



When the going gets tough: Grit predicts costly perseverance



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ARTICLE INFO

Article history:

Received 8 September 2014

Revised 19 August 2015

Accepted 23 August 2015

Available online 1 September 2015

Keywords:

Grit
Persistence
Perseverance
Difficulty
Failure

ABSTRACT

In this research, we investigate how grittier individuals might incur some costs by persisting when they could move on. Grittier participants were found to be less willing to give up when failing even though they were likely to incur a cost for their persistence. First, grittier participants are more willing to risk failing to complete a task by persisting on individual items. Second, when they are losing, they expend more effort and persist longer in a game rather than quit. Gritty participants have more positive emotions and expectations toward the task, which mediates the relationship between grit and staying to persist when they are losing. Results show gritty individuals are more willing to risk suffering monetary loss to persist.

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1. Introduction

To introduce the concept of grit, Duckworth, Peterson, Matthews, and Kelly (2007) titled their paper *Grit: Perseverance and Passion for Long-Term Goals*. With this defining phrase, we can envision how people with grit persist in endeavors related to important life objectives, and empirical research bears this out. Grittier individuals persist through to completion of important life goals like getting married, completing Army training, performing well in class (e.g., GPA), on other academic tasks (e.g., National Spelling Bee) and graduating from school, as well as performing well at work and remaining employed (Duckworth, Kirby, Tsukayama, Berstein, & Ericsson, 2011; Duckworth, Quinn, & Seligman, 2009; Duckworth et al., 2007; Eskreis-winkler, Duckworth, Shulman, & Beal, 2014; Robertson-Kraft & Duckworth, 2014).

Personality researchers have primarily conceptualized grit as one facet of the larger personality trait of conscientiousness; indeed, there is empirical evidence that grit and conscientiousness overlap strongly (e.g., Duckworth & Quinn, 2009). While grit is most commonly seen as one facet of conscientiousness, some researchers instead conceptualize grit as a type of courage (Maddi, Matthews, Kelly, Villarreal, & White, 2012). Courage is the ability to push through fear to perform an action, and from this perspective on grit, grit is the courage to push through fear of

failure to persist at a given task. Accordingly, while less gritty individuals “change their direction in order to cut losses,” people with this kind of courage resist changing their direction and instead “stay the course” (Maddi et al., 2012, p. 21).

This tendency to resist changing direction when losses could be cut could have various implications for gritty individuals. First, we propose that it may inhibit their ability to perform on certain kinds of tasks. While previous research suggests that grit predicts more successful performance, such as in a Spelling Bee (Duckworth et al., 2007), grittier participants may not do as well with tasks that require them to give up on more difficult items to complete the task. For example, while grittier individuals do better at school (e.g., GPA), they might not do as well on standardized tests like the SAT where success is improved if test-takers are able to pass over hard items to first identify and complete the easier items. Indeed, gritty individuals might not want to give up on solving the more difficult questions, to the detriment of answering simpler questions or completing the test. Some suggestive research supports this possibility: while grit *itself* is unrelated to scores on tests of intellectual ability (Duckworth et al., 2007), the larger personality trait of conscientiousness – which grit is a facet of – actually predicts poorer performance on intelligence tests (Moutafi, Furnham, & Paltiel, 2004). We therefore examine whether grittier participants complete as many items on a verbal task that has items that should be passed over (i.e., unsolvable items).

In testing the possibility that higher grit individuals might perform more poorly on tasks that require passing over difficult items, it is valuable that we utilize the context of laboratory tasks. In such tasks, we can not only engineer items that *should* be passed over,

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but we can also directly control the expected likelihood of success at the task. Although theoretically individuals high and low in grit should only be differentiated under conditions of failure or difficulty, prior research examining important life goals could not pinpoint that difficulty is a necessary condition because researchers do not have experimental control over failure at such important goals. It is, however, possible to induce failure on laboratory tasks, which allows us to test the hypothesis that difficulty is a necessary condition to differentiate behavior by grit.

