterious effects on individuals across the life span, but less is known about how they affect grit, a strong predictor of achievements and well-being. This study seeks to investigate the effect of ACEs on grit in a sample of Chinese college students during the COVID-19 pandemic. Data were collected from 1,871 students across 12 universities in China. Findings indicated a significant effect of ACEs on grit, particularly abuse and neglect dimensions of ACE. Since grit is particularly important for professional success, those who have experienced abuse and neglect victimization may struggle throughout their education, and subsequently, in their careers. This calls for interventions to buffer the effects of ACEs on grit.

Keywords: grit, adverse childhood experience, emerging adults, China, college students

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INTRODUCTION

Studies have shown that, regardless of geographic location, almost two-thirds of youth have experienced a significant adverse event (see Carlson et al., 2019 for review). Adverse childhood experiences (ACEs), including abuse (psychological, physical, or sexual), neglect, household challenges such as violence perpetrated against mother and cohabitation with individuals who use substances or have mental illness or incarceration history [Felitti et al., 1998; Center for Disease Control and Prevention (CDC), 2020], from the first 18 years of life have been linked to a plethora of social and health issues in later childhood (Elmore et al., 2020), adolescence (Isohookana et al., 2013, 2016; Crandall et al., 2020; Zhang et al., 2020), and adulthood (Felitti et al., 1998; Brown et al., 2010; Gilbert et al., 2015; Schütze et al., 2020). For example, using data from a sample of children and adolescents ages 8 to 17, Elmore et al. (2020) found that youths with four or more ACEs had 2.29 times greater odds of experiencing depression than those with less than four ACEs. ACEs have also been found to be positively associated with increased risk of self-injury and suicide attempts among adolescents (Isohookana et al., 2013) and suicide attempts among adults (Dube et al., 2001; Fuller-Thomson et al., 2016). In fact, Dube et al. (2001) found that in a sample of over 17,000 adults, individuals with at least one ACE of any category had a two- to five-fold increased risk of attempted suicide. Research has found that the co-occurrence of ACEs is a major risk factor for health conditions ranging from substance use disorders and suicidality to chronic lung disease and cardiovascular disease (see Hughes et al., 2017 for review). Notably, the ACE paradigm has

primarily examined the effects of ACEs through an additive lens, instead of focusing on any single form of maltreatment or abuse (Schütze et al., 2020).

The rise of literature on the strong relation between ACEs and an alarming variety of negative life outcomes is paralleled by the increasing prevalence of scholarship on constructs such as grit. Grit is defined as "perseverance and passion for long-term goals" (Duckworth et al., 2007, p. 1087). Grit describes one's ability to commit to an endeavor, regardless of the failures, setbacks, and adversities experienced along the way (Duckworth et al., 2007; Duckworth, 2016), a trait that is generally used to describe the capacity to adapt to and persevere through hardship (Duckworth, 2016; Stoffel and Cain, 2018).

Grit has been found to be important to bolstering academic achievement (e.g., Duckworth et al., 2007; Datu et al., 2018a; Alhadabi and Karpsinski, 2020) and professional success (e.g., Dam et al., 2019; Gruenberg et al., 2019; Musso et al., 2019; Meyer et al., 2020); beyond this, however, grit has also been linked to several indices of well-being in cross-cultural studies (Singh and Jha, 2008; Kleiman et al., 2013; Akbağ and Ümmet, 2017; Datu et al., 2018a). These indices include self-rated subjective well-being (Akbağ and Ümmet, 2017), happiness (Singh and Jha, 2008), and life satisfaction (Singh and Jha, 2008; Jin and Kim, 2017). Jin and Kim (2017) found that grit increases life satisfaction via increased sense of autonomy and competence, two constructs that may support emerging adults as they make significant strides in their transition to young adulthood (Arnett, 2007). While ACEs may positively predict poor health and life outcomes, these findings underscore the potential of grit to promote positive well-being. In fact, other studies have found that grit negatively predicts psychological distress (Datu et al., 2018a), substance use (Guerrero et al., 2016), and depression and anxiety among university students (Musumari et al., 2018), as well as buffer suicidal ideation risk (Kleiman et al., 2013), all outcomes that are disproportionately higher in populations with greater ACE scores (Dube et al., 2001; Isohookana et al., 2013; Fuller-Thomson et al., 2016; Carlson et al., 2019).

As the sample of interest lives in a cultural context that is distinct from that of Western countries, we note that Datu et al. (2016) found that in collectivist cultures, such as that of the Philippines, grit may be better conceptualized as a construct with two distinct components—*perseverance of effort* and *consistency of interests*. In fact, perseverance of effort (striving harder to accomplish goals despite challenges and hardships) specifically was found to significantly predict academic performance and subjective well-being, while consistency of interests did not (showing steady long-term interest) (Datu et al., 2016). These results differ from previous results based on data from American samples (Duckworth et al., 2007); it is possible that in collectivistic cultures, perseverance of effort is more relevant than consistency of interests. Further study on this construct, originally devised by Western scholars, in cross-cultural contexts is needed.

Though Duckworth et al. (2007) originally developed hypotheses about grit to explain academic and professional success, it has come to the attention of scholars that grit makes a difference outside of classrooms and offices and contributes to adolescents' and emerging adults' psychological well-being. More than this, grit has appeared to have some protective effect against poor mental health outcomes, to which those with ACE histories are prone (Dube et al., 2001; Isohookana et al., 2013; Fuller-Thomson et al., 2016; Carlson et al., 2019).

Thus far, literature has examined grit as a predictor of some outcome variable of interest; less is known about the antecedents of grit. In other words, there is a dearth of knowledge on what accounts for the variance in grit among individuals. Some studies have found that socioeconomic characteristics of individuals and their parents play a role in grit (Guerrero et al., 2016; Datu, 2017). Datu (2017) found that students' sense of relatedness with parents positively predicted students' grit. Meanwhile, parental employment and authoritative parenting style were positively associated with grit among Latino adolescents (Guerrero et al., 2016). Studies have also found that individual traits, such as goal commitment (Tang et al., 2019), self-efficacy (Guerrero et al., 2016), and mindfulness (Raphiphatthana et al., 2018) also positively predict grit.

Given that ACE literature has provided overwhelming evidence of the link between ACEs and negative psychological well-being and of the importance of grit in life outcomes, it is vital to understand the effects of ACEs on grit. This can shed light on policy and practice interventions. Importantly, ACEs have been shown to affects a multitude of factors important to the health, well-being, and achievement outcomes of adolescents, emerging adults, and adults. Less is known, however, about whether ACEs affect grit specifically. Understanding the relation between ACEs and grit may offer the first step in theorizing how ACEs negatively affect the life outcomes of adults who experience traumatizing events during their early life stages. The theoretical framework of this study is based on the trauma theory (Herman, 1992). Trauma theory posits that traumatic experiences, including those listed in the ACEs questionnaire, can impede the psychological well-being of individuals through the development of three symptom clusters: hyperarousal, constriction, and intrusion. Hyperarousal, a key symptom of posttraumatic stress disorder (PTSD), occurs when an individual's sympathetic nervous system is activated by a traumatic memory. The chronicity of hyperarousal reproduces a prolonged state of self-protective vigilance that is difficult to "turn off" or regulate. Often, in response, traumatized individuals experience another symptom cluster, constriction, wherein they may become physiologically, emotionally, and cognitively unresponsive to stimuli. While constriction can functionally help individuals avoid painful trauma-related responses, intrusion may break through, forcing the survivor to relive the trauma through fragmentary images and vivid sensations of the original experience, notably, in the form of nightmares (Herman, 1992). As a result, traumatic experiences overwhelm the victims, disrupt their inner schemas about safety and trust, and strip them of control, connection, and meaning in life. Empirical studies have provided evidence that ACEs are traumatizing events that have extensive harmful and long-term consequences on mental health such as increasing likelihood of depression (McLaughlin et al., 2012; Weder et al., 2014; Merrick et al., 2017), on physical health and risky behaviors such as substance use and delinquency (Herrenkohl et al., 2013; Huang

et al., 2015; Mandavia et al., 2016), as well as on life satisfaction and well-being (McElroy and Hevey, 2014; Mosley-Johnson et al., 2019). Echoing Herman's (1992) conjecture that trauma may leave victims without any connection or meaning in life, increased mental health problems, such as depression, may lead to diminished passion in life. Similarly, escalated risky behaviors such as substance use and delinquency evidently reduce the perseverance to achieve goals and ambitions. As passion and perseverance are two key characteristics of grit, ACEs are likely to be negatively associated with grit.

To the authors' knowledge, grit has not yet been investigated in the context of ACEs, though the two have been demarcated as distinctive constructs. Similarly, although researchers are currently examining grit in college students (Bono et al., 2020) and healthcare professionals (Huffman et al., 2020) during the COVID-19 pandemic, grit among students residing in China during this time is understudied. The novel 2019 coronavirus disease spread rapidly throughout China and the rest of the world, posing a major threat to global public health (Ali et al., 2020). Given the ongoing pandemic, we sought to examine how COVID-19 may have affected college students' grit as well. Scholars have framed the global phenomenon of COVID-19 as a collective trauma, one that may lead to a rise in symptoms of prolonged grief disorder (PGD) (Kokou-Kpolou et al., 2020) and greater levels of stress, depression, anxiety, and PTSD, primarily in Chinese samples (Cao et al., 2020; Qiu et al., 2020; Wang et al., 2020). We do not know, however, how COVID-19, conceptualized as a potential, prolonged traumatizing event, may have affected grit within Chinese samples, particularly college students. Grit among college students may be especially salient given the context of the emerging adulthood life stage, which is characterized as a crucial transitory stage filled with significant increases in responsibility and independence (Arnett, 2007). This life stage is also "the peak age period" during which many societally discouraged behaviors take place, including risky behaviors like illegal drug use, binge drinking, and risky sexual behaviors (Arnett, 2007). Reduced grit at this life stage—in other words, lower perseverance and passion for long-term goals—may be correlated with the uptake of such behaviors, especially in the midst of a global pandemic. This concern provides rationale to assess ACEs and grit within a sample of college students. Guided by trauma theory (Herman, 1992), we hypothesized that ACEs and proximity to COVID-19 would be negatively associated with grit in Chinese college students.

METHODS

Data and Sample

The data used for the present study came from the results of an online anonymous survey. Junior and senior students from 12 geographically diverse universities in China. We selected 12 universities from the north, south, east, west, and middle regions of China to ensure a diverse sample. Afterwards, we reached out to each university's department of social science, and in September 2020, we invited 2,229 junior and senior students to participate in the online survey. Reminders regarding survey participation were sent out 3 and 7 days after the initial invitation. By early October 2020, we had received responses from 1,881 students. After omitting 10 cases due to incomplete answers, we had final analytic sample of 1,871 college students. The response rate was 80%. This research protocol, including an informed consent process, was approved by the research review committee at one of the co-authors' university in China. Students were informed that participation was voluntary and that they could choose to discontinue the survey at any time.

Table 1 presents characteristics of sampled students. About two-thirds of the sample was female, mirroring the social science student population in China. The mean age of the sample was 20.62 and the majority of the sample was Han ethnicity (89.36%). Over half of the students (52.37%) had city household registration (HR), followed by 38.70% with rural HR, and 8.93% with city but prior rural HR. Majority of students reported that their parents were married (89.04%), while a small portion of students reported that their parents were divorced (6.89%). Most students (39.82%) reported their parents' highest education was college and above, followed by junior high school (28.11%), high school (25.17%), and elementary school (6.9%). The average family income was 90,990 RMB (about 13,580 USD) in the past year, with a standard deviation of 122,030 RMB (18,170 USD). About 25% of students reported that their families received at least one form of social welfare, such as low-income assistance, food subsidies, and other subsidies, in the past year. The average number of family members was 3.87. Finally, regarding the college composition, no college occupied the final sample more than 12%, ranged from 2.5 to 11.5%, reflecting the size of students in their social science departments.

Measures

Grit

Grit was measured by the Short Grit Scale (Grit-S) developed by Duckworth and Quinn (2009). The 8 item-scale asks about intrapersonal competencies and assesses the extent to which individuals can maintain focus, interest, and perseverance when obtaining long-term goals. The Grit-S has shown with good psychometric properties, including high criteria and construct validity, as well as high internal consistency and test-retest reliability, in Chinese population (Li et al., 2018; Zhong et al., 2018; Luo et al., 2020). There are two subscales of grit, *perseverance of effort* and *consistency of interests* (referred to as *perseverance* and *consistency* hereafter), each containing 4 items. Example items for Grit-S include "Setbacks don't discourage me. I don't give up easily;" and "I have been obsessed with a certain idea or project for a short time but later lost interest." Answers for each item ranged from 1 (Very much like me) to 5 (Not like me at all). We recoded the scores of each item so that higher scores indicated higher levels of grit. We calculate the average score of grit, as well as perseverance and consistency, by averaging the item scores. The range of the scores to each item ranged from 1 to 5. The Cronbach's alphas were 0.72, 0.83, and 0.69 for the full scale, the perseverance subscale, and the consistency subscale, respectively.

TABLE 1 | Descriptive statistics of sampled students.

	Mean (S.D.)
Sex [%]	
Female	66.97
Male	33.03
Age	20.62 (0.96)
Household Registration [%]	
Rural	38.70
City, rural before	8.93
City	52.37
Grade [%]	
Junior	60.72
Senior	39.28
Ethnicity [%]	
Han	89.36
Others	10.64
Parent Marital Status [%]	
Married	89.04
Separated	0.80
Divorced	6.89
Widowed	2.35
Others	0.91
Parent Highest Education Achievement [%]	
Elementary School and Below	6.90
Junior High School	28.11
High School	25.17
College and above	39.82
Family Income	90990 (122030)
Welfare Status	
No	74.72
Yes	25.28
Number of Family Members	3.87 (1.16)
College [%]	
College 1	7.11
College 2	9.57
College 3	6.25
College 4	10.85
College 5	10.15
College 6	7.06
College 7	6.41
College 8	11.54
College 9	11.12
College 10	2.46
College 11	6.89
College 12	10.58

N = 1,871.

ACEs

The key independent variable, *adverse childhood experiences*, was measured by the Adverse Childhood Experience scale (ACE) and assessed ACEs during the respondent's first 18 years of life [Center for Disease Control and Prevention (CDC), 2020]. Ten items were used to measure ACE across three dimensions: abuse (3 items), neglect (2 items), and household challenges (5 items). The Cronbach's alpha was 0.69 for the above 10 items in this study. Example questions included "Did a parent or other adult in the household often: swear at you, insult you, put you down, or humiliate you?", "Did you often feel that: No one in your family loved you or thought you were important or special?", and "Did you live with anyone who was a problem drinker or alcoholic or who used street drugs?" Each affirmative answer was assigned one point. The sum of all affirmative answers represents the ACE score. A higher score indicates a higher frequency of experiencing adverse events in the first 18 years of life. In addition, we calculate the scores of three dimensions in ACE scale, as well as the percentages of each and the total ACE events.

Proximity to COVID-19

Proximity to COVID-19 infection was measured by asking students whether their family members or friends had tested positive or died due to COVID-19.

Covariates

This study included socioeconomic characteristics of the respondents as covariates. We collected information about respondents' age, sex (0 = male; 1 = female), ethnicity (0 = other, 1 = Han), and household registration (rural; city with prior rural registration; city). We also collected information about their parents' and family's background, including parents' marital status (married, separated, divorced, and widowed), parents' highest educational background (elementary school or below, middle school, high school, and some college or above), number of family members, annual family income in the last year, and welfare status (0 = no; 1 = yes) in the last year. In addition, since we sampled students from 12 colleges across China, we consider that different college characteristics may affect the grit of students. Thus, we took college into account by controlling for college as one of the covariates. Specifically, we used college-fixed dummies that were taken to be constant across individual colleges as covariates.

Analyses

Descriptive analysis was performed to examine the distribution of each main variable. We then conducted regression analysis to estimate the association between key independent variables and the dependent variable while controlling for students' socioeconomic characteristics. The framework underlying this study posits that the extent of grit in college students is determined by ACEs, COVID-19 infection in family and friends, socioeconomic characteristics of the students, and college-level characteristics. The specification of the analytic model is represented by the following equation:

$$Y_i = \alpha_i + \beta_1 * \chi_i + C_i + \varepsilon_i,$$

where Yi is grit of the subject i; α_i is the individual constant; χ is a vector of ACEs, COVID-19 infection in family and friends, and socioeconomic characteristics of subject i; C_i is the college for subject i, or college-fixed effect; β is a vector of regression coefficients; and ε_i is the cross-section error component. Note that with college-fixed effect, the model controls for differences

across colleges. Ordinary least squares (OLS) regression was used for the analyses. All analyses were conducted using STATA software 16.0.

RESULTS

Descriptive Statistics

Table 2 presents the descriptive statistics of grit, ACE, and COVID-19 infection. The sample had an average grit score of 3.07. Scores ranged 1 to 5 and had a standard deviation of 0.44. The average scores of perseverance and consistency were 3.28 and 2.86, respectively. More than one third (35.16%) of students reported that they experienced at least one type of ACE and 8% of them had at least three types of ACEs in childhood. ACE scores in the sample ranged 1–10 with a mean of 0.69 (SD = 1.28). In our study, average ACE subscale scores were 0.28 (SD = 0.63) for abuse, 0.15 (SD = 0.41) for neglect, and 0.26 (SD = 0.61) for household challenges. With regards to individual ACE experiences, 14% of the sample reported parental separation or divorce. Other individual ACE experiences that the sample answered affirmatively at a high rate were emotional neglect (12%), emotional and sexual abuse (both at 11%), physical abuse (6%), and mental illness in the household (5%). The percentages of students reporting physical neglect, incarcerated household member, substance abuse in the household, and mother treated violently were low, all at 3% or below. Finally, <1% of students reported that they had family members or friends who had been infected with COVID-19 (0.5%) or died of COVID-19 (0.4%). Due to low occurrence, we combined both infected and died into one category for regression analysis.

TABLE 2 | Level of grit, adverse childhood experience, and COVID-19 infection.

	Mean (S.D.)
Grit [1-5]	3.07 (0.44)
Consistency of effort [1-5]	2.86 (0.63)
Perseverance [1-5]	3.28 (0.72)
Adverse Childhood Experience [%]	
Occurrence [No=0, Yes=1]	35.16
Three types or more	8.44
Adverse Childhood Experience [0-10]	0.69 (1.28)
Abuse [0-3]	0.28 (0.63)
Emotional abuse [0-1]	0.11 (0.31)
Physical abuse [0-1]	0.06 (0.24)
Sexual abuse [0-1]	0.11 (0.31)
Neglect [0-2]	0.15 (0.41)
Emotional neglect [0-1]	0.12 (0.33)
Physical neglect [0-1]	0.03 (0.16)
Household Challenge [0-5]	0.26 (0.61)
Parental separation or divorce [0-1]	0.14 (0.34)
Mother treated violently	0.02 (0.15)
Substance abuse in the household [0-1]	0.02 (0.14)
Mental illness in the household [0-1]	0.05 (0.21)
Incarcerated household member [0-1]	0.03 (0.16)
COVID-19 infection in family and friends [%]	
No	99.14
Infected	0.48
Dead	0.37

N = 1,871.

Multivariate Analyses

Table 3 presents the standardized estimates of grit, estimated by OLS regression. Following past literature, which has measured ACEs as both dichotomous (occurrence of any ACEs at all) and continuous variables (total ACE score), we conducted two models in order to test the robustness of the association between ACEs and grit. The first modeled ACE as a dichotomous variable that measured the occurrence of any ACEs (0 = no, 1 = yes), while the second one used the observed ACE score in the analysis. When measured as a binary variable in Model 1, ACEs had a significant and negative association with grit. Students with any ACEs reported 0.09 standard deviation less grit than students without any ACEs ($p < 0.001$). Students who had family members or friends infected with COVID-19 did not have any statistically significant difference in grit scores compared to their counterparts. Overall, level of grit increased with age. The adjusted R-square of Model 1 was 0.03. The adjusted R-square kept stable at 0.03 in Model 2. Model 2 showed that the ACE score had a significant and negative association with grit. Like occurrence of ACE, a one standard deviation increase in the ACE score was associated with a 0.09 standard deviation reduction in grit ($p < 0.001$). The rest of the results of Model 2 were similar to those reported in Model 1. The small adjusted R-square values in both models suggest that a lot of variances in grit in Chinese college students were not explained in the models.

Last, we conducted robustness tests on the relationship between ACEs and grit. The same regression analyses in **Table 3** were performed, but the ACE variable was replaced by a different specification: whether a student reported the occurrence of three types or more; the three ACE subscales; or individual ACE items. Each ACE specification was regressed on grit, along with other controls in **Table 3**. In addition to the grit scale, the analyses for the two subscales of grit, perseverance and consistency, were performed as well. Standardized results are presented in **Table 4**. For simplicity, we only present the standardized coefficients of ACE items in **Table 4**. The results for other variables were similar to those reported in **Table 3**. The occurrence of three or more types of ACE had a significant negative association with grit ($B = -0.07$, $p < 0.01$). Both the abuse and neglect subscales had a significant negative relation with grit. There was a greater association with abuse ($B = -0.09$, $p < 0.001$), followed by neglect ($B = -0.06$, $p < 0.01$). The household challenge subscale had no significant association with grit. Next, only three ACE items (emotional abuse, sexual abuse, and emotional neglect) were significantly associated with lower levels of grit. All had an effect size around -0.07 ($p < 0.01$). Physical abuse was marginally associated with grit, with an effect size of -0.04 ($p < 0.10$). All types of household challenges

TABLE 3 | Standardized estimates of grit, by OLS regression.

	Model 1			Model 2		
	B	S. E.	P	B	S. E.	P
Adverse childhood experience [No = 0, Yes = 1]	−0.09	0.02	***	–	–	
Adverse childhood experience [score]	–	–		−0.09	0.01	***
COVID-19 infection in family and friends	−0.01	0.11		0.00	0.11	
Female	0.04	0.02	+	0.04	0.02	+
Age	0.10	0.01	**	0.10	0.01	**
Household registration: city, rural before	−0.03	0.04		−0.02	0.04	
Household registration: city	0.03	0.03		0.03	0.03	
Junior	0.01	0.03		0.01	0.03	
Han	0.00	0.03		0.01	0.03	
Married	−0.02	0.03		−0.01	0.03	
Junior high school	−0.01	0.04		−0.02	0.04	
High school	0.01	0.05		−0.02	0.05	
College and above	0.02	0.05		0.00	0.05	
Family income	−0.03	0.01		−0.03	0.01	
Welfare status	0.03	0.03		0.02	0.03	
Number of family members	−0.02	0.01		−0.02	0.01	
College fixed effects	Yes			Yes		
Adjusted R-square	0.03			0.03		

*N = 1,871. +p < 0.10, **p < 0.01, ***p < 0.001.*

TABLE 4 | Robust tests of ACEs on grit.

	Grit			Consistency			Perseverance		
	B	S. E.	P	B	S. E.	P	B	S. E.	P
ACE Scale									
Occurrence [No = 0, Yes = 1]	−0.09	0.02	***	0.02	0.03		−0.12	0.04	***
Three types or more [No = 0, Yes = 1 for 3 ACEs or more]	−0.07	0.04	**	0.01	0.05		−0.10	0.06	***
ACE score [0–10]	−0.09	0.01	***	0.07	0.01	**	−0.16	0.01	***
Three Dimensions									
Abuse	−0.09	0.02	***	0.02	0.02		−0.13	0.03	***
Neglect	−0.06	0.02	**	0.03	0.04		−0.10	0.04	***
Household challenge	−0.04	0.02		0.10	0.03	***	−0.14	0.03	***
Individual items									
Emotional abuse [0-1]	−0.07	0.03	**	0.02	0.05		−0.11	0.05	***
Physical abuse [0-1]	−0.04	0.04	+	0.02	0.06		−0.07	0.07	**
Sexual abuse [0-1]	−0.07	0.03	**	0.01	0.05		−0.09	0.05	***
Emotional neglect [0-1]	−0.07	0.03	**	0.01	0.04		−0.09	0.05	***
Physical neglect [0-1]	−0.03	0.06		0.05	0.09		−0.08	0.10	***
Parental separation or divorce [0-1]	−0.02	0.04		0.07	0.05	*	−0.09	0.05	***
Mother treated violently	0.01	0.07		0.07	0.10	**	−0.05	0.11	*
Substance abuse in the household [0-1]	−0.04	0.08		0.07	0.11	**	−0.11	0.12	***
Mental illness in the household [0-1]	−0.03	0.05		0.05	0.06	**	−0.08	0.07	***
Incarcerated household member [0-1]	−0.03	0.06		0.03	0.09		−0.06	0.10	*

*N = 1,871. +p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001.*

did not have any statistically significant association with grit overall.

By contrast, household challenges appeared to have a significant positive association with the consistency of interests dimension of grit ($B = 0.10$, $p < 0.01$). This was reflected by the results of regressing consistency onto individual ACE items: parental separation or divorce; mother treated violently; substance abuse in the household; and mental illness in the

household all showed significant positive effects on consistency of interests. Overall, each 1-point increase in ACE score was associated with a 0.07 standard deviation increase in consistency of interests ($p < 0.01$).

Interestingly, ACEs had a greater negative association with the perseverance of effort dimension. Each point increase in ACE score was associated with a 0.16 standard deviation decrease in perseverance ($p < 0.001$), as opposed to a 0.09 standard deviation decrease in grit overall ($p < 0.001$). Students who had reported experiencing at least one ACE had 0.12 standard deviation less perseverance of effort than those who did not experience any ACEs ($p < 0.001$). Those who had experienced 3 or more ACEs had 0.10 standard deviations less perseverance than those who experienced <3 ($p < 0.001$). Meanwhile, each type of ACE—abuse ($B = -0.13$, $p < 0.001$), neglect ($B = -0.10$, $p < 0.001$), and household challenges ($B = -0.14$, $p < 0.001$)—also had significant negative associations with perseverance. Finally, each individual ACE item appeared to have significant negative associations with perseverance. Emotional abuse and substance abuse in the household had the greatest negative association with perseverance (each at $B = -0.11$, $p < 0.001$), followed by sexual abuse, emotional neglect, and parental separation or divorce (each at $B = -0.09$, $p < 0.001$), physical neglect and mental illness in the household (each at $B = -0.08$, $p < 0.01$), physical abuse ($B = -0.07$, $p < 0.01$), incarcerated household member ($B = -0.06$, $p < 0.05$), and finally mother treated violently ($B = -0.05$, $p < 0.05$).

Finally, ACEs tend to have different relations with consistency. Each point increase in ACE score was associated with a 0.07 standard deviation increase in consistency ($p < 0.01$), while the occurrence of at least one ACE and the occurrence of three or more ACEs did not have any significant association with consistency. The association between ACEs and consistency came from household challenges ($B = 0.10$, $p < 0.001$), while abuse and neglect had no statistically significant relation with consistency. Specifically, parental separation or divorce ($B = 0.07$, $p < 0.01$), mother treated violently ($B = 0.07$, $p < 0.01$), substance abuse in the household ($B = 0.07$, $p < 0.01$), and mental illness in the household ($B = 0.05$, $p < 0.05$) all had significant and positive associations with consistency.

DISCUSSION

This study sought to examine ACEs as an antecedent of grit in Chinese college students. Guided by trauma theory (Herman, 1992), we hypothesized that ACEs would be negatively associated with grit in a sample of Chinese emerging adults. Conceptualized as traumatic experiences, ACEs may affect grit via depressive and posttraumatic stress symptoms, including dissociation and negative self-appraisal (Herman, 1992). This cannot be tested, however, without first establishing an association between ACEs and grit. Using sample data from 1,871 junior and senior students from 12 universities spread across China, we found that ACEs had negative effects on grit, though the effect size of −0.09 suggests only a small to moderate effect ($p < 0.001$). Results also indicated that not all types of ACEs nor the number of ACEs experienced were equally negatively associated with grit. Effect sizes varied when grit was regressed onto different ACE specifications. Emotional and sexual abuse, as well as emotional neglect, were most strongly negatively associated with grit overall. Meanwhile, the association between physical abuse and grit was marginally significant.

The significant negative associations between emotional and sexual abuse and emotional neglect and grit may be a result of decreased sense of relatedness. Datu (2017) found that sense of relatedness, the extent to which a person feels accepted by social partners such as parents, teachers, and friends, is positively associated with higher grit. Given that sexual and emotional victimization, as well as neglect, may lead to negative self-appraisal and feelings of rejection in a child (Rohner and Rohner, 1980; Alexander, 1992; Herman, 1992; Feiring et al., 2002), these experiences may impair attachment (Alexander, 1992) and sense of relatedness and, subsequently, grit. This is consistent with trauma theory, which has described that those children who experience severe trauma throughout childhood and adolescence experience turbulent interpersonal relationships as they grow up (Herman, 1992). Indeed, a study on motivation in Chinese adolescents have found that socioemotional relatedness to adults may be more important to sustaining adolescents' motivation than autonomy (Bao and Lam, 2008), indicating the importance of relationships in motivation and related constructs like grit in Asian contexts. This could be exacerbated for adolescents and emerging adults who live in collectivist contexts which emphasize socioemotional relatedness (Iyengar and Lepper, 1999). De Vera et al. (2015) also relayed that social support systems are an important component of grit in Asian cultures, but gaps in grit theory grounded in such contexts continues to be an area of inquiry that requires further investigation (Datu et al., 2017). Future research may use mediational studies to examine how ACEs affect the way that adolescents and emerging adults in collectivist contexts view or approach their peer and family relationships and how this, in turn, may affect grit, as there are currently limited studies on the sub-facets of grit as contextualized in non-Western cultures.

Another potential explanation for the effects of emotional and sexual abuse on grit can be formulated based on the relations between sexual abuse and mindfulness (Elices et al., 2015) and dispositional mindfulness and grit (Raphiphatthana et al., 2018). It is possible that the effects of abuse and neglect on mindfulness mediates the relationship between abuse and neglect and grit. Indeed, trauma theory (Herman, 1992) would also offer insight into these relations, as dissociation is a common posttraumatic symptom exhibited by trauma survivors, making it difficult for individuals to engage in the practice of mindfulness. Further research on this area is warranted.

Interestingly, household challenges had no significant association with students' grit, but when we regressed grit on the ACE subscales, household challenges appeared to have a significant and positive association with the consistency of interests dimension ($B = 0.10$). This finding is interesting considering that Datu et al. (2016) previously reported that

consistency of interests may not be a salient construct in the measurement of grit within collectivistic cultures. Previous scholarly literature by Suh (2007) reported less behavioral consistency in collectivist cultures, which may instead encourage adaptability to situations (Datu, 2017; Datu et al., 2018a,b) to maintain relational harmony (Markus and Kitayama, 1991), however, consistency of interests may be increased by household challenges via fractured relationships and attachments (Alexander, 1992), placing individuals in more autonomous positions. An individual may be more likely to pursue their own personal interests rather than tending to the expectations of others due to a perceived lack of relatedness and acceptance at home.

When the ACE specifications were regressed on perseverance of effort dimension, all specifications—that is, more than one ACE, more than three ACEs, each type of ACE, and each individual ACE scale item—had a significant negative association with perseverance of effort. It is possible that ACEs negatively affect perseverance of effort through their deleterious effects on psychological well-being (Herman, 1992), as those with ACEs are at greater risk of developing mental illnesses such as depression (Schilling et al., 2007; Lamoureux et al., 2012; Chen et al., 2014; Merrick et al., 2017), which is associated with negative symptoms like avolition and anhedonia (Price and van Stolk-Cooke, 2015). Child sexual abuse, for example, has been linked to low self-esteem (Stern et al., 1995; Mwakanyamale and Yizhen, 2019). Those with low self-esteem may be less likely to exhibit perseverance of effort, as they may be deterred by obstacles or failure.

Our findings reflected that COVID-19 had no significant association with grit, though this result may have been caused by measurement error and low COVID-19 prevalence in China at the time of data collection. The prevalence of COVID-19 had stabilized and remained low since April 2020, when the last city, Wuhan, lifted its lockdown (Zhong and Wang, 2020). By the time that data were collected in September 2020, it had been approximately 5 months since China lifted its lockdown measures. Thus, the students were less likely to report proximity to COVID-19 infections in their lives. Further research in this area is required. We offer suggestions for future studies that seek to examine how COVID-19 has impacted the psychosocial well-being of Chinese citizens in the next section.

This study has several limitations. First, our analyses were based on a cross-sectional dataset, which can only approximate an associative relationship, rather than a causal one, among ACEs, COVID-19 infection, and grit during the pandemic. Future studies may use a longitudinal design to examine the causal relationships of these variables. Second, there were other unobserved variables, such as academic stressors and peer support, that could affect grit but were not included in the study. The absence of these unobserved variables may have effects on the estimates reported in this study. Third, the findings of this study are based on data from students of social science departments in 12 colleges across China. Although the large sample size and geographic diversity of these colleges increase our confidence, the extent to which these findings can be generalizable to all Chinese college students is unknown and requires further research. Fourth, the lack of any significant effect of COVID-19 on grit may be the result of measurement error since this was dependent on students' recall of events. There had been low prevalence of COVID-19 in China since April 2020, 5 months prior to data collection. Future research using other countries, where the COVD-19 pandemic still continues to affect daily life, is warranted. Finally, data gathered for key variables such as grit and ACEs relied on students' self-reports. Self-reporting leaves our data subject to unintended and intended reporting errors, including social desirability bias, particularly for data related to ACEs. Considering that ACEs relate to the respondent's home and filial relations, it is possible that respondents may avoid answering questions that reveal intimate details of family's life to preserve their own image as well as their family's image (Eriksson et al., 2017). Eriksson et al. (2017) found that people are willing to sacrifice their own resources to preserve another person's image when that person was considered a member of the in-group. In Chinese culture, which promotes a high-context self (Suh, 2007), saving face is especially salient when discussing matters related to the family unit. Thus, to address this concern, future studies may consider triangulating findings from different data sources, such as peer or teacher reports.

CONCLUSION

This study is one of the first to examine how childhood experiences, specifically ACEs, may differentially predict grit during emerging adulthood. The results indicate that sexual abuse, emotional abuse, and neglect had significant negative associations with grit. Given that grit is particularly important to predict academic and professional success, as well as psychological well-being, those individuals who have experienced sexual and emotional victimization may experience challenges related to their education, career, and health. Our results suggest that interventions to buffer the negative effects of ACEs on grit are necessary. Mindfulness interventions have been found to improve self-esteem (Randal et al., 2015) and self-acceptance (Thompson and Waltz, 2008). Mindfulness has also been shown to positively affect resilience and mental health (Huang et al., 2019, 2020; Cheung et al., 2020), constructs that are related to grit (Musso et al., 2019; Meyer et al., 2020). Although mindfulness interventions have yet to be examined for their effects on grit, past literature has found that mindfulness and grit are significantly positively associated (Raphiphatthana et al., 2018). Our findings thus set up future studies to continue building on our knowledge of grit, including its antecedents and possible ways to bolster it in vulnerable populations, within the context of collectivistic cultures.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Review Committee, School of Public Administration, Guangdong University of Foreign Studies. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

SC, C-CH, and CZ: conceptualization, validation, formal analysis, and writing—original draft preparation. SC and C-CH: methodology and software. C-CH and CZ: resources and investigation and data curation. All authors contributed to the article and approved the submitted version.

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BRIEF RESEARCH REPORT
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True Grit in Learning Math: The Math Anxiety-Achievement Link Is Mediated by Math-Specific Grit

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In this study, we tested a possible mechanism of the association between math anxiety and math achievement: the mediating role of math-specific grit (i.e., sustaining effort in the face of adversity when learning math). In Study 1, a sample of 10th grade students (N = 222) completed a battery of personality and attitude questionnaires, and math achievement was indexed by curriculum-based examination scores. Mediation analyses indicated that math-specific grit, but not domain-general grit, mediated the relationship between math anxiety and math achievement. In Study 2, we replicated and extended the above findings with another sample of 11th grade students (N = 465). Mediation analyses indicated that math-specific grit and math-specific procrastination played sequential mediating roles in the relationship between math anxiety and math achievement. That is, individuals with higher math anxiety were less gritty in math learning, possibly further leading them to be more procrastinated in performing math work, which may finally result in worse math achievement. In summary, the current study provides the first evidence that math-specific grit may mediate the relationship between math anxiety and math achievement. Furthermore, it also demonstrated the value of math-specific grit over domain-general grit in predicting math success, which invites a broader investigation on subject-specific grit.

Keywords: grit, math anxiety, math achievement, procrastination, Chinese adolescent

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INTRODUCTION

Math anxiety is defined as a feeling of fear, tension, and apprehension about math (Ashcraft, 2002). A stable negative association between math anxiety and math achievement has been found across individuals and countries (Foley et al., 2017). By analyzing 747 effect sizes, a recent meta-analytic study revealed a small-to-moderate negative correlation ($r = -0.28$) of this association (Barroso et al., 2021). The present study seeks to explore the mechanisms underlying this association, which may help in developing methods to mitigate the negative effect of math anxiety on math achievement.

In general, psychologists have discovered that math anxiety may lead to worse math achievement in two scenarios—when taking math tests and during daily math learning (Ashcraft, 2002). When taking math tests, math anxiety may deplete cognitive resources (e.g., working memory and attention), resulting in worse math performance (Ashcraft and Kirk, 2001). During daily math learning, math anxiety may alter individuals' attitude, motivation, and self-confidence toward

learning math (Hembree, 1990), resulting in worse math achievement. In this study, we seek to explore a new mechanism explaining the relationship between math anxiety and math achievement in the daily learning scenario—the mediating role of grit.

Grit is one of the most important predictors of academic success [see Eskreis-Winkler et al. (2016) for a review]. The concept was initially developed by Duckworth et al. (2007). They defined grit as trait-level perseverance (referring to sustaining effort in the face of adversity) and passion (referring to consistency in one's interests over time) for long-term goals. Moreover, recent evidence has demonstrated that grit's primary utility in academic achievement lies in the perseverance facet [but see Xu et al. (2020)]. In one meta-analytic study, researchers found that only the perseverance facet added predictive power to academic achievement when controlling for Big Five conscientiousness (Credé et al., 2017). In another meta-analytic study, researchers found that the perseverance facet shows a much larger contribution to academic achievement than the passion facet (Lam and Zhou, 2019). In addition, two facets of grit should not be aggregated together, given that no evidence supporting for a single-factor construct of grit (Guo et al., 2019). Thus, in this study, we used the perseverance facet only to represent the grit construct.

Specifically, we hypothesized that math-specific grit might play a mediating role in the math anxiety–math achievement relationship. Admittedly, there is a lack of empirical studies on math-specific grit in the extant literature. However, based on existing literature on math anxiety and grit, the hypothesized mediation relationships could be illustrated as followed. First, when facing obstacles to learning math, individuals with higher math anxiety levels may be more prone to give up on math learning (i.e., less gritty). This may occur because these individuals have fewer cognitive resources (Ashcraft and Kirk, 2001) and less self-confidence (Hembree, 1990) in facing math-related obstacles than individuals with less math anxiety. Second, giving up in the face of adversity during math learning (i.e., less gritty) may lead to less study time (Duckworth et al., 2007) and more procrastination (Jin et al., 2019), which finally results in worse math achievement. Third, recent literature has demonstrated that domain-specific grit (e.g., grit specific to school learning) can account for more variance in academic achievement than domain-general grit (e.g., Clark and Malecki, 2019; Schmidt et al., 2019). Therefore, we argued that math-specific grit plays a more critical mediating role in the math anxiety-math achievement relationship than domain-general grit. Finally, given that lack of direct evidence regarding the hypothesized relationships, the nature of our investigation is exploratory.

To test the proposed mediation model describing the relationship between math anxiety, math-specific grit, and math achievement, we conducted the current study with Chinese adolescents. In Study 1, we examined whether math-specific grit mediates the relationship between math anxiety and math achievement in one sample of 10th grade students (N = 222). To further verify the specificity of the proposed mediation model, we ruled out the possibility of an alternative model: math anxiety influences math achievement through domain-general grit. In Study 2, we first replicated the results in Study 1 with another sample of 11th grade students (N = 465), which ensured the replicability of the research findings (Pashler and Harris, 2012). In addition, we further explore how math-specific grit influences math learning in depth. As grit makes students less procrastinated (Jin et al., 2019) and procrastination is negatively correlated with academic achievement (Kim and Seo, 2015), we proposed a sequential mediation relationship between math anxiety, math-specific grit, math-specific procrastination, and math achievement. That is, these variables may sequentially influence each other in the above order.

STUDY 1

In Study 1, the first goal was to examine whether math-specific grit is negatively associated with math anxiety and positively associated with math achievement, which has not been tested before. Then, we investigated the mediating role of math-specific grit in the proposed mediation model.

Material and Methods

Participants and Procedure

The participants were 222 high school students in 10th grade recruited from Dali, China. The Medical Ethics Committee of Dali University approved the study. We obtained written consent from all participants and their parents. The mean age of the participants was 16.1 years (SD = 0.5 years); 65.8% of the participants were female. Participants completed a set of paper-based questionnaires in classrooms with their classmates. The main goal of recruiting these participants is to investigate the determinants of academic achievement among adolescents (Li et al., 2020).

