# Grit, Intrinsic Motivation, and Costly Perseverance: Their Interactive Influence in Problem Solving

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#### Abstract

Past studies have linked grit to many positive outcomes in a range of contexts and disciplines. However, contradictory relationships have been reported between grit and academic performance. Previous studies found that grit predicted undergraduate students' GPA but had non-significant relationships with high school students' GPA and SAT scores. The goal of the current study was to explain these discrepant results by exploring grit's interaction with intrinsic motivation and costly perseverance. Intrinsic motivation (i.e., the tendency to seek novelty and mastery) is essential for grit to be beneficial. Costly perseverance (i.e., the tendency to continue a task after it becomes disadvantageous to do so) may decrease the performance benefits of grit. To test these predictions, grit, intrinsic motivation, and costly perseverance were manipulated in a 2x2x2 between-subjects design with 157 participants completing the Remote Associate Test, which is a series of word problems. Performance was measured in *Attempts* (the number of questions answered) and *Successes* (the number of questions answered correctly). Results partially supported the hypotheses: grit only increased performance in the intrinsic motivation condition.

#### Keywords: Grit, Intrinsic Motivation, Costly Perseverance

### **1. Introduction**

Grit, defined as the combination of continuing effort and consistency of commitment to long-term goals in spite of failure and setback<sup>9, 21</sup>, appears to be an important trait-like individual difference. Previous studies in various contexts have demonstrated many positive effects from having a higher level of grit. For example, grittier individuals tend to report better emotion regulation ability<sup>16</sup>, more positive affect<sup>5, 30</sup>, and better working memory<sup>22</sup> than their less gritty counterparts.

Grit also appears to benefit individuals' performance. Eskreis-Winkler, Shulman, Beal, and Duckworth<sup>12</sup> reported that gritty salespeople were more likely to keep their jobs over a six-month period, and Meriac, Slifka, and LaBat<sup>24</sup> found that gritty people tend to work harder. Similarly, a longitudinal study found that novice teachers with higher levels of grit showed more effective teaching and greater academic gains among their students; whereas less gritty novice teachers were more likely to be re-assigned in the middle of the school year. In sport, Larkin, O'Connor and Williams<sup>17</sup> showed that grittier soccer players performed better on assessments of decision-making and situational assessment. Evidence suggests that grittiness contributes to diverse achievement-related behaviors and cognitions.

Grit's potential to benefit performance may be especially important because grit may be a resource that can be developed. One recent study suggested that grit is relatively stable, but nonetheless subject to manipulation. DiMenichi and Richmond<sup>7</sup> asked participants to recall and write about either a difficult time they persisted and succeeded (the "success" condition) or a hard time they persisted but did not succeeded (the "failure" condition). Results showed that participants in the failure condition reported higher grit score than those in the success condition. Those authors

proposed that reflecting on past failures allows people to reframe the experience in a constructive way that increases their subsequent commitment and effort. Grit may thus be a means of increasing individuals' capacity to succeed and thrive.

### 1.1. Inconsistent Effects Of Grit

As noted above, grit has been linked to success and performance in a variety of contexts. It has likewise been associated with academic performance, but these results have been mixed. Consistent with studies in other contexts, grit has been shown to predict school achievement after controlling for intelligence<sup>31, 32</sup>. In particular, past studies revealed a positive correlation between grit and academic conscientiousness, academic motivation, and less likelihood of mind wandering<sup>27</sup>. Moreover, grit predicts deliberate practice<sup>8</sup>, which contributes to academic achievement<sup>18, 25</sup>. As well, grit is positively correlated with lifetime educational attainment<sup>9</sup>.

However, there were also contrary results regarding grit in relation to educational outcomes. While multiple studies suggested a positive relationship between grit and GPA for university students <sup>2, 5, 10, 35</sup>, Ivcevic and Brackett<sup>16</sup> found a non-significant relationship between grit and high school GPA. Furthermore, compared to the criterion-referenced assessments on which GPA is based, results suggested that grit does not benefit students' performance on standardized tests. In particular, Zimmerman and Brogan<sup>35</sup> found a non-significant relationship between grit and LSAT scores, while Duckworth et al.<sup>9</sup> reported that grit was associated with lower SAT scores. Taken together, the results suggest that the benefit of grit may be context-dependent. Specifically, as discussed below, intrinsic motivation and costly perseverance may influence how much grit contributes to one's performance.