There are other benefits of considering the influence of grit in laboratory tasks. First, while research demonstrates that grit predicts achievement of long-term goals – like staying in a relationship, graduating from school, and keeping a job – it usually cannot isolate the role of effort and performance; however, short-term experimental tasks can be constructed to better isolate effort. By considering such tasks, we are therefore able to examine the role of grit in continuation of effort alone, and we do so in one of the present studies.

Furthermore, we can incentivize success on our laboratory tasks with monetary rewards. If grittier individuals do persist at the cost of attempting more items when incentivized by monetary rewards for more correct answers, it seems that they would be trading off greater chances at monetary gains to persist at the more difficult questions. Indeed, because grit includes resistance to “change their direction in order to cut losses,” grittier individuals may be more willing to risk suffering monetary loss to persist at such tasks than their less gritty counterparts.

To more directly test this possibility, we also consider what happens when individuals are given the choice to quit or persist when they are failing. Specifically, we allow participants to opt-out of a task before it is completed, giving them the choice to either exit (and get a \$1 bonus) or to continue, where they could get a \$2 bonus if they ended up winning (but no bonus if they lost). In this case, gritty people might also choose to continue even though things have “gotten tough” for them. As grit is expected to differentiate responses to difficulty, we predict that, although people high and low in grit should both persist when *succeeding*, if they are instead *failing*, grittier individuals will be more likely to continue a task when they have the option to exit. If grittier participants indeed choose to continue, they would be risking a monetary loss to persist in this task. We also explore a possible mechanism for this effect: high grit individuals might not give up when they have the option to quit *because* they have more positive emotions and expectations for the task. They might be optimistic about the task, even when they are failing. We expect grittier individuals to have more positive emotions and expectations for the task, and such positive feelings and expectations might explain why they continue when they could just quit.

We investigate all of these hypotheses by examining the role of grit in tasks that are based on solving anagrams (Study 1), clicking the computer mouse (Study 2), or solving math problems (Study 3). These tasks allow us to investigate whether grit predicts the decision to continue when given the option to quit. As we expect grittier individuals to differ from their less gritty counterparts *only* when they are failing, we use a verbal task that induces a sense of difficulty and failure (in Study 1) and experimentally manipulate feedback about failure at the task (in Studies 2 and 3). Overall, we expect that, when failing, grittier individuals will exert more effort and persist even when risking losses to do so.

2. Study 1

We predict that gritty participants might persist too long, staying on problems that they cannot solve. If they persist at more difficult problems, and thereby interfere with completing the remaining problems, grittier participants would attempt fewer

problems toward the end of the study. To test this possibility, Study 1 explores whether grittier participants complete as many items on a task that has items that should be passed over (i.e., unsolvable items). In particular, after participants reported their level of grit, they were asked to solve anagrams (Aspinwall & Richter, 1999; MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). Including unsolvable anagrams allowed us to test the possibility that grittier individuals may not want to give up on solving the more difficult questions, to the detriment of answering simpler questions or completing as many problems as possible in a limited timeframe. Indeed, if gritty participants persist at the unsolvable anagrams, they may be able to attempt fewer anagrams over the course of the study.

2.1. Methods

2.1.1. Participants

Four hundred and twenty six undergraduates (131 men, 295 women) participated in our study in return for course credit. This sample size was selected based on resource constraints. It was the number of subjects from the subject pool allotted to our researchers by the department.

2.1.2. Procedure and materials

Participants completed all measures online from a computer. After consenting, participants were then asked to report demographic information and complete the 8-item Grit-S (Duckworth & Quinn, 2009). Using a 1 (Not like me at all) to 5 (Very much like me) scale, participants rated items such as “Setbacks don’t discourage me” and “I finish whatever I begin.” This scale has been shown to have reasonable internal consistency with α s from .73 to .83 (Duckworth & Quinn, 2009), with an α of .73 in the current data. To incentivize performance, participants were informed that they would be given an opportunity to unscramble as many anagrams as they could in 20 min and would receive entries into a lottery for \$100 for correct solutions. Specifically, participants were then told that, to solve anagrams, they were to provide words that could be found in a standard English-language dictionary (e.g., not slang words or names) and use all of the letters provided. Participants then were allowed 20 min to make one attempt to unscramble each of 37 anagrams. Twenty one of the anagrams were highly difficult: they only had one correct solution and were chosen from among the most difficult for college-age samples to solve (Aspinwall & Richter, 1999; MacLeod et al., 2002). Interspersed among these 21 difficult (but solvable) anagrams were 16 unsolvable anagrams (Aspinwall & Richter, 1999; MacLeod et al., 2002). As there were no solutions to these 16 anagrams, they served as test items that should be passed over to perform well, as the short time-limit meant that fewer difficult, but solvable anagrams could be completed when time was devoted to these problems with no solution. This allowed us to test whether grittier participants were less likely to give up on solving the more difficult questions to the detriment of completing as many problems. Accordingly, the number of anagrams attempted was used as a dependent variable in this study.