Measures

Math anxiety was measured by the 9-item Abbreviated Math Anxiety Scale (AMAS) (Hopko et al., 2003). The participants rated the extent of their anxiety when facing nine math learning scenarios with response options ranging from 1 (low anxiety) to 5 (high anxiety). The scale consists of two subscales: learning math anxiety (e.g., "listening to another student explaining a math formula") and math evaluation anxiety (e.g., "thinking about an upcoming math test 1 day before"). The Chinese version of the AMAS was established through a translation and back-translation process by the authors of the current study. In this study, the Cronbach's αs for the AMAS, learning math anxiety subscale, and math evaluation anxiety subscale were 0.86, 0.72, and 0.85, respectively. To index math anxiety in a simple and comprehensive manner, the total score of the AMAS was used subsequently.

Domain-general grit was measured by the 4-item perseverance of effort subscale of the Grit-S (Duckworth and Quinn, 2009). Sample items include "I finish whatever I begin." The Chinese version of the Grit-S used in the study has been validated in Chinese adolescents (Li et al., 2018). To measure math-specific grit, we adapted the perseverance of effort subscale of the Grit-S by adjusting the items to math learning

TABLE 1 | Means, standard deviations (SD), and correlations among the major variables in Study 1.

	Mean	SD	1	2	3	4
1. Math anxiety	2.03	0.70	–			
2. Math achievement	94.51	19.10	−0.20**	–		
3. Domain-general grit	3.41	0.68	−0.27**	0.07	–	
4. Math-specific grit	3.43	0.73	−0.48**	0.27**	0.49**	–

$^{**}p < 0.01$.

context (Schmidt et al., 2019). Sample items include "When learning math, I finish whatever I begin." The response options for both scales range from 1 (not at all like me) to 5 (very much like me). In this study, the Cronbach's αs for domain-general and math-specific grit were 0.59 and 0.77, respectively.

Math achievement was indexed by the scores on the final term examination for the first semester (full score = 150) of 10th grade, which reflects the students' learning progress in the first half of the 10th grade year. The achievement tests were administered in the same month as the questionnaire session.

Data Analysis

Statistical analyses were performed using R 3.4.3 with the "lavaan" R package (Rosseel, 2012). For the mediation analysis, the indirect effect was estimated with the bootstrap method (subsample N = 5000), and standardized regression coefficients were reported. In addition, given that several measures were translated or adapted versions of original scales, we performed confirmatory factor analyses to assess their factor structure. In general, they showed satisfactory structural validity; see **Supplementary Materials** for details.

Results and Discussion

Table 1 presents the means, standard deviations, and correlations for the study measures. As expected, math anxiety was negatively associated with math achievement ($r = -0.20$, $p < 0.01$). In addition, after controlling for age and gender, the correlations between math anxiety and math achievement remained significant (partial $r = -0.16$, $p = 0.02$). Thus, our study replicated the negative link between math anxiety and math achievement reported in the literature.

Next, we examined the relationship between math-specific grit and math anxiety/achievement, which has not been tested before. As expected, math-specific grit was negatively correlated with math anxiety ($r = -0.48$, $p < 0.01$) and positively correlated with math achievement ($r = 0.27$, $p < 0.01$).

Critically, we tested whether math-specific grit plays a mediating role in the association between math anxiety and math achievement. Mediating analyses confirmed the proposed mediation model. After including math-specific grit as an intermediate variable, the associations between math anxiety and math achievement were reduced from −0.20 (95% CI = [−0.33, −0.06]) to −0.08 (95% CI = [−0.23, 0.07]) (**Figure 1**) and became statistically non-significant. In addition, the indirect effect ($\beta = -0.11$, 95% CI = [−0.19, −0.03]) accounted for 57.9% of the total effect. Therefore, individuals with more math anxiety were prone to being less grittier when learning math, making them obtain worse math examination scores.

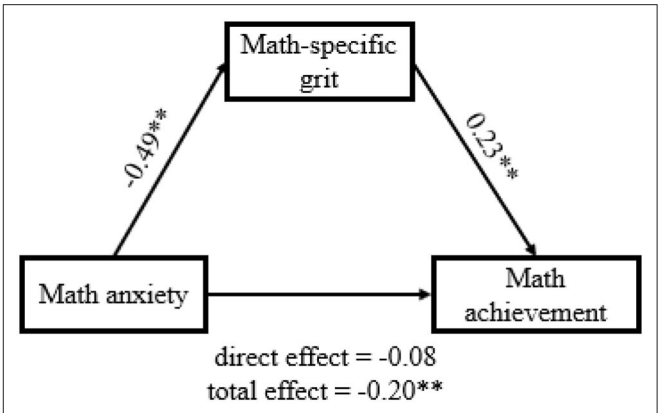

FIGURE 1 | Mediation model of math anxiety as a predictor of math achievement mediated by math-specific grit. Standardized regression coefficients are displayed for all paths. *$^{**}p < 0.01$.

Finally, it is unlikely that math anxiety influences math achievement through domain-general grit. As expected, domain-general grit and math-specific grit shared a large amount of variance ($r = 0.49$, $p < 0.01$). However, when testing the mediation role of domain-general grit in the math anxiety-achievement link, no significant mediation effect was found (indirect effect = −0.002, 95% CI = [−0.04, 0.04]), which might be caused by the small and insignificant association between domain-general grit and math achievement.

STUDY 2

The purposes of Study 2 were twofold. First, to ensure the replicability of the results, we directly replicated the major findings of Study 1 with another independent adolescent sample. Second, we further extend the above findings by testing the proposed sequential mediation model of math anxiety, math-specific grit, math-specific procrastination, and math achievement.

Material and Methods

Participants and Procedure

The participants were 465 high school students in 11th grade recruited from Dali, China. The Medical Ethics Committee of Dali University approved the study. We obtained written consent from all participants and their parents. The mean age of the participants was 17.1 years (SD = 0.54 years); 60.9% of the participants were female. Participants completed a set of paper-based questionnaires in classrooms with their classmates.

Measures

We used the same tools from Study 1 to measure math anxiety, domain-general grit, and domain-specific grit, and found similar reliability scores for the AMAS (Cronbach's α = 0.83), perseverance of effort subscale of the Grit-S (Cronbach's α =

TABLE 2 | Means, standard deviations (SD), and correlations among the major variables in Study 1.

	Mean	SD	1	2	3	4	5
1. Math anxiety	2.14	0.71	–				
2. Math achievement	82.62	20.40	−0.32**	–			
3. Domain-general grit	3.06	0.73	−0.28**	0.03	–		
4. Math-specific grit	3.09	0.84	−0.45**	0.33**	0.52**	–	
5. Math-specific procrastination	2.27	0.93	0.39**	−0.36**	−0.36**	−0.55**	–

**$p < 0.01$.

0.60), and math-specific grit (Cronbach's $\alpha = 0.83$) as those in Study 1.

Math achievement was indexed by the scores on the final term examination for the first semester of 11th grade (full score = 150), which reflects the students' learning progress in the first half of the 11th grade year. The achievement tests were administered in the same month as the questionnaire session.

In addition, the short form of the Academic Procrastination Scale (APS-S) was translated (Yockey, 2016). To measure math-specific procrastination, we adapted it by adjusting the items to the math learning context. Sample items include "When learning math, I put off projects until the last minute". The response options for both scales range from 1 (strongly disagree) to 5 (strongly agree). In this study, the Cronbach's α for the adapted version of the short form APS-S was 0.87.

Data Analysis

We used the same statistical procedures and tools as those used in Study 1. Due to school absence, seventeen students did not take part in the math achievement test. Maximum likelihood estimation method was used to handle missing data in the mediation analysis because it generally produces unbiased estimates in various situations (Baraldi and Enders, 2010).

Results and Discussion

Table 2 presents the means, standard deviations, and correlations for the study measures. In Study 2, we replicated the main correlation patterns between math anxiety, math achievement, domain-general grit, and math-specific grit. In addition, as expected, math-specific procrastination was negatively correlated with math-specific grit and math achievement.

Next, we replicated the findings of the mediation relationship in Study 1. After including math-specific grit as an intermediate variable, the associations between math anxiety and math achievement were significantly changed from −0.32 (95% CI = [−0.42, −0.22]) to −0.23 (95% CI = [−0.33, −0.12]). In addition, the indirect effect ($\beta = -0.10$, 95% CI = [−0.15, −0.05]) accounted for 31.3% of the variance in the total effect. However, no significant mediation effect was observed when the mediator was replaced by domain-general grit ($\beta = 0.02$, 95% CI = [−0.01, 0.05]). Thus, the mediation results observed in Study 1 were successfully replicated in Study 2.

Finally, we tested how math-specific grit and math-specific procrastination play multiple mediating roles in the association between math anxiety and math achievement (**Figure 2**). First, the indirect effects via math-specific grit alone ($\beta = -0.05$, 95% CI = [−0.11, −0.008], 38.7% of the overall indirect effect), and math-specific procrastination alone ($\beta = -0.04$, 95% CI = [−0.08, −0.01], 27.7% of the overall indirect effect) were both significant, suggesting that both mediators could independently mediate the relationship between math anxiety and math achievement. Second, and more importantly, the mediation pathway of math anxiety → math-specific grit → math-specific procrastination → math achievement was also significant ($\beta = -0.05$, 95% CI = [−0.08, −0.02], 33.6% of the overall indirect effect), supporting a sequential mediation model. That is, math anxiety may first decrease math-specific grit, which in turn increases math-specific procrastination and finally results in a lower level of math achievement. Finally, the overall indirect effect ($\beta = -0.14$, 95% CI = [−0.20, −0.08]) accounted for 42.4% of the variance in the total effect ($\beta = -0.32$, 95% CI = [−0.43, −0.22]), supporting a partial mediation relationship.

GENERAL DISCUSSION

In this investigation, we aimed to explore how math anxiety is linked to math achievement by testing the mediating role of math-specific grit. In both Study 1 and Study 2, we found replicable mediation relationships. That is, math-specific grit, but not domain-general grit, mediates the association between math anxiety and math achievement. Moreover, in Study 2, we extend the meditation model found in Study 1 by adding the effect of math-specific procrastination. Our findings support the proposed sequential mediation model with math-specific grit and math-specific procrastination as sequential mediators of the relationship between math anxiety and math achievement.

The current study contributed to the literature in two novel aspects. First, we provide a new explanation of the well-known relationship between math anxiety and math achievement—the mediating role of math-specific grit. That is, math anxiety might make students less persistent in learning math, such as being more procrastinated, doing less math work, and shrinking back when facing difficulties, which might result in worse math grades. These findings may shed light on mitigating the negative effect of math anxiety on math achievement. Educators need to develop methods to break the vicious chain of math anxiety, math-specific grit, math-specific procrastination, and math achievement. For example, educators may develop training programs to increase math-specific grit among individuals with intense math anxiety, such as altering their mindset about learning math (Bettinger et al., 2018; Wang et al., 2018; Xu et al., in press), which may further help to improve their math achievement.

Second, we demonstrated the predictive power of subject-specific grit over domain-general grit when predicting math achievement. In Duckworth and her colleague's original conceptualization of grit, they emphasized that grit reflects individual tendencies in "a variety of domains (e.g., not just work or school) (pp. 1089)". However, recent studies have supported the existence and power of domain-specific grit. Some researchers have developed several domain-specific grit scales,

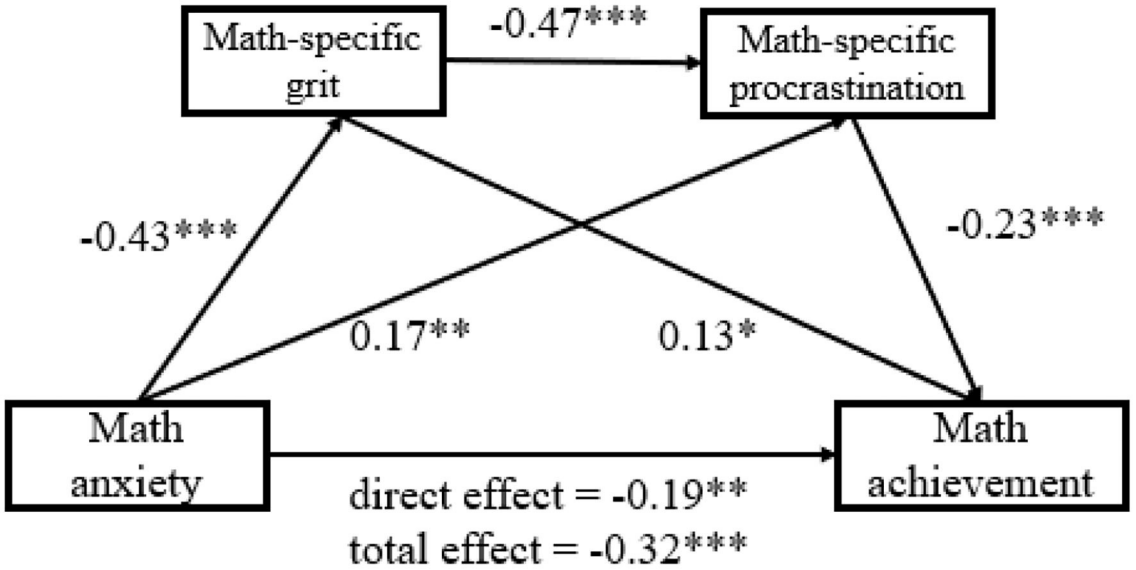

FIGURE 2 | Sequential mediation model of math anxiety as a predictor of math achievement mediated by math-specific grit and math-specific procrastination. Standardized regression coefficients are displayed for all paths. ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

such as the Academic Grit Scale (Clark and Malecki, 2019) and English as a Foreign Language Grit Scale (Ebadi et al., 2018). In addition, some researchers have adapted the original Grit scale to specific domains, including sports and school (Cormier et al., 2019; Schmidt et al., 2019). Consistent with other studies on domain-specific grit, our study demonstrated the predictive power of domain-specific grit over domain-general grit when predicting outcomes in the corresponding domain. However, to the best of our knowledge, the current study provides the first evidence in the math domain. These results implied that math educators should pay more attention to students' grit toward learning math than their domain-general grit.

Several limitations of this research should be addressed by future explorations. First, given the cross-sectional nature of the current study design, we did not provide causal evidence supporting the relationship between the variables. Therefore, experimental or longitudinal designs are needed to explore the causal direction of the mediation model. Second, the internal consistency for the domain-general grit is not high, which might be caused by the limited number of items used (i.e., four items). Thus, future studies may replicate the current findings with improved design of psychometric properties. Third, our sample included only Chinese high school students, which constrains the generalization ability of the research findings. Therefore, replicating the findings in other school grades (e.g., primary school and junior middle school) and different ethnicities (e.g., Caucasian population) is needed.

In conclusion, this study provides a novel explanation of the relationship between math anxiety and math achievement by revealing the mediating role of math-specific grit. Future studies are needed to explore how the mediation model found in this study is distinct and connected to known models for the relationship between math anxiety and math achievement (Hembree, 1990; Ashcraft and Kirk, 2001). In addition, researchers and educators are needed to develop methods to mitigate the negative effect of math anxiety on math-specific grit, which may help students with high math anxiety gain better achievement in math.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Medical Ethics Committee of Dali University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

JL conceived and designed the study. YY, LH, XF, YW, ZY, and TZ contributed to data collection. YY, YZ, and JL analyzed data and wrote the paper. All authors reviewed and approved the manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.645793/full#supplementary-material

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Electrophysiological Prints of Grit

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While scientific interest in understanding the grit trait has grown exponentially in recent years, one important gap in the grit literature relates to its biological and neural substrate. In the present study, we adopted a hypotheses-driven approach in a large sample of young adults (N = 120) with diverse educational backgrounds and work experiences in order to investigate the electrophysiological correlates of grit both during rest and while performing a learning task. Additionally, we selected a measure of impulsiveness to better understand the neural similarities and differences between grit and related self-control constructs. Based on previous work that implicated the prefrontal cortex in grit, we hypothesized that high grit participants would have lower frontal theta/beta ratio (a broadly used index that reflects prefrontally-mediated top–down processes, which might indicate better control over subcortical information). Furthermore, we expected the perseverance of effort facet of grit to be linked to higher complexity during task engagement because previous research has shown complexity indexes (entropy and fractal dimension) to be linked to effort while performing cognitive tasks. Our results revealed that although there were no differences at rest as a function of grit, the participants with high grit and high consistency of interest scores exhibited lower frontal theta/beta ratios during the learning task. This pattern suggests that individual differences in grit might be more evident when top-down control processes are at work. Furthermore, there was a positive association between perseverance of effort and entropy at task, which might indicate more effort and engagement in the task. Finally, no association was found between the neural indexes (frontal theta/beta ratio, entropy, or fractal dimension) and impulsiveness, neither impulsiveness mediated between grit and brain measures. Finally, when controlling for impulsiveness and demographic variables (gender, age, education, and work experience) the effects at the facet level remained statistically significant. While there is still a long way to fully understand the neural mechanisms of grit, the present work constitutes a step toward unveiling the electrophysiological prints of grit.

Keywords: grit, EEG, theta/beta ratio (TBR), entropy, fractal dimension, impulsiveness

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INTRODUCTION

In a world in which new information emerges every second, sticking with one dream can be challenging. Indeed, not everybody chooses to strive toward a long-term goal and even fewer people maintain their motivation until they have achieved it. Grit is the personality trait that defines those people that do tend to pursue long-term goals with enduring passion and perseverance

(Duckworth and Gross, 2014). This newly explored trait has attracted the attention of researchers from different fields (i.e., positive psychology, motivation, and education), given that it has been shown to be able to predict success in various domains and contexts, such as academic (i.e., Duckworth et al., 2007; Clark and Clark, 2019), work achievement (i.e., Mueller et al., 2017), and personal life (i.e., Eskreis-Winkler et al., 2014). More importantly, grit has been shown to be related to different aspects of well-being (i.e., general well-being: Duckworth et al., 2007; Kindt et al., 2009; Kannangara et al., 2018; Jiang et al., 2020; life satisfaction: Li et al., 2018a; lower depression: Musumari et al., 2018; Datu et al., 2019; reduction of risk of suicidal ideation: White et al., 2017; Kaniuka et al., 2020). While interest in grit has grown exponentially over the past few years, the neural processes underlying this trait still remain largely understudied.

Grit is conceptualized as comprising two factors (Duckworth and Quinn, 2009): *perseverance of effort* and *consistency of interest*. The first factor, *perseverance of effort*, highlights the long-term stamina or the effort maintained toward one's superordinate goal, whereas the *consistency of interest* factor taps into the passion for one's goal and the ability to stay committed to interests related to it. Hence, grit is related to both self-control and motivation (Nemmi et al., 2016). The effortful regulation of attention, emotion, and behavior would allow self-controlled individuals to overcome temptations in comparison to their impulsive counterparts (Duckworth, 2011). This ability would help these individuals to achieve long-term goals as well. Interestingly, evidence indicates that self-control and grit correlate moderately ($r = 0.63$; see Duckworth et al., 2007), which suggests that there must be something else besides self-control in the consecution of long-term goals (Duckworth and Gross, 2014; Eskreis-Winkler et al., 2014; Li et al., 2018b; Tedesqui and Young, 2018). On the other hand, motivation is thought to contribute to how people behave, think, and feel. Individual differences in motivation reflect the degree of endurance in people's needs, desires and values (Borghans et al., 2008) and, therefore, a certain pattern of motivation would be behind grit. In fact, there is evidence that grit is positively linked to orientation toward engagement and inversely associated with pursuing pleasure in Western samples (Von Culin et al., 2014; see also: Muenks et al., 2018). In accordance with this conceptualization, the few studies that have already examined the neural basis of grit converge in showing that grit is mainly associated with the function and structure of the prefrontal cortex (PFC) and striatum, which are the key regions for executive control (self-control) and reward (motivation) processes (Myers et al., 2016; Nemmi et al., 2016; Wang et al., 2017, 2018).

For example, Nemmi et al. (2016) examined brain structure as a function of grit in 27 children and found that individual differences in the trait were associated with differences in the volume of the nucleus accumbens, which has been related to reward-seeking (Tobler et al., 2014). In a resting-state functional magnetic resonance imaging (fMRI) study with 20 children, Myers et al. (2016) found grit to be associated with ventral striatal and bilateral prefrontal networks. The ventral striatum was specifically connected to medial prefrontal and rostral anterior cingulate cortices. Importantly, all these regions are thought to be crucial for cognitive-behavioral control, perseverance, and emotional regulation. More recently, Wang et al. (2017) tested resting-state fMRI in 217 healthy adolescents and found a negative relationship between grit and the regional fractional amplitude of low-frequency fluctuations in the right dorsomedial PFC, which is thought to be involved in self-regulation. Furthermore, this association played a mediating role in the link between grit and academic performance. In a related structural MRI study—also with adolescents—, Wang et al. (2018) found greater volume in the right putamen and smaller volume in the left dorsolateral PFC, both regions involved in action planning, motivation, and self-regulation in gritty participants.

Some other attempts have been made to examine the neural basis of grit by using electroencephalography (EEG). In this regard, Kalia et al. (2018) recorded event-related potentials while participants (undergraduate students) performed the attentional network task (ANT; Fan et al., 2002). Kalia et al. (2018) found that people with higher scores in the *perseverance of effo*rt facet of grit were linked to reduced electrophysiological responses (N1) to an alerting cue relative to people with lower scores. According to the authors, this attenuated alerting effect for grittier individuals might be a sign of their more efficient sustained attention due to their stronger intrinsic motivation to perform well. Thus, alerting cues were less effective as a warning signal, since they were already more attentive to the task. More recently, Matthews et al. (2019) included a measure of grit in a study examining the role of worry and resilience in the performance of 68 undergraduate students in a Unmanned Aerial simulation System including different stress-inducing conditions and physiological measures. Although no EEG results were reported regarding the control condition, in the high stress condition there was an association between (high) grit and (lower) gamma activity that the authors interpreted as indicating that grittier individual might also show better stress coping abilities.

While these results are compelling, a number of factors limit the conclusions that can be drawn from them. First, some of the studies employed very small sample sizes. Second, MRI studies primarily focused on the brain state at rest, although it is also possible that differences occur when gritty people engage in a task due to differential information processing. Third, these studies focused only on grit-related traits, leaving out other self-control traits that could provide information regarding the neural similarities and differences between these constructs. Fourth, all studies focused on children, adolescents or grad students with similar life backgrounds, thus limiting the generalizability of their findings. Finally, most studies have used a single brain dimension, although some authors have pointed out that it is necessary to approach the topic using different brain measures (van Zyl et al., 2021). Hence, more studies that use more heterogeneous and larger samples and that employ distinct brain measures in different conditions are required in order to better understand the grit trait.

In addition, it is relevant to examine how different self-control constructs relate to grit by tapping into their commonalities and differences at the neural level. This point is of particular importance because one major concern about the grit construct

has been its dissociation from other concepts related to self-control (Muenks et al., 2017; Schmidt et al., 2018; Vazsonyi et al., 2019; Werner et al., 2019). A key self-control related concept that is thought to be closely related to grit (specifically to its *consistency of interest* facet) is impulsiveness (Schmidt et al., 2018). Impulsiveness is defined as the tendency to perform swift actions without conscious judgment (Patton et al., 1995) and provides an interesting scenario to study the relation between grit and other self-control measures. Impulsiveness is considered to be the opposite of self-control (Duckworth, 2011), but it does not include items related to sensation seeking (Stanford et al., 2009) that are often included in self-control scales and that have been demonstrated to have a distinct nature from impulsiveness or grit (Duckworth and Kern, 2011). Although impulsiveness is conceptually related to the absence of grit, grit is theoretically thought as more complex than just a low impulsiveness pattern (Duckworth and Gross, 2014). In fact, it has been shown that the two constructs are negatively correlated (Grif et al., 2016). However, this relationship is not very strong and the extent to which grit differentiates from impulsiveness is still unknown. Importantly, on some occasions impulsiveness has been shown to predict academic performance beyond grit (Rennicks, 2018). Hence, in the present study we considered impulsiveness when examining the neural underpinnings of grit in order to deal with potential confounding effects.

Furthermore, as stated, it is also convenient to employ heterogeneous samples and take into account the demographic background of the participants when examining the neural bases of grit. This point is of importance because one concern about the existing literature on the neural substrates of grit is the similar and homogeneous samples that the few studies on the topic included, which limits the generalizability of their findings (van Zyl et al., 2021). For this reason, we selected participants of different educational and work background, two variables that have been closely (positively) related to grit (Duckworth et al., 2007; Mueller et al., 2017), and considered these variables when examining the neural underpinnings of grit.

Finally, to gain further understanding of the neural processes underlying grit, a hypotheses-driven approach should be adopted because it allows researchers to conceptually replicate previous findings. In this vein, electroencephalography (EEG) constitutes an adequate technique that provides high temporal resolution and distinct indexes of brain activity, allowing for the formulation of specific hypotheses. Hence, because grit has a strong self-regulation component and because its expression has been linked to activity in the PFC, we focused on a widely used executive control index: the frontal theta/beta ratio (TBR) (Putman et al., 2010, 2014; Angelidis et al., 2016; Syed Nasser et al., 2019). TBR is thought to reflect prefrontally-mediated attentional control and has broadly been used as a biomarker for impulsiveness-related disorders, such as the attention-deficit hyperactivity disorder (Barry et al., 2003; Snyder and Hall, 2006; Lansbergen et al., 2007; Arns et al., 2013; Zhang et al., 2017). High frontal TBR is usually interpreted as failure in exerting top-down control over the automatic processing of subcortical information. Based on previous work that implicated PFC and striatum structures in grit, we hypothesized that high grit participants would have lower frontal TBR, which might reflect better control (top–down processes) over subcortical information (reward information of the striatum). In addition, we aimed to explore whether (1) impulsiveness mediated the possible effect between TBR and grit, and (2) it had a particular TBR pattern dissociable from grit. In the same vein, we also wanted to explore whether the demographic variables of our heterogeneous sample (gender, age, education and work experience) could partially explain the possible association between TBR and grit.

Complementarily, we included a complexity-based approach to the analysis of EEG recordings by tapping into entropy (SampEn) and fractal dimension (HDF) brain indexes. These indexes, based on non-linear assumptions from system theories, are increasingly being recognized as valuable tools for capturing complex brain signals (Costa et al., 2002, 2005; Ouyang et al., 2010). While extreme patterns of complexity at rest can be indicative of pathology (Ibáñez-Molina et al., 2018), complexity indexes have been linked to effort while performing cognitive tasks (Müller et al., 2003; Stam, 2005; Sohn et al., 2010). Given the relationship between *perseverance of effort* and task values, self-efficacy, and general effort (Muenks et al., 2017; Zamarro et al., 2020), it is plausible to hypothesize that high grit participants (high *perseverance of effort* participants in particular) might show higher brain complexity levels during task performance as an indicator of task engagement (Müller et al., 2003; Stam, 2005; Sohn et al., 2010). Again, as with TBR, we explored whether impulsiveness and demographic variables affect this relationship between *perseverance of effort* and complexity indexes.

In sum, in the present study, we adopted a hypotheses-driven approach on a large sample of young adults with diverse educational backgrounds and work experiences in order to investigate the electrophysiological prints of grit. Participants completed the Grit Scale (Duckworth et al., 2007) and underwent EEG recordings at rest and while performing a learning task. Additionally, we selected a measure of impulsiveness to better understand the neural similarities and differences between grit and related self-control constructs. As mentioned, we hypothesized that high grit participants would exhibit lower frontal TBRs (both at rest and while performing a learning task), which might reflect more efficient top-down control over reward processes in comparison to their low grit counterparts. In addition, we expected that participants characterized by high levels of effort on the Grit Scale would also be characterized by greater complexity as an indicator of task engagement (Müller et al., 2003; Stam, 2005; Sohn et al., 2010). Finally, we explored whether impulsiveness and some demographic variables were modulating the effects between grit and the brain..

METHOD

Participants

A total of 120 people ($M_{age} = 23.11$, $SD_{age} = 4.19$, Range = 18–33, 69% female) completed the study in exchange for course credits (0.1 credit/40 min) or monetary reward (7 €/1 h). Participants differed in educational levels and job backgrounds. In terms of education, 17 participants had only attended secondary school, 58 were enrolled in university courses (toward

a variety of degrees), and 45 had already completed a university degree. Of these graduates, 22 were enrolled in master's courses during the time of their participation in the study. With respect to work experience, 54 participants reported that they did not have any professional experience in any field, whereas 66 participants noted that they did have professional experience (i.e., as waiters, researchers, dancers, doctors, etc.). All participants included in the experiment informed in a written health questionnaire to be free from any health issue, neurological problem, drug consumption or cognitive dysfunction diagnosis. The sample was a part of a larger study that focused on individual differences and other non-overlapping findings resulting from that study have already been reported (Aguerre et al., 2020). Participants provided their written informed consent in order to participate in the study, following the Helsinki Declaration guidelines (World Medical Association, 2013), and approval was obtained from the Ethics Committee of the University of Granada.

Materials and Procedure

Participants were tested individually in two sessions that lasted 90 and 120 min, respectively. In the first session, they were administered four questionnaires: a translated version of the Grit Scale (Duckworth and Quinn, 2009), the Spanish versions of the Barratt Impulsiveness Scale (BISS-11; Oquendo et al., 2001) and the Five Facets Mindfulness Questionnaire (Cebolla et al., 2012), as well as the Mindful Attention Awareness Scale (Soler et al., 2012). They also underwent four experimental tasks: the Cued Task-Switching Paradigm (Chevalier et al., 2015), a Stroop-like Conflict Task (Roelofs et al., 2006), the Operation Span (Turner and Engle, 1989), and the AX-Continuous Performance Task (Braver et al., 2009). The second session included MRI and EEG recordings at rest (5 mins with eyes closed) and two experimental tasks: Stop Signal (Verbruggen and Logan, 2008) and a learning task (Anderson et al., 1994), with the latter including simultaneous EEG recordings. For the present paper, we selected the grit and impulsiveness measures as well as the EEG recordings (at rest and at task). The remaining measures are to be included in a forthcoming paper addressing related but non-overlapping research questions.

Grit

We translated the original Short Grit Scale into Spanish applying a back-translation method. The scale is an 8-item self-reported questionnaire that assesses two grit factors: *perseverance of effort* (i.e., "I am diligent") and *consistency of interest* (i.e., "My interests change from year to year"). Cronbach's α of the factors of the English version is in the 0.60–0.79 range (Duckworth and Quinn, 2009). Importantly, in our sample the Cronbach's α is 0.63 for the *perseverance of effort* and 0.83 for the *consistency of interest* facets of grit.

BISS-11

This is a 30-item questionnaire that consists of three impulsiveness factors: cognitive impulsiveness (i.e., "I am happy-go-lucky"), motor impulsiveness (i.e., "I do things without thinking"), and non-planned impulsiveness (i.e., "I plan tasks carefully"). The Cronbach's α of the factors in this questionnaire is 0.83 (Oquendo et al., 2001).

Learning Task

We used an adaptation of the original selective retrieval practice task by Anderson et al. (1994) (see Valle et al., 2019) that is usually employed to investigate retrieval-induced forgetting. In this task, participants were instructed to memorize a list of words for an upcoming memory test. The task comprises 4 phases: study, practice, distraction and probe phases. In the study phase participants were instructed to memorize a list of category-exemplar pairs (54 Spanish words of nine different orthography-based categories were used; i.e., CA-Camera, CA-Casino, BA-Banana). Next, in the practice phase, they were asked to selectively retrieve half of the items of half of the categories by a given cue (i.e., CA-Cam). Then a distractor task was presented, wherein participants had to solve operational problems. In the probe phase, a recognition test was administered for all the studied items and non-studied words of different and same category. For the present work, we used the EEG signal recorded during the learning phase (5 mins). Final performance in the task was examined from the recognition index (d′) for control-baseline items (unpracticed items of unpracticed categories). Given the purpose of the present work, we focused on control-baseline items to examine overall memory performance after study rather than possible retrieval practice effects.

EEG Recording and Preprocessing

Participants were quietly seated with their eyes closed and the light off during the 5-min resting state EEG recording. On the other hand, to obtain the 5 mins of the task EEG measure, we chose the first 5 mins of the selective retrieval task. The selected recordings corresponded to the first 5 mins of the task during which participants were quietly seated with their eyes open, memorizing the category-word pairs. The EEG was recorded using 64 scalp electrodes that were mounted on an elastic cap using an extended 10–20 system. The continuous activity was recorded using Neuroscan Synamps2 amplifiers (El Paso, TX) and was first recorded using a midline electrode (halfway between Cz and CPz) as reference. Before data analyses, a high-pass filter at 1 Hz was applied and the 5-min recording was segmented into 2-s epochs with 0.5 s of overlap. Artifacts were manually removed by carefully inspecting the data using the Fieldtrip toolbox73 on Matlab (Oostenveld et al., 2011). Bad channels, with a high level of artifacts (always below 10% of the total for each participant), were visually detected and interpolated from neighboring electrodes.

Q-EEG Analyses

EEG data were analyzed using the procedures described in Prat et al. (2016). The mean log power spectrum—between 4 and 40 Hz—was calculated by first computing each epoch's power spectrum using the Fast Fourier Transform, followed by log-transforming it, and then by averaging the resulting power spectra across all epochs. To reduce spectral leakage, a Hanning window was applied to each epoch before computing the corresponding Fourier transform. The mean log power was then

separately calculated across theta (4–7.5 Hz), alpha (8–12.5 Hz), beta (13–29.5 Hz), and low-gamma (30–40 Hz) frequency bands for each channel and in each participant. The frontal region of interest (ROI) was selected following Berkovich-Ohana et al. (2012): frontal (AF3, F5, F3, F1, FC3, FC1, AF4, F2, F4, F6, FC2, FC4). The theta/beta ratio was calculated for each participant by dividing the absolute theta power in the frontal cluster by the absolute beta power in the same cluster.

Complexity Analyses

The preprocessed EEG series were used as inputs for the Sample Entropy (SampEn) and Higuchi's Fractal Dimension (HFD) analyses. To avoid effects of change in the stability of the signal, these measures were estimated using a sliding window procedure that was 2 s in length and had a 90% overlap in each time step. The estimations were obtained from the median of the resulting complexity series for each participant, electrode, and experimental condition. SampEn represents the measure of pattern randomness in the signal. The SamplEn algorithm considers the amount of dispersion after a given time lapse between a set of closely related points in the signal. High values of SampEn are then related to time series with random structures (see seminal works of Pincus and Goldberger, 1994; Richman and Moorman, 2000). The estimation of SampEn is needed to set two free parameters (m, p). In our study, these were selected in accordance with the study by Richman and Moorman (2000), which recommended values of $m = 2$ and $p = 0.10$ times the SD of the series. On the other hand, the fractal dimension was estimated using the HFD algorithm (Higuchi, 1988). FD can be considered a measure of the roughness or density of the signal as depicted in a microvolt-time plot. Simple signals resembling a straight line would have a FD close to 1, while signals that tend to fill the entire space would have a FD scoring around 2. The HFD estimator of the FD takes into account the length of the signal (L) at several scales (k). The slope of the regression model for both log transformed variables (ln[k] vs ln[L]) represents the estimated FD (i.e., Ibáñez-Molina and Iglesias-Parro, 2014). Hence, the expected values for HFD are around 1.5 because 1 constitutes the minimum (values forming a straight line) and 2 a maximum (values randomly distributed as a random cloud of points) (for a review see: Kesić and Spasić, 2016). It should be noted that HFD has successfully been applied to analyses of EEG signals in both clinical and non-clinical contexts (Kesić and Spasić, 2016; Ruiz-Padial and Ibáñez-Molina, 2018). In this experiment, we selected a kmax of 55 as an optimal parameter, given that the HFD estimation approximately reached an asymptotic value for all conditions and electrodes.

RESULTS

Data of two participants were removed from the analyses due to artifacts during EEG recordings, while nine participants missed relevant information on the BISS questionnaire. Previous to the main analyses, we ran Shapiro-Wilk tests that confirmed that our independent variables (Grit and BISS) were normally distributed. The basic descriptive statistics are presented in **Table 1**. We report the results in different sections according to the goals of the study. Thus, in the first section, we report analyses testing our hypothesis about the neural correlates of grit with separate regression models in which we included the brain indexes (frontal TBR, entropy, and FD) at rest and at task as dependent variables and grit and its facets as independent variables. In the second section, we examined the relation between grit and impulsiveness in different ways. First, we report the correlation between grit and impulsiveness and tested the possible overlap between the two traits by testing hierarchical regression models. Further, we report mediation analyses to explore whether the main relationships between grit and the neural indexes were mediated by impulsiveness. Finally, we report regression models including the brain indexes (frontal TBR, entropy, and FD) at rest and at task as dependent variables and impulsiveness as the independent variable to look into the neural pattern associated with this trait and its potential similarities with grit. In the third section, we tested whether the different demographic conditions differed in grit scores. Additionally, to further explore their effects on the relationships between grit and the neural indexes, we conducted hierarchical regression analyses with the same structure than before (frontal TBR, entropy, and FD at rest and at task as the dependent variables and grit and its facets as the independent variables) but now controlling for impulsiveness, gender, age, education and work experience. For completeness, in the last section we report correlations between the main variables and performance in the learning task.

Electrophysiological Prints of Grit

To test our hypotheses that high grit scores were related to lower frontal TBR at rest and at task and that the *perseverance of effort* facet of grit would be related with higher complexity during task, we first ran linear regression analyses over the different neural indices (frontal TBR, entropy, and FD) at rest and at task with grit and its facets as predictors (see **Table 2**). The analyses showed a negative association between frontal TBR and overall grit score and *consistency of interest* (facet of grit) while performing the task. On the other hand, the analyses of complexity measures revealed a reliable (positive) association between entropy and *perseverance of effort* while performing the learning task. These associations were not evident at rest. **Figure 1** plots the association between grit and lower frontal TBR at task (for a similar figure at rest see **Supplementary Material 1**).

Grit and Impulsiveness

As expected, there was a negative correlation between impulsiveness and grit ($r = -0.70$, $p < 0.001$; see also **Table 7**). We examined whether the associations between brain indexes and grit were influenced by impulsiveness, by performing hierarchical regression analyses for the different neural indices (frontal TBR, entropy, and FD) at rest and at task with grit and its facets as predictors and controlling for impulsiveness (see **Table 3**). These analyses indicated that both the negative relation between frontal TBR at task and *consistency of interest* and the positive association between entropy at task and *perseverance of effort* were still statistically significant. In contrast, the association between frontal TBR at task and global grit score did not reach significance after controlling for impulsiveness. Additionally,

TABLE 1 | Descriptive statistics for the main variables.

	Score	Minimum	Maximum
Grit	3.35 (0.71)	1.75	4.87
PE	14.4 (2.88)	7	20
CI	12.47 (3.7)	4	20
BISS	46.41 (13.74)	18	85
Rest			
Global q-EEG at rest	2.17 (0.31)	1.49	2.98
Theta q-EEG at rest	2.55 (0.32)	1.8	3.53
Beta q-EEG at rest	2.26 (0.34)	1.52	3.06
Entropy at rest	2.11 (0.04)	1.97	2.17
Fractal dimension at rest	1.69 (0.08)	1.25	1.84
Task			
Global q-EEG at task	2.05 (0.25)	1.41	2.69
Theta q-EEG at task	2.55 (0.23)	1.82	3.16
Beta q-EEG at task	2.09 (0.28)	1.39	2.79
Entropy at task	2.07 (0.05)	1.90	2.16
Fractal dimension at task	1.68 (0.06)	1.48	1.88
Recognition (d′) in the final stage of the selective retrieval task	1.81 (0.62)	−0.36	3

The first column refers to means and standard deviations (SD).

TABLE 2 | Linear regression analyses of grit and its two factors over neural indices (frontal TBR, entropy, and FD) during rest and during the task.

	R^2	ΔF	B	SE	β	*p*
Grit						
F TBR rest	0.00	0.05	0.11	0.48	0.02	0.82
Entropy rest	0.00	0.02	−0.78	1.72	−0.04	0.65
FD Rest	0.00	0.00	0.01	0.79	0.00	0.99
F TBR task	0.04	4.67	−0.85	0.39	−0.19	0.03
Entropy task	0.02	2.81	2.4	1.43	0.15	0.09
FD task	0.01	1.1	1.16	1.1	0.1	0.29
PE of Grit						
F TBR rest	0.00	0.17	0.81	1.96	0.04	0.68
Entropy rest	0.01	1.33	−8.08	7.01	−0.11	0.25
FD rest	0.01	1.03	−3.22	3.17	−0.09	0.31
F TBR task	0.00	0.58	−1.23	1.62	−0.07	0.45
Entropy task	0.04	5.11	12.96	5.73	0.21	0.026
FD task	0.01	1.03	4.55	4.48	0.09	0.31
CI of Grit						
F TBR rest	0.00	0.00	−0.14	−2.53	−0.01	0.96
Entropy rest	0.00	0.01	0.99	9.08	0.01	0.91
FD rest	0.01	0.69	3.41	4.09	0.08	0.41
F TBR task	0.06	7.13	−5.42	2.03	−0.24	0.009
Entropy task	0.01	0.69	6.25	7.53	0.08	0.41
FD task	0.00	0.49	4.05	5.78	0.07	0.48

we performed a mediation analysis to also examine whether the association between grit and the brain indexes was mediated by impulsiveness. These analyses indicated that impulsiveness was not a mediating factor (see **Table 4**). Finally, the regression model over the neural indexes with impulsiveness as the predictor failed to show any significant relationship (see **Table 5**).