### 1.2. Intrinsic Motivation

The differing effects of grit among college and high school students could reflect differences in those students' intrinsic motivation. According to Ryan and Deci<sup>29</sup>, intrinsic motivation involves "doing an activity for the inherent satisfaction of the activity itself rather than for some separable consequences" (p.56). Whereas extrinsic motivation can sustain behaviors and effort by adopting external contingencies or value identifications, intrinsic motivation is linked solely to the enjoyment or satisfaction entailed in an activity; it does not require external contingencies to promote behavior. In itself, intrinsic motivation benefits learning outcomes<sup>19</sup>. It also facilitates other academic factors that improve performance, including creativity<sup>34</sup> and academic engagement<sup>33</sup>. As described below (in 1.4), intrinsic motivation may also moderate the effect of grit on performance.

## 1.3. Costly Perseverance

In addition to the discrepancy between high school and college students, research has indicated that grit benefits criterion-based academic outcomes such as GPA, but not standardized test outcomes<sup>9, 35</sup>. This difference may reflect an interaction between grit and costly perseverance. Costly perseverance is the tendency to continue a task after it becomes disadvantageous to do so, which potentially reduces performance<sup>21</sup>. Since gritty individuals are defined by their sustained effort and consistency of commitment despite failure and setback, costly perseverance may be especially problematic for such individuals. While adversity signals to others that it is time to quit or change focus, gritty people often stick with the task despite their lack of progress. That is, individuals with higher level of grit tend to work longer in aversive conditions due to their inherent perseverance; whereas less gritty individuals tend to move on.

Indeed, Lucas et al.<sup>21</sup> revealed that gritty individuals might incur some costs by persisting when they should not. In those authors' study, participants were asked to unscramble 37 anagrams in 20 minutes. Sixteen of those anagrams had no solution and needed to be passed over to obtain a better performance (i.e., attempting more of the solvable anagrams). The results showed that gritty individuals attempted fewer items than their less gritty counterparts, suggesting that grittier individuals tended to persist on unsolvable items. These results suggest that in conditions when perseverance interferes with performance, the determination involved in grit may be disadvantageous. Thus, grittier individuals' tendency to persist in the face of failure might be a double-edged sword. It is beneficial when ones' long-term goal requires stamina, but may harm performance in tasks that require flexibility. For instance, in standardized tests such as the SAT, success may be diminished if the participant is not able to skip difficult items to attempt and complete easier questions.

## 1.4. Hypotheses

Hypothesis 1: *Grit and intrinsic motivation interact such that grit will have a greater positive effect on task performance when the individual is intrinsically motivated.* Compared to their less gritty counterparts, gritty individuals tend to exert sustained effort to complete a task and achieve success. However, it is not possible to exert sustained effort in all areas of life. Even a gritty person must choose where to concentrate effort. As such, the consistency of commitment and perseverance that cause grit to improve performance will be most relevant in tasks that intrinsically motivating. Therefore, grit should contribute most to performance in conditions of high intrinsic motivation.

Hypothesis 2: In conditions where perseverance reduces performance, the interaction between grit and intrinsic motivation will have a less positive effect on task performance. As noted above (in 1.3), the tendency for gritty individuals to persist in the face of failure may be detrimental when perseverance is costly. Refusing to quit at unsolvable tasks prevents one from working on other, solvable tasks. Therefore, the benefit derived from applying grit to intrinsically motivating tasks should be reduced when persistence is counter-productive.

## 2. Method

This study was approved by the host university's Research Ethics Board. Participants joined through a psychology research participant system and completed the study in person in a research lab.

### 2.1. Participants

A total of 176 undergraduate students (65.34% female) at a large Canadian university participated voluntarily in exchange for introductory psychology course credit. They were randomly assigned to one out of eight conditions. Participants ranged in age from 17 to 44 years, with a mean of 19.93 years (SD = 3.72). Nineteen participants were excluded because they had outlying data (greater than or equal to three standard deviations from the mean). Therefore, the final sample size was 157 students (64.34% female) who ranged in age from 17 to 44, with a mean of 19.65 years (SD = 3.76).

