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Comparative Measures of Grit, Tenacity and Perseverance

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Abstract. Motivation to learn has been shown to be an important asset for success in school and career. This study examined the relationship between psychometric scales as well as survey items regarding motivational characteristics related to learning and achievement. Newer measurement indices related to grit and perseverance are compared to historical indices related to persistence and motivation to study to explore the commonalities or differences in the measures. Major findings were that the three scales of Study Habits from the Computer Attitude Questionnaire (CAQ), Grit part 2 Persistence of Effort and CAQ Motivation / Persistence were closely associated with each other while Grit part 1 Consistency of Interests remained independent, as a separate measure. Multiple gender differences in the measures indicate that females in this study are higher in most of the areas measured.

Keywords: perseverance, grit, persistence, study habits, gender

Introduction

Motivation to learn has been shown to be an important asset for success in school and career. For many years, researchers have studied characteristics that are likely to result in success. Duckworth et al. (2007) introduced a 12-item survey widely used to measure the construct of grit. The two subscales of their instrument were *consistency of interests* and *perseverance of effort* (Duckworth & Quinn, 2009). In 2013, the U.S. Department of Education published a commissioned study in this area expanding this concept to include tenacity and perseverance, and noting that these were non-cognitive factors critical for success for 21st century learners (Shechtman et al., 2013). Other studies have used validated measures of concepts that appear to be aligned with the Department of Education's report entitled *Promoting grit, tenacity, and perseverance: Critical factors for success in the 21st century* (Shechtman, et al., 2013). Since 1991, the authors of this paper have conducted studies including the

concepts of motivational persistence and study habits using items originally derived for multinational comparisons by IEA (Collis et al., 1996). This paper addresses the relationship between the Duckworth measures and similar measures used by the authors for more than two decades as scales on the Computer Attitude Questionnaire (CAQ) (Knezek & Christensen, 1996; Christensen & Knezek, 2002).

Related Literature

A recent U.S. federal government report has focused on grit as a measure of persistence in success (Shechtman, et al., 2013). Some researchers (e.g. Duckworth, et al, 2007) have been studying grit since the 1990s, but even before the term grit was made popular, as early as the 1980s, the International Association for the Evaluation of Educational Achievement (IEA) had been studying a similar composite attribute known as motivation and/or persistence and study habits (motivation to study) on a trans-national basis (Plomp & Pelgrum, 1991; Pelgrum et al., 1993; Collis, et al., 1996). Use of the IEA-based measures has continued by the authors of the current paper into the 21st Century (e.g. Christensen & Knezek, 2002). This paper examines the alignment of motivation/persistence with the newer concept of grit.

Duckworth delineates grit from resilience as "not just having resilience in the face of failures, but also having deep commitments that you remain loyal to over many years" (Perkins-Gough, 2013, p. 16). In a study looking at multiple indicators of success for cadets at West Point Military Academy including SAT scores, class rank and leadership ability, an additional survey to determine the amount of grit was administered. Of all the variables measured, grit was the best predictor regarding which of the cadets would drop out after the difficult first summer training (Duckworth, et al., 2007). Many other studies conducted by Duckworth et al. (2009) indicated that grit can be a predictor of success over and beyond talent. More schools are beginning to recognize the importance of character traits such as grit and resilience as indicators of future success.

Duckworth, et al. (2009) define grit as "trait-level perseverance and passion for long-term goals." The six Duckworth, 2009, et al., studies found that grit scores did not differ between genders. The summary of findings indicates that "Perseverance of Effort was a superior predictor of GPS (grade point average), extracurricular activities and (inversely) television watching among adolescents" (Duckworth & Quinn, p. 172). In a study involving adults, findings indicated that adults with higher levels of grit progressed farther in their education and made fewer career changes than adults with lower levels of grit (Duckworth, et al., 2009). Grit as defined by Duckworth and colleagues clearly has been established as a concept worthy of wider recognition.

Current Study

This study seeks to determine the relationship between survey scales as well as survey items regarding motivational characteristics related to learning. Several analysis techniques were used to examine the consistency of the scales forming the basis of this study, as well as the integrity of psychological constructs, and

their relationship to each other. These include internal consistency reliability analysis, factor analysis, hierarchical cluster analysis and multidimensional scaling. Each technique has been selected for a specific purpose, as well be explained in the following sections.

Methodology

Research Questions

Two research questions were addressed in this study:

1. Are traditional measures of motivation/persistence related to the more recently established measures of grit in secondary school students?
2. Are there differences in levels of grit for male versus female students?