Grit and Demographics

Because grit has been previously related to demographic variables such as education (Duckworth et al., 2007) and work experience (Mueller et al., 2017) among others, we examined first whether such variables were linked to grit scores, and then if they could be driving the relation between grit and the neural indexes.

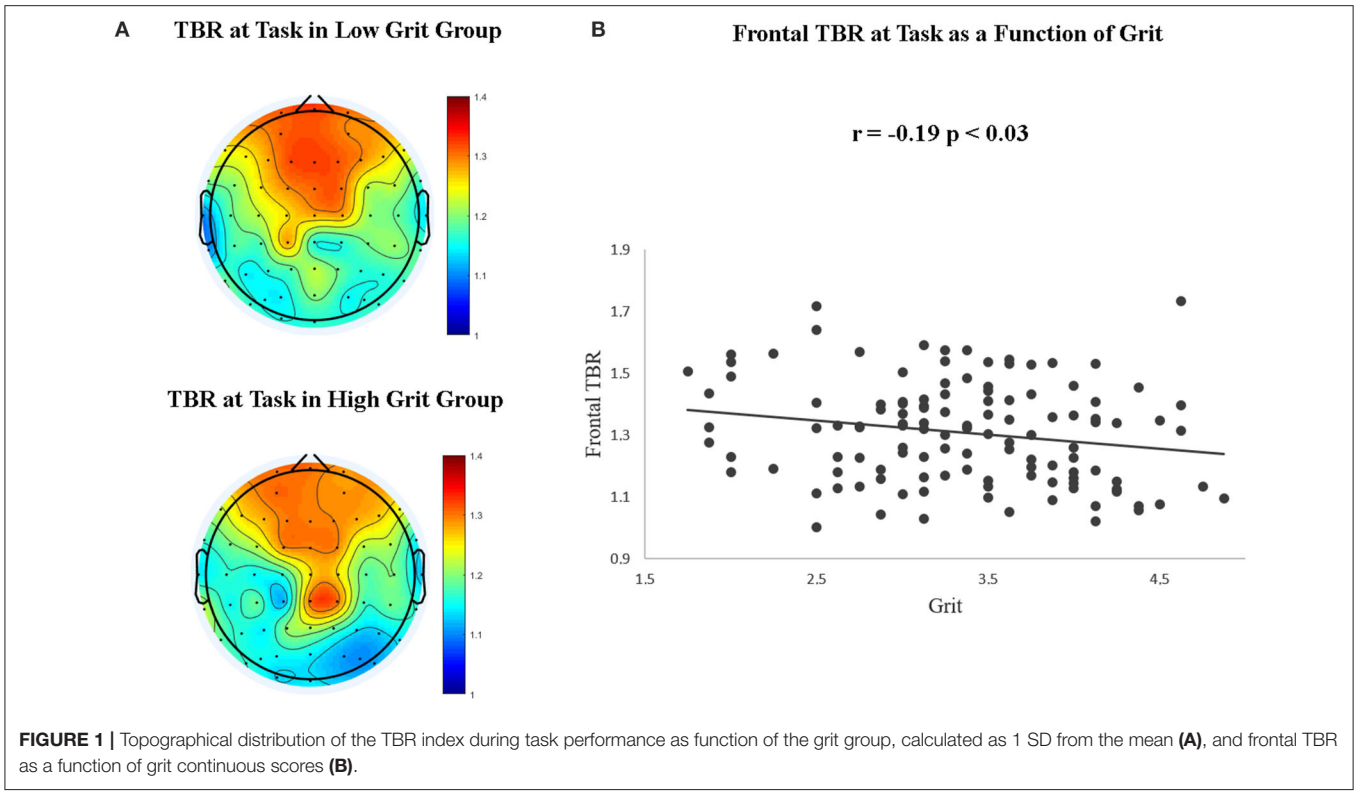

FIGURE 1 | Topographical distribution of the TBR index during task performance as function of the grit group, calculated as 1 SD from the mean **(A)**, and frontal TBR as a function of grit continuous scores **(B)**.

TABLE 3 | Hierarchical regression analyses of grit and its two factors over neural indices (frontal TBR, entropy, and FD) during rest and during the task controlling for impulsiveness.

	R^2	ΔF	B	SE	β	*p*
Grit						
F TBR rest	0.00	0.01	0.00	0.02	0.01	0.9
Entropy rest	0.00	0.49	−0.00	0.00	−0.07	0.49
FD rest	0.00	0.00	0.00	0.01	0.01	0.95
F TBR task	0.03	3.39	−0.04	0.02	−0.17	0.07
Entropy task	0.01	1.28	0.01	0.01	0.11	0.26
FD task	0.01	1.57	0.01	0.01	0.12	0.21
PE of Grit						
F TBR rest	0.00	0.6	0.00	0.00	0.02	0.8
Entropy rest	0.01	1.57	−0.00	0.00	−0.1	0.29
FD rest	0.01	0.89	−0.00	0.00	−0.9	0.35
F TBR task	0.00	0.31	−0.00	0.00	−0.05	0.58
Entropy task	0.04	4.62	0.00	0.00	0.2	0.03
FD task	0.02	2.17	0.00	0.00	0.14	0.14
CI of grit						
F TBR rest	0.00	0.96	0.00	0.00	−0.00	0.96
Entropy rest	0.00	0.06	0.00	0.00	−0.02	0.81
FD rest	0.01	0.66	0.00	0.00	0.08	0.42
F TBR task	0.05	5.9	−0.01	0.00	−0.23	0.02
Entropy task	0.00	0.01	0.00	0.00	0.01	0.9
FD task	0.01	0.42	0.00	0.00	0.08	0.42

To answer this question, we performed Pearson correlations between age and education and grit, and then *t* tests comparing men ($N = 37$) and women ($N = 81$) and people with work experience ($N = 66$) and without ($N = 54$) in their grit scores, after checking that grit was normally distributed in all groups. Results showed no association of grit with age ($r = 0.14$, $p = 0.12$),

TABLE 4 | Mediation analyses of consistency of interest and frontal TBR at task with impulsiveness as a mediator; and perseverance of effort and entropy at task with impulsiveness as a mediator.

	Estimate	SE	z-value	*p*
CI of Grit				
Direct effects				
Consistency of Interest → Task_F_TBR	−0.01	0.00	−2.52	0.01
Indirect effects				
Consistency of Interest → BIS → Task_F_TBR	0.00	0.0	0.82	0.41
Total effects				
Consistency of Interest → Task_F_TBR	−0.01	0.00	−2.69	0.01
PE of Grit				
Direct effects				
Perseverance of effort → EN_Task	0.00	0.00	2.27	0.02
Indirect effects				
Perseverance of effort → BIS → EN_Task	−6.13e −4	9.54e −4	−0.64	0.52
Total effects				
Perseverance of effort → EN_Task	0.00	0.00	2.28	0.02

TABLE 5 | Linear regression analyses of impulsiveness (BISS) over neural indices (frontal TBR, entropy, and FD) during rest and during the task.

	R^2	ΔF	*B*	*SE*	β	*p*
BISS						
F TBR rest	0.00	0.00	0.00	0.00	0.03	0.75
Entropy rest	0.02	0.02	0.00	0.00	0.14	0.15
FD rest	0.02	2.35	−0.00	0.00	−0.15	0.13
F TBR task	0.01	1.06	0.00	0.00	0.1	0.30
Entropy task	0.00	0.3	0.00	0.00	−0.05	0.58
FD task	0.00	0.46	0.00	0.00	−0.07	0.50

education ($r = -0.01$, $p = 0.94$), or gender [$t_{(106.66)} = -0.9$, $p = 0.56$; $M_{\text{Males}} = 3.16$; $M_{\text{Females}} = 3.51$]. However, people with work experience showed higher grit scores than people without work experience [$t_{(106.66)} = 2.68$, $p = 0.01$; $M_{\text{Experience}} = 3.51$; $M_{\text{Non-experience}} = 3.16$]. Next, we ran separate hierarchical regression analyses over the different neural indices (frontal TBR, entropy, and FD) at rest and at task with grit and its facets as predictors, now controlling for impulsiveness, gender, age and education and work experience (see **Table 6**). The results of these analyses showed that the negative relation between frontal TBR at task and *consistency of interest* and the positive association between entropy at task and *perseverance of effort* remained reliable.

Task Performance

Finally, we performed Pearson correlation analyses between the neural indexes (TBR, entropy, FD) at task and memory performance (an index of sensitivity at recognition: d′) in the baseline condition of the selective retrieval task. These correlations did not reach statistical significance (see **Table 7**). We also correlated personality traits (grit and its facets, and impulsiveness) with performance, but these correlations also failed to reach statistical significance (see **Table 7**).

DISCUSSION

In the present study, we aimed to explore the electrophysiological prints of grit during rest and while performing a learning task. One important gap in the grit literature relates to its biological and neural substrates as only a few studies have been carried out to determine its neural mechanisms. Interestingly, despite the fact that there is little research in this area, the results converge to implicate the PFC and striatum, regions systematically associated with executive-control and motivation processes, in the expression of grit. Considering these precedents, we selected an EEG index of executive control—the frontal theta/beta ratio (TBR)—to examine its potential relationship with grit at rest and while engaged in a (learning) task. Furthermore, we selected two complexity indexes—entropy (SampEn) and fractal dimension (HDF)—to explore the possible increase in the dimensional complexity of brain activity during task performance as a function of effort employed by gritty participants. Finally, we also looked into the association between the above-mentioned EEG indexes and impulsiveness in order to determine the similarities and differences of the neural activity underlying grit and impulsiveness. Our results revealed that while there were no differences at rest as a function of grit, neural differences emerged while participants were engaged in the task. Higher

TABLE 6 | Hierarchical regression analyses of grit and its two factors over neural indices (frontal TBR, entropy, and FD) during rest and during the task controlling for impulsiveness, gender, age, education and work experience.

	R^2	ΔF	*B*	SE	β	*p*
Grit						
F TBR rest	0.00	0.08	0.00	0.02	0.03	0.78
Entropy rest	0.00	0.34	−0.00	0.00	−0.06	0.56
FD rest	0.00	0.01	0.00	−0.00	0.00	0.98
F TBR task	0.04	3.67	−0.03	0.02	−0.14	0.15
Entropy task	0.01	1.44	0.01	0.01	0.12	0.23
FD task	0.02	1.64	0.01	0.01	0.12	0.2
PE of Grit						
F TBR rest	0.00	0.42	0.00	0.00	0.06	0.52
Entropy rest	0.01	0.96	−0.00	0.00	0.09	0.33
FD rest	0.00	1.08	−0.00	0.00	−0.1	0.3
F TBR task	0.00	0.00	0.00	0.01	0.02	0.98
Entropy task	0.05	5.48	0.00	0.00	0.22	0.02
FD task	0.02	2.13	0.00	0.00	0.14	0.15
CI of Grit						
F TBR rest	0.00	0.00	0.00	0.00	0.00	0.97
Entropy rest	0.00	0.02	0.00	0.00	0.01	0.9
FD rest	0.00	0.58	0.00	0.00	0.07	0.45
F TBR task	0.05	6.32	−0.01	0.00	−0.23	0.01
Entropy task	0.01	0.67	0.00	0.00	0.08	0.42
FD task	0.00	0.58	0.00	0.00	0.07	0.45

TABLE 7 | Pearson correlations of the main brain variables, the Grit and BISS scores and performance in the task.

	Grit	PE	CI	BISS	Recognition (d')
BISS	−0.7***	−0.51***	−0.67***		
Recognition (d') in the final stage of the selective retrieval task	0.05	−0.07	0.12	−0.17	
Rest frontal TBR	0.02	0.04	−0.00	−0.04	0.01
Task frontal TBR	−0.19*	−0.07	−0.24**	0.08	−0.04
Entropy at rest	−0.04	−0.11	0.01	0.12	−0.09
Entropy at task	0.15	0.21*	0.08	−0.06	−0.13
Fract. Dim. at rest	−0.00	−0.09	0.08	−0.17	−0.07
Fract. Dim. at task	0.1	0.09	0.06	−0.07	−0.05

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Asterisks represent statistically significant correlations after controlling for multiple comparisons with the Banjamini-Hochberg method with false discovery rate at 0.25 (Benjamini and Hochberg, 1995).*

overall grit and higher scores in the *consistency of interest* facet of grit were associated with lower frontal TBRs during the learning task. In addition, we observed an association between *perseverance of effort* and entropy at task, indicating that the higher the facet of grit scores are, the higher the complexity of the EEG recording is. Importantly, impulsiveness (as measured *via* the BISS) did not mediate any of the previous associations neither it was found to correlate with any of the neural indexes at rest or while performing the task. Finally, controlling for impulsiveness and demographic factors (age, gender, education and work experience) reduced the associations with overall grit scores that, however, remained statistically significant at the facet level, which highlights the relevance of these facets of grit as predictors.

The link between frontal TBR and grit during task performance is in line with results from previous studies, supporting the implication of prefrontally-mediated executive control in the grit trait (Myers et al., 2016; Wang et al., 2017, 2018). However, it is remarkable that such an association was not present at rest in our sample. TBR is an EEG index of executive control that is widely used (Arns et al., 2013; Angelidis et al., 2016; Syed Nasser et al., 2019). The ratio of theta band power (4–8 Hz) and beta band power (15–30 Hz) is thought to reflect cortical-subcortical interactions (Schutter and Van Honk, 2005; Arns et al., 2013), so that increased frontal TBR might result from a greater need for top-down control over subcortical structures (i.e., due to the triggering of inappropriate automatic responses). A large body of research suggests that

mid-frontally generated theta activity is linked to activity in the anterior cingulate cortex (ACC) (i.e., Asada et al., 1999; Scheeringa et al., 2008), which is associated with more difficult situations or when reward is less than expected (Schutte et al., 2017). On the other hand, beta oscillatory activity seems to reflect active inhibitory processes involved in maintaining the current cognitive state (Engel and Fries, 2010) and is thought to be in charge of transmitting "fast-motivational signals" to downstream brain structures (Marco-Pallarés et al., 2015). Because this view aligns with the long-term-maintained motivation of gritty people, TBR could be thought of as a marker of prefrontally-mediated executive control over reward processes that are essential to grit. Such a relationship would be similar to the one reported with other subcortical processes (i.e., emotional processing, see Putman et al., 2014), although we recognize that future studies (i.e., by analyzing ERPs that are sensitive to individual differences in executive control) should more precisely determine to what extent this interpretation of the association between TBR and grit is appropriate. Interestingly, it was the *consistency of interest* facet of grit that was related to decreased frontal TBR at task, which is in line with the notion that this brain index is particularly related to the control of reward or intrinsic motivation (Putman et al., 2014). Long-term consistency of interest has been associated with more attention allocation to the current context (Aguerre et al., under review)[1], which might allow gritty people to be more "on-task" and to avoid reward override and mind-wandering (van Son et al., 2018, 2019).

Among other results, Wang et al. (2018) found smaller gray matter volume in the left dorsolateral PFC, a region involved in self-regulation, in participants scoring high in grit. According to these authors, a reduction in gray matter would result from optimal synaptic pruning and myelination during development, which would lead to greater efficiency in corresponding psychological process (Blakemore and Robbins, 2012). Nevertheless, this finding is blind in relation to the direction of the association between grit and synaptic pruning so that grit could be either an antecedent or a consequence of greater synaptic pruning. Additionally, Wang et al. (2017) found a negative association between spontaneous brain activity in the right dorsomedial PFC and grit, which may also indicate a more efficient use of a relevant neural hub for self-regulation. Importantly, these associations were found at rest, while our study showed that differences associated with grit were particularly relevant during task performance. However, contrary to our expectations, we did not observe decreased frontal TBR in gritty participants at rest (when, in principle, there is no need for executive control). Instead, gritty participants (in their *consistency of interest* facet) exhibited lower TBR during the learning task when top-down control processes may be more crucial to keep themselves motivated. Hence, our results can also be interpreted in terms of more efficient executive functioning. When taken as a whole, our results are theoretically convergent with previous findings.

With respect to complexity measures, our results reveal that increased entropy during task performance is linked to a higher *perseverance of effort* facet of grit, but no evidence of association between the fractal dimension index and grit emerged. Entropy is a measure widely used to study self-organization and pattern formation in the complex neuronal networks of the brain (Stam, 2005). Complexity has been shown to increase during task performance (Stam et al., 1996; Bizas et al., 1999; Lamberts, 2000; Micheloyannis et al., 2002; Müller et al., 2003) as a function of the task complexity (Jie et al., 2014). Brain complexity measures have also been linked to a higher number of simultaneously activated cell assemblies, understood as representational units of thoughts and ideas (Mölle et al., 1999). Considering this evidence from previous studies, higher entropy while performing the learning task might be indicative of more effort and engagement in the task, leading to an increase in the number of activated representational units (and their corresponding cell assemblies) while memorizing a list of words. This would also fit with the idea that gritty individuals show higher general sustained attention during task performance (Kalia et al., 2018) and give support to results from previous studies using different techniques that also found *perseverance of effort* to be linked to physiological responses of effort during task (Silvia et al., 2013). In any case, we found this relationship with only one of the complexity indexes (entropy), which may be a result of the sensitivity of the measure or of these distinct measures tapping into different aspects of brain complexity (Raghavendra and Dutt, 2010; Kreuzer et al., 2014). The absence of a relationship between EEG complexity measures at rest and grit is in line with the notion that, while there probably is a stable print of grit at rest as reported by previous research (Myers et al., 2016; Nemmi et al., 2016; Wang et al., 2018), gritty people also exhibit a different and unique functional pattern that is observed only while they are engaged in a task.

On the other hand, the fact that impulsiveness did not mediate any of the associations between grit and neural indexes and that impulsiveness failed to show any relation with such indexes is also remarkable. Even when both grit and impulsiveness relate to self-regulation (Duckworth et al., 2007; Duckworth, 2011) (and they do correlate with one another, see **Table 7**), they exhibit a different neural pattern so reinforcing the view that they are separable constructs (Duckworth et al., 2007). On the other hand, our results concerning impulsiveness suggest that in healthy participants this trait may not involve the executive control-related neural differences that psychopathological conditions (i.e., attention-deficit hyperactivity disorder) may bring (Arns et al., 2013; Zhang et al., 2017). While higher TBR has frequently been found in impulsivity disorders, its relationship with the impulsiveness trait in healthy participants is much less clear (Lansbergen et al., 2007; Threadgill and Gable, 2018). It has been proposed that ADHD may represent the extreme end of the impulsivity continuum, characterized by increased frontal TBR, while high impulsiveness in healthy adults would involve more middle-placed positions of the continuum, characterized by average frontal TBRs (Lansbergen et al., 2007). Finally, the fact that controlling for impulsiveness and the demographic variables made global grit effects disappear but not the effects of the two facets of grit that remained significantly linked to distinct brain indexes, lends support to the different nature of the facets of grit (Credé, 2018). While this dissociation would seem to fit well with the hypotheses of the present study,

[1]Aguerre, N. V., Gómez-Ariza, C. J. and Bajo, M. T. (under review). The relative role of executive control and personality traits in grit.

consistency of interest correlated with a brain activity index that others have interpreted as a marker of enhanced control over reward processes (Putman et al., 2014), and *perseverance of effort* correlated with an index thought to reflect effort during the task (Stam, 2005), which is in line with the results of previous studies that used different techniques (Silvia et al., 2013), this pattern also points to the relevance of incorporating a facet level of analyses in future studies.

While consistent with the association between executive control, task engagement, and grit trait, the present findings should be taken with caution because this is one of the very first studies reporting on the electrophysiological signatures of grit. In addition, there are some considerations for future studies. First, although the TBR is an index with a relatively long history (Arns et al., 2013), its interpretation in terms of interactions between cortical and subcortical brain processes related to grit requires more research. Second, the cross-sectional design used here does not allow us to determine the direction of the association between brain indexes during task and grit. Future studies that employ longitudinal/experimental designs could help address this issue. Third, we only used self-reported measures of the traits of interest. One intriguing possibility for future studies would be to add multiple methods to assess these traits. Convergence of findings with self-reported and performance measures would be of special relevance. In this sense, future studies could add "on-task checks" and "effort checks" to experimental tasks. This could help to determine whether it is (subjective) effort that is exerted during the task and not only the general *perseverance of effort* of participants, which positively relates to entropy at task.

In sum, the present study is one of the first to unveil the electrophysiological prints of grit. Our results indicate that gritty people have a different neural signature during task, mediated by lower frontal TBR and higher entropy, which may reflect a more efficient involvement in the task. It should be noted that these results that were obtained from a large sample of young individuals with different educational and life backgrounds converge with those obtained in studies that involved children and adolescents, which goes a step further toward the generalization of findings regarding brain mechanisms of grit. While there is still a long journey ahead in order to fully understand the neural mechanisms of grit, continuing in this direction will deepen our understanding of the trait and, more importantly, potentially provide us with the empirical evidence needed to develop targeted programs and strategies to improve grit.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Granada. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

This work constitutes a portion of the first author's (NA) doctoral dissertation. NA, CG-A, and MB developed the concept of the study together. NA contributed to data collection, data analyses, and manuscript writing. AI-M supervised the process of data analyses and contributed to manuscript writing. MB and CG-A supervised the process of accomplishing the study and wrote, reviewed, and approved the final version of the manuscript. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.730172/full#supplementary-material

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Importance of Maternal Persistence in Young Children's Persistence

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Persistence of a distant goal is an important personality trait that determines academic and social success. Recent studies have shown that individual differences in persistence involve both genetic and environmental factors; however, these studies have not examined the role of maternal factors on a young children's persistence. The present study examined whether mothers' persistence is associated with persistence in children aged 3–6 years. In addition, the associations between mothers' persistence/parenting style and children's self-control/social development (prosocial behaviors and difficulties) were examined. Our results showed that maternal persistence is essential for the child's persistence. Children's self-control and social development were also associated with the mothers' persistence and parenting style. Our findings suggest that a young child's persistence may develop under the influence of a familiar adult (i.e., mother) and characterizes their social development, highlighting the importance of persistence in parenting.

Keywords: persistence, parenting styles, self-control, social development, preschooler

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INTRODUCTION

Persistence is the tendency to pursue long-term challenging goals. Persistence of a distant goal is not only a powerful measure of the classroom in children's engagement and a robust predictor of academic achievement but also a social success (Duckworth et al., 2007; Duckworth and Gross, 2014; Eskreis-Winkler et al., 2014; Li et al., 2018). However, the persistence of a goal differs substantially between individuals that may arise from both genes and environment (Rimfeld et al., 2016).

A few studies have shown that parents' nurturing attitudes are also significant for the children's persistence. Banerjee and Tamis-LeMonda (2007) found that strong persistence in children is developed between 6 and 14 months and that in low-income mother–infant dyads, infants with strong persistence in the exploration of their toys were raised by mothers who were sensitive and responsive to their infants' emotions and behaviors. In a novel study, adults' efforts promoted attempts to achieve the goal of children at 15 months (Leonard et al., 2017). It was also revealed that the amount of praise from caregivers for their efforts, such as "good job," predicted 18-month-old children's persistence (Lucca et al., 2019).

Although these findings have suggested that caregivers serve as role models for children (Bandura, 1977, 1986), no studies have directly examined the relationship between parents' own persistence (not the persistence response for childcare) and children's persistence.

Moreover, Lucca and Sommerville (2018) only argued that parenting has an impact on children's persistence, while parents' personality is associated with the development of adolescent personality traits (Schofield et al., 2012). Therefore, the persistence of the caregiver (particularly the mother who spends a lot of time with the child compared to father, at least in Japan) is likely to determine the degree of the child's persistence.

Previous studies have shown that supportive and responsive parenting reduces children's behavioral problems and promotes prosocial behavior and self-control (the ability to control one's behavior when exposed to temptations; Baumrind, 1971, 1991; Bornstein, 2006; Duckworth and Gross, 2014). At the same time, responsive and supportive parenting is a persevering task, especially in parenting young children. Therefore, parental persistence is likely to be associated with not only children's persistence but also their self-control and social development. In the meta-analysis, the results of the relationship between responsiveness and self-control in parenting varied from study to study. One study found that the association between responsiveness and self-regulation (e.g., compliance, inhibition, and emotion regulation) was not found among adolescents aged 10–22 years (Li et al., 2019), while another study found no association between responsiveness and self-regulation (e.g., compliance, inhibition, and emotion regulation) among preschoolers (Karreman et al., 2006). However, it remains unclear whether the persistence of parents is associated with both children's self-control and social development, such as behavioral difficulties and prosocial behaviors.

The present study aimed to clarify maternal persistence and parenting style as important environmental factors in the young children's persistence, self-control, behavioral difficulties, and prosocial behaviors. We addressed the following hypotheses: First, maternal persistence and parenting style were the key environmental factors in the child persistence. That is, the mother's persistence was associated with the child's (3–6 years old) persistence because beyond the mother's imitation, as the mother's persistent behavior of the goal and responsive teaching lead to promote the child's persistence (Banerjee and Tamis-LeMonda, 2007; Leonard et al., 2017). In the present study, persistence was measured using the short grit scale (Grit-S) (Duckworth and Quinn, 2009), which has been used to measure persistence in many studies in adults and children and has confirmed validity. Second, as the mother's parenting style was associated with the child's behavioral traits (Baumrind, 1991; Weiss and Schwarz, 1996; Alizadeh et al., 2011), parenting factors (mother's persistence and parenting style) also were associated with the child's self-control, behavioral difficulties, and prosocial behaviors. In the current study, we used an effortful control assessment to measure the temperamental aspect of self-control (Rothbart et al., 2001).

MATERIALS AND METHODS

Participants

Through a web survey, a total of 107 Japanese mothers who lived with at least one child participated in our study (mean age = 35.0, range = 25.2–45.0 years, *SD* = 4.7). They were recruited by a company specializing in surveys (100-person surveys). If the mother has more than one child, we asked her to answer for the oldest child. The participants responded to the questionnaire items for themselves and their term-born children (mean age = 4.4, range = 3.0–6.2 years, *SD* = 0.8, 51 males and 56 females). No participant reported having a history of psychiatric or neurological conditions. Socioeconomic status (SES) was determined by family income and maternal education. Family income was rated on a 12-point scale, and maternal education was rated on a 5-point scale. We separately converted the two scores to z-scores and averaged them to create a total SES score (Moriguchi and Shinohara, 2019). The present study was conducted according to the guidelines provided in the Declaration of Helsinki, and written informed consent was obtained from the parents of each child before any assessment or data collection.

Measures

Mother's and Child's Persistence

The child's and mother's persistence was measured using the short grit scale (Grit-S) (Duckworth and Quinn, 2009), which has eight items and consists of subscales, including perseverance of effort and consistency of interest. The sum of both was used as the score for the overall grit. We used the Japanese version of the Grit-S scale, whose factor structure, validity, and reliability have been confirmed, with a 5-point Likert-type scale ranging from 1 (not at all like me) to 5 (very much like me) (Nishikawa et al., 2015), with total scores of perseverance of effort ranging from 4 to 20 (higher score indicates greater perseverance of effort), total scores of consistency of interest ranging from 4 to 20 (higher score indicates greater consistency of interest), and total scores of overall grit ranging from 8 to 40 (higher score indicates greater overall grit).

Mother's Parenting Style

We used a parenting style questionnaire based on Baumrind's concept of parenting styles (i.e., responsiveness and control) (Baumrind, 1967; Robinson et al., 1995). The Japanese version of the questionnaire consists of 13 items that loaded responsiveness (eight items) and control (five items) factors and has been validated in a previous study (Nakamichi, 2013). A 4-point Likert-type scale ranging from 1 (never) to 4 (always) was provided for each item, with total scores of responsiveness ranging from 8 to 32 (higher score indicates stronger tendency of mother's responsiveness) and total scores of control ranging from 5 to 20 (higher score indicates stronger tendency of mother's control).

Child's Self-Control

The present study used the Japanese short version of two subscales (Yamagata et al., 2006), inhibitory control and attentional focusing, which were representative of effortful control, in the Children's Behavior Questionnaire (CBQ; Rothbart et al., 2001). Inhibitory control consisted of six items that measure the ability to inhibit inappropriate behavior, and

attentional focusing consisted of six items that measure the tendency to maintain attention to the task. The sum of both is used as the score for the total effortful control. A 5-point Likert-type scale ranging from 1 (not true) to 5 (true) was provided for each item, with total scores of inhibitory control ranging from 6 to 30 (higher score indicates greater inhibitory control), total scores of attentional focusing ranging from 6 to 30 (higher score indicates greater attentional focusing), and total scores of total effortful control ranging from 12 to 60 (higher score indicates greater total effortful control).

Child's Social Development

Children's emotional and behavioral problems were assessed using the Japanese version of the Strengths and Difficulties Questionnaire (SDQ) (Matsuishi et al., 2008), which was derived from the original version (Goodman, 1997). The SDQ is a 25-item questionnaire that measures behavioral strengths and difficulties of children and assesses five subscales (hyperactivity, peer relationship problems, conduct problems, emotional problems, and prosocial behaviors), each of which consists of five items. The total difficulty score can be calculated by summing the scores of the four subscales that measure children's weaknesses. A 3-point Likert-type scale ranging from 0 (not true) to 2 (certainly true) was provided for each item, with total scores of total difficulty ranging from 0 to 40 (higher score indicates more behavioral problems) and total scores of prosocial behavior ranging from 0 to 10 (higher score indicates more prosocial behavior).

DATA ANALYSIS

To examine factors associated with the persistence in young children, the relationships among all the variable (children's age, SES, and Grit-S [child and mother], parenting style, effortful control, and SDQ scores) were tested using Spearman's rank correlation analysis, a statistical method for describing correlations in ordinal scales. We then conducted hierarchical multiple linear regression analyses to investigate the independent contributions of mothers' grit (overall grit, perseverance of effort, and consistency of interest) and parenting style (responsiveness and control) to children's grit (overall grit, perseverance of effort, and consistency of interest), effortful control (total effortful control, inhibition control, and attention focusing), and prosocial behavior and total difficulty score.

RESULTS

Correlation Analysis Among Variables

The results of the correlation analysis are presented in **Table 1**. We found significant moderate positive correlations between young children and mothers for each score of Grit-S (i.e., overall grit, perseverance of effort, and consistency of interest) ($\rho[105] = 0.31$, $p = 0.001$; $\rho[105] = 0.43$, $p = 0.001$; $\rho[105] = 0.29$, $p = 0.003$). Furthermore, mothers' responsiveness was significantly positively correlated with children's overall grit and perseverance of effort ($\rho[105] = 0.23$, $p = 0.019$; $\rho[105] = 0.30$, $p = 0.002$). Child grit was mostly significantly correlated with effortful control (see **Table 1**). Mothers' overall grit and perseverance of effort were positively correlated with total difference scores ($\rho[105] = 0.22$, $p = 0.025$; $\rho[105] = 0.21$, $p = 0.034$). Mothers' overall grit, perseverance of effort, and consistency of interest were negatively correlated with the total difficulty score ($\rho[105] = -0.36$, $p < 0.001$; $\rho[105] = -0.24$, $p = 0.014$; $\rho[105] = -0.36$, $p < 0.001$).

Mother's Persistence and Parenting Style Are Associated With Child's Persistence

To analyze the independent contributions of mothers' persistence and parenting style to children's persistence, hierarchical multiple linear regression analyses with the stepwise method were performed (**Table 2**). The control variables to be entered into the models were the child's age and SES.

Mothers' overall grit was significantly associated with their children's overall grit ($\beta = 0.42$, $p < 0.001$). The models explained 18% (R^2), $F_{(3,106)} = 7.70$, $p < 0.001$. Mothers' perseverance of effort was significantly associated with their children's perseverance of effort ($\beta = 0.44$, $p < 0.001$). The models explained 20% (R^2), $F_{(3,106)} = 8.39$, $p < 0.001$. Mothers' consistency of interest and control were significantly associated with their children's consistency of interest ($\beta = 0.34$, $p < 0.001$; $\beta = -0.22$, $p = 0.020$). The models explained 20% (R^2), $F_{(4,106)} = 4.33$, $p = 0.003$.

Mother's Persistence and Parenting Style Are Associated With Child's Self-Control, Prosocial Behavior, and Difficulties

To analyze the independent contributions of mothers' persistence and parenting style to children's self-control, prosocial behavior, and total difficulty score, we performed hierarchical multiple linear regression analyses using the stepwise method (**Table 3**). The children's age and SES were entered as control variables.

Mothers' overall grit, responsiveness, and child's age were significantly related to children's total effortful control ($\beta = 0.46$, $p < 0.001$; $\beta = 0.42$, $p < 0.001$; $\beta = 0.17$, $p = 0.025$). The models explained 42% (R^2), $F_{(4,106)} = 18.21$, $p < 0.001$. Mothers' consistency of interest and responsiveness and children's age significantly predicted children's inhibition control ($\beta = 0.23$, $p = 0.006$; $\beta = 0.46$, $p < 0.001$; $\beta = 0.19$, $p = 0.022$). The models explained 35% (R^2), $F_{(4,106)} = 13.97$, $p < 0.001$. Mothers' overall grit and responsiveness significantly predicted children's attention focusing ($\beta = 0.37$, $p < 0.001$; $\beta = 0.29$, $p = 0.001$). The models explained 32% (R^2), $F_{(4,106)} = 11.76$, $p < 0.001$.

Mothers' responsiveness was significantly related to children's prosocial behavior scores ($\beta = 0.20$, $p = 0.003$). The models explained 10% (R^2), $F_{(3,106)} = 3.82$, $p = 0.015$. Mothers' responsiveness and consistency of interest significantly predicted children's total difficulty scores ($\beta = -0.34$, $p < 0.001$; $\beta = -0.30$, $p = 0.001$). The models explained 28% (R^2), $F_{(4,106)} = 9.68$, $p < 0.001$.

TABLE 1 | Correlation among variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Demografic information															
1. Age	–	0.03	−0.05	0.12	−0.12	−0.08	−0.01	−0.05	0.01	−0.12	0.13	0.11	0.11	−0.12	−0.04
2. SES		–	0.07	0.10	0.05	0.06	0.15	0.06	0.08	0.00	0.15	0.11	0.14	0.06	−0.09
Mother's grit															
3. Overall grit			–	0.76**	0.84**	0.33**	0.20*	0.31**	0.30**	0.24*	0.46**	0.37**	0.43**	0.22*	−0.36**
4. Perseverance of effort				–	0.33**	0.26**	0.12	0.32**	0.43**	0.09	0.39**	0.28**	0.39**	0.21*	−0.24*
5. Consistency of interest					–	0.27**	0.16+	0.20*	0.08	0.29**	0.34**	0.32**	0.28**	0.14	−0.36**
Mother's parenting style															
6. Responsiveness						–	0.35**	0.23*	0.30**	0.03	0.53**	0.49**	0.45**	0.32**	−0.38**
7. Control							–	0.05	0.19*	−0.13	0.24*	0.24*	0.18+	0.22*	−0.26**
Child's grit															
8. Overall grit								–	0.78**	0.70**	0.44**	0.28**	0.51**	0.09	−0.34**
9. Perseverance of effort									–	0.16	0.41**	0.27**	0.46**	0.20*	−0.35**
10. Consistency of interest										–	0.27**	0.16	0.33**	−0.05	−0.18+
Child's effortful control															
11. Total effortful control											–	0.88**	0.87**	0.31**	−0.49**
12. Inhibition control												–	0.55**	0.24*	−0.43**
13. Attention focusing													–	0.30**	−0.44**
Child's strength and difficulties															
14. Prosocial behavior														–	−0.31**
15. Total difficulties score															–

$^{**}p < 0.01$; $^{*}p < 0.05$; $^{+}p < 0.10$.

TABLE 2 | Results of hierarchical multiple linear regression analyses predicting child's persistence from mother's persistence and parenting style.

Valuable	β	*t*-value	*p*-value	95% Confidence interval	
				Low bound	Upper bound
Child's overall grit: $R^2 = 0.18$					
Age	−0.12	−1.32	0.190	−0.004	0.001
SES	0.02	0.22	0.826	−0.884	1.104
Mother's overall grit	0.42	4.67	<0.001	0.328	0.813
Child's perseverance of effort: $R^2 = 0.20$					
Age	−0.06	−0.66	0.513	−0.002	0.001
SES	0.31	0.31	0.761	−0.574	0.783
Mother's perseverance of effort	4.95	4.95	<0.001	0.248	0.579
Child's consistency of interest: $R^2 = 0.15$					
Age	−0.05	−0.50	0.621	−0.002	0.001
SES	0.05	0.51	0.609	−0.462	0.785
Mother's consistency of interests	0.34	3.61	<0.001	0.119	0.409
Mother's control	−0.22	−2.37	0.020	−0.572	−0.050

DISCUSSION

We first demonstrated that the degree of the mother's persistence (overall grit and perseverance of effort) was related to the degree of the child's persistence (overall grit and perseverance of effort). In addition, the mother's high consistency of interest (part of grit scale) and low control (part of parental style) were associated with the child's high consistency of interest. Second, the mother's persistence and responsiveness to the child were associated with the child's self-control, behavioral difficulties, and prosocial behaviors.

Our findings have revealed mothers' persistence is an important factor in children's persistence and possible implications for understanding the developmental mechanisms contributing to the persistence in children aged 3–6 years. According to the social learning theory, observational learning is crucial (Bandura, 1977, 1986). Persistent mothers showed persistent behavior not only in caring for their children but also in every aspect of their daily lives, and their children routinely observed this behavior from their parents. Therefore, through observational learning, it is possible for children to learn and develop persistent behavior from their mothers' behaviors.

Importantly, we found that not only the mother's high consistency of interest but also the mother's low control was associated with the child's persistence (high consistency of interest). Previous studies have shown that children and adolescents tend to internalize and externalize problems when their mothers are more controlling (Baumrind, 1991; for review, see Chorpita and Barlow, 1998). Mothers who have more control over parenting and have excessive interference in the behavior of their children may reduce their willingness to set goals and autonomy in their goal-achieving behavior. In the context of the present study, high parental control might prevent children from continuing their persistent act on their own initiative.

Interestingly, we found that mothers' persistence and responsiveness were associated with children's self-control. This result suggests that a persistent mother may be more responsive to her child. As Bernier et al. (2010) showed, the generous support of the mother was involved in the development of the child's executive function; in our study, children of mothers with high persistence might be more likely to receive support from their mothers and grow up in an environment where they could concentrate on their activities and increase their persistence. Furthermore, the correlation between persistence and self-control in young children is shown. This result is consistent with prior studies on children, adolescents, and adults (Duckworth et al., 2007; Oriol et al., 2017), exploring the relationship between persistence and self-control. To achieve long-term goals, we need to regulate desires and exercise self-control; therefore, it is inevitable that children's persistence and self-control are positively correlated. Persistence and self-control may share mechanisms (Duckworth and Gross, 2014). For example, in terms of neural mechanisms, persistence and self-control may have a common neural basis (i.e., prefrontal cortex) (Rothbart et al., 2007; Posner and Rothbart, 2009; Hosoda et al., 2020). To elucidate the cognitive basis of grit, further examination should employ neural measurements that allow us to directly ascertain this possibility.

Our results showed that the mother's consistency of interest and responsiveness could also be related to children's behavioral difficulties. This is the first report to demonstrate that mothers' persistence (consistency of interest), as well as parenting style (responsiveness), are associated with low behavioral difficulties in young children. Our findings are consistent with theories of parenting, suggesting that consistency in parenting behaviors leads to better adjustment in children (Bornstein, 2006). In terms of social learning theory, consistent behaviors of parents lead to predictability of behaviors, which makes it easier for children to learn. In such an environment, children can increase their successful experiences and improve their self-efficacy (Bandura, 1977, 1986). From an attachment perspective, consistent parental behaviors may form a stable attachment for

TABLE 3 | Results of hierarchical multiple linear regression analyses predicting child's self-control, prosocial behavior, and difficulties from mother's persistence and parenting style.

Valuable	β	*t*-value	*p*-value	95% Confidence interval	
				Low bound	Upper bound
Child's total effortful control: $R^2 = 0.42$					
Age	0.17	2.27	0.025	0.188	2.806
SES	0.11	1.41	0.163	−0.392	2.298
Mother's overall grit	0.34	4.26	<0.001	0.230	0.632
Mother's responsiveness	0.42	5.35	<0.001	0.639	1.392
Child's inhibition control: $R^2 = 0.35$					
Age	0.19	2.32	0.022	0.136	1.736
SES	0.11	1.36	0.178	−0.574	1.365
Mother's consistency of interest	0.23	2.80	0.006	0.080	0.467
Mother's responsiveness	0.46	5.62	<0.001	0.413	0.862
Child's attention focusing: $R^2 = 0.32$					
Age	0.15	1.78	0.078	−0.081	1.501
SES	0.09	1.11	0.272	−0.360	1.266
Mother's overall grit	0.37	4.33	<0.001	0.143	0.386
Mother's responsiveness	0.29	3.39	0.001	0.161	0.617
Prosocial behavior: $R^2 = 0.10$					
Age	−0.09	−0.93	0.355	−0.002	0.001
SES	0.04	0.46	0.649	−0.356	0.570
Mother's responsiveness	0.29	3.06	0.003	0.067	0.316
Total difficulties score: $R^2 = 0.28$					
Age	−0.02	−0.27	0.792	−0.003	0.002
SES	−0.09	−1.11	0.268	−1.578	0.443
Mother's consistency of interest	−0.30	−3.43	0.001	−0.659	−0.176
Mother's responsiveness	−0.34	−3.94	<0.001	−0.837	−0.276

children (De Wolff and van Ijzendoorn, 1997; Fuertes et al., 2006; Moss et al., 2011).