#### 2.2. Measures

#### 2.2.1. grit

The grit scale<sup>9</sup> contains twelve items, with six items measuring the consistency of commitment (e.g., "I have been obsessed with a certain idea or project for a short time but later lost interest") and the other six items measuring perseverance of effort (e.g., "I finish whatever I begin"). This study used the six-item perseverance scale as a manipulation check, as this element of grit was being manipulated. Participants rated items on a 5-point scale from 1 (*Not like me at all*) to 5 (*Very much like me*). This scale has been shown to have an acceptable internal consistency, with  $\alpha$  scores from .77 to .85<sup>8,9</sup>. Internal consistency in this study was  $\alpha = .75$ .

#### 2.2.2. intrinsic motivation

The subscale on Interest/Enjoyment from the Intrinsic Motivation Inventory<sup>6</sup> was used as a manipulation check because it is the most direct self-report measure of intrinsic motivation. Using a seven-point scale from 1 (*not at all true*) to 7 (*very true*), participants rated seven items such as "While I was doing this activity, I was thinking about how much I enjoyed it." This scale has been shown to have a good internal consistency with  $\alpha = .82^{14}$ . Internal consistency in this study was  $\alpha = .92$ .

#### 2.2.3. task performance

Participants completed the Remote Associate Test (RAT)<sup>23</sup>, which was originally designed as a creativity test but has since been used to test general task performance in a context-free setting<sup>3</sup>. Each RAT question consists of three clue

words that are related to one solution word. For example, if the clue words were *age*, *mile*, and *sand*, the solution word would be *stone*, because *age* combines with *stone* to form the phrase *stone age*, *mile* and *age* form the compound *milestone*, and *sand* and *stone* form *sandstone*<sup>2</sup>. This study used the 55 most difficult items from Bowden and Jung-Beeman's list of 144 RAT items<sup>2</sup>. Performance was measured in two ways. *Attempts*, assessed effort, counting the number of solution words that participants wrote on the answer sheets, regardless of their correctness. *Successes* measured the quality of work, counting the number of correct answers that participants wrote on the answer sheets.

#### 2.3. Design And Procedures

After giving informed consent, participants spent up to 15 minutes writing as part of the grit manipulation (see 2.3.1) and completing the associated manipulation check. Then the RAT was introduced. After learning about the task, participants spent 10 minutes completing five practice questions taken from Bowden and Jung-Beeman's list<sup>2</sup>. After practice concluded, participants were asked to complete as many questions as possible in 20 minutes. There were 55 RAT questions available, presented in sequence from easiest to hardest. After the task, participants completed a questionnaire with all remaining measures. Finally, participants were debriefed and dismissed.

This study manipulated grit, intrinsic motivation, and costly perseverance in a 2x2x2 between-subjects design (high/low grit, and high/low intrinsic motivation, high/low costly perseverance).

### 2.3.1. manipulation of grit

Following DiMenichi and Richmond<sup>7</sup>, grit was manipulated through an expressive writing task. Participants were asked to recall and write in detail about a time when they either failed to overcome difficulties (high grit) or succeeded in overcoming a setback (low grit).

### 2.3.2. manipulation of intrinsic motivation

Intrinsic motivation (IM) was manipulated via positive interaction with the experimenter. Various immediacy behaviors have been shown to increase students' intrinsic motivation<sup>15</sup>. These positive behaviors include maintaining eye contact and smiling. As such, in the high IM, the experimenter provided participants with more immediacy behaviors. After completing one item, participants were required to put their hand up and wait for experimenter's feedback (i.e., eye contact and head nodding) before moving on to the next one. To ensure that participants would follow the instruction, participants were only given one RAT item a time. In the low IM condition, participants received immediacy behaviors at a lower frequency. There was still only one RAT item per sheet, but they received the sheets in sets of five. Thus, participants only interacted with the experimenter at the conclusion of each set (i.e., one fifth as often as in the high IM condition). The number of participants in each session was restricted to seven people to ensure that the experimenter could respond to each participant promptly.

### 2.3.3. manipulation of costly perseverance

Based on Lucas et al.<sup>21</sup>, costly perseverance was manipulated by the inclusion of unsolvable, fake RAT items. In the high costly perseverance group, 22 of the RAT items were unsolvable ones of our creation (e.g., row/cake/taker). Because there was no solution for these items, time spent on them was wasted, creating a condition of costly perseverance. The unsolvable items were randomly distributed among the 33 solvable ones. Pretesting indicated that no participants would complete more than 33 items, so the unsolvable ones did not impose a direct limit on participants' ultimate performance; they only created a potential to waste time through perseverance. In the low costly perseverance condition, all items had solutions.