Instrumentation and Participants

One hundred fifty-two (152) upper secondary school participants completed the Duckworth Grit survey and the CAQ Motivation/Persistence and Study Habits subscales. These students were finishing their final year of secondary school at a residential academy of mathematics and science accepting applicants from across the state of Texas. Academy participants acquire two years of university credit while completing their last two years of secondary education.

Reliability of Motivation/Persistence and Grit Scales for Secondary School Students

Internal consistency reliability was assessed for the original scales used in this study in order to determine the performance of the scales with secondary school students. The Grit survey items are shown in Table 1 while the Motivation/Persistence and Study Habits items are shown in Table 2.

Table 1. Grit Survey Items

Part 1. Consistency of Interests
1. I often set a goal but later choose to pursue a different one.
2. New ideas and new projects sometimes distract me from previous ones.
3. I become interested in new pursuits every few months.
4. My interests change from year to year.
5. I have been obsessed with a certain idea or project for a short time but later lost interest.
6. I have difficulty maintaining my focus on projects that take more than a few months to complete.
Part 2. Perseverance of Effort
7. I have achieved a goal that took years of work.
8. I have overcome setbacks to conquer an important challenge. I finish whatever I begin.
9. Setbacks don't discourage me.
10. I finish whatever I begin.
11. I am a hard worker.
12. I am diligent.

Table 2. CAQ Motivation/Persistence and Study Habits Items

1. I study by myself without anyone forcing me to study. (701)
2. If I do not understand something, I will not stop thinking about it. (702)
3. When I don't understand a problem, I keep working until I find the answer. (703)
4. I review my lessons every day. (704)
5. I try to finish whatever I begin. (705)
6. Sometimes, I change my way of studying. (706)
7. I enjoy working on a difficult problem. (707)
8. I think about many ways to solve a difficult problem. (708)
9. I never forget to do my homework. (709)
10. I like to work out problems which I can use in my life every day. (710)
11. If I do not understand my teacher, I ask him/her questions. (711)
12. I listen to my teacher carefully. (712)
13. If I fail, I try to find out why. (713)
14. I study hard. (714)
15. When I do a job, I do it well. (715)

As shown in Table 3, Cronbach's alpha for the original CAQ Motivation/Persistence scale (.74) and the Study Habits scale (.82) compare favorably with the reliability estimates of .77 and .81 previously published for these two scales (Knezek et al., 2000). Similarly, the reliabilities found in the current study for the scales of the Grit survey part 1 Consistency of Interests (.74) and Grit survey part 2 Perseverance of Effort (.68) are acceptable or better (DeVellis, 1991) as were the reliabilities previously published by Duckworth and colleagues (Duckworth, et al., 2007, 2009). Duckworth and Quinn (2009) analyzed the Grit 12-item survey with two factors and determined that the measurement properties were better for an 8-item (two factor) survey (Grit-S). However, for this study, the reliability analysis for the scales from the 8-item Grit survey and the 12-item Grit survey did not support the higher reliability analysis on both of the Grit scales. Overall, the reliabilities were somewhat lower for the subjects in the current study, on all scales.

Table 3. Cronbach's Alpha for CAQ and Grit Scales

Scale	*Published Alpha*	*Current Study*
CAQ Motivation/Persistence (items 1,2,3,5,7,8,9,14,15)	.77 (2000)	.74

CAQ Study Habits (items 1,4,5,6,9,10,11,12,13,14)	.81 (2000)	.80
CAQ SH/Persistence (15 items)	–	.82
Grit Survey Part 1 with 6 items (items 1,2,3,4,5,6)	.84 (2007)	.74
Grit Survey Part 2 with 6 items (items 7,8,9,10,11,12)	.78 (2007)	.68
Grit-S Part 1 with 4 items (items 1,2,5,6)	.73 to .79 (2009)	.64
Grit-S Part 2 with 4 items (items 9,10,11,12)	.60 to .78 (2009)	.72
Grit-S all 8 items (4 Pt. 1 + 4 Pt. 2) (items 1,2,5,6,9,10,11,12)	.73 to .83 (2009)	.75
Grit Survey all 12 items	.85 (2007)	
CAQ 15 + Grit 12	–	.84

Construct Validity

Exploratory factor analysis (principal components, varimax rotation) was run on the two surveys separately. The Grit survey produced four factors with eigenvalues greater than one. Examination of the scree plot shown in Figure 1 indicated two to four factors likely existed. Forcing the factor structure to two factors resulted in the alignment of the twelve total items along two factors consistent with the Grit survey original scales. As shown in Table 4, only item 9, *I finish whatever I begin*, had extensive cross loading on both factors (.505 on Factor 2 and .471 on Factor 1).