The present study has several limitations. First, because the metacognition was immature in our participants (3–6 years old) and they were unable to self-evaluate for persistence (Smortchkova and Shea, 2020), and the coronavirus pandemic has also been occurring, children's persistence was scaled by their mothers through online investigation, which had the potential to contain parents' biases. Future studies should examine the reliability of using questionnaires to assess children's persistence using behavioral data that objectively and quantitatively demonstrate children's persistence in addition to parental reports. Second, we investigated the associations between mothers' persistence and their children's persistence; however, we were not able to verify whether environmental care or genetic factors were more likely. In the future, it is necessary to consider genetic factors (Willems et al., 2019). Third, although the current study focused on the association with the mother as a factor in the persistence in children, the association with the father and other microsystems (school, teacher, and peer) may be possible (Padilla-Walker et al., 2012; O'Neal, 2018; Li et al., 2020). Fourthly, the current study utilized a cross-sectional design. Finally, whilst we used grit as a measure of persistence, "resourcefulness" and "frustration tolerance and courage" could also be considered concepts related to persistence (e.g., Rosenbaum and Ben-Ari, 1985; Rosenbaum, 1990; Wong, 1995). Examining these issues reveals the importance of parental persistence in the developmental factors of children's persistence. In addition, it can lead to a better understanding of the role of persistence in children's behavioral problems and their associated parental persistence.

The present findings provide among the first direct evidence that a high level of mother's persistence is essential for a young child's high persistence. Our results also suggest that mothers' persistence and responsiveness can also be associated with the level of self-control and behavioral difficulties of their young children. We propose that, ultimately, using mothers' persistence as an index of children's persistence may promote the development of a new strategy for education for developing children's persistence with perspectives on parent–child relationships and suggest the importance of educational interventions that enhance parents' persistence.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the institutional review board (University of Tokyo, 348-5). All procedures involving human subjects in this study were approved by the Ethics Committee of Musashino University (R2-001). The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

CH conceptualized. MI, AS, KO, and CH contributed to the design of the work. MI took part in the data acquisition. MI, AS, KH, and CH contributed to the analysis and interpretation of data of the work. MI, AS, and CH contributed to the drafting of this paper. All authors approved the final version for submission and agreed to be accountable for all aspects of the work to ensure that all questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Psychometric Properties of the Grit-S in Chinese Nurses

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Grit, as a positive psychological trait, could affect the stability of nursing workforce and nurses' physical and mental health continuously. The Short Grit Scale (Grit-S) with fewer items than the original Grit Scale was widely used to measure individual trait-level grit. However, the psychological properties of Grit-S among Chinese nurses have not been verified. A self-designed sociodemographic questionnaire was used to investigate 709 Chinese nurses in the study, and Grit-S, Big Five Inventory-44, Brief Self-Control Scale, 10-item Connor-Davidson resilience scale, and Task Performance Scale were adopted to collect information of grit, personality, self-control, resilience, and work performance. The confirmatory factor analysis, Pearson correlation analysis, hierarchical regression analysis, and multi-group confirmatory factor analysis were conducted to verify the psychometric properties of the Grit-S. The results demonstrated that the Grit-S had sound validity and reliability among Chinese nurse samples and had good measurement invariance across nurses in general hospitals and psychiatric hospitals. The results of this study provide confidence in using the grit measurement among Chinese nurse in the future.

Keywords: grit, scale validation, psychometric properties, nurses, China

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INTRODUCTION

The attention to positive psychology has led to increased interest in its important concepts, and grit is one of them. Individuals with high grit level can maintain their interest and efforts and move forward, regardless of setbacks or difficulties. When exploring why some individuals with similar intelligence quotient are more successful, Duckworth et al. (2007) proposed that trait-level grit may be the key to success and constructed two aspects of grit: maintaining efforts and interest in goals for a long time (Duckworth et al., 2007).

Subsequently, the relationship between grit and personal performance or success has been widely studied, covering a wide range of fields, such as education (Christopoulou et al., 2018; Wei et al., 2019), military (Maddi et al., 2012, 2017), management (Schimschal and Lomas, 2019), economy (Dugan et al., 2019), sports (Meyer et al., 2017; Cormier et al., 2019), and so on. These strands of research have verified that grit could positively predict personal achievements.

Moreover, the studies on the relationship between grit and other psychological indicators and healthcare indicators have sprung up over the past few years. Previous studies have found that grit could negatively predict stress, anxiety and depression (Zhang et al., 2018a; Datu et al., 2019; Coleman, 2020), reduce suicidal ideation (Kleiman et al., 2013), and be an important protective factor for adolescent Internet addiction (Borzikowsky and Bernhardt, 2018; Kim et al., 2021). By contrast, grit could positively promote health management skills and health-related quality of life (Traino et al., 2019), improve individual wellbeing (Arya and Lal, 2018; Schimschal et al., 2021) and life satisfaction (Li et al., 2018a).

Considering the two elements of grit: Consistency of interest and perseverance of effort, it is easy to connect it with career and career achievements which are full of challenges, setbacks, difficulties, and require long-term persistence. There is no doubt that healthcare profession, especially nursing, is one of them. Nurses account for more than half of the staff in hospitals (Gutsan et al., 2018) and they are also numerous in the field of primary healthcare (Wolff-Baker and Ordona, 2019). Women still account for the vast majority of nurses in the world (Gutsan et al., 2018). However, nurses have been facing numerous and complex difficulties, especially in hospitals and psychiatric wards, where nurses often confront the uncertain physiological and psychological needs of various patients, complex interpersonal communication problems, insufficient understanding and support of managers, and heavy workload, as well as individual life responsibilities, family problems, and financial needs, especially in the international context of the current global shortage of nurses' human resources (Zhang et al., 2018b). Therefore, how to reduce nurses' job burnout and enable nurses to maintain their nursing jobs has become an important proposition around the world.

Studies have shown that grit is a powerful personality trait, which could predict the burnout of healthcare students (Jumat et al., 2020). In the study of nursing staff, it was found that the grit of long-term goals was conducive to long-term work in nursing posts and was negatively correlated with burnout (Seguin, 2019). Moreover, when training the next generation of nursing successors, it is important to consciously cultivate the trait-level grit of nursing students. Previous studies have shown that grit not only helped to improve the adaptability to clinical practice (Baek and Cho, 2020), but also positively predicted the clinical and academic performance of nursing students after controlling for their study years and other demographic factors (Terry and Peck, 2020). In addition, in the field of disaster nursing, the grit of nurses has also been found significant to maintain emergency preparedness, which was also the deep reason for nurses to complete their tasks well in disaster (Tyer-Viola, 2019).

However, the understanding of grit may be different in different cultural backgrounds (Datu et al., 2017; Datu and Mclnerney, 2017). Although the psychometric properties of Short Grit Scale (Grit-S) have been validated among Chinese adolescents (Li et al., 2018b), whether the two-factor structured grit is suitable for Chinese nurses remains to be verified. In addition, compared with nurses in general hospitals, psychiatric nurses have more opportunities to be exposed to psychological-related knowledge and skills training, which may affect their understanding of grit. Therefore, the measurement invariance (MI) across nurses in general hospitals and psychiatric hospitals needs to be studied.

MATERIALS AND METHODS

Participants

Seven hundred and fifty-six nurses who met the criteria were recruited through online advertising and responses from 709 of whom were valid. The response rate was 93.7%. The inclusive criteria were as: (a) registered nurses in the people's Republic of China; (b) at least 1 year working experience in clinical nursing or clinical nursing management; (c) no previous or current diagnosis of mental illness or drug or alcohol dependence; and (d) informed and agreed to participate in the study voluntarily. The exclusion criteria included as: (a) retired nursing staff; (b) nurses on leave during the investigation. The participants gave their informed consent and voluntarily participated in the study. The participants' characteristics are shown in **Table 1**.

Measures

All tests were conducted in Mandarin Chinese.

Sociodemographic Characteristics Data

A self-designed questionnaire was used to collect sociodemographic information, including age, gender, marital status, length of nursing work, nursing degree, nursing title, and employed hospitals' type.

TABLE 1 | Sociodemographic characteristics description.

	Nurses (*N* = 709)
Age, mean years and SD (P25, P50, P75)	31.74 ± 7.38 (27, 30, 35)
Length of nursing work, mean years, and SD (P25, P50, P75)	10.67 ± 8.12 (5, 8, 14)
Gender, % (*N*) of female	90.7% (643)
Marital status	
Unmarried	27.9% (198)
Married	68.1% (483)
Divorced	3.7% (26)
Widowed	0.3% (2)
Nursing degree	
Technical secondary school degree	5.2% (37)
College degree	38.1% (270)
Bachelor degree	56.1% (398)
Graduate degree	0.6% (4)
Nurse title	
None	23.0% (163)
Primary	51.6% (366)
Intermediate	24.0% (170)
Vice senior	1.4% (10)
Employed hospital	
General hospital	53.3% (378)
Psychiatric hospital	46.7% (331)

SD, standard deviation; P25, 25 percentile; P50, 50 percentile; and P75, 75 percentile.

Short Grit Scale

The self-report scale, consisting of two subscales (Consistency of Interest and Perseverance of Effort), was developed and validated by Duckworth and Quinn (2009). A total of eight items were included in the scale, using the 5-point Likert scale (from 1 "not like me at all" to 5 "very much like me"). The higher the factor score, the stronger the corresponding factor. The Chinese version of the Grit-S has good reliability and validity (Li et al., 2018a). The Cronbach's α of the total scale ranged from 0.69 to 0.72 and that of subscales was from 0.58 to 0.71 in the Chinese population (Wang, 2016). The Grit-S was used to assess the grit of all participants in this study and the Cronbach's α of the total scale and subscales was from 0.68 to 0.75.

Big Five Inventory-44

The BFI is widely used in personality measurement all over the world (John et al., 1991, 2008; Li et al., 2015). It includes five personality domains: extraversion, agreeableness, conscientiousness, neuroticism, and openness, with a total of 44 items (16 reversed items). It is a 5-point Likert scale, and the item answers range from "strongly disagree" to "strongly agree." The average score is used to evaluate a certain domain. The higher the average score is, the more obvious the personality of the domain is. The BFI has been proved to have acceptable validity in Chinese population [root mean square error approximation (RMSEA) = 0.072–0.099; Zhou, 2010], and the internal consistencies for all personality traits were acceptable (from 0.75 to 0.91; Guo et al., 2021). It is widely used to measure the personality characteristics of nurses in China (Xia et al., 2013; Yu et al., 2019). In this study, BFI-44 was used to measure participants' personality and to test the convergent validity and criterion-related validity of the Grit-S.

Brief Self-Control Scale

The scale, which is used to assess individual self-control, was developed by Tangney et al. in 2004. The brief version (13 items) had high correlation ($r = 0.92$–0.93) with the total version (36 items). The items were rated on a 5-point scale, with responses ranging from "not at all like me" to "very much like me"(Tangney et al., 2004). The higher the score of Brief Self-Control Scale (BSCS), the stronger the individual self-control. The Cronbach's α of BSCS was 0.862, and Cronbach's α of each dimension ranged from 0.606 to 0.761 in Chinese population (Tan and Guo, 2008). In this study, BSCS was used to assess individual self-control and to test the convergent validity and criterion-related validity of the Grit-S.

10-Item Connor-Davidson Resilience Scale

The 10-Item Connor-Davidson Resilience Scale (CD-RISC-10) is a unidimensional dimension scale to measure resilience, which was revised from the CD-RISC (Connor and Davidson, 2003; Campbell-Sills and Stein, 2007). It comprises of 10 items, each rated on a 5-point scale (0–4). The higher the score, the better the individual's resilience.

The Cronbach's α was 0.85 and the factor loading was from 0.44 to 0.74 which indicated good reliability and construct validity in the original study (Campbell-Sills and Stein, 2007). The CD-RISC-10 also showed excellent psychometric properties with favorable internal consistency, structure, and criterion-related validity in Chinese samples (Wang et al., 2010; Cheng et al., 2020). And 48.641% of the total variance was explained in the sample of Chinese nurse students, the Cronbach's α was 0.851 (Ye et al., 2016). In this study, CD-RISC-10 was used to assess individual resilience and to test the convergent validity and criterion-related validity of the Grit-S.

Task Performance Scale

Task Performance Scale (TPS), which measures individual task performance, was from Williams and Anderson (1991) (Bachrach et al., 2007). The seven-point scale has five items (e.g., "*adequately completes assigned duties.*"), and each response ranges from highly disagree to highly agree. Task performance is represented by the average score. The higher the score, the better the task performance. The Cronbach's α of the scale was 0.79 in 304 Chinese and American graduate students (Bachrach et al., 2007). In this study, TPS was used to evaluate participants' task performance and to test the criterion-related validity of the Grit-S.

Procedure

The study was ethically approved by the Ethics Committee of Chengdu fourth Hospital and the registration number of the Chinese Clinical Trial Registry is ChiCTR1900020715. Participants were recruited through online advertising. Before investigation, written informed consents were obtained. All questionnaires were self-rated, and participants filled separately. According to the unified guidelines, the investigators clarified the unclear and ambiguous items proposed by the participants during the field investigation. And 111 nurses completed the retest after 3 months.

Data Analyses

The following data analyses were used to verify the psychometric characteristics of Grit-S in Chinese nurses including structural validity, reliability, convergent validity, criterion-related validity, and measurement invariance across nurses working in general hospital and psychiatric hospital.

Confirmatory factor analysis (CFA) and Chi-square test were used to verify the structural validity of Grit-S. CFA which is widely used to test the hypothetical relationship between ordinal variables (such as Likert-type items; Flora and Curran, 2004) was performed with IBM SPSS AMOS 23.0. In this study, CFA was used to verify the structural validity with maximum likelihood estimation method. Moreover, Chi-square test was used to compare the two models (unidimensional model and two-dimensional model).

The reliability which was analyzed by SPSS 25.0 was shown by internal consistency using Cronbach's α (Schweizer, 2011) and the test-retest reliability after 3 months. The convergent validity was assessed by two-tailed Pearson correlations between both factors of grit with self-control, resilience, and personality. In order to verify the criterion validity, hierarchical regression

analysis was used to explore the influence of age, gender, length of nursing work, personality, and grit on task performance.

In addition, compared with nurses in general hospitals, psychiatric nurses may have different education, training, and work experience, which may affect their understanding of grit. Therefore, it is necessary to test the measurement invariance across general hospital nurses and psychiatric hospital nurses by the multi-group confirmatory factor analysis (MGCFA) which was conducted by lavaan package of R 4.0.5.

RESULTS

Confirmatory Factor Analysis

According to the previous study, the following indices and their criteria were adopted to evaluate the model fitting (Hu and Bentler, 1999), including comparative fit index (CFI) with value greater than 0.95, Tucker-Lewis Index (TLI) with value greater than 0.95, RMSEA with value less than 0.06, and standardized root mean square residual (SRMR) with value less than 0.08. To select the optimal model, two-dimensional model and unidimensional model were compared by chi-square test (see **Table 2**). And the results supported the former (**Figure 1**).

Internal Consistency and Test-Retest Reliability

The internal consistency of the scale was evaluated by Cronbach's α. By calculating Cronbach's α of all 709 nurse samples, the Cronbach's α for score of consistency of interest was 0.723, for score of perseverance of effort was 0.682, and for total Grit-S was 0.751. According to the CFA results of this study, the factor load of item 2 was not satisfactory. Cronbach's α of EFF factor after trying to delete item 2 increased to 0.772 and that of Grit-S also increased to 0.772.

To examine test-retest stability, 111 nurse samples (90 female; $M_{age} = 31.60$, SD = 6.603) were retested with Grit-S after 3 months. The score correlation coefficient of consistency of interest before and after was 0.805 and that of perseverance of effort and total Grit-S was 0.702 and 0.885, respectively. All test-retest reliability coefficients were acceptable.

Convergent Validity and Criterion-Related Validity

Table 3 shows the bivariate correlation between the Grit-S factor scores and the scores of self-control, resilience, and personality. The total score of Grit-S and its two factors had a significant positive correlation with self-control and resilience, respectively, and was highly positively correlated with conscientiousness. But in the factor neuroticism of personality, they had a strong negative correlation. These results suggested that the Grit-S was highly correlated with concept-related structure and had acceptable convergent validity.

The results from regressing age, gender, length of nursing work, personality, and grit on task performance are presented in **Table 4**. In the first step, age, gender, length of nursing work, and personality factors were used as independent variables and task performance as dependent variables for regression analysis. The results showed that length of nursing work ($\beta = 0.258$, $p = 0.048$), agreeableness ($\beta = 0.200$, $p < 0.001$), conscientiousness ($\beta = 0.241$, $p < 0.001$), and openness ($\beta = 0.134$, $p = 0.001$) were related to task performance of nurse. In the second step, when entering two factors of grit (consistency of interest and perseverance of effort) into the model, age ($\beta = -0.294$, $p = 0.021$), length of nursing work ($\beta = 0.305$, $p = 0.016$), agreeableness ($\beta = 0.155$, $p < 0.001$), conscientiousness ($\beta = 0.140$, $p = 0.002$), openness ($\beta = 0.097$, $p = 0.012$), and perseverance of effort ($\beta = 0.261$, $p < 0.001$) were related to task performance of nursing. However, there was no statistical correlation between consistency of interest and task performance in the nurse sample.

Measurement Invariance

Multi-group confirmatory factor analysis was conducted to test the MI across nurses working in different hospitals (general hospital and psychiatric hospital). The comparison of models tested in MGCFA was shown in **Table 5**. The higher-level test of MI could be executed only after the lower-level test passes ($p < 0.05$). It passed four tests in turn in this study: configural invariance, metric invariance, scalar invariance, and strict invariance and all values of p were not less than 0.05. The results showed that Grit-S had good measurement invariance among nurses in general hospitals and psychiatric hospitals.

DISCUSSION

The Grit-S was developed from the original Grit Scale (Duckworth et al., 2007; 12-items version) and maintained the same two-factor structure. Compared with the original version, Grit-S has fewer items (eight-items version) and still maintains good reliability and validity, and it is widely used and translated into multilingual versions, such as Polish version (Wyszyńska et al., 2017), Spanish version (Arco-Tirado et al., 2018), and Czech version

TABLE 2 | Model fit indices and comparison of Grit-S.

Model	χ^2	df	TLI	CFI	RMSEA	SRMR	$\Delta\chi^2_{(\Delta df)}$
Two-dimensional	61.132	19	0.953	0.968	0.056	0.0340	
Unidimensional	360.024	20	0.643	0.745	0.155	0.0919	$298.892^{***}_{(1)}$

df, degree of freedom; TLI, Tucker-Lewis Index; CFI, comparative fit index; RMSEA, root mean square error approximation; and SRMR, standardized root mean square residual.
$^{***}p < 0.001$ (two tailed).

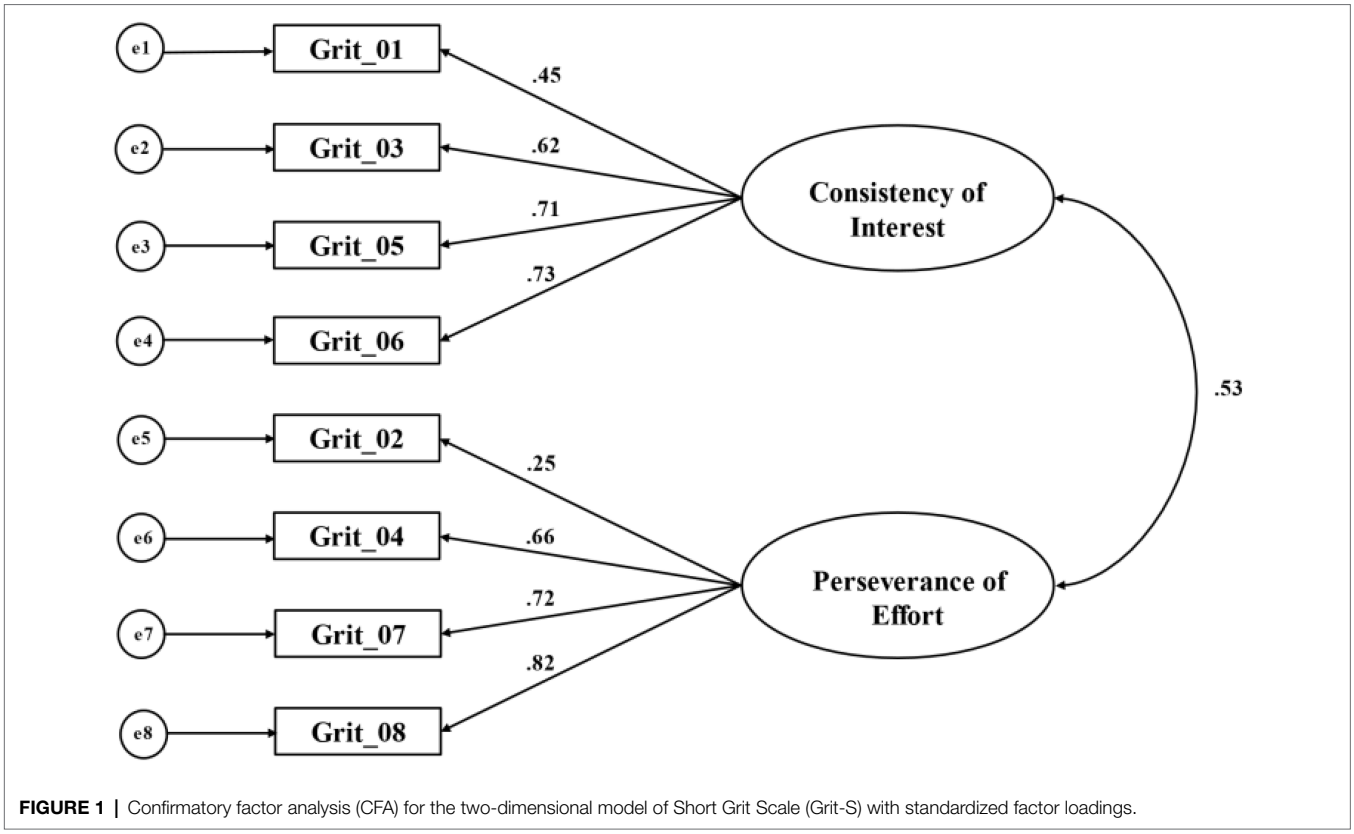

FIGURE 1 | Confirmatory factor analysis (CFA) for the two-dimensional model of Short Grit Scale (Grit-S) with standardized factor loadings.

TABLE 3 | Correlation between consistency of interest, perseverance of effort, total Grit-S, self-control, resilience, and personality.

		M	SD	1	2	3	4	5	6	7	8	9
1	Consistency of interest	12.47	2.627	—								
2	Perseverance of effort	14.57	2.361	0.377**	—							
3	Total Grit-S	27.03	4.141	0.849**	0.809**	—						
4	Self-control	42.82	6.556	0.588**	0.595**	0.713**	—					
5	Resilience	37.26	5.553	0.368**	0.560**	0.553**	0.484**	—				
6	Extraversion	25.16	4.191	0.216**	0.309**	0.313**	0.248**	0.477**	—			
7	Agreeableness	35.34	3.941	0.322**	0.402**	0.433**	0.478**	0.430**	0.206**	—		
8	Conscientiousness	32.92	4.604	0.410**	0.532**	0.563**	0.648**	0.475**	0.305**	0.495**	—	
9	Neuroticism	22.94	4.832	−0.414**	−0.334**	−0.453**	−0.463**	−0.561**	−0.448**	−0.457**	−0.492**	—
10	Openness	32.10	4.867	0.298**	0.349**	0.389**	0.0319**	0.428**	0.416**	0.283**	0.354**	−0.361**

**$p < 0.01$ (two tailed).

(Schmidt et al., 2021). Li et al. (2018b) translated it into Chinese and evaluated its psychometric properties among Chinese adolescents. Following previous studies, this study expanded the applicable population of Grit-S and verified the validity of construct and the acceptable reliability in the Chinese nurse sample.

The convergent validity and criterion-related validity also were proved, as shown in **Tables 3** and **4**. It is worth noting that this study found that perseverance of effort was related to task performance in sample of nurses. However, the relationship between consistency of interest and task performance has not been found. The work performance might be more affected by the perseverance of effort facet of grit than the consistency of interest facet. A meta-analysis based on 66,807 participants showed that perseverance of effort could explain the variance in academic performance even after controlling for some variables (Credé et al., 2017). Moreover, good measurement invariance across nurses in general hospitals and psychiatric hospitals was found.

Although the two-dimensional structure (consistency of interest and perseverance of effort) of grit was significant, item 2 (*setbacks do not discourage me*) was noteworthy because its low standardized factor loading (0.25) on perseverance of effort. In the study of Duckworth and Quinn in 2009, it was found that the standardized factor loading of this item was 0.37, which was not ideal. The same results have appeared in Polish version (standardized factor loading = 0.33; Wyszyńska et al., 2017), Spanish version (standardized factor loading = 0.27; Arco-Tirado et al., 2018), and Chinese version (standardized factor

TABLE 4 | Hierarchical regression analysis of the impact of age, gender, length of nursing work, personality, and grit on task performance.

	Step 1			Step 2		
	β	*t*	*p*	*β*	*t*	*p*
Age	−0.238	−1.824	0.069	−0.294	−2.317	0.021*
Gender	0.059	1.727	0.085	0.055	1.655	0.098
Length of nursing work	0.258	1.984	0.048*	0.305	2.408	0.016*
Extraversion	−0.005	−0.121	0.903	−0.038	−0.960	0.338
Agreeableness	0.200	4.926	<0.001***	0.155	3.861	<0.001***
Conscientiousness	0.241	5.565	<0.001***	0.140	3.099	0.002**
Neuroticism	−0.001	−0.026	0.979	−0.005	−0.107	0.914
Openness	0.134	3.448	0.001**	0.097	2.533	0.012*
Consistency of interest				0.020	0.515	0.607
Perseverance of effort				0.261	6.367	<0.001***
R^2		0.209			0.255	
ΔR^2					0.046	
F		23.133***			23.905***	

*$p<0.05$; **$p<0.01$; ***$p<0.001$ (two tailed).

TABLE 5 | The indices of model fit of Grit-S analyzed by MGCFA.

Model	χ^2	df	$\Delta\chi^2$	Δdf	AIC	BIC	*p*
Configural	81.240	38			13,033	13,261	
Metric	84.893	44	3.6527	6	13,024	13,225	0.72
Scalar	97.674	50	12.7810	6	13,025	13,198	0.05
Strict	103.550	58	5.8758	8	13,015	13,152	0.66

MGCFA, multi-group confirmatory factor analysis; df, degree of freedom; AIC, Akaike information criterion; and BIC, Bayesian information criterion.

loading = 0.34; Li et al., 2018b). This study also found that after removing item 2, the internal consistency of the factor (perseverance of effort) and the total Grit-S were improved, which increased from 0.682 and 0.751 to 0.772, respectively. Item 2 (*setbacks do not discourage me*) was not ideal in different cultural background. It might be caused by the expression difference. Specifically, the expression of "*setbacks do not discourage me*" might be inconsistent with daily expression in different cultural backgrounds, or it was not easy to be used by individuals in daily life. Whether item 2 (*setbacks do not discourage me*) belongs to the concept of grit or how to revise its expression needs further research.

More and more studies showed that grit played an important role in the cultivation of nurses (Halperin and Regev, 2021), the maintenance of nurses' physical and mental health, the improvement of academic performance (Oducado, 2021), and the stability of nursing staff (Jeong et al., 2019). Adopting a widely used, simple and effective scale to measure nurses' grit could not only improve the overall understanding of the concept, but also provide the possibility for the comparison of grit in different occupations. The professional dilemma faced by psychiatric nurses has always been worthy of attention. In addition, they will be exposed to more psychological training than nurses in general hospitals. This contradiction might interfere psychiatric nurses' understanding of grit, which is also related to measurement accuracy of grit in nurse population. This study verified that Grit-S had excellent measurement invariance in psychiatric nurses and general hospital nurses and suggested that Grit-S could be an appropriate tool to measure the grit among Chinese nurses in the future.

The limitations of this study are as follows. First, the measurement bias comes from the self-report questionnaire, that is, the inaccurate report of participants. Second, the measurement invariance test was conducted only across nurses in psychiatric hospitals and general hospitals. In measuring invariance, more nursing subspecialties should be involved in the future. Finally, the Chinese version of Grit-S used in this study did not undergo the back-translation process.

CONCLUSION

Grit is an essential trait for the challenging profession of nursing. This study demonstrated the Grit-S is a sound scale in measuring grit among Chinese nurses. In addition, through the measurement invariance test, it was suggested that different sub-professional nurses might have the consistent understanding of grit. This study is a fair foundation for the study on nurse grit in the future.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of Chengdu Fourth Hospital. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CH, DW, and YY were involved in all aspects of the study from design, analysis, interpretation of data, and preparation of the manuscript. LuY and LeY were involved with the interpretation of data and preparation of the manuscript. All authors contributed to the article and approved the submitted version.

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The Moderating Role of Grit in the Relationship Between Perfectionism and Depression Among Chinese College Students

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Background: As a personality trait, perfectionism has shown a close association with psychological disorders, such as depression. The protective effect of grit on depression has been confirmed by a series of recent studies. Therefore, it is necessary to investigate the buffering role of grit in the above relationship and the possible underlying mechanism.

Objective: Based on the multidimensional theory of perfectionism, we differentiated two dimensions of perfectionism as positive and negative and further examined the relationships between these two dimensions of perfectionism and depression. We also aimed to examine the possible moderating effect of grit on the above two relationships.

Methods: Us a questionnaire survey approach, a total of 2,602 college students (1,608 females and 994 males) were assessed using the Frost Multidimensional Perfectionism Scale the Short Grit Scale, and the Center for Epidemiological Studies-Depression Scale. Hierarchical regression analysis was used to investigate the direct effect of two dimensions of perfectionism on depression as well as the moderating role of grit in these associations.

Results: After controlling for gender, age, family income, and academic performance, both positive and negative perfectionism had positive predictive effects on depression, and grit negatively moderated these two relationships. Specifically, grit completely counteracted the effect of positive perfectionism on depression yet partly counteracted the effect of negative perfectionism on depression.

Conclusion: Grit prevents the depressive symptoms raised by positive and negative perfectionism.

Keywords: perfectionism, grit, depression, college students, moderating role

INTRODUCTION

The Direct Effect of Perfectionism on Depression

Perfectionism, as a stable personality trait, manifests itself in unrealistic standards, overly strict self-evaluation and extreme all-or-nothing thinking, which could result in a series of negative outcomes (Frost et al., 1990). For college students, a cross-cultural meta-analysis revealed that the level of perfectionism has consistently increased since 1989 (Curran and Hill, 2019). Similar to research on perfectionism, research on depression among college students has shown continuous growth, which could be a worrying trend (Gao et al., 2019). College students, who are still in emerging adulthood, have not fully formed coping styles toward difficulties (Heffer and Willoughby, 2017), and facing multiple pressures may lead to a greater possibility of depression affliction (Lan et al., 2019). Therefore, it is of great importance to investigate the possible association between perfectionism and depression in college students.

Regarding the factors that may influence depression, Beck (1986) stated that individual's cognitive patterns could play a significant role. Following Beck's cognitive theory of depression, the Integrated Cognitive Model (ICM) took the interaction of dysfunctional attitudes and negative life events as the predictor of depression (Kwon and Oei, 1992). Specifically, dysfunctional attitude referred to a personality trait referring to having an overly rigid cognitive schema of oneself and the world, and perfectionism was one of its major manifestations. From the perspective of theory, perfectionism could be a cause of depressive symptoms, and many related studies have confirmed that (Limburg et al., 2017). For perfectionists, an inappropriate coping style for certain circumstances could result in the arousal of negative emotions such as depression (Tran and Rimes, 2017). Additionally, strict personal standards could lead to higher stress, and the brain association between stress and depression has also been confirmed by cognitive neuroscience (Hankin et al., 2005), which indicates that perfectionism acts as a risk factor for depression *via* stress.

In addition, cluster analysis revealed that perfectionism could be divided into two dimensions: positive and negative (Parker, 1997). Specifically, positive perfectionism was characterized by high personal standards but less concern over mistakes, and negative perfectionism was characterized by extreme concern over mistakes and self-doubt. According to the dual process model explicated by Slade and Owens (1998), for positive perfectionists, the motivation to achieve success allowed them to remain secure emotionally in light of failure, while for the negative perfectionists, the motivation to avoid failure led to the opposite attitude to failure. Furthermore, Dunkley et al. (2003) expressed that positive perfectionism had positive effects by arousing the coping strategies of problem solving, while negative perfectionism conversely had negative effects by arousing the coping strategies of problem evasion. In the Chinese context, the reliability of separating perfectionism into positive and negative parts was also verified. A series of studies have revealed that positive perfectionism was more likely to be associated with positive outcomes and negative perfectionism played an opposite role (Zi and Zhou, 2006; Chen et al., 2013; Wang and Li, 2017).

However, regarding the effect of positive perfectionism on depression, research has shown inconsistent results. While some research has claimed a buffering role of positive perfectionism in depression (Elion et al., 2012), other research showed them to be unrelated (Bergman et al., 2007), indicating that there might be a moderating variable in this relationship. For negative perfectionism, although the present research showed consistent results of the predictive effect on depression (Tran and Rimes, 2017), it is still unclear whether there are possible moderating mechanisms.

The Moderating Effect of Grit

From the view of positive psychology, the predictive effect of positive coping strategies on depression needs to be discussed (Sin and Lyubomirsky, 2009). According to the diathesis–stress model, the interaction of susceptible traits and buffering mechanisms could act as a predictor of psychological disorders; that is, if individuals have risk traits for psychological problems but develop efficient coping methods for negative events, the possibility of psychological disorders emerging could be greatly reduced (Monroe and Simons, 1991). For the present relationship, grit might be a moderator buffering the negative outcomes caused by perfectionism.

Grit is a stable positive personality trait, defined as perseverance and passion for long-term goals, comprising consistent interests and perseverance. For the relationship of perfectionism and grit, the present literature showed inconsistent viewpoints. Conceptually, grit symbolizes a long-term and passionate commitment, implying a more open mind toward all possible obstacles, while perfectionism implying the obsession with the unrealistic high standard and the ideal outcomes, which was the opposite of grit. However, considering the multidimensions of perfectionism, the positive and negative factors might play different roles in the possible relationship above. For example, in the positive level, the self-oriented perfectionism prediction on conscientiousness and in the negative level, socially prescribe perfectionism showed prediction on neuroticism trait (Stoeber et al., 2009). Meanwhile, grit is also positively correlated with conscientiousness and negatively correlated with neuroticism (Duckworth et al., 2007), and all the evidence above indicating the possible relationship between perfectionism and grit.

Besides, grit can closely influence one's attitude toward failure and misfortune (Duckworth et al., 2007), implying the possible inner association between grit and adverse mental processes. A meta-analysis confirmed the negative correlation between grit and negative emotional outcomes such as depression (Credé et al., 2017), and a series of previous studies implied the possible buffering role of grit in depression caused by negative personality traits (Musumari et al., 2018). First, from the perspective of present grit theory, when pursuing long-term goals, individuals with higher grit levels tend to maintain persistence and passion while facing obstacles (Duckworth et al., 2007). Thus, grit could help individuals form the belief that failure is

unavoidable when striving for success and eventually resist the sense of discrepancy raised by high personal standards (Datu et al., 2018). In addition, cognitive neuroscience has also determined the deeper connection between grit and depression in the brain. A series of studies have confirmed that grit corresponds to the prefrontal cortex (PFC) (Wang et al., 2016). At the same time, dysfunction of the PFC also showed an undeniable connection with self-criticism caused by perfectionism (Longe et al., 2010). Specifically, dysfunction of the PFC could have a negative influence on one's numerous emotion-related functions, such as self-evaluation and stress coping, which could eventually lead to depression (Dixon et al., 2017), and grit could restrict the process described above. In addition, for individuals with high grit levels, a more optimistic attribution style might occur when facing negative outcomes (Duckworth et al., 2009), which might promote and alleviate the intrinsic effects of positive and negative perfectionism on depression by adjusting cognitive patterns (Flett et al., 1998).

Based on the discussion above, there is evidence for the buffering effect of grit on the relationship between perfectionism and depression. Meanwhile, considering the diverse influences of perfectionism's two dimensions on depression, differentiation of grit's moderating effect on the two relationships might be possible. As a result, the two dimensions of perfectionism need to be investigated to further clarify the relationship between perfectionism, grit, and depression.

Present Study

Based on the ICM, the present study took a dialectical perspective, aiming to examine both the positive and negative influences of perfectionism on depression. Meanwhile, following the view of positive psychology and diathesis–stress model, grit, which is regarded as a positive and preventive personality trait, was also investigated to determine whether it could promote and buffer the positive and negative outcomes produced by two dimensions of perfectionism. Based on relevant theory and former studies, two hypotheses were proposed. Hypothesis 1: In a group of Chinese college students, positive perfectionism acts as a negative predictor, and negative perfectionism acts as a positive predictor of depression. Hypothesis 2: Grit moderates the relationship between the two dimensions of perfectionism and depression. However, it should be noted that a previous study confirmed the influence of gender, age, and family income on depression (Lu et al., 2015). Additionally, several studies have revealed the influence of grit on academic performance (Wang et al., 2016). Because of these findings, the demographic variables above were considered covariates in the following study design.

MATERIALS AND METHODS

Participants

Using the convenience sampling method, a total of 2,602 college students from several universities in China took part in the survey, which was conducted in November 2019. Excluding 8 participants who chose not to report their age, the mean age of the participants was 19.52 ($SD = 1.38$), with a range of 17–29 years. A total of 1,608 participants (61.8%) were female, while 994 participants (38.2%) were male. The purpose of the survey was explained, and informed consent was obtained from the participating students. The study was approved by the Research Ethics Committee of Beijing Normal University, which confirmed that all research processes performed in this study were in accordance with the ethical standards.

Measures

Perfectionism

The Frost Multidimensional Perfectionism Scale (FMPS; Frost et al., 1990) was used to assess the level of participants' perfectionism. The Chinese version of FMPS was revised by Zi and Zhou (2006), which showed good reliability and validity in the Chinese participant group. The 25-item instrument consists of the following five subscales: concern over mistakes (Cronbach's alpha = 0.92), parental expectations (Cronbach's alpha = 0.85), personal standards (Cronbach's alpha = 0.87), doubts about actions (Cronbach's alpha = 0.82), and organization (Cronbach's alpha = 0.93). Of these, organization is an indicator of positive perfectionism, while concern over mistakes, parental expectations, personal standards, and doubts about actions compose the negative perfectionism (Parker, 1997). Responses are rated on a 5-point Likert-type scale ranging from strongly disagree (1) to strongly agree (5). Item scores for the two dimensions were added to generate a total score of positive and negative perfectionism, and a higher score indicates a higher level of positive or negative perfectionism.

Grit

The Short Grit Scale (Grit-S) was used to assess the participants' ability to persevere and sustain passion for long-term goals. The Chinese version of Grit-S was revised by Wang et al. (2016), which has good reliability and validity for Chinese participants. For all eight items, responses are rated on a 5-point Likert-type scale ranging from strongly disagree (1) to strongly agree (5). Previous research has indicated that the Grit scale has good reliability and validity (Duckworth et al., 2009). In the current study, Cronbach's s alpha was 0.95.

Depression

The Center for Epidemiological Studies-Depression Scale (CES-D; Radloff, 1977) was used to assess participant levels of depressive symptoms. The Chinese version of CSE-D was revised by Chen et al. (2009), having good reliability and validity in Chinese culture. For all 20 items, responses are rated on a 4-point Likert-type scale ranging from never (0) to always (3). In the current study, Cronbach's s alpha was 0.96.

Data Analysis Strategies

Data were analyzed using IBM SPSS version 26.0 and Interaction version 1.7. The results of Harman's single-factor test suggested

that the variance for both rotated and unrotated first factors was below the threshold of 40%, which indicated that there was no significant common method bias in the study samples. Descriptive statistics were calculated to clarify the preliminary relationship between variables. Based on the descriptive statistics, the moderating effect of grit on the relationship between perfectionism and depression was examined by hierarchical regression analysis, and the significance of moderating effects was further confirmed by a simple slope test.

RESULTS

Descriptive Statistics and Correlations

The means and standard deviations of all variables and the intercorrelations among all variables are presented in **Table 1**. According to the results, first, demographic variables were correlated with psychological variables to different extents. In addition, a significant positive correlation was established between negative perfectionism and depression, while there was no significant correlation between positive perfectionism and depression. In addition, grit was positively correlated with positive perfectionism but negatively correlated with negative perfectionism and depression.

Moderating Analysis

Hierarchical regression analysis was used to examine the moderating effect of grit on the relationship between perfectionism and depression, and the results are displayed in **Table 2**. The results indicated that the age, family economic situation, and academic performance of college students had significant predictive effects on depression ($\beta = 0.06$, $p < 0.01$; $\beta = -0.06$, $p < 0.01$; $\beta = -0.08$, $p < 0.001$), while gender had no influence on depressive symptoms ($\beta = 0.01$, $p > 0.05$). Meanwhile, positive and negative perfectionism had significant predictive effects on depression ($\beta = 0.09$, $p < 0.001$; $\beta = 0.41$, $p < 0.001$), and grit also significantly predicted depression in both relationships ($\beta = -0.38$, $p < 0.001$; $\beta = -0.31$, $p < 0.001$). Furthermore, the interactions of both positive and negative perfectionism with grit acted as significant predictors of depression ($\beta = -0.09$, $p < 0.001$; $\beta = -0.09$, $p < 0.001$).