2.2. Results and discussion

One participant failed to complete the Grit-S, and therefore was not included in the analyses reported below. Furthermore, while Study 1 was completed with participants online in order to obtain sufficient sample size within given resource limitations, the fact that participants were not observed in a lab meant they could cheat on the task. Indeed, programs are available online to solve anagrams (e.g., <http://anagram-solver.net>). To be able to exclude cheaters, the final three anagrams in this study were used because they were all

solvable but very difficult (anagrams for “impromptu”, “obtest”, and “kismet”). Participants who completed all three of these final anagrams correctly were excluded based on the very high likelihood that they cheated, as it was almost impossible that they had time remaining after the 34 previous anagrams to complete all three of these final anagrams *correctly* without using an online anagram solving service. By this metric, only 43 of 426 participants appeared to have cheated. There was also no significant relationship between grit and likelihood of cheating ($B = .44$, $Wald(1) = 2.19$, $p = .14$). Grittier individuals also solved no more anagrams than those who were lower in grit, $r(380) = .04$, $p = .47$.

Participants on average attempted 30.45 anagrams out of the 37 possible anagrams ($SD = 11.13$). As expected, grit was negatively associated with number of anagrams attempted, $r(380) = -.10$, $p = .05$. This suggests that grittier participants may have been more focused on solving the more difficult questions to the detriment of completing as many problems. Specifically, although it was a small effect, they did complete fewer items on our anagram task. Importantly, this task was timed and had items that should be skipped to improve performance; specifically, by skipping the unsolvable items, participants attempt more of the solvable ones.

These unsolvable items also served to create a sense of difficulty, adversity, and failure during the study. This is important because adverse conditions are theoretically required to see differences between gritty and less gritty individuals. For example, recall the conceptualization of grit as courage to push through fear of failure. For grit to matter, there must be an imminent possibility of failure – some fear to be pushed through. Therefore, a sense of difficulty should be a necessary condition for grittier participants to be differentiated from their less gritty counterparts. We investigate this further in Study 2 by manipulating a sense of failure during a game. This game also allows us to somewhat isolate effort from performance to better determine the influence of grit on effort.

3. Study 2

Study 2 tests the claim that grit predicts effort when failing at tasks. Participants completed a measure of grit and then played a game that was driven by effort (how rapidly they clicked a computer mouse). Over 8 rounds, they received rigged feedback

about their success; we hypothesized that grittier participants would expend greater effort throughout the rounds of the game when they are losing than lower grit participants.

3.1. Methods

3.1.1. Participants

One hundred and thirty two participants (73 men, 59 women) were recruited from Craigslist and paid \$25 for their participation. This sample size was selected based on resource constraints. It was the number of subjects allotted for this study on the grant funding this research.

3.1.2. Procedure and materials

Participants completed the study in individual rooms at computers (with webcams), through which all materials were administered. As in Study 1, after consenting, participants were then asked to report demographic information and complete the Grit-S, which had an α of .81 in this study. Participants then completed a game where performance was based on effort. They were randomly assigned to one of 4 experimental conditions where their experience of winning or losing the game was manipulated. Specifically, after a tutorial, they ostensibly competed against another participant who had arrived at the same time in a game called MouseWars. MouseWars is an online game that allows for manipulation of winning or losing without creating suspicion (Gratch, Cheng, Marsella, & Boberg, 2013). Participants see themselves and their partner on a gameboard (Fig. 1), and take turns spinning a roulette wheel. If it lands on their color, the mouse advances one square toward their goal. A player wins when the mouse reaches his/her goal (“blue wins” or “red wins” depicted in Fig. 1). Players can influence what percentage of the wheel contains their color (and thus the probability of advancing one square toward their goal) by expending effort: players get 10 s during which they can ostensibly increase their chances of advancing by clicking the mouse button as rapidly as possible, so greater number of mouse-clicks indicates greater effort. Participant’s effort (number-of-clicks) during an initial phase was also measured as a baseline.