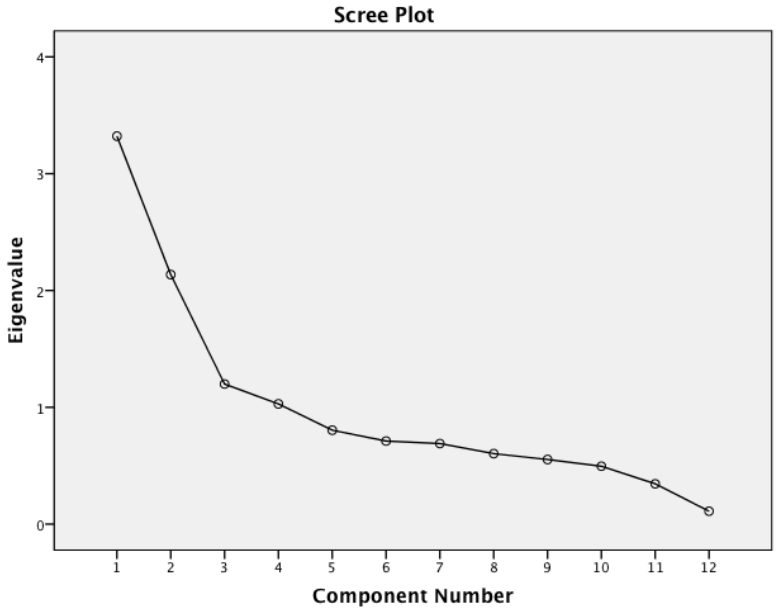

Figure 1: Screen plot of eigenvalues for Grit survey principal components.

Table 4. Factor Loadings for Grit Survey Items

Grit Item	Component	
	1	2
Grit Item 4 (Rev)	.774	-.167

Grit Item 3 (Rev)	.698	-.142
Grit Item 1 (Rev)	.698	.168
Grit Item 5 (Rev)	.644	
Grit Item 2 (Rev)	.604	.124
Grit Item 6 (Rev)	.473	.317
Grit Item 11		.888
Grit Item 12	.128	.852
Grit Item 8	-.102	.519
Grit Item 9	.471	.505
Grit Item 7		.451
Grit Item 10	.225	.373

Note: Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
a. Rotation converged in 3 iterations.

Exploratory factor analysis (principal components, varimax rotation) was also run on the 15 items from the CAQ scales. The CAQ scales together produced four factors with eigenvalues greater than one. Examination of the scree plot shown in Figure 2 indicated two to three factors likely existed. Forcing the factor structure to three factors resulted in the most parsimonious solution, with Cronbach's alpha for Factor 1 = .73 (6 items), for Factor 2 = .74 (5 items) and Factor 3 = .65 (4 items). The factor loadings on the three factors are listed in Table 5. Because Factor 3 exhibited marginal reliability and was represented by only four items, only the first two factors were retained. Item 5, *I try to finish whatever I begin*, showed extensive cross loading between Factor 2 (.461) and Factor 1 (.444).