A simple slope test was used to further examine the significance of the moderating effects, and all the study variables were standardized (see **Figures 1, 2**). The results indicated that for individuals with

TABLE 1 | Means, standard deviations, and correlations among all study variables.

Variables	*M* ± *SD*	1	2	3	4	5	6	7	8
1. Gender[a]	–	1							
2. Age	19.52 ± 1.38	0.00	1						
3. Family Income[b]	–	0.00	−0.10***	1					
4. Academic Performance[c]	–	0.11***	0.05**	0.07**	1				
5. Positive Perfectionism	19.40 ± 5.78	0.25***	−0.04*	0.05**	0.15***	1			
6. Negative Perfectionism	44.91 ± 16.40	0.11***	−0.04	0.00	0.07***	0.56***	1		
7. Grit	26.55 ± 4.33	0.05*	−0.01	0.04	0.16***	0.28***	−0.11***	1	
8. Depression	34.31 ± 8.05	0.00	0.06**	−0.07**	−0.08***	−0.03	0.43***	−0.36***	1

*[a]male = 1, female = 0; "b" mean the range of the participants' Family Income, "c" means the range of participants' Academic Performance (which were represented by average academic score in college). [b]below ¥1,000 = 1, ¥1,000–¥3,000 = 2, ¥3,000–¥6,000 = 3, ¥6,000–¥10,000 = 4, ¥10,000–¥15,000 = 5, ¥15,000–¥20,000 = 6, beyond ¥20,000 = 7; [c]average academic score 0–59 = 1, 60–69 = 2, 70–79 = 3, 80–89 = 4, 90–100 = 5. *p < 0.05, **p < 0.01, and ***p < 0.001.*

TABLE 2 | The moderating effect on the relationship between perfectionism and depression.

Variables	*F*	*B*	*SE*	*β*	*t*
Step 1	9.43***				
Gender		0.08	0.33	0.01	0.25
Age		0.36	0.12	0.06	3.13**
Family Income		−0.36	0.13	−0.06	−2.81**
Academic Performance		−0.79	0.19	−0.08	−4.20***
Step 2	74.14***				
Positive Perfectionism		0.12	0.03	0.09	4.51***
Grit		−0.71	0.04	−0.38	−20.02***
Step 2	188.23***				
Negative Perfectionism		0.20	0.01	0.41	24.69***
Grit		−0.58	0.03	−0.31	−18.35***
Step 3	67.34***				
Positive Perfectionism × Grit		−0.03	0.01	−0.09	−4.78***
Step 3	166.74***				
Negative Perfectionism × Grit		−0.01	0.00	−0.09	−5.12***

***p < 0.01 and ***p < 0.001.*

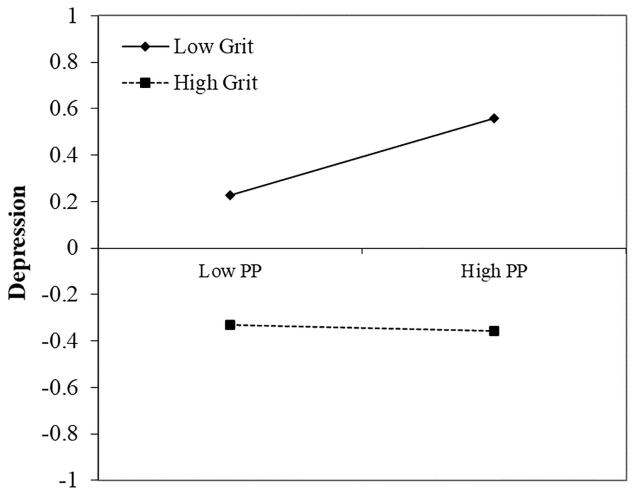

FIGURE 1 | The moderating role of grit on the relationship between positive perfectionism and depression. All the study variables were standardized. PP = Positive perfectionism. High/low level of PP = M ± 1SD. High/low level of grit = M ± 1SD.

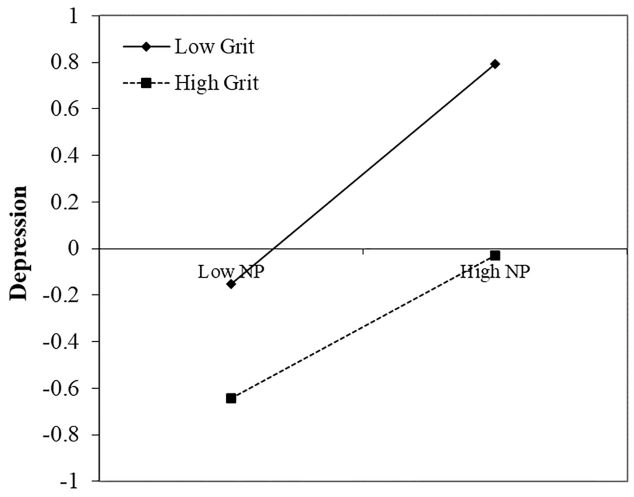

FIGURE 2 | The moderating role of grit on the relationship between negative perfectionism and depression. All the study variables were standardized. NP = Negative perfectionism. High/low level of NP = M ± 1SD. High/low level of grit = M ± 1SD.

a high grit level (1 *SD* above the mean), the predictive effect of positive perfectionism on depression vanished (simple slope = −0.01, $t = -0.47$, $p > 0.05$), yet the predictive effect of negative perfectionism on depression remained (simple slope = 0.31, $t = 12.51$, $p < 0.001$). However, for individuals with a low grit level (1 *SD* below the mean), the predictive effect of positive perfectionism on depression was still present (simple slope = 0.17, $t = 6.27$, $p < 0.001$), and a stronger predictive effect of negative perfectionism on depression occurred compared to the individuals with a high grit level (simple slope = 0.47, $t = 19.31$, $p < 0.001$).

DISCUSSION

Using the mean of hierarchical regression analysis, we established a moderating model to clarify the buffering effect of grit on the relationship between perfectionism and depression. Descriptive statistics indicated different correlation levels between demographic variables and psychological variables, which emphasized the necessity of controlling for covariates. Of note, inconsistent with the hypotheses, positive perfectionism was not significantly correlated with depression. For this unexpected result, a possible explanation could be the limitation of Pearson correlations; that is, they focus only on the two present variables and overlook other influential confounding factors (Fan, 1997). Therefore, further investigation controlling for covariates needs to be conducted to reveal the relationship between the study variables.

The Direct Effects of Perfectionism on Depression

The results of hierarchical regression analysis indicated that both positive and negative perfectionism positively predicted depression, which was not consistent with previous results. For negative perfectionism, its positive effect on depression was consistent with previous studies (Slade and Owens, 1998); that is, a higher level of negative perfectionism might result in a greater risk of depression symptoms. Dunkley et al. (2003) confirmed that negative perfectionism could mislead college students to ignore personal capacity and develop self-critical attitudes, which ultimately led to unpleasant emotions.

However, unlike the results shown in the related systematic review (Wright et al., 2021), the present study found a positive predictive effect of positive perfectionism on depression. The difference could be attributed to the following. First, for positive perfectionists, the tendency toward organization has a strong relationship with compulsive beliefs (Hollander, 1965) and was thought to be a significant predictor of obsessive–compulsive disorder (Martinelli et al., 2014), and obsessive–compulsive disorder was closely related to depressive symptoms (Goodwin, 2015). As a result, positive perfectionism may raise the level of depression *via* compulsive behavior. In addition, according to an evaluative review of the dual process model, when interpreting the outcome of positive perfectionism, researchers should not overlook the present experience and environment of individuals (Flett and Hewitt, 2006). A related study also revealed that when facing certain situations, such as achievement failure, individuals who were regarded as having traits of positive perfectionism also showed a high risk of depressive symptoms (Hewitt and Flett, 2002).

For college students, the appropriate organization can improve planning skills when facing multiple burdens from academic work and social activities, but the excessive organization may result in unrealistic compulsive beliefs, such as not accepting any change in their plans or magnifying the consequence of any failure. Based on that, the inconsistency of the predictive effect of positive perfectionism on depression with previous studies might be attributed to the different situations that individuals were experiencing.

The Moderating Effects of Grit on the Relationship Between Perfectionism and Depression

The results of hierarchical regression analysis also showed that grit acts as a moderator between the two dimensions of perfectionism and depression, indicating that grit could be a buffering mechanism against susceptibility traits, which verifies the diathesis–stress model (Monroe and Simons, 1991).

First, as a positive personality trait, grit itself has a preventive effect on depression. Grittier individuals tend to be mindful and have growth mindsets (Li et al., 2018), allowing college students to reconstruct unpleasant experiences and gain new perspectives on academic and peer interactions. Based on this process, students can gain the ability to develop problem-solving strategies to improve learning efficiency and change their inappropriate interpersonal communication patterns, which contributes to relieving negative emotions. In addition, having both grit and perfectionist tendencies can provide great benefits to individuals. Grittier individuals pursue long-term goals, which could compensate for the lack of life meaning caused by perfectionism (Kleiman et al., 2013; Park and Jeong, 2016). Perfectionists in college tend to experience more pressure when meeting strict personal standards for academic performance, and grit could significantly improve their academic achievement to alleviate the mental burden (Rice et al., 2006; Tang et al., 2019).

Meanwhile, the result of the simple slope test is also worthy of attention. Grit entirely counteracts the promoting effect of positive perfectionism on depression, but not the promoting effect of negative perfectionism. The difference can be attributed to the source of perfectionism's two dimensions. Compared to positive perfectionism, the origin of negative perfectionism contains external factors such as parental expectations. To attain acceptance and love, perfectionists must internalize the high standard set by their parents (Frost et al., 1990), which implies that a positive coping style could not entirely prevent the occurrence of negative emotions at the individual level. Besides, compared to previous studies, the different roles of positive perfectionism are also worth noticing, and the reasons may be attributed to cultural factors. Chinese culture tends to regard the organization as a noble quality and emphasis its necessity, resulting in the education on pursuing organization. However, college students have to face multiple pressure from different sources, which increases the difficulties in achieving high organization in their campus life. The students may have the awareness to be organized but failed due to the lack of grit, and the discrepancy between ideal and reality increased their depression. The relative study also revealed the complicated relationship among perfectionism, grit, and negative academical emotions in Chinese college students (Liu et al., 2021). The present result can also be a possible explanation for positive perfectionism's different effects in former studies. For grittier individuals, considering the buffering effect of grit, pursuing organization will not increase depression levels.

General Discussion

Based on the dual process model of perfectionism and the diathesis–stress model, we partitioned perfectionism into positive and negative subtypes and further investigated the buffering effect of grit on the relationship between perfectionism and depression. Verifying and replenishing the previous theories and studies, the present results confirmed the preventive role of positive traits on the adverse outcome caused by negative traits, introducing a new idea to reduce the prevalence of depression among undergraduates.

However, several limitations should also be noted when interpreting the current results. First, since a self-report inventory was used, subjectivity is inevitable, which necessitates that future studies use other data collection methods, such as laboratory experiments. Next, the cross-sectional data lack precision when drawing causal relationships, which could be improved by using a longitudinal design, that is, adding additional time points in future studies. Furthermore, the population scope was limited to college students, which may raise the uncertainty of the external validity, requiring further research in various participant groups. In addition, recent studies have revealed the rationality of separately researching the two dimensions of grit (i.e., consistency of interests and perseverance of effort) (Credé, 2018), so future studies can examine the effects of grit's two dimensions to further clarify the underlying mechanism. Finally, the internal consistency reliability of variables in the current study was too high, which could result from the potential overlap between items (Tavakol and Dennick, 2011), or the relatively consistent answering patterns of participants when facing specific items. Future studies could take more consideration into the selection of inventories and the correspondence between the inventories and participants.

Despite the limitations above, the merits of the present study are clear for the psychological care of college students. Since grit is a malleable trait (Duckworth, 2016), college students can develop grit to prevent the risk of depressive symptoms. For college students, when facing the choice that will have a long-term impact on the future, they should first consider their interests to identify their passion. In addition, a proper and specific long-term goal should also be set to ensure that they persevere toward it. For those working in psychological counseling, guidance on discovering interests and setting goals for college students should also be noted. Once a high level of grit is cultivated, the depressive symptoms raised by perfectionism can be prevented or alleviated.

CONCLUSION

Through the examination of the direct effects of positive and negative perfectionism on depression as well as the moderating effects of grit on the relationship above, we drew the following conclusions. Firstly, in specific situations, both positive and negative perfectionism can act as potential risk factors for depression. Furthermore, grit can significantly prevent the depressive symptoms raised by positive and negative perfectionism, which emphasized the role of grit in reducing the occurrence of depression among college students.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The Research Ethics Committee of Beijing Normal University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JZ developed the study design, drafted the manuscript, and revised the manuscript critically for important intellectual content. ML developed the study design, performed the statistical analysis, and drafted the manuscript. WW participated in and supervised the data collection, assisted in data collection and analysis, and made important modifications to the manuscript. All authors contributed to the article and approved the submitted version.

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Grit and Meaning in Life of Chinese Nurses: The Chain Mediating Effect of Social Support and Hope

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Grit is defined as perseverance and passion for long-term goals, and it may affect the stability of the nursing workforce and the physical and mental health of nurses continuously. Meaning in life has received considerable attention from scholars, which is an important component in positive psychology. This study aimed to delve into the relationship between grit and the meaning in life of Chinese nurses. Additionally, we also sought to prove the chain mediating effect of social support and hope on this relationship. An online questionnaire survey was used to collect data from 704 Chinese nurses using the self-made demographic questionnaire with Short Grit Scale (Grit-S), the Perceived Social Support Scale (PSSS), Adult Dispositional Hope Scale (ADHS), and Meaning in Life Questionnaire (MLQ). Moreover, Process version 3.3 plug-in SPSS 25 was used to test the mediation effect between variables. The results showed a strong positive relationship between grit and meaning in life and verified the mediating effect of social support and hope on grit and meaning in life. The results also confirmed the chain mediating model between grit, social support, hope, and meaning in life.

Keywords: grit, social support, hope, meaning in life, China, nurses

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INTRODUCTION

Since the 1950s, positive psychology has become increasingly prominent among scholars. Researchers pointed out that positive psychology should pay attention to positive mental status (i.e., positive emotions, positive environments, and positive attitudes) and other related concepts (Seligman et al., 2005; Moskowitz et al., 2019). Meaning in life, related to the ability of an individual to survive in the face of adversity, is a basic element of human existence (Frankl, 1966). Steger et al. (2008) noted that the key to meaning in life is to be aware of the current goal and ultimately achieve it. Nursing plays a paramount role in saving lives and promoting the health status of patients, as well as being the frontline workers in global health emergencies like the outbreak of the covid-19 pandemic. High role expectations and varieties of stressors caused a negative impact on the development of the careers of nurses (Tyer-Viola, 2019). Based on numerous demands for nurses, they are required to have a greater sense of responsibility and mission. Therefore, nurses must own a clear life goal, and strive to enhance the sense of meaning in life. The study of Czekierda et al. (2017) identified meaning in life as a potential role of physical health,

with a mild to moderate positive impact. More studies had confirmed that meaning in life is positively correlated with the quality of life and self-esteem (Barnett et al., 2019; Bernard et al., 2020). Furthermore, meaning in life is an important predictor of subjective well-being (Krok and Gerymski, 2019) and is related to positive emotions, life satisfaction, and career decision self-efficacy (Sari, 2019). Meanwhile, researchers showed an insufficient sense of meaning in life may experience stressor-related distresses suicidal tendencies, and negative thinking (Barnett et al., 2019; Lew and Chistopolskaya, 2020; Ostafin and Proulx, 2020).

The Impact of Grit on Meaning in Life

When encountering challenges or disasters, nurses need to delve into high-quality patient care, retain resilience, and process professionally in the face of adversity continually (Brennan, 2017). Generally, a personality trait named grit drives nurses to complete the mission on difficult occasions (Meyer et al., 2020). Gritty people always adopt various strategies to achieve long-term goals and alleviate negative impacts in life (Blalock et al., 2015). Duckworth and Quinn (2009) categorized grit into consistent interest and persistent effort. The existing studies had confirmed that grit is an important non-cognitive trait of success or failure among nursing students (Terry and Peck, 2020), nurses (Tyer-Viola, 2019), or nurse leaders (Seguin, 2019). Grit was a significant predictor of nursing students in clinical and academic achievement, regardless of demographic factors (Terry and Peck, 2020). Researchers demonstrated that grit was associated with increased job involvement, greater career longevity, lowered turnover intention, and improved well-being for nurses and nurse leaders (Jeong and Seo, 2019; Seguin, 2019). Therefore, the study tried to hypothesize the following:

Hypothesis 1: Grit will significantly predict meaning in life (grit→ meaning in life).

The Mediating Role of Social Support Between Grit and Meaning in Life

Perceived social support implies that individuals experience a subjective feeling of being understood, respected, and supported by others (Liu and Aungsuroch, 2019). Social support was categorized as external (from friends and family) and internal (from colleagues and leaders) support (Hamama et al., 2019). Social support was regarded as motivation that improved job satisfaction and alleviated the work stress of nurses successfully (Orgambídez and Almeida, 2020). In the study of Nowicki and Ślusarska (2020), they indicated that peer support is an important risk factor for traumatic stress among nurses, especially facing major public health events. The work of Krause and Rainville (2020) suggested that social support mediated the relationship between age and meaning in life. In another study, Lee et al. (2017) discovered a significant relationship between the search for meaning and perceived social support. When receiving more social support, nurses can cope with the negative effects of stressful environments, stimulate enthusiasm for work, and improve their sense of meaning in life. Therefore, the study tried to hypothesize the following:

Hypothesis 2: Social support will act as a mediator between grit and meaning in life (grit→ social support→ meaning in life).

The Mediating Role of Hope Between Grit and Meaning in Life

Hope is a positive expectation of results (Scioli et al., 2011) and plays a vital role in clinical practice (Zhang et al., 2020). The broaden-and-built theory of positive emotions showed that hope can reduce the influence of negative emotions by constructing psychological resources (Fredrickson, 2001). Numerous studies have shown that hope reduces psychological distress, maintains adaptation to disease, improves well-being, and driving directions for existence (Mattioli et al., 2008; Rustøen et al., 2011). In addition, a high level of personal hope can divert their attention from negative events (Kaleta and Justyna, 2020), reduce the risk of depression and suicide, and improve meaning in life (Sun et al., 2021). Therefore, the study tried to hypothesize the following:

Hypothesis 3: Hope will act as a mediator between grit and meaning in life (grit→ hope→ meaning in life).

The Chain Mediating Role of Social Support and Hope on Grit and Meaning in Life

Many studies have suggested grit, social support, hope, and meaning in life were positively correlated with quality of life, job satisfaction, and well-being (Seguin, 2019; Bernard et al., 2020; Orgambídez and Almeida, 2020; Shiri et al., 2020). Nurses with grit can be combined with positive environmental factors represented by social support and positive attitudes represented by hope to tolerate stress, and improve quality of life, job satisfaction, subjective well-being, and finally enhance the sense of meaning in life. Therefore, the study tried to explore the following:

Hypothesis 4: Social support and hope will jointly act a chain mediator role in the relationship between grit and meaning in life (grit→ social support→ hope→ meaning in life).

Although previous studies have separately explored the relationship between grit, social support, hope, and meaning in life, few studies have shown how grit affects the meaning in life through the mediating role of social support and hope. Generally, only a few works of literature have focused on personality traits and meaning in the life of hospice nurses (Barnett et al., 2019), oncology nurses (Candela and Piredda, 2020), and pediatric nurses (Taubman-Ben-Ari and Weintroub, 2008). Therefore, this study intended to delve into the impact of the grit of Chinese nurses on the meaning in life from the perspective of positive psychology and analyze the mediating role of social support.

MATERIALS AND METHODS

Participants

Since data collection was conducted at one specific time, the nature of this study was cross-sectional. The study group

consisted of 756 nurses who were recruited from different hospitals in Chengdu City, China, who met criteria through an online questionnaire survey. Among the 756 nurses, 704 of whom were valid (52 nurses failed to complete all answers). The response rate was 93.12%. All participants had signed informed consent and voluntarily participated in this study. The inclusion criteria were: (a) obtained professional qualification certificate in the People's Republic of China; (b) have at least 1-year working experience in clinical nursing or clinical nursing management; (c) no previous or current diagnosis of mental illness or drug or alcohol dependence; (d) had a basic phone or computer skills; (e) informed to participate in the study. Nurses who failed to complete the survey were excluded. The characteristics of the participants are shown in **Table 1**.

Measures

All tests were conducted in Mandarin Chinese.

Demographic Variables

A self-made demographic questionnaire was utilized in this study to collect the characteristics of participants, including gender (male, female), age, educational background (college degree, bachelor's, or graduate degree), and length of nursing work.

Grit

The self-reported Short Grit Scale (Grit-S) was developed and validated by Duckworth and Quinn (2009) including two subscales, namely, consistency of interest and perseverance of effort. A total of eight items in the scale were included and used the 5-point Likert scale (from 1 = "not like me at all" to 5 = "very much like me"). The Grit-S of the Chinese version has good reliability which had been verified by Li et al. (2018). The Cronbach's α of the self-reported scale was 0.73–0.83 in a previous study (Duckworth and Quinn, 2009). In addition, the Cronbach's α of subscales were from 0.58 to 0.71 in China (Wang, 2016).

TABLE 1 | Baseline characteristics and difference in the grit score of nurses.

Variables	All sample (n = 704)	Grit scores (M ± SD)	t/F	P
Gender			t = 1.618	0.106
Male	66 (9.4%)	27.85 ± 4.27		
Female	638 (90.6%)	26.99 ± 4.10		
Age(years)			t = −1.057	0.291
<30	315 (44.74%)	26.89 ± 4.18		
≥30	389 (55.26%)	27.22 ± 4.07		
Educational background			t = 0.876	0.381
1 College degree	302 (42.9%)	27.23 ± 3.97		
Bachelor or graduate degree	402(57.1%)	26.95 ± 4.23		
Length of nursing work			t = 0.028	0.978
<10	403 (57.24%)	27.07 ± 4.07		
≥10	301 (42.76%)	27.06 ± 4.19		

SD = standard deviation.

Social Support

The 12-item Perceived Social Support Scale (PSSS) was developed and validated by Zimet et al. (1990), including three subscales (family support, friends support, and other support). Participants rated on a 7-point Likert response format (from 1 = "very strongly disagree" to 7 = "very strongly agree"). The total scores ranged from 12 to 84, with higher scores suggesting greater perceived social support. The Cronbach's α for the PSSS was 0.914 in the current study (Liu et al., 2016).

Hope

The Adult Dispositional Hope Scale (ADHS) was originally designed by Snyder et al. (1991) and the Chinese version was applied and verified by Ren (2006). The ADHS may be applied to individuals older than 15 years to assess the dispositional level of hope. The scale consisted of 12 items, wherein 4 items (items 3, 5, 7, 11) served as fillers and were not interpreted. The other 8 items were divided into 2 dimensions, measuring pathways thinking (items 1, 4, 6, 8) and agency (items 2, 9, 10, 12). ADHS adopted a 4-point scoring method (from 1 = "definitely false" to 4 = "definitely true"). The Cronbach's α of the scales was from 0.74 to 0.84 (Snyder et al., 1991).

Meaning in Life

The 10-item Meaning in Life Questionnaire (MLQ) was originally compiled by Steger et al. (2008), including two subscales, namely, the presence of meaning and the search for meaning. The Chinese version of MLQ was revised and verified by Wang et al. (2016). Participants rated on a seven-point Likert response format (from 1 = "completely inconsistent" to 7 = "completely consistent"). The Cronbach's α of the two subscales was 0.88 and 0.93, respectively (Steger et al., 2009).

Procedure

The study was ethically approved by the Ethics Committee of Chengdu 4th Hospital and the registration number of the Chinese Clinical Trial Registry is ChiCTR1900020715. Nurses were asked to complete an anonymous online survey. Each hospital appointed an investigating nurse who had been trained by researchers previously. Participants had signed informed consent before the investigation and voluntarily participated in this study. Investigating nurse is requested to distribute the questionnaire to other nurses. Subsequently, nurses were invited to click on a web link[1] to access the questionnaire *via* mobile phones. The investigating nurses explained the unclear and ambiguous items suggested by the participants during the field investigation according to the unified guidelines. Note that all questionnaires were self-rated, and participants filled separately.

Statistical Analysis

The following data analyses were used to verify the relationship between grit and meaning in life and verify the mediating effect of social support, and hope on grit and meaning in life. Note that the statistical description of the count data was represented by the composition ratio [n (%)], while the measurement data

[1]http://www.wjx.cn/

conforming to the normal distribution was represented by ($M \pm SD$). Comparison between groups was represented by the *t*-test. Pearson correlation analysis was adopted between both factors of grit, social support, hope, and meaning in life. Process V3.3 in SPSS (IBM. V25.0) was used to analyze the mediating effect of social support and hope on grit and meaning in the life of clinical nurses. The bootstrap method was used to estimate the 95% confidence interval with 5,000 repeated sampling, and Two-sided inspection level $\alpha = 0.05$.

RESULTS

A total of 756 nurses were recruited in this study, with 704 nurses satisfying the necessary criteria. A majority of nurses were female (90.6%) and their average age was 31.79 (SD = 7.38) years. Almost half of the nurses (57.1%) possessed a bachelor's or graduate degree. Their average length of nursing work was 10.72 (SD = 8.12) years (**Table 1**). However, there were no significant differences in the grit scores of nurses among different subgroups of gender, age, educational background, and length of nursing work ($P > 0.05$) (**Table 1**).

Correlation Analysis of Major Study Variables

Pearson correlation analysis showed that grit was positively related to social support ($r = 0.407$, $P < 0.01$), hope ($r = 0.506$, $P < 0.01$), and meaning in life ($r = 0.455$, $P < 0.01$). Similarly, social support was positively correlated with hope ($r = 0.484$, $P < 0.01$) and meaning in life ($r = 0.546$, $P < 0.01$). In addition, hope was positively related to meaning in life ($r = 0.589$, $P < 0.01$) (**Table 2**).

Multiple Mediating Analyses Between Variables of Clinical Nurses

The results showed the total effect ($\beta = 0.456$, $t = 13.5$, $P < 0.001$) and the direct effect ($\beta = 0.142$, $t = 4.251$, $P < 0.001$) of grit on the meaning in life were both significant, after controlling the variables such as gender, educational background, and length of nursing work. Grit significantly predicts social support ($\beta = 0.408$, $t = 11.827$, $P < 0.001$) and social support predicts meaning in life ($\beta = 0.311$, $t = 9.402$, $P < 0.001$), indicating that social support played a mediating role between grit and meaning in life. Similarly, grit significantly predicts hope ($\beta = 0.367$, $t = 11.107$, $P < 0.001$) and hope predicts meaning in life ($\beta = 0.37$, $t = 10.459$, $P < 0.001$) indicating that hope played a mediating role between grit and meaning in life. Meanwhile, social support can also predict hope ($\beta = 0.338$, $t = 10.223$, $P < 0.001$). Therefore, social support and hope had a chain mediating effect between grit and the meaning in the life of Chinese nurses (**Table 3**).

Results of the mediating effect analysis in **Table 4** showed that Bootstrap's 95% CI of total indirect effect did not contain 0 [Bootstrap 95% CI:0.258,0.374], accounting for 68.86% of the total effect. Importantly, three indirect effect pathways influenced the relation of grit and meaning in life. Firstly, mediating effect value of Path1 (Grit → Social Support → Meaning in Life) was 0.127 [Bootstrap 95% CI:0.09,0.166], accounting for 27.85% of the total effect. Secondly, mediating effect value of Path2 (Grit → Hope → Meaning in Life) was 0.136 [Bootstrap 95% CI:0.100,0.176], accounting for 29.82% of the total effect. Thirdly, the mediating effect value of Path3 (Grit → Social Support → Hope → Meaning in Life) was 0.051 [Bootstrap 95% CI:0.034,0.072], accounting for 11.18% of the total indirect effect. Note that the Chain mediating model is shown in **Figure 1**.

Pairwise comparison of the different indirect effects paths was adopted to verify whether these paths were significant different. The results showed that Comparison 2 [Bootstrap 95% CI:0.04,0.116] and 3 [Bootstrap 95% CI:0.047,0.116] were significant, except Comparison 1 [Bootstrap 95% CI: –0.067,0.053].

TABLE 2 | Correlation analysis of study variables.

Variables	*Mean*	*SD*	1	2	3	4
1. Grit	27.03	4.14	–			
2. Social support	42.82	6.56	0.407**	–		
3. Hope	21.94	2.96	0.506**	0.484**	–	
4. Meaning in life	21.07	4.24	0.455**	0.546**	0.589**	–

SD = standard deviation.
***P < 0.01.*

DISCUSSION

A rigorous perusal of existing literature revealed that limited studies have investigated the relationship and specific pathways between grit and meaning in life among Chinese nurses. The present study adopted a chain mediating model to explore the influence of grit, social support, and hope on meaning in life in Chinese nurses. The results supported the hypotheses and verified the mediating role of social support and hope in the relationship between grit and meaning in life.

Interestingly, a key finding of this study was grit had a significant positive effect on meaning in life, after controlling for gender, educational background, and length of nursing work. These results strengthen the relationship between grit and meaning in life (Oriol et al., 2020). We extended this conclusion to Chinese nurses. Nurses were increasing due to the development of health services in China (Zhao and Zhang, 2015). While nurses were confronted with more and more work and psychological pressure because of the huge influx of illness patients, workplace violence (Lu et al., 2019), and insufficient resources for health services, such as shortage of beds and the imbalance between medical staff and patients (Zeng et al., 2013). Individuals with higher grit do not seek immediate satisfaction and success but strive to achieve their goals after years of unswerving efforts (Duckworth et al., 2007). In the study of Sharkey et al. (2017), they indicated that grit positively correlated to health-related life quality among adolescents and young adults. In addition, there was a positive relationship between grit and life satisfaction, with self-esteem as the mediator variable in employees (Li et al., 2018). The work

TABLE 3 | Regression model of the effect of grit on meaning in life among Chinese nurses.

Variables	*β*	*t*	*P*	*LLCI*	*ULCI*	R^2	*F*
Step 1 Outcome variable: Social support							
Predictor grit	0.408	11.827	<0.001	0.341	0.476	0.172	29.647
Step 2 Outcome variable: Hope							
Predictor grit	0.367	11.107	<0.001	0.302	0.432	0.369	67.910
Mediator social support	0.338	10.223	<0.001	0.273	0.403		
Step 3 Outcome variable: Meaning in life							
Predictor grit	0.142	4.250	<0.001	0.077	0.208	0.452	81.884
Mediator 1 Social support	0.311	9.402	<0.001	0.246	0.376		
Mediator 2 Hope	0.370	10.459	<0.001	0.300	0.439		
Step 4 Outcome variable: Meaning in life							
Independent variable grit	0.456	13.500	<0.001	0.390	0.522	0.208	36.679

TABLE 4 | Multiple mediated analysis between variables of nurses.

	Effect	Boot SE	Bootstrap 95% CI		Effect ratio
			Low	High	
Total effect	0.456	0.034	0.390	0.522	100%
Direct effect	0.142	0.034	0.077	0.208	31.14%
Total indirect effect	0.314	0.030	0.258	0.374	68.86%
Path1: Grit→ Social Support→ Meaning in Life	0.127	0.019	0.090	0.166	27.85%
Path2: Grit→ Hope→ Meaning in Life	0.136	0.020	0.100	0.176	29.82%
Path3: Grit→ Social Support→ Hope→ Meaning in Life	0.051	0.010	0.034	0.072	11.18%
Comparsion1 (Path1 and Path2)	–0.009	0.031	–0.067	0.053	
Comparsion2 (Path1 and Path3)	0.076	0.020	0.040	0.116	
Comparsion3 (Path2 and Path3)	0.085	0.020	0.047	0.126	

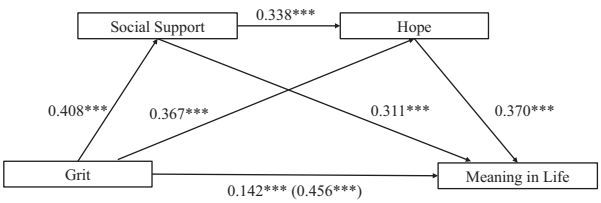

FIGURE 1 | Chain mediating model (***$P < 0.01$).

of Vainio and Daukantaitë (2016) implied that grit was positively related to well-being and mediated by a sense of coherence and authenticity. Thus, grit could play a positive role in promoting quality of life and meaning in life.

Furthermore, social support, hope, and meaning in life were both positively correlated, had been proven in many studies (Mahon and Yarcheski, 2017; Cao and Zhou, 2021; Torregrosa-Ruiz et al., 2021). The work of Bruhn and Philips (1987) noted individuals generated hope by seeking help from trustworthy people, which meant hope was given and received in a supportive relationship. Similarly, Russinova (1999) stated hope occurred with the support of family, parents, friends, and peers. The study of Lin et al. (2020) suggested that social support and meaning in life were associated with the life satisfaction of people. Researchers indicated people with social support and the presence of meaning in life were fewer negative effects and were less susceptible to mental illness (Lin et al., 2020; Cao and Zhou, 2021). Karataş et al. (2021) pointed that meaning in life and hope were significant predictors of life satisfaction. In addition, Snyder (2002) stated that hope, as an important psychological fore, turned stress into motivation with a positive impact on life satisfaction.

Another important finding is the chain mediating effect of social support and hope in the relationship between grit and meaning in the life of Chinese nurses. This is the main theoretical contribution of this research. The results showed grit

indirectly affects meaning in life through three pathways: social support, hope, and the chain mediating effect of social support and hope. Previous studies demonstrated the partial mediating effect of social support in the relationship between resilience and the quality of life (Zhang et al., 2017). The current study demonstrated social support played a partial mediating role in the correlation between grit and the meaning in life (Path 1), accounting for 27.85% of the total indirect effect, which means that grit and social support are important predictors in the meaning of life. Social support is one of the most common positive external sources for coping with negative psychological events and has been widely cited as a protective factor of psychosocial adaptation (Oexle and Sheehan, 2020). The study also confirmed the mediating effect of hope underlying grit and meaning in life relationships (Path 2), accounting for 29.82% of the total indirect effect. It can be found that the mediating role of hope is greater than social support. Hope is a vital psychological resource, which is of great significance for building values and achieving success. Nurses with brave and gritty can increase motivation to attach goals, raise the level of hope, and eventually generate a sense of meaning. Finally, there existed another insignificant path (grit → social support → hope → meaning in life) (Path 3), accounting for 11.18% of the total indirect effect, which showed grit influenced the meaning in life through social support and hope. Social support and hope jointly promote meaning in life. Under tremendous work and psychological pressure, improvement of the sense of meaning in life contributes to reduce negative emotions and improve the quality of life and well-being of nurses.

The study enriches the content of positive psychology and deeply explores the mechanism of grit on meaning in life from the perspective of Chinese nurses. It turns out that social support and hope have an important role in the relationship, which provides a useful reference for the construction of a structural model of grit in the future.

CONCLUSION

Grit is an essential trait for the challenging profession of nursing. Some insights were provided into the relationship between grit and meaning in the life of Chinese nurses. This study demonstrated the relationship between grit and the meaning in the life of Chinese nurses and the mediate effect of social support and hope on grit and meaning in life. Specifically, the results gave evidence to infer that grit has a positive correlation with social support, hope, and meaning in life. Moreover, grit might directly or indirectly affect meaning in life through social support and hope. Based on the mediate effects, Path 1 and Path 2 played an important role in the total indirect effect. In conclusion, grit positively affected Chinese nurses to increase their levels of social support, hope, and meaning in life.

LIMITATIONS

There were several limitations in the current study. Firstly, the results were based on an online self-reported survey, which was highly prone to inaccurate and biased responses from participants. Secondly, this study was cross-sectional in design and impossible to clarify the causal relationship between the variables. Longitudinal research should be designed to supplement and verify the validity and reliability of our findings. Thirdly, the mediation variables in this research were social support and hope, while other variables might mediate grit and meaning in life. Finally, interactions between social support and hope were not analyzed and reported in this research.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Committee of Chengdu 4th Hospital. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LY was involved in all aspects of the study and preparation of the manuscript. DW was involved with the design of the study and preparation of the manuscript.

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BRIEF RESEARCH REPORT
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University Students' Online Learning During COVID-19: The Role of Grit in Academic Performance

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The governmental restriction due to COVID-19 pandemic led to Italian Universities moving teaching from face-to-face, to online. This represented an unexpected transition from traditional learning to what can be considered "e-learning." This, together with the psychological distress that may be associated with the experience of lockdown, might have affected students' performance. It was hypothesised that grit may be a protective factor in such situations. Indeed, compared to their less "gritty" peers, individuals with higher levels of grit are expected to exhibit greater persistence in the pursuit of goals despite setbacks. Within educational contexts, grit is portrayed as a potentially important influence on outcomes such as achievement level, retention and probability of graduation. A longitudinal study was conducted using an online survey in order to assess the moderated mediation effect of grit on students' achievement. One hundred seventy-six undergraduate students from two universities in the north of Italy participated in the survey. The results showed that grit affects students' grades in final exams; perceived self-efficacy in the management of complex problems had a mediation effect on grades, while psychological distress moderated the first part of the mediation process. These novel findings extended our knowledge regarding the role of grit in academic performance investigating for the first time the role of self-efficacy and psychological distress in a learning carried out entirely online.

Keywords: grit, self-efficacy, psychological distress, e-learning, Higher Education, COVID-19 pandemic, online learning

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INTRODUCTION

The COVID-19 pandemic has affected educational systems worldwide, leading to the near-total closures of schools and universities. On 4th March 2020, the Italian Education Minister announced that all schools and universities in Italy would close to face-to-face teaching from 5th March and encouraged online teaching to attempt to slow the rate of contamination. Indeed, at that time, Italy was Europe's worst hit country. Universities recommended the use of platforms that could be used to engage learners remotely and limit disruption to education, leading to the an unexpected transition from traditional (face-to-face) learning to what can be considered e-learning. E-learning encompasses the "delivery of education through Information and Communication Technology (ITC) using a variety of instructional designs and formats, and includes synchronous and asynchronous delivery [...] Synchronous e-learning is often mediated by human interaction between the learning and instructor using ITC and/or between learners who use ITC to interact and learn from each other in real time. [...] asynchronous e-learning involves more self-directed

learning; it can occur at any time and place determined by the learner, and does not rely on a human facilitator being present" (Lawn et al., 2017, p. 2).

Italy has 97 universities, of which: 67 are public universities, 19 are legally recognised private universities and the remaining 11 are telematic universities. Unlike universities that were already offering online and/or blended courses as part of their programmes (mainly the telematic universities), the others took their time to adapt to the sudden transition from traditional face-to-face courses to online courses. During this time, students' academic quality of life and their performance may have been affected. Further, following over 2 months of stay-at-home orders, most students' homes became their entire worlds: the place where they slept, ate, studied, practised sports, and socialised.

Whilst a goal of e-learning empirical research includes the identification and effective management of factors that may influence e-learning outcomes, there appears to be limited consideration of the effect of non-cognitive skills, such as grit, on students' performance within e-learning systems. Grit is described as the individual's persistence and continuous effort to achieve long-term goals. It is measured by a two-factor structure, composed of the perseverance of effort and the consistency of interest (Duckworth et al., 2007), even though recent studies have found a unidimensional structure (e.g., Postigo et al., 2021c). Moreover, González et al. (2020) found that there is construct overlap with the self-control construct. Indeed, studies of grit in university students demonstrated a high correlation between grit and self-control (Kannangara et al., 2018). The authors of the scale themselves concur that innovations on grit measurements are needed, reporting that "compared to [their] development of the original Grit Scale and its short form over a decade ago, [...] alternative measures will [...] more closely adhere to contemporary best practises in scale development" (Duckworth et al., 2021, p. 3). Despite the debate on the psychometric properties of the scale, one may agree on the fact that, in e-learning settings, which allow learning anywhere and anytime, grit may have a role in students' performance, since they are required to adopt self-control behaviours and use a remote environment in a continuous way, without losing effort or interest.

There does exist limited study on the role of grit in engagement in entirely online courses, carried out prior to the current pandemic. Buzzetto-Hollywood et al. (2019) asked 160 students attending a Mid-Atlantic minority serving university to complete a series of questionnaires. They found that higher grit scores correlated progressively to both students' self-discipline and self-efficacy. However, in this study, a positive relationship to student achievement in fully online courses was not confirmed. Alhadabi and Karpinski (2020), in a study of 258 undergraduate students in one public university in the United States, have seen that grit is positively associated with academic performance (measured through students' Grade Point Average) through a sequential pathway of mediators including self-efficacy and achievement orientation goals.