## 3. Results

#### 3.1. Preliminary Statistical Analysis

Values greater than or equal to three standard deviations from the mean of a variable were considered outliers. Since this study was underpowered (i.e.,  $\beta = .07$  at N = 157, Cohen's f = .02,  $\alpha = .05$ ;  $\beta = .14$  at N = 157, Cohen's f = .02,  $\alpha$ 

= .1), such extreme cases had greater potential to bias the results. Thus, 19 participants' data were excluded from the analysis.

Attempts (performance effort) ranged from 2 to 44 (M = 18.61, SD = 10.23) and Successes (performance quality) ranged from 0 to 11 (M = 3.04, SD = 2.49). Kolmogorov-Smirnov<sup>4</sup> tests showed that both dependent variables failed the assumption of normality (p < .001). Histogram distribution revealed positive skewness for both variables, reflecting the fact that scores of less than zero were not possible. However, violations of normality should not cause major bias if the sample size is large enough (i.e., greater than 30 or 40)<sup>11</sup>. Therefore, the data were not transformed. Levene's test<sup>20</sup> revealed that both variables met the assumption of homogeneity of variance.

#### 3.2. Results

First, we tested the two-way interaction effect in predicting *Attempts* (number of answered questions regardless of correctness), then we investigated the three-way interaction effect on *Successes* (number of correct solutions). Planned contrast analyses were computed following significant interactions.

#### 3.2.1. attempts

A two-way factorial ANOVA yielded a main effect for the intrinsic motivation manipulation (F(1, 149) = 11.65, p = .001,  $\eta_p^2 = .07$ ), such that individuals who were more intrinsically motivated tended to attempt more items than those who are less motivated (M = 20.30 vs. M = 15.91). The interaction between the grit manipulation and the intrinsic motivation manipulation was not significant (F(1, 149) = 3.52, p = .06,  $\eta_p^2 = .02$ ). The three-way interaction also was not significant (F(1, 149) = 1.45, p = .23,  $\eta_p^2 = .01$ ).

Planned contrast analyses revealed that individuals in the high grit condition attempted more RAT questions in the high IM condition (M = 23.55) than in the low IM condition (M = 19.04; p = .001). This supported Hypothesis 1, suggesting that gritty individuals only answered more questions when they were intrinsically motivated by the task (Figure 1).

Further planned contrast analyses were also generally consistent with predictions. Individuals in the high grit condition tended to attempt more questions than individuals in the low grit condition when both were in the high IM condition (M = 23.55 vs. M = 15.21; p = .06). Similarly, individuals in the low grit condition did not show significant differences in their attempts based on the IM manipulation (M = 19.04 vs. M = 16.62; p = .27), and individuals in both the high and low grit conditions had a similar number of *Attempts* in the low IM condition (M = 15.21 vs. M = 16.62; p = .55).





### 3.2.2. successes

The main effect of costly perseverance was significant (F(1, 149) = 26.51, p < .001,  $\eta_p^2 = .15$ ). The three-way interaction of Grit x Intrinsic Motivation x Costly Perseverance was not significant (F(1, 149) = 3.51, p = .06,  $\eta_p^2 = .02$ ), and neither was the planned contrast. Contrary to prediction, individuals' performances in the high costly perseverance condition did not significantly differ across conditions (all ps > .10).

Although the contrast analysis found no significant differences, the average *Successes* in each group showed a trend consistent with the predicted three-way interaction. As Table 1 shows, when costly perseverance was high, participants in the high grit / high IM condition had the lowest average *Successes*. In conclusion, Hypothesis 2 was not supported. This failure may reflect a lack of statistical power. It might also reflect the very low success rate revealed in this study (i.e., mean *Successes* = 3.04). This low value creates a "floor effect" that may have prevented the full variation in individual performance from being reflected in the observed scores.

-		High costly perseverance	
		Low grit	High grit
Intrinsic	Low IM	2.1	2.3
Motivation	High IM	2.4	1.8

Table 1. Mean Successes by condition (high costly perseverance condition only)

#### 4. Discussion

This study examined the interactive influence of grit, intrinsic motivation, and costly perseverance on task performance. Using a full 2x2x2 factorial design, participants' performance was measured in terms of effort and quality.