Using a scripted game, MouseWars manipulates both the ultimate outcome of the game and the path participants take to get there (Gratch et al., 2013). Participants were randomly assigned to a 2 (final outcome: win vs loss) \times 2 (path: reversal-of-fortune



Fig. 1. MouseWars game interface.

vs close-call) design. While our present research question only concerns differences between those who experience failure and success during this game, for the purposes of another research project analyzing the facial expressions recorded via the webcam, we manipulated both success (winning-in-the-end vs losing-in-the-end) and whether they end up pulling off a last minute win (in reversal-of-fortune) or not (in close-call). Specifically, some participants were randomly assigned to experience a reversal-of-fortune, but their experience differed based on whether they won or lost in the end: participants in “reversal-of-fortune win-in-the-end” experienced losing but then ended up winning (the other player jumped out to an early lead (rounds 1–7), but then the participant pulled even (round 8), and, on this last turn, won), whereas participants in “reversal-of-fortune lose-in-the-end” experienced winning but then ended up losing (they jumped out to an early lead, got caught up to and then lost). Other participants are randomly assigned to experience a close-call, but again their experience differed based on whether they won or lost in the end: participants in “close-call lose-in-the-end” experienced losing and ended up losing (the other player jumped out to an early lead, and although the participant pulled even (round 8), the other player won), participants in “close-call win-in-the-end” experienced winning and ended up winning (they jumped out to an early lead, got caught up to, but still won) (Fig. 2). Note that, in both “reversal-of-fortune win-in-the-end” and “close-call lose-in-the-end”, players lose during the whole game up to the last round; the only difference is whether they end up pulling off a last minute win (in reversal-of-fortune) or not (in close-call). Accordingly, we report analyses below considering only whether they experienced winning or losing during the game, testing our hypothesis using an average of all rounds except the final one. We exclude the final round because of this manipulation of whether they end up pulling off a last minute win (in reversal-of-fortune) or not (in close-call).

3.2. Results and discussion

We first tested whether grit scores predict increases in effort compared to what would be expected from baseline depending on our condition variables. There was no significant association between grit and effort at baseline ($r(130) = -.02$, ns). Next,

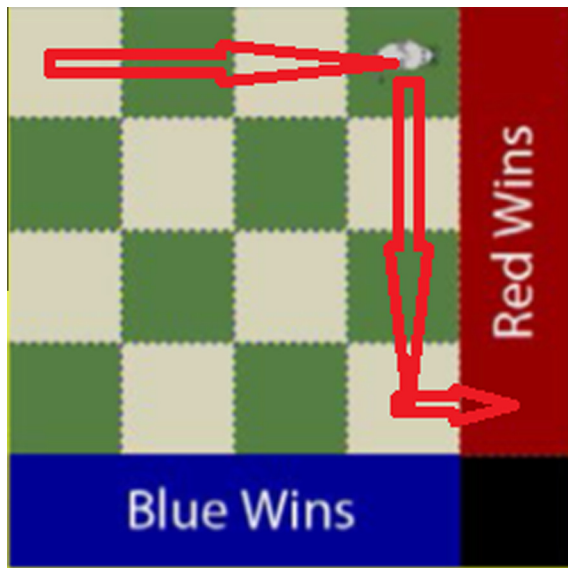


Fig. 2. Example of a condition in Study 2. The participant (blue player) is in experience-losing-and-lose condition, where the other player jumps out to an early lead, and although the participant pulls even, they end up losing the game to the other player.

Table 1
Results from the full regression model in Study 2 predicting average number of clicks.

Parameter	β value	t value	Df
Intercept		20.88***	127
Baseline # of clicks	.57	7.80***	127
Condition (COND)	-.03	-.045	127
Z-scored grit (GRIT)	.19	1.90 [†]	127
COND \times GRIT	-.17	-1.63 [^]	127

*** $p \leq .001$.

[†] $p \leq .06$.