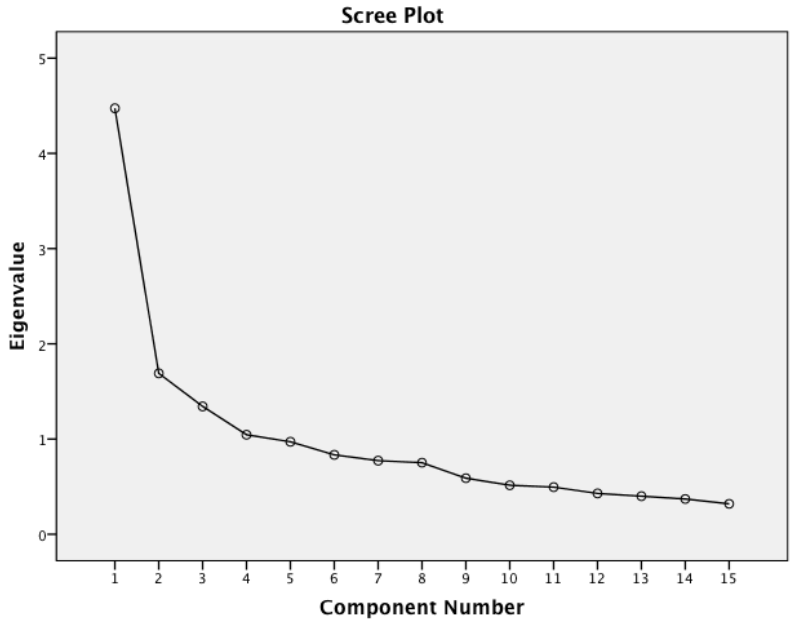

***Figure* 2. Screen plot of eigenvalues for CAQ principal components.**

Table 5. Factor Loadings for Three Factors Emerging from 15 Items on the CAQ

	Component		
	1	2	3
CAQ Item 14	.741		.347
CAQ Item 1	.681		-.142
CAQ Item 9	.585	.136	
CAQ Item 12	.526	.105	.408
CAQ Item 15	.449		.120
CAQ Item 13	.433	.256	.378
CAQ Item 8	-.141	.783	.231
CAQ Item 7		.731	.218
CAQ Item 3	.366	.714	
CAQ Item 2	.356	.584	
CAQ Item 5	.444	.461	.281
CAQ Item 6	-.249	.134	.782
CAQ Item 11	.205	.109	.723
CAQ Item 4	.398		.541
CAQ Item 10	.252	.222	.440

Note: Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
a. Rotation converged in 6 iterations.

Cronbach's alpha for each of the CAQ three-factor solution scales is shown in Table 6, along with comparable indictors for the 6-item and 4-item versions of the Grit scales. These internal consistency reliabilities range from minimally acceptable to very good according to guidelines established by DeVellis (1991).

Table 6. Internal Consistency Reliabilities for CAQ and Grit Scales

Subscale	*Reliabilities*
CAQ Factor 1 Study Habits (items 14,1,9,12,15,13)	.73
CAQ Factor 2 Persistence (items 7,8,2,3,5)	.74
CAQ Factor 3 Practicality (items 6,11,4,10)	.65
CAQ Motivation to Study (SH/Persistence items 14,1,9,12,15,13,7,8,3,2,5)	.78
CAQ 15 items	.82
Grit Survey Part 1 Consistency of Interests with 6 items (items 1,2,3,4,5,6)	.74
Grit Survey Part 2 Persistence of Effort with 6 items (items 7,8,9,10,11,12)	.68
Grit-S Part 1 Consistency of Interests with 4 items (items 1,2,5,6)	.64
Grit-S Part 2 Persistence of Effort with 4 items (items 9,10,11,12)	.72
Grit Survey all 12 items	.75
CAQ 15 + Grit 12 items	.84

Relationship between constructs on the Grit and CAQ scales

Scale scores were produced for each of the four constructs retained after factor analysis. A scale score for each subject on each construct was computed by averaging the five-point ratings for the items on each construct. Higher-order factor analysis (Dunn-Rankin, et al., 2004) was used to identify the relationships among the Grit and CAQ scales. As shown in Figure 3, the scree plot indicated one or two higher-order factors were likely to exist. The solution resulting in two higher order factors produced strong loadings for each scale, with CAQ Study Habits, CAQ Persistence, and Grit part 2 Perseverance of Effort forming higher-order Factor 1 (HF1) and Grit part 1 Consistency of Interests forming higher-order Factor 2 (HF2) on its own. These outcomes are shown in Table 7. Upon examination of the analysis, it appears that the CAQ measures are more closely aligned with the type of grit measured on part 2 of the Grit survey, the perseverance of effort rather than the consistency of interest.