The first hypothesis was supported, in that gritty individuals performed better when they were intrinsically motivated. Although the quality of work was not influenced by the interaction between grit and intrinsic motivation, participants' effort was influenced. Gritty individuals exerted more effort than their less gritty counterparts when they were intrinsically motivated. The likeliest explanation for this result is that grit possesses a domain-specific property. That is, gritty individuals do not devote unrelenting effort to everything they do, but rather only to the things they judge interesting and important. When intrinsically motivated, gritty individuals will display their perseverance. In contrast, demotivated gritty individuals do not differ from their less gritty peers.

The second hypothesis was not supported. There was no significant three-way interaction and the planned contrast analyses revealed that there was no significant difference in the high costly perseverance groups. Differences in the low costly perseverance condition were not part of this study, and so will not be considered a finding, to avoid capitalizing on chance. While the planned contrast was not significant, it seems suggestive that the pattern of means showed a trend consistent with prediction. Gritty individuals with high intrinsic motivation had the lowest mean performance quality. This study cannot be considered to provide support, but it is possible that the small sample's low power and the "floor effect" prevented detection of the predicted interaction.

In summary, the results suggest that intrinsic motivation may be necessary to foster grit's performance benefits. We found that gritty individuals only outperformed their less gritty counterparts when they were internally motivated. As such, this study may explain the seemingly contradictory findings in previous studies, which show that grit predicts college GPA, but not high school GPA<sup>2,5,9,10,15,35</sup>. If one assumes that college students are more intrinsically motivated in their studies, the discrepant findings are not contradictory; they are just as one would expect.

From a practical perspective, the results suggest that educators should try to create learning environments that foster students' interest and motivation. All students will benefit from such environments (as there was a main effect on performance from intrinsic motivation), and it will help to unleash the true potential of students' grit. Furthermore, the development of intrinsic motivation should likely be incorporated into any interventions of grit, or the results are likely to be less than desired.

#### 5. Limitation and future study

One of the limitations of the study was generalizability. Most participants in this study were educated young students. Given the limited age range in this sample, the findings may not be generalizable to the general public. This study was conducted in an artificial environment, so the generalizability of the results to real-world is limited. The study's use of absolutely unsolvable anagrams may have artificial, in that many real-world situations can be resolved with sufficient effort.

Another limitation was the level of difficulty in the Remote Associate Test questions used. Given that 55 RAT questions were available, but the mean of *Successes* was only 3.04, it may be that the questions used in this study were too difficult for the population. This difficulty may have created an accidental "floor effect" by constraining performance and thus biased the results. The constraint on observed variance may have prevented accurate representation of the true differences in performance, and thereby lead to non-significant results and conclusions that the independent variables have no effect.

Finally, this study was underpowered (i.e.,  $\beta = .07$ ), increasing the likelihood of accepting a false null hypothesis (i.e., Type II error).

For these reasons, future study should address these limitations to more accurately assess the interactions among grit, intrinsic motivation, and costly perseverance in the context of problem-solving. To do so, it is recommended to recruit participants from various age groups to increase representativeness and generalizability, to adjust the difficulty of RAT questions so as to capture the true population variance, and to recruit a sufficient sample size to ensure the statistical power of the study.

#### 6. References

1. Bowden, Edward M., and Jung-Beeman Mark. "Normative data for 144 compound remote associate problems." *Behavior Research Methods, Instruments & Computers* 35, no. 4 (2003): 634-639. doi:10.3758/BF03195543.

2. Bowman, Nicholas A., Hill Patrick L, Denson Nida, and Bronkema Ryan "Keep on truckin' or stay the course? Exploring grit dimensions as differential predictors of educational achievement, satisfaction, and intentions." *Social Psychological and Personality Science* 6, no. 6 (2015): 639–645. doi:10.1177/1948550615574300.

3. Caza, Arran, McCarter Matthew W., and Northcraft Gregory B. "Performance benefits of reward choice: A procedural justice perspective." *Human Resource Management Journal* 25, (2015):184-199. doi:10.111/1748-8583.12073.