In summary, grit is demonstrated to be a stable characteristic that influences the development of strategies needed to achieve long term goals and is also applicable to e-learning experiences. Furthermore, multiple studies support the mediating role of self-efficacy in the relationship between grit and achievement goals. The above suggests that the stability of grit and the mediating role of self-efficacy between grit and achievement goals justifies the placement of these variables in a sequential model. Recent studies overcome the limits of previous research investigating the relations between grit and academic achievement that mostly relied on cross-sectional design, and shed some light on the direction of these effects by using longitudinal design (e.g., Postigo et al., 2021a; Tang et al., 2021). However, after an exhaustive literature search, no other studies have been found that examine the impact of grit on academic achievement during the COVID-19 pandemic, not even in unexpected and "forced" e-learning experiences. Several studies confirmed that the lockdown experience had an impact on students' mental health and well-being causing psychological distress, and thisin turn may have a negative impact on self-efficacy (e.g., Amerio et al., 2020; Orgilés et al., 2020; Saladino et al., 2020).

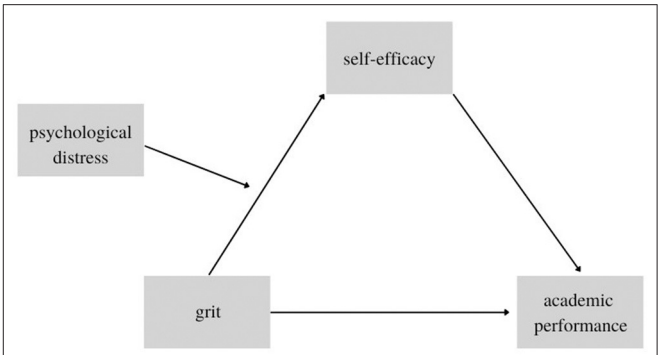

FIGURE 1 | Conceptual model.

Indeed, it has been observed that individuals experiencing elevated symptoms of psychological distress (i.e., depression, anxiety, general stress) often report less successful goal pursuit and achievement due in part to a lack of motivation, lower self-confidence, and negative expectations about their future outcomes (Moss-Pech et al., 2021). Therefore, the aim of the study was to investigate whether the psychological distress caused by lockdown would moderate the mediation of self-efficacy between grit and academic performance. We reasoned that grit could exert a crucial role by impacting on the performance, mediated through self-efficacy, when the psychological distress is not too high. From this premise, we tested the conceptual model depicted in **Figure 1**.

MATERIALS AND METHODS

Participants

Out of 482 respondents, only 216 fully completed all three measures. Measures including missing values were excluded. One hundred and seventy six completed questionnaires were included in the final sample. Participants' ages ranged from 19 to 47 years ($M = 22.06$; $SD = 4.67$). The majority of the respondents

were female (93%), while very few were male (7%). Most of the participants resided in Emilia Romagna (65%) and Lombardia regions (15%); very few participants resided in the other Italian regions; however, the only region that was not represented at all was Piemonte. 78% of the participants were single; 12% in a relationship; and 10% were married. The study corresponded with the first Italian lockdown, and during this time 80% of the participants were living with their parents, 14% with a partner, and 6% with house-mates.

The majority of participants were enrolled at Modena and Reggio Emilia University (67%); to the remaining 33% studied at Parma University. 80% of the sample were Undergraduate Students, whilst the remaining 20% were Postgraduate Students. Of the Undergraduates, the sample studied a variety of subjects: Educational Science (72%), Nursing Sciences (5%), Philosophy (2%), and Psychology (1%), respectively. Of the Postgraduate students, 18% studied Primary Teacher Training, whilst 2% studied Environmental Science and Technology. In all cases, the courses the participants were undertaking were originally face-to-face courses, but had moved online into synchronous e-learning as soon as the first Italian lockdown started—which coincided with the beginning of the second semester.

Procedure

The longitudinal study was carried out over three time points.

Time 1: Respondents received the first questionnaire pack which contained the following measures: (1) the Short Grit scale and (2) the Symptom Checklist-6. This was administered during the second semester of the academic year 2019/2020, between March and April.

Time 2: Respondents completed (3) the Perceived self-efficacy in the management of complex problems scale. This was administered at the end of the same semester, between the end of May and the beginning of June, and before the start of the exams.

In both time points the measures were completed electronically via the LimeSurvey platform.

Time 3: Instructors made available to the researchers the anonymised exam marks of the students' final exams (4). This took place between July 2019 and February 2020.

To co-ordinate data across the three time points, respondents were asked to provide their 6-digit University ID number. The dataset was managed using a "double blind" process, such that those who assembled the data did not know the study objectives and were unable to associate the data to a specific individual. Those who analysed the data received a dataset that lacked the respondents' ID numbers.

Instruments

Demographic and academic information was obtained (age, gender, region, marital status, level of study—undergraduate or postgraduate, University attended, and course studied). Participants also completed:

(1) The *Grit-s scale* (Italian version by Sulla et al., 2018). This consists of 8 items using a 5-point Likert scale ranging from "not like me at all" to "very much like me." The scale contains two dimensions: Consistency of Interest (four items) and Perseverance of Effort (four items). In the current study global grit score was computed as the mean of the items ($\alpha = 0.74$, range of observed scale: 1.50–4.75), given that the two dimensions were highly and positively correlated [$r_{(176)} = 0.40$; $p < 0.001$].

(2) *Symptom Checklist 6* (SCL-6; Rosen et al., 2000). This is a unidimensional 6-item index of psychological distress based on the Symptom Checklist-90-R (Derogatis and Savitz, 2000). Respondents indicate their agreement to a series of questions about symptoms they experienced on a 5 point Likert scale from "Never" to "Always." The measure is adapted, such that each question begins "During the lockdown period, how often did you?..." Example items include: *During the lockdown period how often: did you look to the future with no hope; feel down; feel on pins and needles.* A final score was computed as the mean of the items ($\alpha = 0.57$, range of observed scale: 0.00–5.00).

(3) *Perceived self-efficacy in the management of complex problems scale* (Farnese et al., 2007). This scale consists of 24 items. Respondents are asked to answer in relation to their experience both this semester and in general how often they feel capable of certain things. Sample items include: *"turning stress and anxiety into positive energy"; "having self-control in difficult time"; "meeting deadlines."* Respondents indicate their agreement on a 5-point Likert scale from "Definitely Not" to "Definitely." A final score was computed as the mean of the items ($\alpha = 0.91$, range of observed scale: 1.54–4.79).

(4) *Marks.* In Italian Universities grades are given on the basis of 30 points. That is, the maximum mark available is 30. The minimum mark to achieve a pass is 18. Marks below 18 are considered a fail grade, and are not registered. When a student's performance is considered outstanding, a *laude* can be awarded.

Data Analysis

A preliminary analysis for grit, distress, self-efficacy and exam marks was performed using IBS SPSS Statistics for Windows, Version 22.0 (2012). Means, standard deviations, and indices of skewness and kurtosis were calculated for each variable.

In order to test our hypothesised mediation moderated model, we used the SPSS macro PROCESS (Hayes, 2012, Model 7), by inserting grit as independent variable, self-efficacy as mediator, distress as moderator and marks as the dependent variable. We used bootstrapping (with 1,000 resamples) to compute 95% confidence intervals (CI). CIs that do not contain 0 denote statistically significant indirect effects.

RESULTS

Descriptive Statistics

Table 1 reports descriptive statistics among variables. Inspection of skewness and kurtosis indicated that departures from normality were not severe (the indices were between −1.14 and 1.44), so no variable transformations were deemed necessary.

TABLE 1 | Descriptive statistics.

	Mean	SD	Kurtosis	Skewness
Grit	3.48	0.60	−0.56	−0.03
Distress	2	0.81	0.47	0.65
Self-efficacy	3.62	0.52	−0.62	1.44
Marks	26.95	4.33	−1.14	0.41

Moderated Mediation Model

The model was significant, $F_{(2,173)} = 9.91$; $p < 0.001$; and explains about 10% of the variance. Specifically, an effect of grit emerges on the exam marks, $t_{(173)} = 4.13$; $p < 0.001$. In line with the literature (e.g., Wolters and Hussain, 2015; Alhadabi and Karpinski, 2020) this effect was partially mediated by self-efficacy, indirect effect: 0.32; β = 0.30 95% C.I. [0.10, 0.60]. As for the moderator, the gritXdistress interaction was significant, $t_{(172)} = -2.65$, $p = 0.01$, in particular, the mediation effect was present only for low levels of psychological distress, $t_{(172)} = 4.10$; $p < 0.001$, β = 0.35; 95% C.I. [0.23, 0.54], but not for high levels, $t_{(172)} = 1.04$; $p = 0.30$, β = 0.28; 95% C.I. [−0.05, 0.21].

This study found that higher grit scores were progressively related to both self-efficacy and performance. Our results showed that the effect of grit on performance through the mediation of self-efficacy was present when the distress was low. The higher the levels of grit and self-efficacy, the biggest was the academic success; therefore, grit positively influences final exams' marks.

DISCUSSION

The current study aimed to investigate the role of grit in academic performance during the COVID-19 induced transition from traditional face-to-face learning to e-learning courses. This, we proposed, along with the strict lockdown regulations, may have caused psychological distress in university students.

Self-efficacy was seen to function as a mediator between grit and academic performance confirming the results of previous investigations. However, these previous investigations do not appear to have been tested during an unexpected transition to online learning. It has been suggested that students' expertise in computer use and different e-learning platforms deeply influences their participation in e-learning (Cidral et al., 2018). Furthermore, Wu et al. (2010) claim that the lack of adequate computer skills may represent an important impediment to effective online delivery. It is vital therefore for future studies to attempt to replicate these findings specifically investigating students' perceived self-efficacy in the use of technologies and e-learning platforms.

However, the effect of grit on performance through the mediation of self-efficacy was present only for low levels of psychological distress. The success of e-learning, and a university career in general, requires that students show a good level of self-efficacy, as well as self-control, dutifulness, conscientiousness, resilience and a strong motivation to pursue their long-term goals, that is, all attributes of grit. In fact, the results of the current study confirm that grit increases students' performance. Still, these findings suggest that distress may disrupt goal pursuit even in grittier students. This result may have implications for the practise of university instructors, students, but also health professionals, for example, the psychologists who work within the university counselling services.

Especially in an unforeseen situation like the unexpected introduction of e-learning, professors might need to put even a greater effort in being warm and welcoming, as well as making their lessons more participative and as interactive as possible. it should be noted that also the absence of classmates might have had an impact on students' quality of academic life. This may indicate a need for some additional training of academic staff and a greater level of support provided for them by their institutions, as online instructors may face some unique challenges compared to those who teach in person. Some of the challenges for online learning are the change of roles and responsibilities (e.g., Zheng and Smaldino, 2009), the use of technology (e.g., Valentine, 2002), and, of course, the changes in interpersonal relations, especially with the students (Brown, 2001). Indeed, Knowlton (2000) asserted that in online learning the instructor and students are a community of learners: the professor serves as mentor; the students become active participants in learning. "In online student-centred education, the professor serves as the facilitator, while students collaborate with each other in order to develop personal understanding of course content" (Yang and Cornelious, 2005; p. 3). Moreover, we know from previous studies (e.g., Ishitani, 2016; Silva and Almeida, 2021) that academic integration (i.e., how often students meet up with other students, met with an academic advisor, or talked with faculty about academic matters outside of class) plays a vital role in student persistence in Higher Education. In order to encourage their persistence (which makes a considerable part of grit) even when teaching is online, university institutions must be aware that a good academic integration need to be guaranteed. Some example may be the implementation of efficient online platforms or spaces where extra measures to prevent the spread of viruses are taken in order to prevent the disruption of students' participations in study groups, meetings with academic advisor, etc.

To further consider students, they would need to be made aware of the effect of psychological distress on their performance and take care of their quality of academic life and their mental health so that their grit does not diminish and they can take real advantage of it. Puljak et al. (2020) found that, while students have mostly been satisfied with how they have adapted to e-learning during the COVID-19 pandemic, they have missed the lectures and personal communication with their peers and instructors that they experience in face-to-face settings. Students declared that e-learning could not replace regular learning experiences; only 18.9% of students were interested in e-learning exclusively in the long run.

Regarding their mental health, students should tailor coping strategies to meet their specific needs, promote their psychological resilience and should be provided with adequate support to do this. Communication campaigns should ensure that students are aware that their university has a counselling service and they should lobby for one if attending a university

which does not operate such a service. The need for mental health professionals (e.g., professional counsellors) arises after situations such as pandemics. Udwin et al. (2000) found that students who received psychological support after the crisis were able to solve their problems in a healthy way and adapt to daily life more easily. It should be considered an imperative for universities to build awareness of students' mental health needs and concerns, and to empower their students to seek help and support. The university counselling centres within the two universities where the current study was conducted set up options to continue to provide students with counselling services at a distance and made this available to students from March 2020. This is commendable especially since telemental health has been found to be effective in treating anxiety and depressive symptoms (Brenes et al., 2015; Dorsey and Topol, 2020). Whilst new appointment requests increased. several students that were already using the service were required to pause their psychological support pathways until the service got back to face-to-face appointments. This might be due to the lack of adequate computer skills but also computer equipment.

It should be noted that the generalisability of these results is subject to certain limitations. The major limitation of this study is the sample features. The study was a longitudinal study and typical of such studies experienced participant attrition due to the time required for full completion. The study design intended to collect data via convenience sample of universities that the authors had direct links with to better enable data collection. During the pandemic there has been a notable increase in online studies which increased demand amongst academics to respond to similar requests. This decision around data collection methodologies may have led to the gender imbalance observed in the sample, as the courses targeted were typically overrepresented by female students. This is also linked to a further limitation: only a few university degree programmes were represented. Of those programmes represented, they formed mainly the ones related to social services areas, which are, in fact, dominated by females, and so arguably did represent the specific student populations to a degree. Whilst it is worth mention that literature on grit has reported different results on grit level on the basis of age, but not on the basis of gender (e.g., Credé et al., 2017; Kannangara et al., 2018), several studies of the undergraduate population reported females displaying higher academic self-efficacy than males (e.g., Sachitra and Bandara, 2017). Hence, the ability to generalise the reported results remains restricted. Further research would be needed to test the model presented on other degree programmes as well as other universities, with a more balanced sample of students.

Furthermore, the cross-sectional nature of some measures (i.e., self-efficacy and distress) induces us to be cautious about casual relationships. Another limitation of the present study is the low reliability (in term of Cronbach alpha coefficient) of the distress scale.

Notwithstanding these limitations, this is the first study to our knowledge to investigate the role of grit, self-efficacy, and psychological distress on academic performance in online learning settings. Also, few are the studies that analysed academic grit longitudinally, and mainly with younger students (e.g., Jiang et al., 2019; Tang et al., 2019; Postigo et al., 2021b). This study permits development of knowledge on key aspects of academic performance and academic success, and will encourage future investigations that may inform the policy of university institutions on the mental health of their academics and students.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AA and FS performed the statistical analysis. FS wrote the first draft of the manuscript. All authors contributed to conception and design of the study, manuscript revision, read, and approved the submitted version.

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Multiple Roles of Grit in the Relationship Between Interpersonal Stress and Psychological Security of College Freshmen

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Grit, as an important positive psychological quality, has rarely been studied for its role involved in the mechanism between stress and psychological security. This article explores the moderating and mediating role of grit in the relationship between interpersonal stress and psychological security of freshmen through two studies. In study 1, freshmen from several Chinese universities ($N = 1,224$) were recruited to complete a battery of questionnaire, including assessments about interpersonal stress, grit, and psychological security. The moderating effect analysis showed that grit moderated the relationship between interpersonal stress and psychological security. Specifically, grit buffered the negative effects of interpersonal stress on freshmen's psychological security, but this effect was obvious only when the level of interpersonal stress was relatively low, and decreased when the level of interpersonal stress was high. In study 2, college freshmen from another university apart from above ones ($N = 604$) were recruited, and we verified the results of study 1 and further explored the mediating role of grit in the relationship between interpersonal stress and security. The moderating effect analysis of study 2 also verified that of study 1. The mediating effect analysis showed that interpersonal stress not only negatively predicted psychological security, but also affected psychological security through the mediation of grit. In general, grit played a mediating and moderating role in the relationship between interpersonal stress and psychological security. This study provides first-hand evidence to explain the multiple roles of grit in the relationship between interpersonal stress and psychological security.

Keywords: grit, interpersonal stress, psychological security, multiple roles, college freshmen

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INTRODUCTION

With the rise of positive psychology research, grit has received a great deal of attention from psychologists as an important theme in positive psychology and has emerged as a significant predictor of individual psychology and behavior, such as academic achievement (Duckworth et al., 2007), wellbeing (Datu et al., 2018), and job performance (Musso et al., 2019). Furthermore, some researchers have analyzed the protective effect of grit in the face of risk factors on

mental health (Hobfoll, 1989; Kaniuka et al., 2020; Li and Zhu, 2020). However, previous studies have failed to further elucidate the mechanism of grit's protective effect on mental health. There are two different views on the role of positive psychology quality in stress and mental health, including the stress-buffering hypothesis and the stress-vulnerability hypothesis (Li et al., 2012). So far, little is known the mechanisms of grit is stress-buffering or stress vulnerability in risk factors and mental health.

Regarding the role of grit in mental health, previous studies focused on the protective effect of grit (Hobfoll, 1989; Kaniuka et al., 2020; Li and Zhu, 2020), which revealed the moderating effect of grit on the relationship between risk factors and mental health. Some research found that positive psychological quality also played a mediating role in the relationship between risk factors and mental health (Cheung et al., 2021). In addition to the moderating effect, it is possible that grit may also mediate association between risk factors and mental health, that is, grit may play multiple roles in this association at the same time. Therefore, the present study seeks to explore the mechanisms underlying this association between risk factors and mental health using moderating variables and mediating variables, which may help develop methods to mitigate the negative effect of risk factors on mental health.

The Impact of Interpersonal Stress on Psychological Security

Every year, a large number of high school students enter universities and become freshmen. This transformation of identity is a pressure and challenge for them (Praharso et al., 2017), as they will face various adaptation problems, such as new interpersonal relationships and new learning styles (Arnett, 2000; Bruffaerts et al., 2018). In this condition, if some people cannot successfully deal with these pressures, which leads to various mental health problems, they have no other choices but to drop out of school (Haktanir et al., 2018). Interpersonal stress is one of the most prominent stressors for freshmen's mental health (Li J. et al., 2021). Interpersonal stress refers to the fact that individuals exhibit specific behavioral patterns when interacting with others, resulting in repeated difficulty in interacting with others (Hayden et al., 2019). Interpersonal stress can lead to nervous and painful emotions (Locke, 2005), as well as Internet addictions (Simcharoen et al., 2018). For college freshmen, they have to end or change the previous interpersonal relationships after entering college due to distance and rebuild new interpersonal relationships (Paul and Brier, 2001). During this period, college freshmen begin to define themselves in terms of social relations and become more concerned about their social value and acceptance by others (Tian et al., 2019). Therefore, during this period, college freshmen will pay a lot of attentions to their new classmates and friends, and invest plenty of time and energy in it (Arnett, 2000). However, due to the lack of interpersonal skills for some freshmen, they are prone to encountering interpersonal problems (Segrin and Flora, 2000; Kirkpatrick and Zang, 2011). Therefore, this study regards interpersonal stress as a prominent stressor affecting freshmen's mental health. Although relevant studies have analyzed the impact of interpersonal stress (stressors) on college students' mental health, the study of its mechanism is still insufficient.

Presently, viewed from the national level and social level, psychological security which is an internal need for stability has been attached more importance. *Psychological security means that a person can meet the basic needs of self-protection and feel that he is psychologically sheltered* (*supported, seen*; Zotova, 2011). It is mainly manifested as a sense of certainty and control over the people or things around the environment (Cong and An, 2004). Maslow (1943) also proposed in the hierarchy of needs theory that the sense of security is one of the basic needs of human beings. This need is not only physical, but also psychological. In fact, many human behaviors are conducted to maintain psychological security (Hart, 2014). Therefore, psychological security is of great significance to human beings. Some researchers believe that psychological security is an important factor in characterizing mental health (Iliceto et al., 2020). Some researchers even regard psychological security and mental health as synonyms (Geng et al., 2021). There are two main sources of psychological security, one is the cognition of whether the environment is safe and the other is the judgment of whether one is capable of coping with changes (Aranzamendez et al., 2014). When college freshmen shift from a familiar environment to a new environment, it forces them to face the pressure of readjusting to the new environment and rebuilding interpersonal relationship, and they are vulnerable to psychological security problems (Hiester et al., 2009; Li X. et al., 2021). Therefore, this study uses psychological security as an indicator of freshmen's mental health. According to the theory of emotional security, an individual's interpersonal troubles will have an impact on his psychological security (Cummings and Miller-Graff, 2015). A good interpersonal relationship is an important way to obtain a sense of security (Bostrom et al., 2013). Existing empirical studies have also shown that classmate relationship and teacher-student relationship in high school are significant predictors of psychological security of students in Grade 10 (Huang et al., 2020). Therefore, the study tried to hypothesize the following:

> *Hypothesis 1*: Interpersonal stress will significantly predict psychological security.

The Moderating Effect of Grit

Previous studies have found that interpersonal stress of college students is a risk factor affecting their mental health (Wang and An, 2014; Ye et al., 2021); however, not all people who encounter interpersonal risk factors present with mental health and behavioral problems (Forrest-Bank, S et al., 2014). The key reason lies in the protective effect of positive psychological qualities (such as grit and psychological capitals; Hobfoll, 1989; Kaniuka et al., 2020). With the rise of positive psychology orientation in the field of mental health research, the positive effects of grit on individual psychology and behavior have attracted the attention of many researchers. Grit, as a positive

psychological quality, is often described as a personality characteristic for coping with difficulties and stress (Stoffel and Cain, 2018). Grit is the persistence of interest in the pursuit of goals and the perseverance to overcome difficulties and pressures (Duckworth et al., 2007; Duckworth, 2016), which mainly includes perseverance (reflecting the degree of a person's unremitting pursuit of goals and positive altitude in facing difficulties) and passion (reflecting the degree of a person's devotion or concentration to a certain thing or activity; Duckworth et al., 2007). Based on China's national conditions, Lu et al. (2012) further expanded the connotation of grit on the basis of perseverance and passion, adding control (the ability to control one's own emotions and surrounding events), and challenge (whether an individual can take change as a challenge and move forward bravely) as its factors (Lu et al., 2012). This proposal has been promoted in China, and its reliability and validity have been well verified (Yu et al., 2014; Zhang and Liang, 2016).

In recent years, researchers have paid more attentions to the protective effect of grit on mental health. According to the theoretical model of the relationship between grit and health (Maddi and Khoshaba, 1994), the protective effect of grit on mental health is mainly through moderating effect on stress, so as to maintain and improve mental health level. Some empirical studies have also verified the protective effect of grit in the face of stress on mental health. For example, Marie et al. (2019) found that grit protected college students from suicidal thoughts by weakening the negative effects of post-traumatic stress disorder (Marie et al., 2019). Li J. et al. (2021) found that grit buffered the negative effects of peer bullying and school disengagement on problematic Internet game use in adolescents (Li and Zhu, 2020). Kleiman et al. (2013) found that grit protected people from suicidal intention by increasing their pursuit of the meaning of life (Kleiman et al., 2013). Based on previous studies, this study posits that grit could buffer the impact of interpersonal stress on freshmen's psychological security, that is, grit plays a moderating role in interpersonal stress and psychological security.

Although the protective effect of positive psychology (resilience, self-resilience, and emotional regulation) on mental health has been recognized by many researchers (Hobfoll, 1989; Vanderbilt-Adriance and Shaw, 2008; Sleijpen et al., 2017; Weissman et al., 2021), there are two different views on the mechanism of positive psychology between stress and mental health (Li et al., 2012). One is the stress-buffering hypothesis. According to this model, positive psychology can buffer the adverse effects of stress on mental health, and this buffering effect is more obvious when stress is high (Johnson et al., 2011). The theoretical model is supported by relevant empirical studies. For example, Li X. et al. (2021) found that grit buffered the negative effects of peer bullying and school disengagement on problematic Internet game use in adolescents, and the result was more obvious when peer bullying and school disengagement were serious (Li and Zhu, 2020). The other is the stress-vulnerability hypothesis, which holds that positive psychology has limited effects on mental health by buffering stress. Comparatively speaking, the buffering effect of positive psychology is greater when stress stays in low level (Hankin et al., 2004; Ingram and Luxton, 2005). This view is also supported by empirical studies. For example, previous study found that the protective effect of mental resilience on adolescents' Internet addiction decreased with the increase of autocratic parenting style (Liu and Li, 2017). Although a series of studies were conducted on the protective effect of grit, the mechanism of this protective effect is still unclear. This study further analyzes whether the protective effect of grit is a hypothesis of stress-buffering or stress vulnerability. *It is known that, for Chinese people, interpersonal relationships are regarded as extremely important social resources and have important effects on individual psychology and behavior* (Datu, 2017). *Usually, when individuals encounter severe interpersonal stress, they will greatly lose energy and attention* (Herman, 1992), *resulting in a lack of self-confidence in the individual's control of the surrounding environment. Therefore, the study tried to hypothesize the following:*

> *Hypothesis 2*: Grit will act as a moderator between interpersonal stress and psychological security. Specially, when the level of interpersonal stress is low, grit can better protect the psychological security of college freshmen; when the level of interpersonal stress is high, the protecting effect will decline.

The Mediating Effect of Grit

Grit not only may play a moderating role in the relationship between interpersonal stress and sense of security, but also may play a mediating role. According to the relationship model between psychological diathesis and mental health (Wang and Zhang, 2012), psychological diathesis is an endogenous factor determining the level of individual mental health, and external pathogenic risk factors will play a role through internal psychological quality. The internal psychological diathesis can not only moderate the influence of external risk factors on individual mental health, but also exert direct or mediating effect on individual mental health. Different from other personality theories, positive psychology believes that grit is not a stable personality trait, but a state trait that is influenced by a variety of factors and conducive to the healthy development of individuals (Duckworth and Yeager, 2015). According to trauma theory, it is difficult for people to focus their energy and attention on practical behaviors when facing interpersonal problems (Herman, 1992). Some researchers believe that grit act as more "state-like" than "trait-like," which is easily changed by other factors (Jiang et al., 2019). Relevant empirical studies have also found that adverse childhood experiences would have a negative impact on the grit of college students, and different types of adverse childhood experiences would have different impacts on grit (Cheung et al., 2021). Students' anxiety about math will weaken their grit in math learning, thus impacting math performance (Yu et al., 2021). Jiang et al. (2019) found through a longitudinal study that students' academic performance would affect their grit level in the later period (Jiang et al., 2019). Based on previous studies, this study infers that

interpersonal stress, a severe stressor for college freshmen to adapt to a new environment, negatively predicts their grit level.

In addition, as a positive personality trait, grit is also closely associated with mental health. Many relevant studies have been carried out in the field of empirical research. For example, the higher the level of grit was, the lower was the level of post-traumatic stress disorder in medical care providers (Musso et al., 2019) and the higher was the wellbeing in adults (Datu et al., 2018; Li et al., 2018), and the lower was the depression and anxiety of college students (Musumari et al., 2018). *Therefore, the study tried to hypothesize the following:*

Hypothesis 3: Interpersonal stress will significantly predict grit.

Hypothesis 4: Grit will act as a mediator between interpersonal stress and psychological security.

Present Study

This is helpful to better understand the role of grit in the relationship between interpersonal stress and psychological security, and to provide some ideas for future psychological security interventions. Therefore, this research sought to examine the multiple roles of grit in the relationship between interpersonal stress and psychological security from moderating variables and mediating variables, guided by the theoretical model of the relationship between psychological quality and mental health. Study 1 explored the moderating effect of grit on the relationship between interpersonal stress and psychological security. On the basis of verifying the results of study 1, study 2 further explored the mediating role of grit in the relationship between interpersonal stress and psychological security.

STUDY 1

The main purpose of study 1 was to explore whether grit plays a moderating role in the relationship between interpersonal stress and psychological security, and to further examine whether the nature of this moderating role is stress-buffering or stress vulnerability.

Materials and Methods

Participants and Procedure

A total of 1,317 freshmen were recruited from colleges and universities in City Zunyi, China. After eliminating 93 incomplete questionnaires, 1,224 valid questionnaires were preserved, with an effective rate of 92.9%. The mean age of the subjects was 19.91 years old ($SD = 0.87$ years). Of these, 55.3% were girls. The entire set of questionnaires composed of the instructions and questionnaires was distributed in the form of a paper questionnaire manual and tested by participants anonymously in the classroom and collected on the spot. This study was approved by the Review Committee of Zunyi Normal College, and participants of the study voluntarily participated in this questionnaire survey.

Measures

Grit

Grit was assessed using Hardiness Scale (HS) which was developed by Lu et al. (2012). There were 27 items in total, including four subscales. They are about perseverance, control, commitment, and challenge. Sample item used to measure persistence goes as "If I have a definite goal, I will not give up even when I encounter obstacles." Sample item used to test control factors goes as "I like to try new and exciting things." Sample item to test engagement factor goes as "I get involved in even simple tasks." Sample item to test the challenge factor goes as "When I encounter difficulties, I always try to find a solution." The scale is scored in four levels, with four options from 1 to 4 being "completely inconsistent," "somewhat consistent," "consistent," and "completely consistent." The higher the score is, the stronger is the personality grit. The reliability and validity of this questionnaire have been fully verified (Yu et al., 2014). In this study, reliability coefficients (Cronbach' α) of the internal consistency of subscales involving perseverance, control, commitment and challenge, and total scale were 0.76, 0.83, 0.81, 0.79, and 0.94, respectively. In this study, the total score of the questionnaire is used to describe grit, mainly because the total score of the questionnaire is considered to be a comprehensive evaluation of grit (Duckworth and Gross, 2014; Li et al., 2018).

Interpersonal Stress

Interpersonal stress was assessed using the Interpersonal Relation Synthetic Diagnose Test (Zheng, 1999), which has 28 items in total, including four factors: conversation, making friends, manner of dealing with people and events, and heterosexual communication. "Yes" counts for 1 point and "no" counts for 0 point. The higher scores indicate severe interpersonal stress. In this study, reliability coefficients (Cronbach' α) of the internal consistency of subscales involving conversation, making friends, manner of dealing with people and events, and heterosexual communication and total scale were 0.73, 0.78, 0.65, 0.71, and 0.90, respectively. For a brief description of interpersonal stress, the subsequent data are presented with a total score for interpersonal stress.

Psychological Security

Psychological security was assessed using Psychological Safety Scale (Cong and An, 2004). There are 16 items in total, including two main factors of interpersonal security and certainty in control. The scale was scored at five levels, with five options from 1 to 5 being "very consistent," "basically consistent," "neutral or uncertain," "basically inconsistent," and "very inconsistent." The higher the total score is, the stronger is the person's psychological security. In this study, the reliability coefficients (Cronbach' α) of internal consistency of subscale involving interpersonal security and certainty in control and total scale were 0.88, 0.88, and 0.93, respectively. In order to briefly describe psychological security, the subsequent data are expressed as the total score of psychological security.

Covariates

As socioeconomic characteristics, such as age and gender, have a significant impact on the total grit scores (*See* Kannangara et al., 2018)*, we treated the socioeconomic characteristics of the subjects as covariates, in order to get the true relationship between grit, interpersonal stress, and psychological security*, such as age and gender (1 = male; 2 = female), annual family income (1 = less than 10,000 yuan, 2 = 10,000–30,000 yuan, 3 = 30,000–60,000 yuan, 4 = 60,000–100,000 yuan, 5 = more than 100,000 yuan), only child (1 = only child, 2 = non-only child), and household registration (1 = rural, 2 = city).

Data Analysis

SPSS 26.0 was used for data analysis, and all missing values were removed from the data. Harman's single-factor test was used to check the degree of deviation of the common methods in this study. Unrotated exploratory factor analysis of all variables showed that there were 13 factors with characteristic roots greater than 1, and the variance explained by the first factor was 20.95%, which did not exceed the critical standard of 40%. Therefore, it can be assumed that there was were no serious common method biases in the variables involved in Study 1. Descriptive analysis and correlation analysis were adopted to test the mean and standard deviation of each variable and their correlation coefficients. Then, hierarchical regression analysis was used to examine the moderating effect of grit on the relationship between interpersonal stress and psychological safety, and the significance of moderating effects was further conducted by a simple slope test. In addition, all these variables, such as age, gender, family income, birth, and only child of college freshmen, were treated as covariates.

Results and Discussion

Means, standard deviations, and intercorrelations among all variables are presented in **Table 1**. As expected, interpersonal stress was significantly negatively correlated with psychological security ($r = -0.62$, $p < 0.001$). Grit significantly negatively correlated with interpersonal stress ($r = -0.21$, $p < 0.001$) and positively correlated with psychological security ($r = 0.36$, $p < 0.001$).

Hierarchical regression analysis was used to examine the moderating effect of grit on the relationship between interpersonal stress and psychological security, and the results showed that interpersonal stress significantly negatively predicted psychological security ($\beta = -0.56$, $p < 0.001$; Hypothesis 1), while grit significantly positively predicted psychological security ($\beta = 0.24$, $p < 0.001$). The interaction effect of interpersonal stress and grit significantly predicted psychological security ($\beta = -0.07$, $p < 0.01$), suggesting that grit had a significant moderating effect, as shown in **Table 2**.

In order to better present the essence of the moderating effect of grit on the relationship between interpersonal stress and psychological security, high score group and low score group were divided based on the mean value of grit plus or minus one standard deviation, and a simple effect analysis chart was drawn, as shown in **Figure 1**. Simple slope test found that when the grit level was low (*M*-1*SD*), psychological security showed a declining trend with interpersonal stress score increases (simple slope = −0.51, $t = -18.36$, $p < 0.01$); with the increase of interpersonal stress score, the decreasing trend of psychological security was more obvious when grit level was high (simple slope = −0.64, $t = -19.42$, $p < 0.01$). In other words, with the increase of interpersonal stress, the protective effect of grit on psychological security decreased rapidly. Therefore, the moderating effect of grit on the relationship between interpersonal stress and psychological security could be explained by the stress-vulnerability model (Hypothesis 2).

STUDY 2

First, study 2 used another set of data to re-examine the stability of study 1's results, namely, to examine the moderating effect of grit on the relationship between interpersonal stress and psychological security. Secondly, the mediating effect of grit was examined on interpersonal stress and psychological security.

Materials and Methods

Participants and Procedure

A total of 647 freshmen were recruited from another university in city Guiyang, Province Guizhou, China. After 43 incomplete questionnaires were removed, 604 valid questionnaires remained, with an effective rate of 93.3%. The mean age of these was 19.93 years old (*SD* = 0.83 years), 54.3% were girls. Its procedure was the same as that of study 1.

Measures

Questionnaires covering grit, interpersonal stress, and psychological security were the same as these used in study 1, and intrinsic reliability was recalculated using the data collected from Study 2. The reliability coefficients (Cronbach' α) of the internal consistency of subscales involving perseverance, control, commitment and challenge, and total scale were 0.76,

TABLE 1 | The mean (*M*), standard deviation (*SD*), and correlations of main variables in Study 1.

S. No.		*M*	*SD*	1	2	3
1.	Interpersonal stress	8.32	6.19	–		
2.	Grit	66.03	12.43	−0.21***	–	
3.	Psychological security	52.05	12.33	−0.62***	0.36***	–

*N = 1224, ***p < 0.001.*

TABLE 2 | Analysis of the moderating effect of grit on interpersonal stress and psychological security in Study 1.

Variables	*F*	*B*	*SE*	*β*	*t*
Step 1	3.63**				
Age		0.49	0.41	0.03	1.18
Sex		−2.19	0.73	−0.09	−2.99**
Annual family income		0.59	0.31	0.06	1.89
Only child		−1.54	1.27	−0.04	−1.22
Household registration		0.62	1.26	0.02	0.49
Step 2	134.34***				
Interpersonal stress		−1.12	0.04	−0.56	−25.36***
Grit		0.24	0.02	0.24	10.86***
Step 3	119.71***				
Interpersonal stress × grit		−0.01	0.01	0.07	−3.20**

$^{**}p<0.01$, $^{***}p<0.001$.

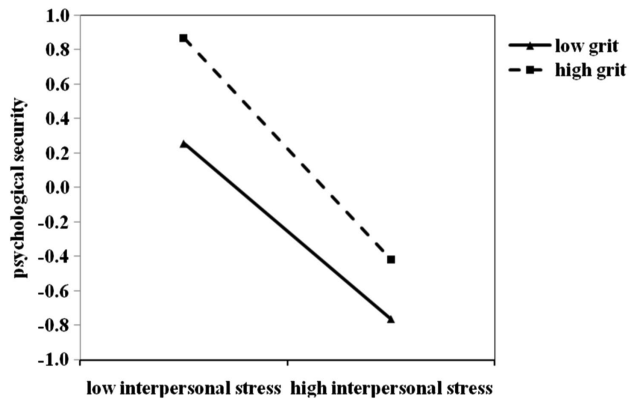

FIGURE 1 | The moderating role of grit on the relationship between Interpersonal stress and Psychological security in Study 1. All the study variables were standardized. High/low level of Interpersonal stress = M ± 1SD. High/low level of grit = M ± 1SD.

0.85, 0.81, 0.80, and 0.95, respectively. The reliability coefficients (Cronbach' α) of internal consistency of the internal consistency of subscales involving conversation, making friends, manner of dealing with people and events, and heterosexual communication and total scale were 0.74, 0.78, 0.69, 0.73, and 0.91, respectively. The reliability coefficients (Cronbach' α) of internal consistency of subscale involving interpersonal security and certainty in control and total scale were 0.89, 0.88, and 0.94, respectively.

Data Analysis

Except for the mediating effect analysis method, the data analysis tools and procedures used in study 2 were the same as those used in Study 1. The results of Harman's single-factor test showed that there were 15 factors with characteristic roots greater than 1, and the variance explained by the first factor was 21.94%, which did not exceed the critical standard of 40%. Therefore, it could be assumed that there were no serious common method biases in the variables involved in Study 2. In study 2, the PROCESS Macro developed by Hayes (2018) was used to analyze the mediating effect, with interpersonal stress as the independent variable, grit as the mediating variable, and psychological security as the dependent variable. Bias-corrected bootstrapped confidence intervals were used to test the significance of the mediating effect of grit (subsample $N = 5{,}000$), and the regression coefficients were standardized. At the same time, the age, gender, family income, family birth, and only child of freshmen were treated as covariates.

Results and Discussion

Means, standard deviations, and intercorrelations among all variables were presented in **Table 3**. As expected, interpersonal stress was negatively correlated with psychological security ($r = -0.60$, $p < 0.001$; Hypothesis 2). Grit negatively correlated with interpersonal stress ($r = -0.22$, $p < 0.001$) and positively correlated with psychological security ($r = 0.39$, $p < 0.001$).

Furthermore, we repeated the steps in study 1 to examine the moderating effect of grit on the relationship between interpersonal stress and psychological security. The results showed that interpersonal stress negatively predicted psychological security ($\beta = -0.53$, $p < 0.001$), while grit positively predicted psychological security ($\beta = 0.26$, $p < 0.001$). The interaction effect of interpersonal stress and grit significantly predicted psychological security ($\beta = -0.09$, $p < 0.01$), suggesting that grit had a significant moderating effect, as shown in **Table 4**. In order to better present the essence of the moderating effect of grit on the relationship between interpersonal stress and psychological security, the method of study 1 was repeated and a simple effect analysis chart was drawn, as shown in **Figure 2**. Simple slope analysis showed that when the grit level was low (M-1SD), the psychological security followed a decreasing trend with the increase of interpersonal stress score (simple slope = −0.48, $t = -12.33$, $p < 0.01$). With the increase of interpersonal stress score, the decrease of psychological security was more obvious when grit level was high (simple slope = −0.64, $t = -12.86$, $p < 0.01$). In other words, with the increase of interpersonal stress, the protective effect of grit on psychological security decreased rapidly (Hypothesis 2). Therefore, Study 2 again verified that the moderating effect of grit on the relationship between interpersonal stress and psychological security which could be explained by the stress-vulnerability model.

TABLE 3 | The mean (*M*), standard deviation (*SD*), and correlation coefficients of the main variables in Study 2.

S. No.		*M*	*SD*	1	2	3
1.	Interpersonal stress	8.09	6.25	–		
2.	Grit	66.39	12.94	−0.22***	–	
3.	Psychological security	52.51	12.55	−0.60***	0.39***	–

N = 604, ***p < 0.001.

TABLE 4 | Analysis of the moderating effect of grit on interpersonal stress and psychological security in Study 2.

Variables	*F*	*B*	*SE*	*β*	*t*
Step 1	2.85**				
Age		1.30	0.63	0.09	2.08*
Sex		−2.52	1.06	−0.10	−2.38*
Annual family income		0.48	0.45	0.04	1.06
Only child		−2.10	1.81	−0.05	−1.16
Household registration		1.62	1.76	0.04	0.92
Step 2	63.39***				
Interpersonal stress		−1.07	0.07	−0.53	−16.61***
Grit		0.25	0.03	0.26	8.14***
Step 3	56.98***				
Interpersonal stress × grit		−0.01	0.01	−0.09	−2.71**

*p < 0.05, **p < 0.01, ***p < 0.001.