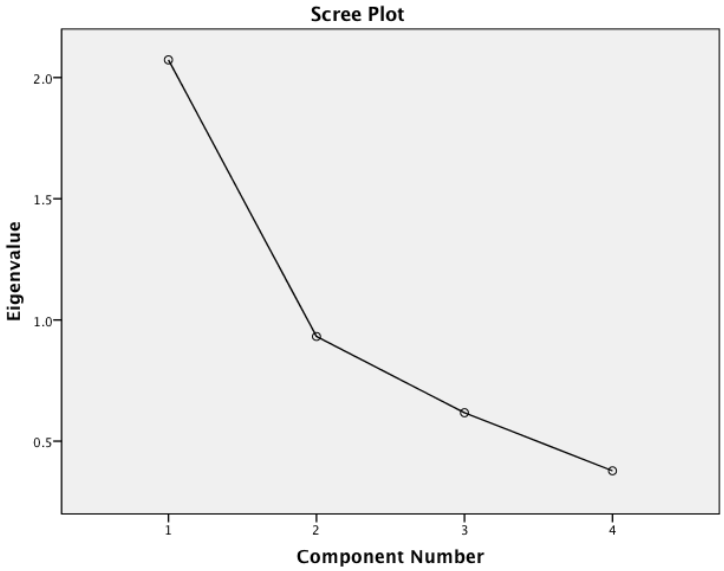

***Figure 3*. Screen plot of eigenvalues for higher-order factor analysis of CAQ and Grit scales.**

Table 7. Higher-Order Factor Loadings for Four Grit-related Scales

Measurement Indices	Component	
	1	2
CAQ Study Habits	.847	.170
CAQ Motivation / Persistence	.794	-.117
Grit Part 2 Perseverance of Effort	.748	.353
Grit Part 1 Consistency of Interests		.961

Note: Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

A hierarchical cluster analysis (SPSS, 2010) was run on the four scale scores in order to further explore the relationships among the Grit survey and the CAQ scales. As graphically displayed in Figure 4, and more specifically in the dendogram connections illustrating the strengths of associations among the scales, CAQ Study Habits and Grit part 2 Perseverance of Effort clustered together at the first agglomeration stage, and were shortly joined by CAQ Motivation / Persistence. Grit part 1 Consistency of Interests became absorbed into the common cluster at the last agglomeration stage with a much greater distance. These relationships are consistent with the findings of the higher-order factor analysis.

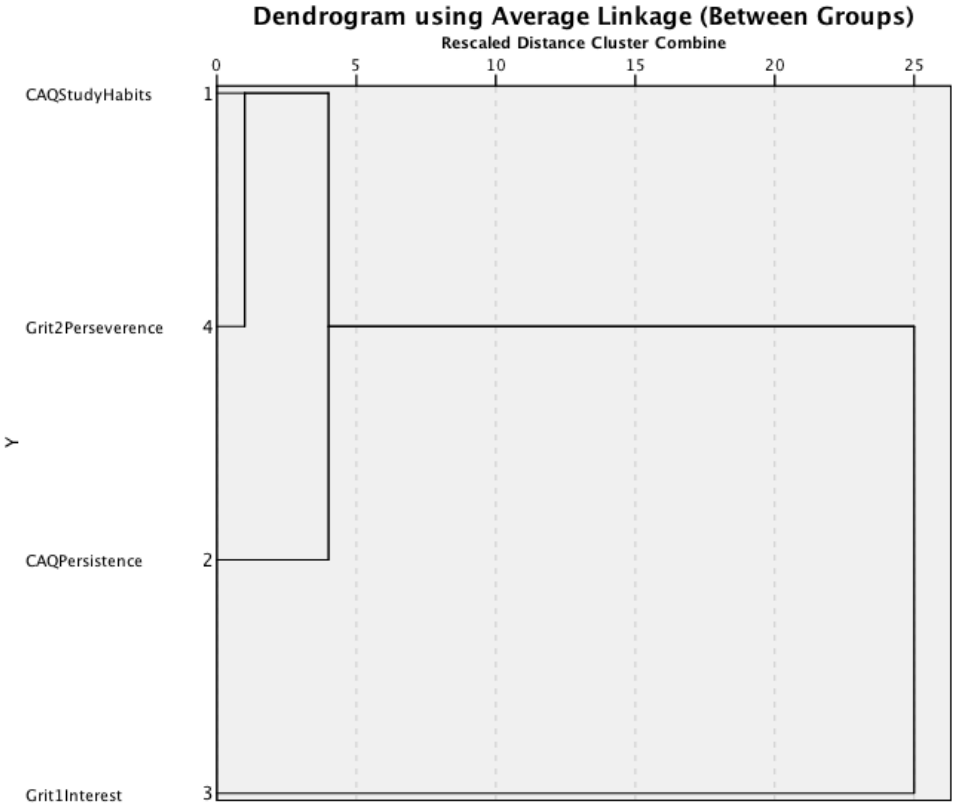

Figure 4: Hierarchical cluster analysis display for relationship among four scales

The Multidimensional scaling (MDS) procedure PROXSCAL (SPSS, 2010) was used to help determine the minimum number of higher order constructs that would adequately represent the four scales. As shown in Figure 5, a two-dimensional MDS solution places the scales as objects in relation to each other in a fashion congruent to the higher-order factor analysis and the hierarchical cluster analysis. Note that in the one-dimensional solution of Figure 6, Study Habits is physically close to Grit part 2 Persistence of Effort, and these two are not far from CAQ Motivation / Persistence. All three of these are distant from Grit part 1 Consistency of Interests. The total dispersion accounted for (D.A.F.) in the two-dimensional solution is .99985, indicating that almost all of the distances between the four scales as objects can be accounted for by placing the scales in the two-dimensional orientation shown in Figure 5.