4. Chakravarti, Indra, Mohan, Laha R. G., and Roy J. *Handbook of methods of applied statistics*. New York: Wiley, 1967.

5. Credé, Macus, Tynan Michael C., and Harms Peter D. "Much ado about grit: A meta-analytic synthesis of the grit literature." *Journal of Personality and Social Psychology* 113, no. 3 (2017): 492-511. doi:10.1037/pspp0000102

6. Deci, Edward, Eghrari Haleh, Patrick Brian C, and Leone Dean R. "Facilitating internalization: The selfdetermination theory perspective." *Journal of Personality* 62, no. 1 (1994):119-142. doi:10.1111/j.1467-6494.1994.tb00797.x.

7. DiMenichi, Brynne C., and Richmond Lauren L. "Reflecting on past failures leads to increased perseverance and sustained attention." *Journal of Cognitive Psychology* 27, no. 2 (2015):180-193. doi:10.1080/20445911.2014.995104.

8. Duckworth, Angela, Lee, Kirby Teri A., Tsukayama Eli, Berstein Heather, and Ericsson K. Anders. "Deliberate practice spells success: Why grittier competitors triumph at the national spelling bee." *Social Psychological and Personality Science* 2, no. 2 (2011):174-181. doi:10.1177/1948550610385872.

9. Duckworth, Angela, Lee, Peterson Christopher, Matthews Michaels D., and Kelly Dennis R. "Grit: Perseverance and passion for long-term goals." *Journal of Personality and Social Psychology* 92, no. 6 (2007):1087-1101. doi:10.1037/0022-3514.92.6.1087.

10. Duckworth, Angela, Lee, and Quinn Patrick D. "Development and validation of the short grit scale (grit-s)." *Journal of Personality Assessment* 91, no. 2 (2009):166-174. doi:10.1080/00223890802634290.

11. Elliott, Alan C, and Woodward Wayne A. *Statistical analysis quick reference guidebook with SPSS examples*. London: Sage, 2007.

12. Eskreis-Winkler, Lauren, Shulman Elizabeth P., Beal Scott A., and Duckworth Angela Lee. "The grit effect:

Predicting retention in the military, the workplace, school and marriage." *Frontiers in Psychology* 5, no. 36 (2014): 1-12. doi:10.3389/fpsyg.2014.00036.

13. Estepp, Christopher M., and Roberts Grady. "Teacher immediacy and professor/student rapport as predictors of motivation and engagement." *North American Colleges and Teachers of Agriculture* 59, no. 2 (2015): 155. Retrieved from https://www.nactateachers.org/attachments/article/2283/15% 20Estepp.

14. Goudas, Marios, and Biddle Stuart J.H. "Perceived motivational climate and intrinsic motivation in school physical education classes." *European Journal of Psychology of Education* 9, no. 3 (1994):241. 250doi:10.1007/BF03172783.

15. Gunter, Glenda A. "The Effects of the Impact of Instruction Immediacy on Cognition and Learning in Online Class." *World Academy of Science, Engineering and Technology Internaltional Journal of Educational and Pedagogical Sciences* 1, no. 11 (2007): 729-735. Available at https://waset.org/publications/481/the-effects-of-the-impact-of-instructional-immediacy-on-cognition-and-learning-in-online-classes.

16. Ivcevic, Zorana, and Brackett Marc. "Predicting school success: Comparing conscientiousness, grit, and emotion regulation ability." *Journal of Research in Personality* 52, (2014): 29-36. doi:10.1016/j.jrp.2014.06.005.

17. Larkin, Paul, O'Connor Donna, and Williams A. Mark. "Does grit influence sport-specific engagement and perceptual-cognitive expertise in elite youth soccer?" *Journal of Applied Sport Psychology* 28, no. 2 (2016): 129-138. doi:10.1080/10413200.2015.1085922.

18. Lee, Suran, and Sohn, Young Woo. "Effects of grit on academic achievement and career-related attitudes of college students in Korea." *Social Behavior and Personality* 45, no. 10 (2017):1629-1642. doi: 10.2224/sbp.6400.

19. Lepper, Mark R., Corpus Jenniger Henderlong, and Iyengar Sheena S. "Intrinsic and extrinsic motivational orientations in the classroom: Age differences and academic correlates." *Journal of Educational Psychology* 97, no. 2 (2005): 184-196. doi:10.1037/0022-0663.97.2.184.