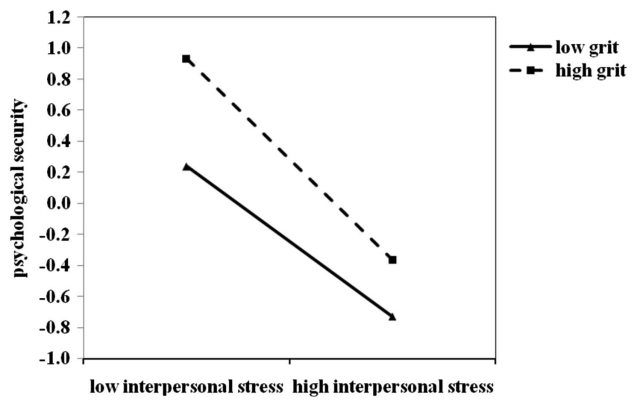

FIGURE 2 | The moderating role of grit on the relationship between Interpersonal stress and Psychological security in Study 2. All the study variables were standardized. High/low level of Interpersonal stress = M ± 1SD. High/low level of grit = M ± 1SD.

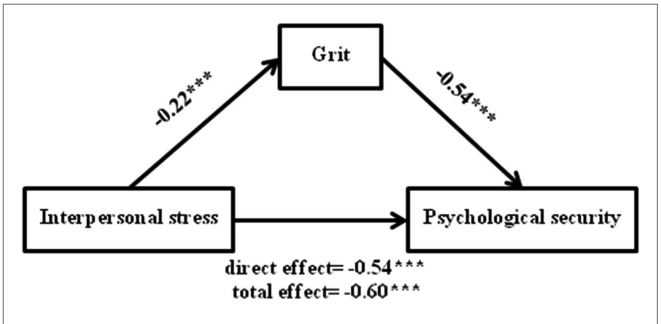

FIGURE 3 | Mediation model of interpersonal stress as a predictor of psychological security mediated by grit. Standardized regression coefficients are displayed for all paths. ***p < 0.001.

Finally, we examined the mediating effect of grit on the relationship between interpersonal stress and psychological security. The results showed that the direct effect of interpersonal stress on psychological security was −0.54 (95% CI = [−0.60, −0.47]), and the indirect effect of grit was −0.06 (95% CI = [−0.09, −0.03]). Bootstrap 95% confidence interval for the mediating effect did not include 0, indicating that the mediating effect of grit was significant, accounting for 10% of the total effect, as shown in **Figure 3**. The results of this study indicated that interpersonal stress of college freshmen could directly affect the level of psychological security and also indirectly affected the level of psychological security through the mediation of grit (Hypothesis 3 and 4).

GENERAL DISCUSSION

Guided by the relationship model of psychological quality and mental health, this study took college freshmen as participants and explored the effecting mechanism of grit on the relationship between interpersonal stress and psychological security. All hypotheses were supported, and both study 1 and 2 found that grit could buffer the effect of interpersonal stress of college students on the level of psychological security, but this buffering only evidently be showed in the lower level of interpersonal stress, and

this buffering declined rapidly at higher levels of interpersonal stress. In addition, this study also found that interpersonal stress not only directly affected the level of psychological security, but also had an impact on the level of psychological security through the mediation of grit.

The Moderating Effect of Grit

This study found that grit played a moderating role in the relationship between interpersonal stress and psychological security, which supported the theoretical view of the relationship between grit and health (Kobasa and Puccetti, 1983). The theory described grit as a protective factor when people deal with stressful events, that is, grit could buffer the adverse effects of stress on mental health. At the same time, this result is consistent with the relevant empirical results. Marie et al. (2019) found that grit protected individuals who suffered traumatic experiences from suicidal idea. We can understand the protective role of grit against stress in this way: gritty individuals will actively seek change in the face of stress and difficulties (Duckworth et al., 2009) and mobilize their own positive emotions and resources to cope with stress, so as to alleviate the adverse effects of stress on themselves and avoid anxiety, depression, and other adverse emotions (Musumari et al., 2018). Moreover, gritty individuals are more likely to receive social support (Wallace et al., 2001). Thus, gritty individuals may exhibit less mental health confusion and higher levels of psychological security. It is worth noting that an important finding of this study is that grit had a significant buffering effect on stress only when the level of stress was low, so the protective effect of grit on psychological security is suitable to be explained by the stress-vulnerability model (Li et al., 2012). This phenomenon can also be mentioned in related research on individual positive resources. For example, Praharso et al. (2017) found that social support was also vulnerable to buffering the impact of life changes on college freshmen depression. The protective effect of grit on mental health was more obvious when the stress was low. When the pressure was high, the protective effect of grit would decrease significantly. This suggests that although grit has a protective effect on people's mental health, we should not overstate the role and scope of grit. Therefore, in the future intervention of psychological security, it should not be ignored to focus on relieving the stressors themselves (such as interpersonal stress).

The Mediating Effect of Grit

In this study, grit was also found to have a mediating role in the relationship between interpersonal stress and psychological security. In other words, interpersonal stress could directly affect the level of psychological security and also could affect psychological security through the indirect effect of grit. It could be explained in two ways. On the one hand, interpersonal stress negatively predicts grit. This is consistent with the findings of related studies that adverse childhood experiences negatively predict grit level of college students (Cheung et al., 2021). According to self-determination theory, the satisfaction of belongingness needs is the basic premise for a person's healthy growth and development (Ryan and Deci, 2000). If an individual encounters interpersonal troubles, such as being rejected, ignored, or repelled, his sense of belonging will not be satisfied. This sense of belonging in interpersonal relationships is very important for Chinese people who are collectivist-value-oriented (Datu, 2017), which will affect the persistence of individual behaviors and make it difficult for individuals to focus their energy and attention on behaviors (Herman, 1992), thus leading to a decline in grit level. One the other hand, grit positively predicted psychological security. This is consistent with the findings of relevant studies that grit positively predicted the psychological security of the elderly (Wallace et al., 2001). It can be interpreted as follows: gritty individuals are more likely to pursue the meaning of life and goals in life (Hill et al., 2016), and they tend to believe that their abilities can be improved through their own efforts (West et al., 2016). They exhibit higher self-discipline in daily life and learning (Muenks et al., 2016) and self-improving learning behaviors (Wolters and Hussain, 2014), thus making their lives more fulfilling and secure.

Especially in Study 2, grit was found to be functional in mediating the relationship between interpersonal stress and psychological security, which provides implications for future interventions of grit or psychological security. On the one hand, grit is not fixed to some extent, but relatively variable and plastic (Wang et al., 2018; Alan et al., 2019), which could be affected by external or internal factors (Wong and Vallacher, 2018); therefore, intervention methods can be used in the future. For example, improving academic performance (Tang et al., 2019), expanding social support (Wallace et al., 2001), and fostering growth mindset (Wang et al., 2018) can improve the grit level of individuals (Alan et al., 2019). On the other hand, in addition to improving interpersonal relationships, grit can also serve as a starting point to improve the psychological security of college freshmen.

The Multiple Roles of Grit

In this study, we found that grit plays multiple roles between interpersonal stress and psychological security, namely, a moderating role and a mediating role. This means that interpersonal stress indirectly affects psychological security through the mediation of grit, and the relationship between interpersonal stress and psychological security depends on the level of grit. In other words, grit is a bridge of interpersonal stress affecting psychological security, and will change the direction and intensity of interpersonal stress and psychological security, and is an important resource for college freshmen to maintain mental health. The results of this study support the view of the relationship model between psychological quality and mental health, that is, risk factors play a role through internal psychological quality, and the internal psychological quality can not only moderate the impact of external risk factors on individual mental health, but also influence individual mental health level directly or serves as a mediating variable (Wang and Zhang, 2012). The simultaneous moderating and mediating effects of one variable have been similarly verified in other studies (Dicke et al., 2014; Attar-Schwartz, 2015). *Based on the findings of this study, combined with the view of the relationship model between psychological quality and mental health* (Liu and Li, 2017)*, we propose an*

dual-effects theory about grit. According to this theoretical model, grit can be regarded as a complex binary construct that affects mental health. On the one hand, as a plastic variable, grit is affected by external risk factors, such as interpersonal stress. The interpersonal stress will inhibit the positive effects of grit to a certain extent. In this case, grit mediates the relations between external risk factors and mental health. On the other hand, as a relatively stable and important personality trait, grit can also interact with external risk factors to affect mental health. Thereby, grit may act as mediator and moderator between external risk factors and mental health at the same time, changing the direction and intensity of the risk factors' impact on mental health. In general, the results of this study expand our understanding of the concept of grit, namely, grit is relatively stable and variable; at the same time, integrating with the previous research results, we consider that grit acts on as both mediator and moderator in mental health, and therefore, the present study helps us deeply understands the mechanism of grit between risk factors and mental health. Moreover, the results of this study can also help us to explain the development outcome of mental health (*such as psychological security*) *and the complex process of its formation. Taken together, the present study provides important theoretical insights and practical guidance for both the prevention and intervention of mental health.*

Limitations

This study has several limitations. First of all, this study conducted a cross-sectional study on the moderating and mediating effects of grit on the relationship between interpersonal stress and psychological security, and a cautious attitude should be taken in interpreting the results (Fiedler et al., 2011). This is because cross-sectional methods cannot well describe the causal relationship among interpersonal stress, grit, and psychological security. In addition, this study found that the protective effect of grit on psychological security was applicable to low level of interpersonal stress, which supported the hypothesis of stress vulnerability of positive psychological quality instead of the stress-buffering hypothesis. However, it remains to be explored whether the protective effect of grit decreased because the depletion of grit was caused by high level of interpersonal stress. In the future, longitudinal research can be used to explore the influence of different levels of interpersonal stress on grit, so as to verify whether high level of interpersonal stress will cause the loss of grit. Secondly, this study collected data through self-evaluation, and some of the questionnaires involved the evaluation of individuals, such as The Interpersonal Relation Synthetic Diagnose Test, which is easy to induce the social evaluation anxiety of the participants, and may lead to the concealment of true responses of the participants, thus interfering with the results of the study. Therefore, future studies can consider interviews or other evaluation methods (Hill et al., 1998). Thirdly, this study only analyzes the influence of interpersonal stress on grit and psychological security, without examining the influence of other possible important factors, such as students' academic performance. Some studies showed that academic performance was closely related to grit and psychological problems of college freshmen (Bruffaerts et al., 2018). In addition, the data in this study were selected from objects with Chinese cultural background, and whether it can be extended to objects of other cultures remains to be further tested. For instance, Chinese society emphasizes collectivism, while the West emphasizes individualism (Wang et al., 2019). The question of whether interpersonal stress might have a more pronounced effect on grit in China other than in the West remains to be explored.

CONCLUSION

This study examined the effecting mechanism of grit on the relationship between interpersonal stress and psychological security of college freshmen, and found that grit played multiple roles. First, grit moderated the relationship between interpersonal stress and psychological security. Specifically, grit could buffer the negative impact of interpersonal stress on psychological security. However, this effect was obvious only when the level of interpersonal stress was low, and decreased rapidly when the level of interpersonal stress was high. Secondly, grit played a mediating role between interpersonal stress and psychological security, that is, interpersonal stress not only directly affects psychological security, but also affects psychological security through the mediating role of grit.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Committee of Zunyi Normal College. Participation was voluntary, based on written informed consent, and withdrawal from the studies was allowed at any given time. Written informed consent was obtained from all participants for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

QY and KX conceived and designed the study. MS, DT, and HZ contributed to data collection. QY analyzed the data. QY, MS, and KX wrote the paper. All authors reviewed and approved the manuscript.

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The Association Between Connectedness and Grit Among Thai In-school Adolescents in Urban Chiang Mai, Thailand

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Aim: To investigate the associations between Grit, connectedness, and parental involvement in Thai adolescents. Grit, perseverance, and passion for long-term goals are predictors of academic success and health. There is a small but developing knowledge of the predictors of Grit in Asia, especially Thailand. This paper investigates the proposition that connectedness and parental involvement are positively associated with Grit.

Method: A total of 2,839 lower secondary (grade 8), higher secondary (grade 11), and vocational (year 12) students from 21 schools in Chiang Mai, Thailand participated in a survey that measured Grit using the Short Grit Scale. Bivariate analysis was conducted using the *t*-test, ANOVA, or Kruskal–Wallis H test as appropriate. Multiple ordinary least squares linear regression analysis was performed to determine factors associated with Grit.

Results: Satisfactory relationships with teachers ($p = 0.01$), parental support ($p = 0.03$), interest in school ($p = 0.01$), having been asked by parents to do homework ($\beta = -0.69$; $p = 0.012$), and having been told by parents that they had done something bad ($\beta = -1.09$; $p = 0.02$) associated with Grit. These findings can aid in design of tailored interventions to improve Grit in Thai adolescents.

Keywords: Grit, students, connectedness, parental involvement, Thailand

INTRODUCTION

Researchers have long been interested in identifying factors that contribute to academic attainment and a healthy successful life. One non-cognitive factor that has rapidly captured the attention and curiosity of educators, researchers, policymakers, and the public as a strong predictor of academic, health, and life success is Grit (Duckworth et al., 2007; Duckworth and Quinn, 2009). Grit has been examined for its contribution to academic and work-related success in Western countries. Thus far, it has not been extensively investigated in developing Asian countries with lower educational resources. Individual student characteristics, such as effort, make a

significant but slighter smaller contribution than socio-economic background to student performance (Asadullah et al., 2021) while high performing South-East Asian education systems such as Vietnam appear to benefit from favorable individual cultural capital characteristics such as Grit, discipline, or perseverance. This study focusses on Thailand which does not perform as well on Grit or on educational performance (Asadullah et al., 2020), as some other Asian countries. Given Grit's potential role in contributing to academic success and the need to improve Thailand's educational performance, it is useful to explore factors, such as connectedness and positive parental involvement, that may contribute to improved Grit.

Theoretical Background

Grit has been conceived as a personality trait and is defined as "perseverance and passion for long-term goals" and as "working strenuously toward challenges, maintaining effort and interest over years despite failure, adversity, and plateaus in progress" (Duckworth et al., 2007). Grit consists of two components: perseverance of efforts and consistency of interest that in combination make the higher-order construct of Grit. Although Grit has been extensively questioned as a construct (Credé et al., 2017), its use is growing as an important component of successful education.

A growing body of research has investigated how Grit is constructed and whether it can be clearly distinguished from similar concepts. For example, a study of nursing students found that Grit is correlated with resilience because it includes persistent effort, although it is also distinguished by "consistent interest" or ability to "stick" when things get difficult (Meyer et al., 2020). Grit also differs from enthusiasm which appears to be important to educational outcomes but can be feigned (Moe, 2016; Moe et al., 2021). Enthusiasm and passion are similar (Keller et al., 2016), although the component of passion in Grit has been described as "strong enthusiasm" (Sigmundsson et al., 2020).

Grit as Predictors of Life Success

Grit is increasingly seen as important as it has been found to account for variance in successful academic outcomes over explanations provided by traditional intelligence quotient (IQ) tests. It also predicts health behaviors, and life success in the form of marriage stability and employment retention (Duckworth et al., 2007; Reed et al., 2013; Eskreis-Winkler et al., 2014). Those showing Grit were more likely to succeed in various goals: students were more likely to graduate from high school; soldiers were more likely to complete an Army Special Operations Forces (ARSOF) selection course; sales employees were more likely to keep their jobs; and men were more likely to stay married (Eskreis-Winkler et al., 2014). Higher measured Grit is also related to greater healthcare management skills, higher mental health-related quality of life, and higher physical health-related quality of life in college students (Sharkey et al., 2017). In addition, Grit has been identified as a protective factor against substance use and risk behaviors, suicide risks, late-life cognitive impairment, and negative self-concept in children with reading disorders (Kleiman et al., 2013; Guerrero et al., 2016; Thomas et al., 2016; Credé et al., 2017; Rhodes et al., 2017).

Given that Grit predicts academic, health, and life successes and has been identified as a protective factor against negative consequences in life. Examining factors associating with Grit may be a critical step in identifying possible areas of intervention to enhance Grit. It is important to measure Grit among young people as it is associated with future success over the life course.

Social Connectedness as a Factor for Grit Development

Although Grit is largely contingent on genetic factors (Rimfeld et al., 2016; Tucker-Drob et al., 2016), like other personality traits, it can be influenced by social and environmental factors (Duckworth et al., 2007; Datu, 2017, 2021; Alan et al., 2019). However, most research on Grit thus far has examined its predictive validity toward academic and life success. There is a dearth of research that has examined Grit as an outcome. Few studies have linked Grit to social connectedness. As defined by Catalano et al., connectedness is the emotional attachment and commitment a child makes to social relationships in the family, peer group, school community, or culture (Catalano et al., 2002). It is recognized that the quality of a child's bonds to family and other domains is an essential element of positive development into a healthy adult. In relationship with Grit, studies among middle and high school students in the United States have shown that factors such as school engagement, relationships with adults and peers, and school culture were strongly related to Grit (Farrington et al., 2012).

As we have noted much of the current knowledge on Grit derives from research in western countries. One of the few studies conducted in an Asian context argues that in collectivist Asian cultures, Grit is positively associated with connectedness or relatedness. A study of Filipino high school students found that having positive relationships with parents and teachers matters for long-term goals (Datu, 2017). However, this study did not include specific factors related to practical areas of parental involvement. A Chinese study found that some Adverse Childhood Experiences (ACEs) that are sometimes associated with the home environment, may negatively impact Grit (Cheung et al., 2021). It seems that sexual and emotional abuse and neglect from ACEs impacts negatively on relatedness (Cheung) which is related to Grit. A recent study that compared Grit and mindfulness between students in New Zealand and Thailand found no difference in effort between the two groups; however, the New Zealand students endorsed higher levels of perseverance of effort relative to Thai students (Raphiphatthana et al., 2019). Another study among high school students in Thailand found no correlation between Grit and success in computer programming learning (Thanasuan et al., 2017). The study was, however, limited by its small sample size (46 participants). Despite increasing interest in Grit globally, few studies thus far have examined the associations between Grit, connectedness, and family involvement anywhere, including Thailand.

Conceptual Framework

In this study, we use the theoretical underpinning of Grit developed by Duckworth and others as described above to explore the relationship between social connectedness and Grit

in Thai in-school adolescents in Chiang Mai. In particular, we investigate the concept of how social connectedness acts in predicting or developing Grit. We hypothesized that connectedness to social agents (parents, peers, and teachers) has positive correlation to Grit in Thai in-school adolescents in Chiang Mai.

MATERIALS AND METHODS

Study Design, Population, and Setting

This is a cross-sectional, quantitative study conducted in urban Chiang Mai between November 2016 and February 2017 designed to investigate associations with Grit and factors that may predict it. For the education system in Thailand, school levels are divided into primary schools (grades 1–6), lower secondary schools (grades 7–9), higher secondary schools (grades 10–12), and vocational schools (years 1–3, which equivalent to grades 10–12 in higher secondary schools). In urban area Chiang Mai City, it has 21 secondary and vocational schools in total, including 15 secondary schools, which having both lower and higher secondary school levels (five public and 10 private), and six vocational schools (two public and four private). Participants were recruited from all 21 schools in urban Chiang Mai. They were recruited from among lower secondary students (grade 8), higher secondary students (grade 11), and vocational school students (year 2).

The recruitment was a two-step process. Cluster random sampling was conducted. The first step consisted of a random selection of the classrooms in each school. In the second step, all students in each of the selected classrooms were invited to participate in the study. The number of students in the selected classrooms ranged between 20 and 45. All invited students participated in the study, giving a 100% response rate. The sample size was calculated using methods previously described by Krejcie and Morgan (1970). The overall sample was conceptualized as comprising two subsamples from each type of school (lower secondary school, higher secondary school, and vocational school), with each representing males and females separately, and is summarized in **Appendix Table 1**. The sample size in this study was calculated with a 5% margin of error, the proportion of the population with a given characteristic was set at 0.5 (to be conservative and provide the maximum sample size), and the Chi-square value for one degree of freedom at 95% confidence interval (3.841). The estimated total sample size was therefore 2,310 students. Nevertheless, because the recruitment was based on number of classrooms rather than individual students, 2,839 participants completed the questionnaire and are included in the study.

Data Collection, Instruments, and Variables

Participants anonymously completed a Thai-language, self-report questionnaire that collected information related to their socio-demographic and economic background, behaviors, connectedness, parental involvement, and psychological variables. Prior to completing the questionnaire, participants were provided with information regarding the study by trained research assistants. Data collection occurred on school grounds; however, neither teachers nor any staff members affiliated with the school were present during the data collection.

Measures

Primary Outcome: Grit

Grit was assessed using the eight-item Short Grit Scale (Duckworth and Quinn, 2009). The scale consists of items which assess a respondent's perseverance of effort (e.g., "I am a hard worker" and "Setbacks do not discourage me"). It also included some reverse-scored items that measure consistent pursuit of passionate interest (e.g., "New ideas and projects sometimes distract me from previous ones") using a five-point Likert scale, ranging from 1 = "Not like me at all" to 5 = "Very much like me." The scores from all the items are averaged to obtain an overall "Grit score" ranging from 1 ("Not at all Gritty") to 5 ("Extremely Gritty"). The scale showed a moderate degree of internal consistency in a Thai language version, with Cronbach's alpha = 0.69. Based on the distribution of scores, the level of Grit among the participants was grouped into three categories: (i) "Low" for scores below the 25th percentile; (ii) "Average" for scores ranging from the 25th to the 75th percentile; and (iii) "High" for scores above the 75th percentile. The full details of the Grit questionnaire and scoring system are reported in **Appendix Table 2**.

Independent Variables

The independent variables which we examine for their relationship with Grit are as follows:

- Connectedness with father (perceived satisfaction of relationship with father); mother (perceived satisfaction of relationship with mother); parents (perceived love and care from parents; perceived mental support from parents); siblings (perceived satisfaction of relationship with siblings); teachers (perceived satisfaction of relationship with teacher); school (perception of school; interest in school subject); and friends (perceived satisfaction of relationship with friends).
- Parental involvement variables were measured with items: "How often did your parents need to ask you to do your homework?"; "How often did your parents notice when you have a problem/feel ill at ease?"; and "How often did your parents tell you when you had done something bad?"
- Socio-economic and demographic variables (e.g., age; gender; education level; parents' marital status; parents' level of education; family household income; perceived family financial situation).
- Behavioral variables (e.g., use of alcohol; use of tobacco; use of drugs; engagement in sexual activity) and self-esteem (measured using the Rosenberg Self-Esteem Scale; Rosenberg, 1965). See **Appendix Table 3** for more details on this scale and its calculation.

Data Analysis

The analysis was performed using SPSS 17 (PASW) for Windows (SPSS Inc., Chicago, Illinois, United States). Bivariate analysis was conducted using the *t*-test, ANOVA, or Kruskal–Wallis H test as appropriate. Multiple ordinary least squares linear regression analysis was performed to determine factors associated with Grit. The multivariable model included all independent variables that were significant at $p < 0.20$ in the bivariate analysis. We adjusted

for these variables in order to examine each factor for its independent relationship with Grit, removing potential confounding effects. In addition, the following variables were systematically included in the models regardless of their values of *p*: self-esteem; education level; household income; perceived family financial status; mother's education level; and fathers' educational level because they are important, potentially modifiable factors. The significance level was set at $p < 0.05$. There was no evidence of multicollinearity.

Ethics Statement

The study was approved by the Human Experimentation Committee of the Office of Research Ethics of the Research Institute for Health Sciences, Chiang Mai University (Certificate of Ethical Clearance No. 48/2016). Before participating, potential participants were first informed about the study's objectives, their roles, and their rights to give or not to give any information during the interview, the confidentiality of the personal data, and the way that the findings of the study would be presented. Participants over 18 years of age provided written informed consents prior to participating in the study. For participants under 18 years old, written informed consent was obtained from their legal guardian and written assents to participate in the study were obtained from the participants.

RESULTS

Characteristics of the Participants

A total of 2,839 participants completed the questionnaire, including 919 (32.4%) students from lower secondary schools, 1,090 (38.4%) students from higher secondary schools, and 830 (29.2%) from vocational schools. Slightly more than half of the participants were female (53.2%). Most participants were from households with a monthly income between 10,000 and 50,000 Thai Baht (333 and 1,666 USD), and perceived that they earned enough to save and spend (62.0%). The majority reported that their parents were married or lived together (68.0%), but for a substantial proportion (22.4%), the parents were either divorced or separated. For most respondents, the parents' level of education was at least secondary school: 63.6% for mothers and 62.8% for fathers (**Table 1**).

The majority felt that they were well connected to their parents and friends. For example, satisfaction with the relationship with mother, father, and friends was 88.9%, 78.6%, and 91.5%, respectively. Similarly, most felt that their parents (80.8%) and friends (70.4%) gave them mental/emotional support. The proportion of those who reported parental support, and involvement in the positive ways was generally high. However, many reported that their parents needed to ask them to do homework (92.3%) and chores around the house (94.2%) or told them when they had done something bad (97.8%).

There were also high levels of connectedness with the school and teacher. Most participants were satisfied with the relationship with their teacher (74.6%), liked the school (84.1%), were interested in the subject at school (89.1%), and felt that their performance at school was at least average (82.9%). In terms of substance use, 45.8% reported ever drinking alcohol, 18.8% ever smoked a cigarette, and 7.9% ever used marijuana. Around 18.1% reported having had sex and 21.5% were classified as having low self-esteem (**Table 2**).

TABLE 1 | Participants' general characteristics and bivariate analysis of factors associated with Grit (2,839 participants in total).

Participants Characteristics	Frequency (%)	Mean Grit Score (SD)	*p
Grit			
Low	627 (22.1)	N/A	
Average	1,628 (57.3)	N/A	
High	584 (20.6)	N/A	
Sex			0.049
Male	1,330 (46.8)	25.07 (3.47)	
Female	1,509 (53.2)	24.80 (3.78)	
Education			<0.001
Lower secondary school	919 (32.4)	24.97 (3.81)	
Higher secondary school	1,090 (38.4)	25.32 (3.79)	
Vocational school	830 (29.2)	24.34 (3.13)	
Household income			<0.001
<10,000	319 (11.4)	24.46 (3.26)	
10,000–44,999	1,185 (42.2)	24.94 (3.53)	
≥50,000	690 (24.6)	25.52 (4.02)	
Do not know	616 (21.9)	24.50 (3.47)	
Perceived family financial status			<0.001
Enough to save and spend	1740 (62.0)	25.22 (3.63)	
Enough to spend/not save	506 (18.0)	24.42 (3.74)	
Not enough	245 (8.7)	24.16 (3.90)	
Do not know	314 (11.2)	24.68 (3.41)	
Marital status of parents			0.021
Divorced/separated	630 (22.4)	24.60 (3.64)	
Married/live together	1914 (68.0)	25.06 (3.68)	
One/both parents passed died	225 (8.0)	24.56 (3.35)	
Do not know	47 (1.7)	24.96 (3.32)	
Mother's highest education level			<0.001
Primary education and less	645 (22.9)	24.60 (3.37)	
Secondary/high school	675 (24.0)	24.93 (3.52)	
College/university	1,114 (39.6)	25.28 (3.77)	
Do not know	379 (13.5)	24.40 (3.82)	
Father's highest education level			<0.001
Primary education and less	562 (20.0)	24.66 (3.36)	
Secondary/high school	629 (22.4)	24.72 (3.49)	
College/university	1,135 (40.4)	25.42 (3.83)	
Do not know	482 (17.2)	24.33 (3.53)	
Ever drank alcohol			<0.001
No	1,530 (54.2)	25.19 (3.73)	
Yes	1,294 (45.8)	24.61 (3.51)	
Ever smoke cigarette			<0.001
No	2,295 (81.2)	25.03 (3.70)	
Yes	530 (18.8)	24.45 (3.31)	
Ever used marijuana			0.280
No	2,607 (92.1)	24.94 (3.63)	
Yes	223 (7.9)	24.67 (3.75)	
Ever bullied and/or assaulted			0.001
No	712 (25.2)	25.34 (3.81)	
Yes	2,118 (74.8)	24.79 (3.57)	
Ever had sex			<0.001
No	2,324 (81.9)	25.03 (3.71)	
Yes	515 (18.1)	24.92 (3.64)	
Self-esteem**			<0.001
Low (<15)	592 (21.5)	23.18 (3.43)	
Normal (15–25)	2,117 (76.8)	25.27 (3.42)	
High (>25)	49 (1.8)	30.06 (4.95)	

**Value of p measures statistical significance of differences in Mean Grit score between participant groups using Student's-t test or analysis of variance (ANOVA) as appropriate.*
***Measured using Rosenberg self-esteem scale as described in **Appendix Table 3**.*

TABLE 2 | Participants' perception and experience related to connectedness and bivariate analysis of factors associated with Grit (2,839 participants in total).

Participants Characteristics	Frequency (%)	Mean Grit Score (SD)	*p
Perceived satisfaction of relation with mother			<0.001
Not satisfied/not sure	313 (11.1)	23.98 (4.09)	
Satisfied	2,502 (88.9)	25.05 (3.56)	
Perceived satisfaction with relationship with father			<0.001
Not satisfied/not sure	600 (21.4)	24.34 (3.94)	
Satisfied	2,209 (78.6)	25.12 (3.59)	
You feel love and care from your parents			<0.001
Other	404 (14.3)	23.80 (3.76)	
All the time/quite so much	2,413 (85.7)	25.12 (3.59)	
You feel that your parents give you mental support			<0.001
Other	541 (19.2)	23.92 (3.54)	
All the time/quite so much	2,273 (80.8)	25.17 (3.63)	
Perceived satisfaction with relationship with friend			<0.001
Not satisfied/not sure	239 (8.5)	24.14 (4.06)	
Satisfied	2,582 (91.5)	25.00 (3.59)	
You feel that your friends are take care/ kind to you			<0.001
Other	663 (23.5)	24.30 (3.59)	
Always/a lot	2,161 (76.5)	25.12 (3.64)	
You feel that your friends give you mental support			<0.001
No	833 (29.6)	24.43 (3.66)	
Yes	1984 (70.4)	25.13 (3.61)	
Perceived satisfaction with relationship with teacher			<0.001
Other	716 (25.4)	24.12 (3.66)	
Satisfied	2,104 (74.6)	25.19 (3.60)	
Perception of one's school			<0.001
Other	448 (15.9)	24.02 (3.59)	
I like my school	2,371 (84.1)	25.09 (3.62)	
Interest in subjects at school			<0.001
Other	308 (10.9)	23.71 (3.69)	
Interested	2,525 (89.1)	25.07 (3.61)	
Perceived performance at school			<0.001
Low (lower middle/low)	482 (17.1)	23.89 (3.17)	
Middle	1,432 (50.7)	24.74 (3.46)	
Top (top/upper middle)	910 (32.2)	25.78 (3.98)	
How often did your parents need to ask you to do your homework?			< 0.001
Never	208 (7.4)	26.18 (4.29)	
Ever (sometime/regularly/once in a while)	2,602 (92.3)	24.83 (3.57)	
Do not know	9 (0.3)	27.44 (3.94)	
How often did your parents make you do chores around the house?			0.001
Never	149 (5.3)	25.93 (4.61)	
Ever (sometime/regularly/occasionally)	2,652 (94.2)	24.87 (3.57)	
Do not know	14 (0.5)	26.64 (3.85)	
How often your parents notice when you have a problem/ feel ill at ease?			0.054
Never	324 (11.5)	24.48 (4.05)	
Ever (sometime/regularly/occasionally)	2,376 (84.6)	25.00 (3.54)	
Do not know	109 (3.9)	24.80 (4.37)	
How often did your parents tell you when you had done something bad?			0.089
Never	51 (1.8)	25.84 (4.30)	
Ever (sometime/regularly/occasionally)	2,750 (97.8)	24.92 (3.63)	
Do not know	12 (0.4)	23.58 (2.67)	
How often did your parents let you know when you had done a good job?			0.004
Never	147 (5.2)	24.01	
Ever (sometime/regularly/occasionally)	2,576 (91.6)	24.97	
Do not know	90 (3.2)	25.43	
How many times have you argued or had a fight with at least one of your parents?			0.005
Never	457 (16.3)	25.42 (4.05)	
Ever (sometime/regularly/occasionally)	2,302 (82.0)	24.82 (3.56)	
Do not know	47 (1.7)	25.21 (3.24)	

**Value of p measures statistical significance of differences in Mean Grit score between participant groups using Student's-t test or analysis of variance (ANOVA) as appropriate.*

Factors Associated With Grit

Many factors were significantly related to Grit in the bivariate analysis (**Tables 1** and **2**). In the adjusted model (**Table 3**), Grit scores were higher among participants who perceived that their parents gave them mental/emotional support ($\beta = 0.49$; $p = 0.028$), those who were satisfied with their relationship with

TABLE 3 | Multivariable analysis of factors associated with Grit.

	n	*β**	95% CI	*p*
Self-esteem				
Low (<15)	592	Ref		
Normal (15–25)	2,117	1.287	0.959, 1.615	<0.001
High (>25)	49	5.266	4.242, 6.290	<0.001
Sex				
Male	1,330	Ref		
Female	1,509	−0.384	−0.664, −0.088	0.006
Educational level				
Lower secondary school	919	Ref		
Higher secondary school	1,090	0.304	−0.036, 0.599	0.072
Vocational school	830	−0.459	−0.870, −0.047	0.029
Perceived family financial status				
Lower secondary school	1740	Ref		
Higher secondary school	506	−0.418	−0.780, −0.056	0.024
Vocational school	245	−0.619	−1.119, −0.119	0.015
Lower secondary school	314	−0.082	−0.527, 0.363	0.717
You feel that your parents give you mental support				
Other	541	Ref		
All the time/quite so much	2,273	0.499	0.053, 0.946	0.028
Perceived satisfaction of relation with teacher				
Other	716	Ref		
Satisfied	2,104	0.437	0.113, 0.761	0.008
Interest in the subject at school				
Other	308	Ref		
Interested	2,525	0.612	0.147, 1.077	0.010
Perceived performance at school				
Low (lower middle/low)	482	Ref		
Middle	1,432	1.024	0.612, 1.436	<0.001
Top (top/upper middle)	910	0.436	0.056, 0.815	0.024
How often did your parents need to ask you to do your homework?				
Never	208	Ref		
Ever (sometime/regularly/ occasionally)	2,602	−0.686	−1.223, −0.148	0.012
Do not know	9	3.077	0.533, 5.621	0.018
How often did your parents tell you when you had done something bad?				
Never	51	Ref		
Ever (sometime/regularly/ occasionally)	2,750	−1.088	−2.022, −0.154	0.022
Do not know	12	−4.609	−7.013, −2.205	<0.001

**Multivariate associations were adjusted for all covariates included in the table, although this table includes only variables that showed significant differences (p = 0.05 or less).*

their teachers ($\beta = 0.44$; $p = 0.008$), and those who were interested in the subjects at school ($\beta = 0.61$; $p = 0.01$). Two variables of parental involvement were related to Grit. Participants who responded that their parents who had to ask them to do homework ($\beta = -0.69$; $p = 0.012$) and had ever told them if they have done something bad ($\beta = -1.09$; $p = 0.02$) had lower Grit scores compared to those who responded never.

In addition, we found that Grit scores were on average higher among participants with normal self-esteem ($\beta = 1.29$; $p < 0.001$) and high self-esteem ($\beta = 5.27$; $p < 0.001$) compared to those with low self-esteem. Female participants had lower Grit scores compared to male participants ($\beta = -0.38$; $p = 0.006$). Although there was no statistical difference between the participants in terms of household income, those who perceived that they did not earn enough to save ($\beta = -0.418$; $p = 0.024$), or just did not earn enough ($\beta = -0.619$; $p = 0.015$), had lower Grit scores than those who perceived earning enough to save. Grit scores were also higher among the participants who were classified as average ($\beta = 1.02$; $p < 0.001$) and top ($\beta = 0.44$; $p = 0.024$) in terms of their performance at school. However, the Grit scores of participants from vocational schools were lower compared to those from secondary school ($\beta = -0.46$; $p = 0.029$).

DISCUSSION

To the best of our knowledge, this study is the first to assess the association of connectedness and parental involvement, in both positive and negative ways, with Grit among adolescents in Thailand. Existing studies have unlikely to examine positive and/or negative parental involvement in the detail reported here. This provides new insights into the social factors that influence Grit. Strength of this study is that it is based on a large sample of Thai adolescents, randomly recruited from all public and private secondary schools, high schools, and vocational schools in urban Chiang Mai. The data thus allow for

generalizability of our results for Chiang Mai city students. We found that being satisfied with relationships with the teacher, perceived parental support, interest in subjects at school, and positive parental involvement were predictors of Grit.

There is evidence in the United States showing a positive correlation between Grit and school motivation, perceived peer support, perceived teacher support, and perceived school safety (Eskreis-Winkler et al., 2014). Students' experiences in school including school engagement, relationships with adults and peers, school culture, and self-reported GPA were found to be most strongly related to Grit (Wanzer, 2018). Similarly, in our study, we found a positive relationship between Grit and connectedness to school; specifically, in those reporting a satisfactory relationship with teacher and interest in school subjects. In our study, there was a positive correlation between perceived parents' provision of mental support with Grit. However, satisfaction with relationship with fathers and mothers and perceived love and care from parents, which were statistically significant in bivariate analysis, lost significance in the multivariable model. It is possible that adolescents who receive positive mental support from parents perceived this to be manifest as love and care.

In this study, we found participants who responded that their parents who had to ask them to do homework and had ever told them if they have done something bad had lower Grit scores compared to those who responded that this had never happened. It can be explained that participants who had self-discipline had no need from parents to ask them to do their own homework. In case of telling children when they do something bad in Thai context, particularly among laypeople in which parents and children normally talk to each other a lot. Parents will tell their children straightforwardly and sometimes emotionally in loud voices if they do something wrong. Many children tend to interpret this as parents blaming them. So, for those who had never been told by parents that they did something bad can indicate that they had no need to be told/blamed by parents because of their good behavior or self-discipline. It is likely that students who perceived parental involvement to be critical had lower Grit, reinforcing research showing that Grit is built on positive connections that build self-esteem.

Indeed, the present study showed that Grit scores were on average higher among participants with normal and high self-esteem. Self-esteem can also predict perseverance and consistent interest, which are components of Grit (Weisskirch, 2018). One study demonstrated that self-esteem mediated the relationship between Grit and life satisfaction (Li et al., 2018). Thus, it is reasonable to conclude that higher self-esteem would associate with higher Grit because individuals with a positive self-evaluation may persevere more in the face of challenges.

This study also revealed that adolescents who perceived that they belonged to households with insufficient income had lower Grit scores than those whose household income was sufficient and allowed for savings. Although there is a paucity of research on the relationship between subjective socioeconomic status (SES) and Grit, studies on students' persistence in higher education consistently found that students from a low socioeconomic background were less likely to persist through college (Pascarella and Terenzini, 1991, 2005; Reason, 2009).

The evidence thus far is inconclusive on gender differences in Grit levels. Our study, like others (Christensen and Knezek, 2014; Tiittanen, 2014) found that male students had higher Grit than female students. In a patriarchal society like Thailand, men's traditional roles as the leader and main provider for the family may contribute to men's perseverance and Grit in the pursuit of long-term goals. However, other studies, some in patriarchal culture, reported only marginal or no significant differences in Grit level between males and females (Ali and Rahaman, 2012; Flaming and Granato, 2017). Research also indicates that differences between genders vary. For example, Duckworth and Gross (2014) found that girls had more self-control than boys. Given that self-control and Grit were strongly correlated, though not perfectly (Duckworth and Gross, 2014), this would suggest that females with higher self-control have higher Grit. However, it was not clear whether gender differences in self-control and/or self-discipline persisted into adulthood (Duckworth and Seligman, 2006).

LIMITATIONS

This study has some limitations. First, no causal inference can be drawn from the documented associations due to the cross-sectional study design. Future, longitudinal studies would be of particular value in assessing the causative factors for Grit. Second, although participants were recruited from all 21 schools in urban Chiang Mai, it is unclear to what extent the results can be generalized to other settings in Thailand, given the significant local and regional socioeconomic and demographic heterogeneity in the country. Some of the actual differences of Grit between categories were small and might not be of public health significance. These might occur because of large sample size. Readers may need to accept the results with caution. Finally, we acknowledge that our results depend on self-report from participants which may induce some bias.

CONCLUSION AND IMPLICATIONS

This brief research report provides evidence of factors associated with Grit in Thai students. The data showed that connectedness to social agents (parents, peers, and teachers) and positive parental involvement had positive correlation to Grit in Thai students in Chiang Mai. However, our findings are preliminary, and further research is required to understand the relationships between connectedness, positive parental involvement and Grit as well as their impacts on health, academic, and life success. Thailand is interested in improving the standard of its educational programs, so that it may catch up with its South-East Asian neighbors such as Vietnam and other neighboring countries. A deeper understanding of the factors that build Grit and therefore academic outcomes would contribute to this project. This study has identified potential home and school-based

factors for further study and potentially for interventions, for urban Thai students in Chiang Mai and across the country.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Human Experimentation Committee of the Office of Research Ethics of the Research Institute for Health Sciences, Chiang Mai University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

AT and KT conceived the study. AT, KT, PM, and KS collected the data. AT, MK, and CB contributed to data analysis and interpretation. AT drafted the paper. All authors contributed to the article and approved the submitted version.