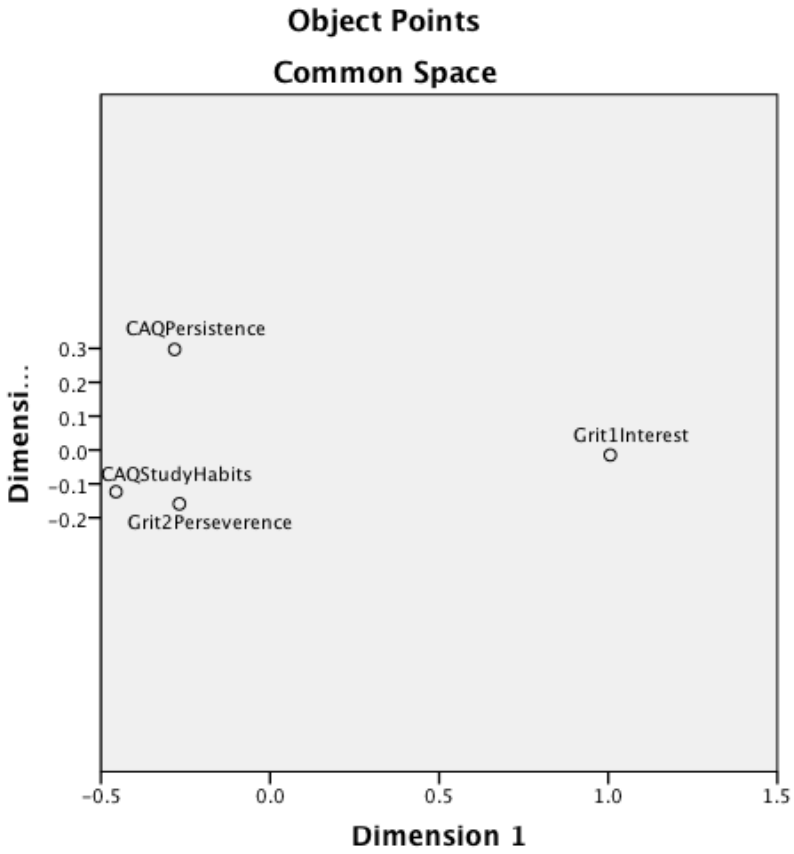

Figure 5: Two-dimensional multidimensional scaling solution for four measures of persistence, study habits, perseverance, and consistency of interests.

The one-dimensional solution produced by multidimensional scaling analysis (MDS) for the four scales in this study is shown in Figure 6. This solution places the three scales of CAQ Study Habits, Grit part 2 Persistence of Effort and CAQ Motivation / Persistence together at one extreme with Grit part 1 Consistency of Interests at the other extreme. The total dispersion accounted for (D.A.F.) is .99364, just slightly less than the two-dimensional solution.

A separate analysis with the Multidimensional Scaling procedure ALSCAL [SPSS, 2010] indicated that the one-dimensional solution accounts for 95% (RSQ = .95) of the variance in the distance matrix. This implies that minimal information will be lost if the simpler one-dimensional (straight line) solution is retained. However, the authors have elected to retain the two-dimensional solution shown in Figure 5 because it illustrates the fine granularity separation of CAQ Motivation / Persistence from the cluster of CAQ Study Habits and Grit part 2 Perseverance of Effort that is also represented in the hierarchical cluster analysis shown in Figure 4.