20. Levene, H. *Robust tests for equality of variances*. Edited by I. Olkin et al. Stanford: Stanford University Press, 1960.

21. Lucas, Gale M., Gratch Jonathan, Cheng Lin, and Marsella Stacy. "When the going gets tough: Grit predicts costly perseverance." *Journal of Research in Personality* 59, (2015): 15-22. doi:10.1016/j.jrp.2015.08.004.

22. Marshall,Seth. "Predicting college students' positive psychology associated traits with executive functioning dimensions." *College Student Journal* 50, no. 2 (2016): 179-190. Retrieved from

http://uml.idm.oclc.org/login?url=https://search-proquest-

com.uml.idm.oclc.org/docview/1871093594?accountid=14569.

23. Mednick, Sarnoff A. "The associative basis of the creative process." *Psychological Review* 69, no. 3 (1962): 220-232. doi:10.1037/h004885.

24. Meriac, John P., Slifka John S, and LaBat Lauren L. "Work ethic and grit: An examination of empirical redundancy." *Personality and Individual Differences* 86, (2015): 401-405. doi:10.1016/j.paid.2015.07.009.

25. Moulaert, Veronique, Verwijnen Maarten G. M., Rikers Remy, and Scherpbier Albert J. J. A. "The effects of deliberate practice in undergraduate medical education." *Medical Education* 38, no. 10 (2004): 1044-1052. doi:10.1111/j.1365-2929.2004.01954.x.

26. Pribyl, Charles B., Sakamoto Masahiro, and Keaten James A. "The relationship between nonverbal immediacy, student motivation, and perceived cognitive learning among Japanese college students." *Japanese Psychological Research* 46, no. 2 (2004): 73-85. doi:10.1111/j.0021-5368.2004.00238.x.

27. Ralph, Brandon C. W., Wammes Jeffrey D., Barr Nathaniel, and Smilek Daniel. "Wandering minds and wavering goals: Examining the relation between mind wandering and grit in everyday life and the classroom." *Canadian Journal of Experimental Psychology/Revue Canadienne De Psychologie Expérimentale* 71, no. 2 (2017): 120-132. doi:10.1037/cep0000116.

28. Ratelle, Catherine F., Guay Freferic, Vallerand Robert J., Larose Simon, and Senécal Caroline. (2007). "Autonomous, controlled, and amotivated types of academic motivation: A person-oriented analysis." *Journal of Educational Psychology* 99, no. 4 (2007):734–746. doi:10.1037/0022-0663.99.4.734.

29. Ryan, Richard M., and Deci Edward L. "Intrinsic and extrinsic motivations: Classic definitions and new directions." *Contemporary Educational Psychology* 25, no. 1 (2000): 54-67. doi:10.1006/ceps.1999.1020.

30. Singh, Kamlesh., and Jha Shalini Duggal. "Positive and negative affect, and grit as predictors of happiness and life satisfaction." *Journal of the Indian Academy of Applied Psychology* 34, (2008): 40-45. Retrieved from http://uml.idm.oclc.org/login?url=https://search-proquest-

com.uml.idm.oclc.org/docview/622115103?accountid=14569

31. Tough, P. How children succeed: Grit, curiosity, and the hidden power of character. New York: Mariner Books, 2013.

32. Vainio, Mia M., and Daukantaite Daiva. "Grit and different aspects of well-being: Direct and indirect relationships via sense of coherence and authenticity." Journal of Happiness Studies 17, no. 5 (2016): 2119-2147. doi:10.1007/s10902-015-9688-7

33. Yamauchi, Hirotsugu. "An approach to the hierarchical model of motivation in a classroom: A reply to Rousseau and Vallerand." Psychological Reports 90, no. 1 (2002): 273-278. doi:10.2466/pr0.2002.90.1.273

34. Zhu, Xiao xia, and Peng Fang Xiang. "How intrinsic motivation facilitate employee creativity in work process." AIS eLibrary, https://pdfs.semanticscholar.org/74ba/ca9c578594396fd572dafaacd8c211028fa2

35. Zimmerman, Emily, and Brogan Leah. Grit and legal education. (August 14, 2015). Drexel University Thomas R. Kline School of Law Research Paper No. 2015-A-08. Available at

https://digitalcommons.pace.edu/plr/vol36/iss1/4/