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Antecedents and Consequences of Grit Among Working Adults: A Transpersonal Psychology Perspective

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Positive psychology has paved the way for newer and more informed ideas of living a meaningful, integrated and well-rounded quality of living. The current era of the pandemic has also moulded the ways in which individuals perceive their quality of life and how they want to integrate a holistic approach towards their well-being. The workplace settings have seen tremendous changes in terms of how employers, employees and the organisations at large function and operate. The pre-pandemic concept of success has shifted its focus from hard work to developing grit among employees to increase the overall efficiency of the organisations. Grit has revolutionised the conventional standards of success, meaning in life and has impacted personal as well as occupational welfare. This integration of positive psychology and transpersonal psychology has catalysed the purpose for the current study. To help organisations and individuals thrive in their professional endeavours at the workplace and to provide them with relevant psychological tools to enhance their occupational growth, the present study has been conducted empirically to investigate the antecedents and consequences of grit among 209 working professionals in India. The results of this study indicate that the transpersonal capital of metacognition, flow, optimism and empathy have a significant role to play in developing grit among the participants. The findings have implications for enhancing job satisfaction and job performance of participants. The current research also provides a framework to organisations towards designing interventions for improving efficiency at the workplace.

Keywords: grit, transpersonal psychology, metacognition, flow, empathy, optimism, job satisfaction, job performance

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INTRODUCTION

The phenomenon of grit has received considerable attention over the last decade. Grit, which has been defined as the passion and perseverance for long-term goals (Duckworth et al., 2007), is an essential predictor of long-term achievement and success. Research on grit in domains such as military, workplace sales, high school and marriage found that gritty individuals were less

prone to withdrawing from their respective life commitments (Eskreis-Winkler et al., 2014). The year of 2021 is the year of the Great Resignation (Cook, 2021), wherein four million Americans quit their jobs in 2021 due to difficulty in managing work from home responsibilities, increased workload and burnout. The global pandemic has caused employees all over the world to rethink their life goals and whether it aligns with their current jobs. Lin et al. (2021) found that the COVID-19 was associated with job insecurity which was also related to emotional exhaustion and organisational deviance. Job satisfaction and organisational commitment were also found to be linked with each other during the global pandemic (Chanana, 2021). In light of this literature, it is important to help organisations retain their employees by assessing the factors that can contribute to increasing the well-being of employees. Grit is essential for organisations and employees to thrive (Lee and Duckworth, 2018). To explore the factors that predict grit and how grit in turn impacts employee job satisfaction and performance, a conceptual model is hypothesised to study the antecedents and consequences of grit among working adults in the present study.

In the ever-changing and fast paced world that has valued and emphasised the significance and implications of talent and hard work, which led to the achievement of success, as a major event that would occur in an individual's life, has been widely prevalent (Mendick et al., 2015; Biondo and Rapisarda, 2018; Olivos, 2019). This meritocratic idea of possessing a conventional framework of personal and professional success, mostly extrinsically driven, has been challenged and has undergone a series of advancements in the way importance is ascribed to cultivation of meaning in life (Baczko-Dombi and Wysmulek, 2015). The reliance on innate talent was contradicted by Ericsson (2006) who coined the term "deliberate practice" to imply that continuous and repeated efforts over a period of time will lead to sustainable results and thereby assist in becoming an expert in a particular domain of career (Helding, 2011). Emphasis on environmental predictors of success for talent development has also found supporting evidence for creating an interactive space for personal and environmental factors to foster individual's potentials in terms of developing persistence for making use of one's talent (Subotnik et al., 2019). This shift from secluding the idea of success to talent and hard work, towards understanding the contextual psychological phenomenon involved in high performance, has led to the emergence of several theories of developing perseverance.

Revolutionised in the past decade, the emerging concept of grit, as a non-cognitive trait and a psychological tool to make sustained efforts towards achieving long-term goals in challenging domains, irrespective of talent (Duckworth et al., 2007) has received enormous recognition in the scientific community. Grit in the present paper can be understood from the framework given by Singh and Chukkali (2021) as the ability to adapt to situations, to show perseverance of effort, spirited initiative and steadfastness in not only long-term goals but also in situations requiring immediate attention. Grit provides contrary evidence to the conventional nature of possessing innate talents to obtain success. Measuring grit as a domain-specific construct in different achievement fields has found to be advantageous (Cormier et al., 2019). The emergence of grit in recent years has been tremendously rapid due to its utility and application in various settings such as healthcare, education and at the workplace (Christopoulou et al., 2018; Lee and Duckworth, 2018; Singh and Chopra, 2018; Musso et al., 2019). A systematic review by Fernández-Martín et al. (2020) revealed that grit serves as a predictor of educational, professional, personal success. In the educational setting, teaching grit can help students stay persistent and develop academic resilience in the face of adversity, self-regulate learning and achieve long-term challenging tasks and also prevents the depressive symptoms stimulated by positive and negative perfectionism (Hochanadel and Finamore, 2015; Ray and Brown, 2015; Bogin, 2017; Karlen et al., 2019; Xu et al., 2019; Tyumeneva et al., 2021; Yu et al., 2021a; Zhang et al., 2021; Chen et al., 2022). The pursuit of goals by being gritty is also linked with reduced chronic stress and lesser academic problems (Kalia, 2021) and associated with self-control but in a distinct form (Duckworth and Gross, 2014). In healthcare, possessing the qualities of grit helps healthcare workers perform better in crisis situations, assists in the quality of patient care being provided, can affect healthcare professionals' job involvement and reduce burnout (Jeong et al., 2019; Tyer-Viola, 2019; Lee et al., 2021) The study of grit also exists in other dimensions of positive psychology. Due to the increased importance of enhancing meaning-making (Russo-Netzer, 2019), grit has been found to generate hope, meaning in life and 195 also leads to enhanced levels of flourishing (Vela et al., 2015; Valdez and Datu, 2021; Yang and Wu, 2021). Subjective well-being is also associated with grit (Kwon, 2021). Neural correlates of grit show prefrontal cortex and striatum and their functions that can contribute to individual differences in grit (Wang and Li, 2021).

Grit has significant implications during the COVID-19 pandemic in mitigating the effects of psychological distress imposed by the global health crisis. Research has found that grit can foster pandemic resilience to face the adversities caused by it (Bono et al., 2020; Schmahl, 2021). Individuals with higher levels of grit adopted better coping strategies leading to mitigated perceived stress by incorporating psychological tools such as minimisation and positive self-instruction during the COVID-19 lockdown and also results in inculcating healthier lifestyles to navigate the stressors of the global pandemic (Urban and Urban, 2020; Zepetnek et al., 2021). Interestingly, fear of the pandemic was also found to be safeguarded by higher levels of internal consistency, a principal component of grit, along with growth mindset, consequently reducing psychological distress (Masuyama et al., 2021; Mosanya, 2021). Pursuit of goals with grittiness is also connected to internal authenticity and possessing a sense of coherence (Vainio and Daukantaitė, 2016; Arya and Lal, 2018). On the other hand, grit has also been criticised on the grounds of not taking into account systemic privilege Schreiner (2017) as well as the decontextualized nature in which the concept of grit has been understood in the existing literature without any socio-cultural relevance and meaning provided for the same (Datu and Mclnerney, 2017; Kirchgasler, 2018). However, this concern was addressed by Morell et al. (2020) as it was found that the factor structures of grit scales such as perseverance of effort in the Grit-S (Duckworth and Quinn, 2009) was revealed to be the strongest determinant across three different samples and hence, provided

evidence for how grit is not consistent across ages and cultures but can be significant in particular contexts. Therefore, it can be appropriately stated that the existing literature evidently highlights the relevance and usefulness of grit for individuals across the eastern and the western parts of the world, and grit predominantly increases psychological well-being across different career domains and professions (Salles et al., 2014; Jin and Kim, 2017; Arya and Lal, 2018; Datu, 2021).

It is imperative to look at the various concepts laid down by researchers investigating the psychology of achievement from the western and eastern perspectives. One of the pioneering researchers in this area, Dweck (2019) coined the term "growth mindset" referring to the ability to develop the belief that intellectual abilities can be learnt and fostered over time which is different from a "fixed mindset" wherein people believe that abilities cannot be learnt and are fixed. The application of the growth mindset has especially provided assistance to academic enhancement and improvement in student learning outcomes (Hochanadel and Finamore, 2015; Claro et al., 2016; Yeager et al., 2016; McCabe et al., 2020; Chen et al., 2022). The triarchic model of grit conceptualised by Datu et al. (2017) brought forth a newer framework for assessing grit, with the additional dimension of adaptability to situations to the existing two factor theory of grit (Duckworth et al., 2007) consisting of perseverance of efforts and consistency in interests. This triarchic model was linked with career exploration and talent development. Armstrong et al. (2018) developed a new model of grit in the context of self-regulation which found six strategies namely, temporal perspective, perpetual evaluation, motivational orientation, strength and resource gathering, system thinking and framing, that can be used by organisations to inculcate grittiness among their leaders of innovation.

Jachimowicz et al. (2018) defined passion as a strong feeling towards an important value or preference in individuals and found that previous studies had only emphasised perseverance and not on passion and, thus, indicated that the amalgamation of perseverance and passion can significantly benefit the development of grit. Another framework for assessing workplace goal orientation was assessed by developing a goal orientation process model namely "GRRR" by Ceschi et al. (2021) which found grit as a predictor of resilience, in the form of construct relationships of grit leading to resilience which in turn, results in recovery, thus, proving to be a significant model in order to assess workplace long-term relationships among grit, resilience and recovery. To bridge the gap between grit researches in the eastern perspective, Singh and Chukkali (2021) developed a reliable framework for measuring grit, including dimensions of grit, adaptability to situation, perseverance of effort, spirited initiative and steadfastness in adverse situations. These perspectives provide deep and extensive insights into the advancement and implementation of grit in important areas of functioning in individual's lives.

Drawing from the transpersonal psychology perspective, the present study is conducted for the purpose of taking the entire human experience into account. The field of transpersonal psychology, also known as the fourth force, was founded by Maslow who moved humanistic psychology into the spiritual realm (Hastings, 1999). The shift from humanistic psychology to transpersonal psychology took place to honour the entire spectrum of human experience by studying the intangible, but important parts of existence, mainly, spirituality and its transpersonal dimensions (Valle, 1989). Transpersonal phenomenon heralded to importance, to challenge the ethnocentric biases of the time (Grof, 2008). Transpersonal psychology is concerned with the "study of humanity's highest potential, and with the recognition, understanding, and realisation of unitive, spiritual, and transcendent states of consciousness." (Lajoie and Shapiro, 1992). It has been defined by Bynum (1992) as the study of psycho-spiritual disciplines and processes accounted for in the science and religion of the earliest discovered civilisations. The present paper draws the operational definition from the work of Hartelius et al. (2013) who explained transpersonal psychology as "a transformative psychology of the whole person in an intimate relationship with an interconnected and evolving world, it pays special attention to self-expansive states as well as to spiritual, mystical, and other exceptional human experiences that gain meaning in such a context." Daniels (2013) identified four distinct perspectives within transpersonal psychology, namely, religious, psychological, humanistic/existential/feminist and ecological perspectives. The transcendent and reflective nature of this field has recognition due to its applicability and significance, over the past few decades and is pivotal to human survival and advancement in life (Friedman, 2002; Ardelt and Grunwald, 2018). To expound on the broader meaning of daily work and living, Adams (2019) captures the essence of how the transpersonal quality is deeply embedded in our personal and vocational domains, thus, studying existential concerns through phenomenology and contemplative spirituality. While considerable attention has been given to the more widespread forms of transcendence, such as meditation, prayer, non-ordinary states of consciousness, transcendence can also found within daily life experiences and in simple events of interpersonal relationships, in the openness to gather knowledge of different cultures, environmental activism and even in contemporary physics (Clements et al., 2016). Often misconstrued to be inclusive of supernatural speculations, transpersonal psychology is instead, a science that helps in understanding the interconnectedness individuals can feel, when they identify with their external environments, their past, present and future and are engaged in expanding the traditional and conventional ways in which life should be viewed, lived and perceived (Friedman, 2018). Grit and transpersonal psychology are linked with each other through their deeper constructs and mechanisms. Spirituality, an important component of transpersonal psychology (Hartelius et al., 2013), has a positive relationship with grit (Dutta and Singh, 2017). Flow, the antecedent of grit, as discussed in the present paper, is facilitated through self-transcendence (Osin et al., 2016) and serves as a transpersonal transformative practice for individuals (Galloway, 2005).

Employee well-being since the inception of the COVID-19 pandemic has compelled organisations to introduce and implement new solutions to tackle ordeals and challenges across myriad areas of operations among the abrupt change in working

conditions (Carnevale and Hatak, 2020; Diab-Bahman and Al-Enzi, 2020). The pandemic heralded a new era of remote work along with many other unique and unprecedented challenges affecting the well-being as well as organisational functioning of workplaces. Evidently, it was found by Juchnowicz and Kinowska (2021) that being involved in remote work had a negative impact on affect well-being in terms of work-life balance and relationships. Research also indicates that stress induced due to the COVID-19 pandemic led to reduced employee performance (Yu et al., 2021b). Occupational health became a central area of study during the pandemic due to the tremendous employee exhaustion, job insecurity, organisational layoffs, decreased social support which were some of the major factors in impacting employee well-being during the pandemic (Kriz et al., 2021; Meyer et al., 2021). Firms with employee satisfaction have also been found to navigate the crisis of the pandemic more efficiently (Shan and Tang, 2020). Several employee engagement practices have also been made use of, to boost and increase motivation among employees to lead to professional and personal development in the form of recognition and acknowledgment sessions, e-learning modules and work-from-home regime tasks and activities which led to increase in employee commitment towards the organisation (Chanana and Sangeeta, 2020). Other than these practices, the presence of a supportive work environment comprising interpersonal trust in colleagues and managers can lead to job satisfaction (Bulińska-Stangrecka and Bagieńska, 2021). Interestingly, Nemteanu and Dabija (2021) reported that an emerging area such as internal marketing, which implies promoting the values and objectives of the organisation towards the employees themselves, also has a positive impact on job satisfaction.

Grit at the workplace is an under researched area since most of the literature till date has explored grit in the educational setting. Lee and Duckworth (2018) found that to help organisations obtain a culture of grit, it is imperative to select individuals who are gritty. Evidently, the existing literature provides findings for utilising the concept of grit to hire employees and to assign meaningful work to foster their engagement (Singh and Chopra, 2018) but is also useful for job-seekers in optimising job search performance (van der Vaart et al., 2021). Grit is also considered worthy of practical application by employers in the hiring process and deemed more than just a theoretical concept (Butz et al., 2019). Grit also improves the organisational environment of the workplace in specific constructs such as strengthening stamina and resilience of employees (de Waal et al., 2022). Choi et al. (2020) found that grit not only strengthens the relationship between corporate social responsibility and meaning orientation but also leads to an improved organisational citizenship behaviour. Since workplace politics also plays a significant role in the functioning of an organisation, grit, both in employees and supervisors, neutralises the political dynamics of the workplace at hand (Jordan et al., 2018a,b). Similar results of the significance of grit at the workplace were found by Popoola and Karadas (2022) as the presence of grit was associated with career success. Partially supporting these findings, Clark and Plano Clark (2019) found that grit is necessary for career success but other factors such as luck, networking and opportunity play an an important role in determining success in one's career and in the Asian context, components of personal motivation, social support system must be considered while conceptualising grit (Vera et al., 2015). The findings of these studies are imperative of the fact that grit serves as an essential psychological tool while navigating the ecosystem of workplaces.

Grit, in the isolation of passion and perseverance in promoting well-being of individuals has been challenged and called into question as not being psychometrically unsatisfactory (Credé, 2018; Tynan, 2021). Existing literature on employee well-being during the COVID-19 pandemic has profoundly benefited organisations but lacks the approach of taking the entire human experience into account and is also inadequate in providing a dynamic and broad conceptual model on dealing with the workplace challenges brought about by the inception of the COVID-19 pandemic from a holistic perspective. Additionally, previous research is insufficient in terms of recognising the need, importance and implementation for fostering grit among working professionals by inculcating transpersonal factors such as metacognition, flow, empathy and optimism. Current knowledge on predictors has found hope and low rumination as the antecedents of grit (Raphiphatthana and Jose, 2021) which, although significantly helps in advancing research on constructs of positive psychology in relation to grit, but is limited in providing a sustainable framework for developing and generating grit, especially at workplaces.

Olckers and Koekemoer (2021) explored the underlying mechanisms which can contribute to career success and found psychological ownership as the possible construct influencing performance through grit and the perception of career success. Research also states that grit is mainly useful in the presence of socioeconomic resources and individuals with higher incomes are more likely to become entrepreneurs (Arco-Tirado et al., 2019). Hill et al. (2016) also examined the predictors of grit and found life direction as a predictor of becoming grittier. However, the existing body of research has not yielded beneficial results in developing a model that could contextualise an individual's socioeconomic and other concerns by helping them inculcate qualities of transpersonal capital that could significantly improve their overall well-being as well as enhance their job satisfaction and job performance. There is a need for examining grit beyond the two factor theory of passion and perseverance (Datu, 2021).

There is a gap in the present literature in terms of giving a deep understanding and insight into the underlying mechanisms of grit and how grit can enhance the occupational health of employees and employers. Thus, the present study aims to fill this gap by providing an eastern perspective of the antecedents and consequences of grit. The current paper tackles these issues through its formulation of a conceptual framework that could help organisations thrive and foster employee satisfaction and performance through the perspective of transpersonal psychology.

In the context of the current study, the transpersonal capital of metacognition, optimism, flow and empathy are of utmost significance and importance to workplaces, owing to their

inclusive and comprehensive nature of providing a deep understanding and insight into expanding the well-being of individuals. There is supporting evidence to the expansiveness of the transpersonal perspective suggesting that self-transcendence can be facilitative of meaning-making and flow experiences and these subjective flow encounters also mediate psychological capital and happiness at work (Osin et al., 2016; Kawalya et al., 2019). To increase workplace spirituality, Palframan and Lancaster (2019) drew their findings from the transpersonal model and observed that self-reconciliation can lead to meaning-making and enhancement of self-expression and inner purpose at the workplace. Usman et al. (2020) also suggest and recommend the usage of transpersonal perspectives such as Sufism, to improve well-being and mental health at the workplace and to deal with workplace stressors and anxiety. The study of values and transformation to enhance workplace spirituality has been of recent focus and has been receiving importance due to its beneficial implications for organisations (Kochukalam et al., 2018; Palframan and Lancaster, 2019; Dubey et al., 2020; Khari and Sinha, 2020).

The usage of the transpersonal psychology perspective has not been implemented or thoroughly researched earlier in terms of enhancing workplace management (Avramchuk, 2020). Through this theoretical perspective of transpersonal psychology, the present study aims to explore the relationship between the antecedents and consequences of grit at the workplace among working professionals in India from the perspective of transpersonal psychology.

MATERIALS AND METHODS

The study followed a quantitative approach for data collection and analysis. The sample was selected on the basis of inclusion and exclusion criteria. Purposive sampling was used to selectively obtain data from working professionals living in India along with other criteria for selection for participation in the study. All measures were in the English language.

Participants

The data were collected from 209 participants who were working professionals in organisations in India through the online platform of Google Forms (Vasantha Raju and Harinarayana, 2016; Torrentira, 2020) which consisted of questionnaires of the variables being measured in the study, namely, grit, metacognition, optimism, flow, empathy, job satisfaction and job performance. Purposive sampling method was used to gather participants for data collection. The informed consent of the participants was taken before beginning the data collection as part of an important ethical consideration to respect human rights (Mumford, 2018). They were informed about the purpose of the study and about the benefits of participating in the research as mentioned in the form itself for their voluntary participation. The inclusion criteria of the sample were as follows: (a) working professionals in an organisation in India; (b) are citizens of India; (c) are above the age of 18 years. The responses of participants who did not meet the inclusion criteria were eliminated. **Table 1** demonstrates the descriptive statistics reported in the study in the data collection.

TABLE 1 | Descriptive statistics of participants.

Variable		Frequency	Percentage (%)	Mean	SD
Age	20–63			26.04	6.087
Gender	Male	117	56		
	Female	92	44		
Educational qualification	Post-graduation	65	31.1		
	Graduation	149	67		
	Diploma	4	1.9		
Home town	Urban	187	89.5		
	Rural	22	10.5		

Measures

Grit

Grit was assessed using the Multidimensional Scale of Grit developed by Singh and Chukkali (2021) which measures four factors of grit, namely adaptability to situation, perseverance of effort, spirited initiative, steadfastness in adverse situations. It is a 12-item scale. There is no reverse scoring and the minimum score is 12 and maximum is 60. The scale has a good reliability of 0.795. Convergent validity indicated positive correlation with PCASS ($r = 0.527$) and Revised Norwegian Dispositional Resilience (Hardiness) Scale ($r = 0.565$).

Metacognition

Metacognition was assessed using the Metacognition Self-Assessment Scale developed by Pedone et al. (2017) which measures five abilities of metacognition, which are monitoring, differentiation, integration, decentration and mastery. It is scored on a 5-point Likert scale with a minimum score of 18 and a maximum score of 90. To measure reliability, Cronbach's alpha ranged from 0.72 and 0.87. The MSAS has a good factorial validity and internal consistency.

Optimism

Optimism was assessed using the Life Orientation Test-Revised developed by Scheier et al. (1994) and is used to measure optimism versus pessimism. It is a 10-item 4-point Likert scale and consists of reverse scoring of items 3, 7 and 9. The sum total of items 1,3, 4, 7, 9 and 10 is taken for the individual scores of participants. Cronbach's alpha was found to be 0.78 indicating adequate internal consistency. The convergent and discriminant validity of the LOT-R are also acceptable.

Flow

Flow was assessed using the Flow Short Scale developed by Rheinberg et al. (2003) and cf. Engeser and Rheinberg (2008) and is a 13-item 7-point Likert scale measuring flow and worry. The English version of the scale (Rheinberg, 2015)

was used for measuring flow. Items measuring flow were summed for the use of the present research. Cronbach's alpha ranged between 0.80 and 0.90. Administration of the Flow Short Scale takes 30–45 s.

Empathy

Empathy was assessed using the Toronto Empathy Questionnaire developed by Spreng et al. (2009) and is a 16-item questionnaire with strong convergent validity, internal consistency and high test–retest reliability. The TEQ consists of negatively worded items for reverse scoring that are items 2, 4, 7, 10, 11, 12, 14 and 15. The sum of all the scores is used for derivation of total scores.

Job Satisfaction

Job satisfaction was assessed using the Job Satisfaction Survey developed by Spector (1985) which is a 36-item survey ranging from "strongly disagree" to "strongly agree" measuring nine sub-scales namely, pay, promotion, supervision, fringe benefits, contingent rewards, operating conditions, coworkers, nature of work, communication and the total satisfaction is calculated by the sum of all the 36 items. The survey also consists of negatively worded items which are 2, 4, 6, 8, 10, 12, 14, 16, 18, 19, 21, 23, 24, 26, 29, 31, 32, 34 and 36. High scores obtained on the scale indicate job satisfaction. The psychometric properties of the survey indicate high internal consistency reliability of 0.91 and is a widely used measure of job satisfaction.

Job Performance

Job performance was assessed using the Individual Work Performance Questionnaire developed by Koopmans et al. (2013) which measures three dimensions of work performance, namely, task performance, contextual performance and counterproductive work behaviour. It is an 18-item questionnaire and the scores for the three dimensions are obtained separately. The internal consistency, convergent validity and discriminative validity of the IWPQ are acceptable. It is widely used for research purposes in assessing work performance and serves as a reliable and valid instrument for examining individual work performance in different occupational sectors (Koopmans et al., 2014).

Procedure

The Institutional Ethics Committee reviewed the application for the present research and gave the necessary permissions for the ethical clearance for data collection. A pilot study was conducted with 30 respondents to estimate the time taken and the relevance of responses received through the tools being used for the study. After the successful response in the pilot study, the data were then collected for the full-scale study. The informed consent for voluntary participation was collected from the participants before the conduction of the study. The data collection was conducted on an online platform with the inclusion of all the above-mentioned measures in a self-reported form (Mutepfa and Tapera, 2018). The items of the measures were listed in a sequential form, in the following manner, starting from the Multidimensional Scale of Grit, Metacognition Self-Assessment Scale, Flow Short Scale, Life Orientation Test-Revised, Toronto Empathy Questionnaire, Job Satisfaction Survey and Individual Work Performance Questionnaire. The administration of the test included giving a brief introduction of the study as well as its nature, purpose and use in the academic research. The participants were also informed about their rights of confidentiality, privacy, anonymity and withdrawal in order to make an informed decision to participate in the study (Allen, 2017).

Data Analysis

G*Power

To estimate the required sample size for the study, the G* Power 3.1 software was used, which is a widely used software for determining sample size and to conduct power analysis (Faul et al., 2009; Kang, 2021). The results from the Power Analysis on G-Power revealed that the minimum sample size in the study should be 138, which has been achieved.

Harman's Single Factor Test

To assess the common method bias which refers to the presence of systematic variance in the undertaken measures, which can have an impact on the reliability and validity of the tools employed in the research (Aguirre-Urreta and Hu, 2019), the Harman's Single Factor Test has been employed on SPSS Statistics 28.0.1. To conduct this test, one single factor is extracted by loading all the items into one common factor. The total variance for the common factor was found to be 24%, which is less than 50%, indicating that there is no presence of common method bias in the measures.

Statistical analyses were performed using the following software and statistical methods. The total scores of all measures were used to conduct the analysis to ensure uniformity. To substantiate the relationship between the antecedents (metacognition, optimism, flow, empathy) and consequences (job satisfaction, task performance, contextual performance and counterproductive work behaviour) of grit, the Pearson correlation analysis was conducted on IBM SPSS Statistics 26.0 (Antonius, 2012). Furthermore, to test the hypothesised associations among the exogenous and endogenous variables based on the proposed conceptual framework, IBM SPSS Amos 27.0 was used (Arbuckle, 2011)

RESULTS

A total of 209 working professionals living in India in the age range of 20–63 years, males (56%) and females (44%) working at organisations in different sectors were a part of the study. 31.1% were post-graduates, 67% were undergraduates and 1.7% reported to have done diplomas. Also, it was noted that 89.5% belonged to urban areas, whereas 10.5% belonged to rural areas, as shown in **Table 1**. To measure for sample

TABLE 2 | Correlation analysis among study variables.

Variable	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Grit	49.30	7.03	0.622**	0.162*	0.537**	0.002	0.173*	0.441**	0.565**	−0.042

*(1) Metacognition, (2) optimism, (3) flow, (4) empathy, (5) job satisfaction, (6) task performance, (7) contextual performance, and (8) counterproductive work behaviour. SD, standard deviation. **p < 0.01; *p < 0.05.*

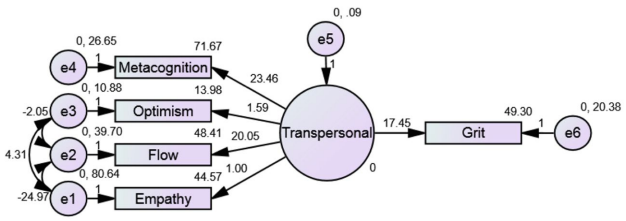

FIGURE 1 | Confirmatory factor analysis of antecedents of grit.

TABLE 3 | Fit indices of the CFA model of antecedents of grit.

Model	*df*	Chi square	RMSEA	CFI	NFI	SRMR	TLI	AIC	*p*
Default model	2	3.144	0.052	0.995	0.987	0.018	0.976	39.144	0.208

adequacy, an exploratory factor analysis was performed and the KMO (Kaiser–Meyer–Olkin) test was performed and was found to be 0.749 which represents acceptable sample adequacy and the results of Bartlett's Test of Sphericity revealed the correlation matrix to not be random χ^2 (36) = 588.862, p = <0.001, and was found suitable for the factor analysis to be performed (Singh and Chukkali, 2021).

Table 2 shows the correlation among the variables measured in the study. Pearson correlation analysis found that grit is positively correlated with metacognition ($r = 0.662$, $p < 0.01$), optimism ($r = 0.162$, $p < 0.05$), flow ($r = 0.162$, $p < 0.05$), job satisfaction ($r = 0.173$, $p < 0.05$), task performance ($r = 0.441$, $p < 0.01$) and contextual performance ($r = 0.565$, $p < 0.01$).

Two confirmatory factor analyses were performed, one for the antecedents of grit and one for consequences of grit to ensure that the measurement models were adequate. The model fitted the data acceptably for antecedents of grit, $\chi^2 = 3.144$, $p = 0.208$, CFI = 0.995, RMSEA = 0.052, SRMR = 0.018, NFI = 0.987, TLI = 0.976, AIC = 39.144, and for consequences of grit $\chi^2 = 2.740$, $p = 0.254$, CFI = 0.997, RMSEA = 0.042, SRMR = 0.035, NFI = 0.990, TLI = 0.985, AIC = 38.740, respectively, and indicate a good fit for both the models (Schumacker and Lomax, 2010; **Figures 1, 2**; **Tables 3**, **4**).

DISCUSSION

The present study aimed to examine the multiple causal relationship between the antecedents and the consequences of grit. To bridge the gap between the need for a conceptual model for exploring the factors contributing to grit and its outcomes to help organisational sectors thrive, in the context of an eastern perspective, the theoretical perspective of transpersonal psychology, the hypothesised conceptual framework was formed, with the transpersonal factors of metacognition, optimism, flow, empathy as predictors of grit and job satisfaction and job performance (task performance, contextual performance and counterproductive work behaviour) as consequences of grit. Based on the data collected from 209 working professionals living in India, working in different parts of India, the findings of the analyses were found to be consistent with the hypothesis of the study that transpersonal capital predicts grit which, in turn, predicts job satisfaction and job performance. Grit was strongly associated with metacognition, optimism, job satisfaction and task performance, consistent with the existing body of literature (Arslan et al., 2013; Min Hee and Sook Hee, 2019; Chandrawaty and Widodo, 2020; Clement et al., 2020).

The relevance of the findings of the present study, implicating that the transpersonal factors of metacognition, flow, empathy and optimism can result in grit, can be due to the acknowledgement and inclusion of the contemporary human experience resulting from transpersonal psychology (Hartelius et al., 2007). The results are also consistent with the current knowledge on the antecedents of grit, as flow experiences at the workplace have been found to be effective tools for reconstructing individual and team performance (Aubé et al., 2014; Hout et al., 2018) as well as in fostering well-being (Peifer et al., 2020) and job satisfaction (Maeran and Cangiano, 2013). The positive association between grit and metacognition found in the present research can be attributed to the metacognitive processes in which individuals and teams

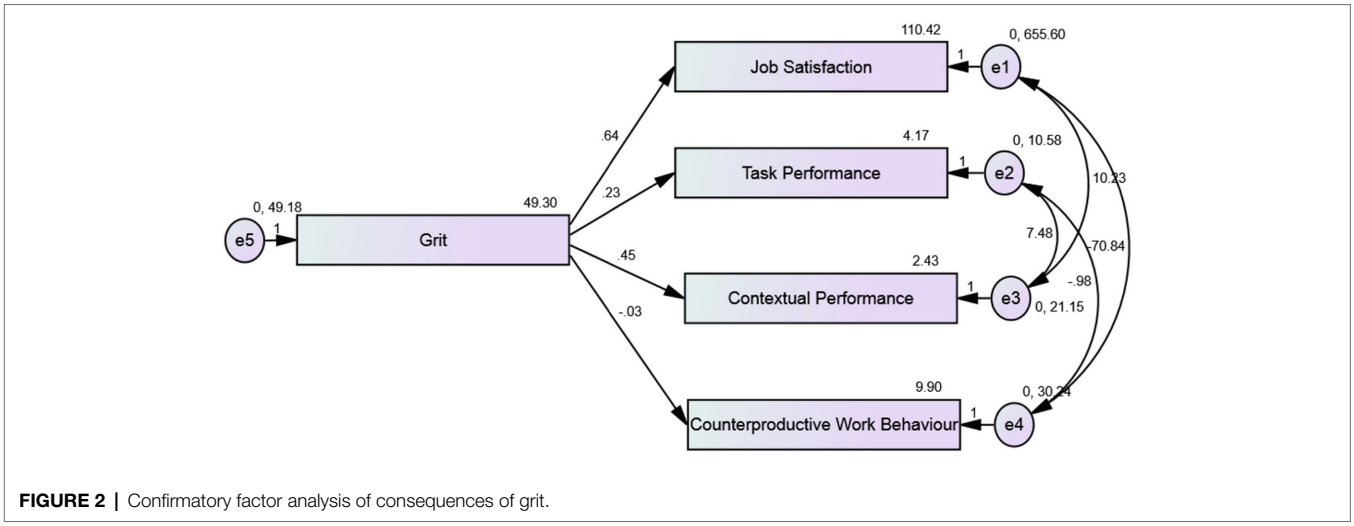

FIGURE 2 | Confirmatory factor analysis of consequences of grit.

TABLE 4 | Fit indices of the CFA model of consequences of grit.

Model	*df*	Chi square	RMSEA	CFI	NFI	SRMR	TLI	AIC	*p*
Default model	2	2.740	0.042	0.997	0.990	0.035	0.985	38.740	0.254

engage in, during crucial decision making tasks (McCarthy and Garavan, 2008). Metacognition has been studied in conjunction with theory of mind, social cognition and self-regulation (Baker et al., 2020) and it has also been identified important to study job-seeking behaviours and job-search outcomes, as the process of seeking and finding jobs requires metacognitive skills, implying the ability to set goals, plan, develop and strategise their job search progress and job performance (Mikulecky and Ehlinger, 1986; Turban et al., 2009; Kanar and Bouckenooghe, 2021). The other transpersonal capital of optimism also positively correlates with grit, consistent with previous studies (Steinfort, 2015; Clement et al., 2020; Loftus et al., 2020; Oriol et al., 2020; Kim and Lee, 2021). Optimism has also been shown to foster and predict perseverance, an essential component of grit (Binsch et al., 2017). Congruent with the results of the present study, utilisation of positive psychology based workplace training programmes to stimulate a culture of optimism in organisations to promote inculcation of positive emotions is also an advantageous method to advance a sense of well-being at the workplace (Pykett and Enright, 2016). Similar findings were found by Malik (2013) who indicated that optimism can help maintain positive organisational behaviour at the workplace. The positive association between grit and empathy in the present research is consistent with the existing literature which suggests that higher levels of grit indicate higher empathic orientation (Isenberg et al., 2020) and Singh (2014) who established that fostering empathy at the workplace can help in adapting to different situations. Interestingly, Paakkanen et al. (2021) stated that validating and constructive responses can help in developing positive emotions among coworkers.

The field of transpersonal psychology has seen a shift from its emphasis on altered states of consciousness towards an inclusive, diverse, holistic, experience of simple transcendence at the individual and collective levels (Hartelius et al., 2021; Richards Crouch et al., 2021). Transpersonal psychology is one of the only areas in the discipline of psychology encompassing the wide dimensions of spirituality, which focuses on achieving the epitome of human potential (Cowley, 1993). This perspective in the current study offers interesting insights into the occupational health of employees. The pandemic saw a considerable decline in work satisfaction among employees and the indirect effects of social isolation on remote work satisfaction (Toscano and Zappalà, 2020; Möhring et al., 2021) as well as the impact on the well-being of employees due to financial situation and physical health (Harju et al., 2021), making it crucial to identify the need to address the health emergency that has arisen due to the deadly pandemic. In this context, incorporating the perspective of transpersonal psychology into inculcating and improving the mental, physical, emotional and overall well-being of the working professionals community is of utmost importance. Law and Buckler (2021) substantiated the usefulness of transpersonal coaching in times of the COVID-19 pandemic to reconstructing new meaning on the basis of the past, to expand one's sense of being, to experience the higher self, to reach a state of self-transcendence, and to integrate mindfulness in one's life, thereby positively impacting our intrapersonal and interpersonal relationships, our environment and the planet at large. The role of self-transcendence, which implies reaching beyond one's immediate confines and inculcating the quality which may result due to this process, which has been found as a measurable construct of transpersonal psychology (Garcia-Romeu, 2010), has become an crucial state for seeking relief and dealing with uncertainty during the pandemic (Worth and Smith, 2021). Other studies support the importance behind this construct, by recognising how meaning-making and self-transcendence can affect well-being, facilitate healing and serve as a buffer against suffering imposed by the COVID-19 pandemic (Wong, 2016; Wong et al., 2021). Henceforth, it can be stated

that the entirety of human experience that transpersonal psychology seeks to promote and facilitate, can help individuals deal with the inevitable suffering caused by the pandemic, emotionally, physically and on a deep, collective level.

The necessity of a framework providing insights into understanding how to inculcate grit within working professionals and how grit in itself can influence and enhance job satisfaction and job performance at the workplace has played a pivotal role in the foundation of the present study. The need for grit to be integrated within a conceptualised framework has been ongoing in recent times (Jordan et al., 2019; Kim et al., 2021; Sudina and Plonsky, 2021; de Waal et al., 2022) but has left a gap in addressing the well-being and occupational health of employees from the lens of transpersonal psychology. Previous research on conceptualising grit include an attempt by Southwick et al. (2019) to provide the organisational antecedents of grit, namely leadership, culture and job design with the consequences of employee retention, engagement and job performance. The present research has furthered the work of the former researchers on grit, by acknowledging employee welfare from a broader lens by focusing attention on metacognitive, flow experiences and inculcating empathy and optimism, to sustain the pressures of life. The work by (Claro et al., 2016; Fitzgerald, 2016; Yeager et al., 2019; Wolcott et al., 2020) on growth mindset which implies that mindset is a construct that can permeate across socioeconomic disadvantages, is facilitative of the results of the current study, as it means that the non-cognitive trait can be learnt through development of metacognition, flow, optimism and empathy within working professionals, with the collective support of a positive organisational culture, thereby also contributing to transformational leadership at work (Caniëls et al., 2018).

The implications of this study are several, including the potential for the conceptual framework of antecedents and consequences of grit from a transpersonal psychology perspective to be utilised, studied and implemented in organisations to improve employee well-being, health, welfare and to improve their levels of satisfaction and performance. Since the study is one of the pioneering researchers in understanding occupational outcomes from a transpersonal lens, it can serve as a guiding foundation for nurturing the capabilities and strengths of employees, considering that the study is one of the first in offering an eastern perspective of the factors behind the development of grit and its outcomes, in the context of the collectivist groundwork of India. Companies, organisations and working professionals across India have faced the setbacks of the transition from shifting from offline to remote work as well as occupational layoffs, burnout, decrease in work performance, work engagement, job satisfaction with a reduction in personal well-being. The inclusion and integration of grit through the transpersonal capital of metacognition, flow, optimism, empathy can significantly elevate not only the performance and satisfaction of employees, but will also equip themselves with psychological tools to help them navigate the ordeals and uncertainties of everyday life and henceforth, it will create a sense of meaning towards their work and personal life.

There are a few limitations in the study. Firstly, due to the online collection of data, there is room for error and inaccurate responses by participants owing to technical difficulties. Owing to the pandemic, the data could not be collected in person, thus, increasing the level of portraying oneself socially desirable on the online data collection platform. Secondly, the constructs being measured in the study, are not a part of everyday occupational vocabulary, thereby, making it important for organisations to truly understand the constructs before trying to inculcate, improve and implement them in their workplace settings, especially in rural workplace settings which may not be familiar with these constructs, as majority of the participants in the study belonged to urban settings. Hence, further efforts can be made to inform and elevate the understanding of organisations for improving efficiency among employees. Thirdly, more diverse research can be conducted to study gender differences and inequalities (Cénat et al., 2020) in assessing and inculcating grit among employees to provide an understanding of organisations in the collectivist culture impacted by sociocultural, economic factors that may affect the grit levels of employees and how these factors can be dealt with, to provide equal opportunities for all individuals to learn, grow and develop their talents as well as adaptability to situations, perseverance of effort, spirited initiative and steadfastness in adverse situations (Singh and Chukkali, 2021).

CONCLUSION

The present study pioneers in the research on studying the factors predicting grit, as well as the consequences of grit, from a transpersonal psychology lens and to offer a unique conceptual framework on the same. Grit is crucial for the personal and professional development of employees and others across the organisational sector. Previous research has focused on the importance of grit, but have not recognised the essential factors that can shape grit among individuals at work, from a higher order perspective, such as transpersonal psychology. The study has provided a conceptual understanding of the antecedents of grit, namely, metacognition, flow, optimism and empathy, which were found to have a positive association with each other, and the consequences of grit, namely, job satisfaction and task performance, contextual performance, counterproductive behaviour. Data analyses using path analysis revealed goodness of fit of the measurement models, thereby, substantiating the hypothesis of the study that the transpersonal factors can predict grit, which in turn can result in job satisfaction and job performance. The study offers a beneficial perspective on grit, by predominantly investigating grit from a transpersonal lens, amalgamating useful constructs from positive psychology and examining the consequences of grit inclusive of organisational psychology, from a collectivist setting.

AUTHOR'S NOTE

The Job Satisfaction Survey developed by Paul Spector in 1985 reserves its copyright permissions (Copyright Paul E. Spector 1994, All rights reserved). The permission for using the Multidimensional Scale of Grit, Flow State Scale, Individual Work Performance Questionnaire and Job Satisfaction Survey was obtained from the authors.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Institutional Ethics Committee of Christ (Deemed to be University), Delhi NCR, India. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

DA, SC, and SS contributed in the conceptualisation of the research, data analysis, interpretation of data, and manuscript preparation. DA contributed in data collection and in drafting of the paper. All authors contributed to the article and approved the submitted version.

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