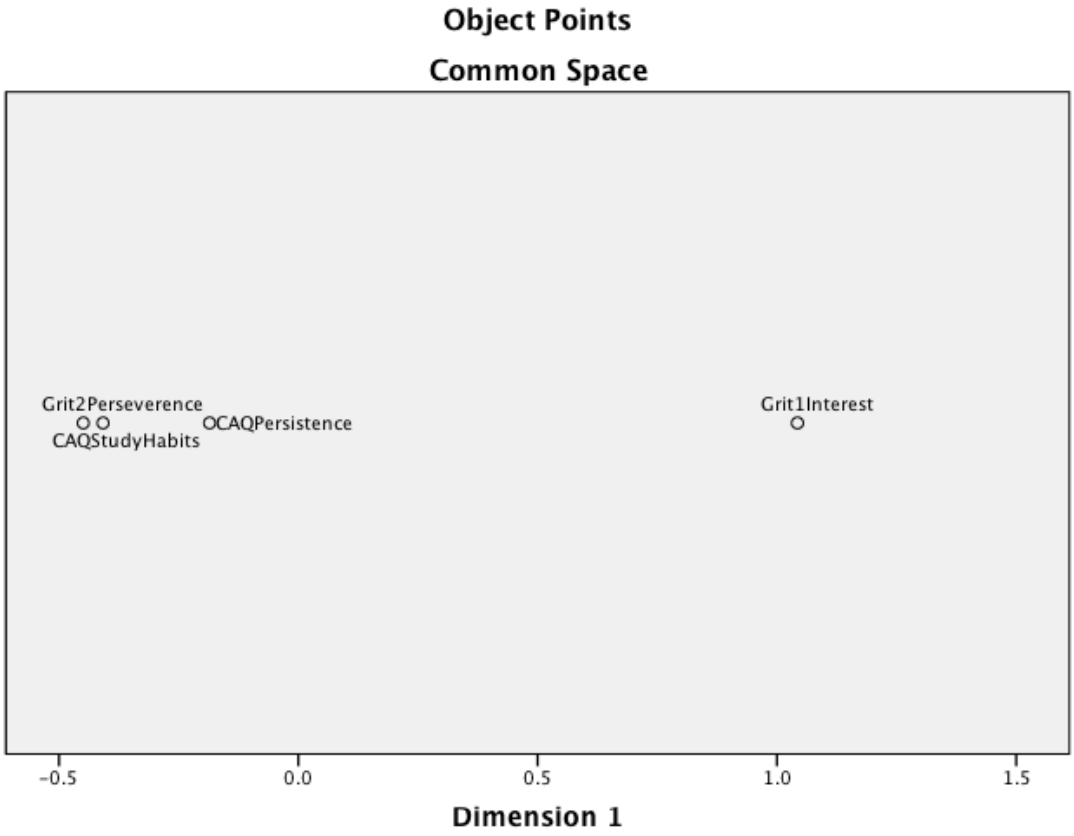

Figure 6. One-dimensional multidimensional scaling solution for four measures of persistence, study habits, perseverance of effort, and consistency of interest.

Gender Differences in Grit

As shown in Table 8, there were significant differences ($p < .05$) for gender in just one of the four factors measured. For Grit part 1 Consistency of Interests, females were found to be significantly ($p < .025$) higher than males. When effect sizes were calculated to assess the magnitude of the differences (rather than likelihood by chance), females were found to be higher than males in three of the four areas: Grit1Interest ES = .35; CAQ StudyHabits ES = .31; and Grit2Perseverance ES = .30.

Only in the area of CAQ Persistence, were females lower than males (ES = -.19). Since an effect size of .30 or greater is normally considered to be an educationally meaningful (Bialo & Sivin-Kachala, 1996), the trends in these data indicate that the female participants in this study may generally be higher than the male participants in several types of grit. Specifically for the total scale score of Duckworth's Grit survey (parts 1 and 2 combined), the females were significantly higher ($p = .011$) in the type of grit measured by the Grit survey, than the males. The effect size (Cohen's d) was .42, indicating a small to moderate magnitude of difference in male vs. female total Grit (Cohen, 1988).

Table 8. Gender Differences in Grit-Related Measures

Scale	Gender	N	Mean	Std. Dev.	Sig.	Effect Size
CAQ Study Habits	Male	79	3.95	.64		
	Female	72	4.14	.56		
	Total	151	4.04	.61	.056	.31
CAQ Persistence	Male	79	3.88	.83		
	Female	72	3.75	.49		
	Total	151	3.82	.69	.251	-.19
Grit1 Interest	Male	79	2.71	.71		
	Female	72	2.95	.62		
	Total	151	2.82	.68	.029	.35
Grit2	Male	79	3.87	.63		
Perseverance	Female	72	4.03	.44		
	Total	151	3.95	.55	.064	.30
Grit Total Score	Male	79	3.29	.53		
	Female	72	3.49	.42		
	Total	151	3.38	.49	.011	.42

Discussion

Two Kinds of GRIT

More than 100 years ago, Galton (1892) found large differences between the perseverance it takes to complete minor versus major accomplishments. Findings from this study indicate there are different kinds of grit being measured across the psychometric scales administered to these high school aged participants. Two types of constructs related to grit emerged among the four primary scales used in this study. It is possible that one type of grit is related to persistence and perseverance to accomplish a goal while another type of grit is related to being consistently interested in one thing over time – a breadth versus depth of interest. It is also possible that the underlying distinctions are related to concepts such as intensity and stamina. Additional research in this area is warranted.

Gender Differences in Grit

While the Duckworth et al. studies using the Grit survey found no significant differences by gender, the current study found significant differences (p =.011) in the original 12-item Grit scale. The current study had an equal distribution of males and females while the Duckworth studies were somewhat skewed in the area of gender. In the current study, females appear to be higher on three of the four primary scales used, and they may be lower than males on the fourth. This fourth area (CAQ Persistence) is somewhat focused on tackling a difficult problem and persisting until "winning the challenge" while the other three focus on consistency of interest over time, having good study habits, and steadily persevering in pursuit of a goal.

Study Limitations

National versus International Contexts. The International Association for the Evaluation of Educational Achievement (IEA) developed and validated the motivation /persistence and study habits items used in this study for a multi-national context. By contrast, the validity and reliability of the 12-item version of Grit was developed from a single-nation perspective and might not necessarily be most sensitive to the cultural nuances around the world. The current study was based on a sample of high-school aged students that was predominantly Asian American and Caucasian but also included representations of Hispanic and African American students. Although other languages in addition to English were spoken by subsets of the participants in this study, most were born in the US. Also because these students chose to attend a residential mathematics and science academy as juniors in high school, it is likely they are more homogeneous in their level of grit – with grit likely being high. Therefore this research could be viewed as a pilot study toward refinement of a grit instrument that could be used across a more broad population in the world.

Issues of Sampling and Generalizability. A note of caution is warranted with respect to whether the findings from previous studies cited in this paper, as well as from the current study itself, would necessarily generalize to all students. The research reported in this paper by Duckworth and colleagues focused on subjects (e.g. Military academy students) who would likely be considered highly motivated and possessing substantial grit. Likewise the students in the current study were selected as an entering class of 200 from among the brightest in the state in mathematics and science, and certainly college bound. Perhaps additional studies are warranted in which the participants selected are more diverse in their levels of grit before the findings reported in the literature regarding the psychometric construct(s) of grit are accepted as consistently existing throughout the general public. Nevertheless, if the delimitation that most studies appear to have been completed on persons high in grit, then findings regarding the importance of grit are consistent. For example, a study of more than 3500 participants attending nine different colleges found that follow-through (a type of grit) was the single best predictor, over many other predictors including SAT, high school rank, and high school extracurricular involvement, of significant accomplishments in college (Willingham, 1985).

Implications of Findings for Parents and Teachers

McMurry (2014) has pointed out that the current strong emphasis on intelligence scores for predicting children's success in school may be misguided given recent findings indicating the importance of grit. She has offered the following practical suggestions for parents:

1. Allow children to fail because of the choices they make.
2. Do not be a *snowplow f*or your child (clearing all obstacles).
3. Encourage your child to have a growth mindset.
4. Teach children how to set goals and identify necessary steps to achieve them.
5. As a parent, be a role model of grit yourself.

Based on the analysis by McMurry (2014), educational policy makers may wish to re-examine the question of what should be the goal of K-12 education? Is it to prepare students to be productive citizens in our communities and world or is it to achieve the highest possible scores on standardized tests to get into college? Duckworth's research on grit has shown that there are more accurate indicators of success than SAT or ACT scores (Duckworth & Quinn, 2009). Grit appears to have more to do with intrinsic motivation than extrinsic motivation. In Gladwells' book, *Outliers: The Story of Success*, he notes that it takes 10,000 hours of devotion to a craft or skill for mastery (Gladwell, 2008). Quite possibly it is grit rather than some external motivation that would cause someone to spend 10,000 hours perfecting their craft.

Conclusion

As far back as the 1800s, Galton (1892) studied biographical information to conclude that ability alone did not account for success. He further concluded that "ability combined with zeal and with capacity for hard labour" (p.33) were traits of high achievers. More recent studies of high achieving students continue to indicate that the zeal Galton described is similar to the indicators used to measure grit, perseverance, persistence and study habits described in this paper. There are many examples of students who the highest achieving students in their high school graduating class yet fail to be successful in college because they find they are not prepared to fail. They have not had to develop the grit it takes to conquer difficult material. Placing more emphasis on non-cognitive student measures such as perseverance and grit may play an important role in supporting student success in school and in the work place.

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