[^] $p \leq .10$.

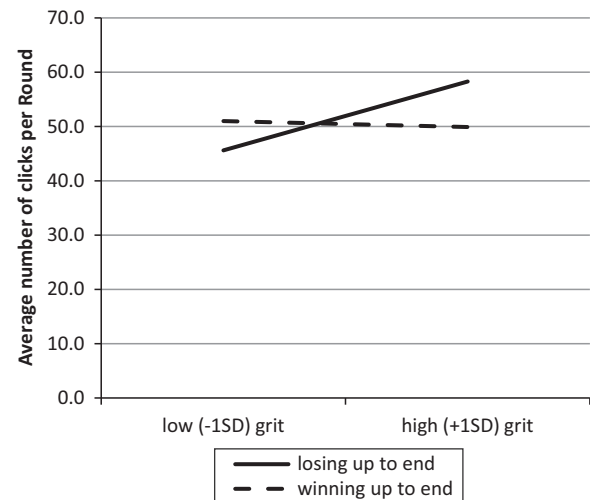


Fig. 3. Predicted means by winning or losing leading up to the final outcome for average number-of-clicks (controlling for initial number-of-clicks) at high grit (+1SD) and low grit (-1SD).

moderated regression analyses were performed to test the effects of grit, condition, and their interactions on effort averaged across all rounds but the final one while controlling for baseline effort. Recall that players who were assigned to either a “reversal-of-fortune win-in-the-end” or “close-call lose-in-the end” experienced losing the game right up until the final round. Therefore, we collapsed the two condition variables into one variable reflecting the experience of *losing* throughout the game until the final round, or *winning* (which consisted instead of participants who experienced either “reversal-of-fortune lose-in-the end” or “close-call win-in-the-end”) and tested the effect of this variable, in combination with grit, on average number-of-clicks across all rounds but the final one. As depicted in Table 1, when we entered the main effects of grit (centered), condition (dummy-coded: 0 = experience-losing, 1 = experience-winning), and the grit \times condition interaction, there was a marginal interaction ($\beta = -.017$, $t(127) = -1.63$, $p = .10$). Follow-up simple slope analyses (Fig. 3) revealed that grittier participants increase the number-of-clicks from baseline more than lower grit participants in the losing condition ($\beta = 0.19$, $t(127) = 1.90$, $p = .06$) but not in the winning condition ($\beta = -.05$, $t(127) = -.045$, ns).¹

¹ Although it was not directly relevant to our hypotheses, we tested the effects of both factors and grit on effort expended on round 8. Moderated regression analyses were performed to test the effects of grit, conditions, and their interactions on effort on round 8 while controlling for baseline effort; we predicted mouse-clicks on round 8 (controlling for baseline mouse-clicks) from the main effects of grit (centered) and conditions (dummy-coded: 0 = lose in end, 1 = win in end, and 0 = reversal-of-fortune, 1 = close-call) and all interaction terms. There was no significant interaction ($\beta < 0.12$, $p > .26$).

Lower grit individuals seem to have no problem persisting when things are going *well*, but it is exactly under conditions of difficulty that grit should differentiate behavior (Duckworth et al., 2007). And it does: our findings confirm that grit leads people to continue increasing effort when failing. Our results also suggest that game contexts could be useful to further study grit. Study 2's MouseWars has several benefits: it cleanly measures effort in a paradigm where success can reasonably be manipulated via false feedback, thereby affording experimental control. These benefits stem from the way MouseWars gauges effort: mouse-clicks are a pure measure of effort, and relying on mouse-clicks made it hard for participants to gauge success themselves, so success can be manipulated. Therefore, the results of Study 2 confirm that grittier participants give it their all when it really matters and thereby expend even more effort when failing.

As another way to investigate perseverance under adversity among gritty people, we also consider the possibility that gritty individuals might persist in (rather than exit) a task even when failing at the task. In Study 2, when faced with a losing battle, gritty participants increased their effort. Such persistence may also drive participants to complete such a task even when they are given the option quit. Additionally, we explore a potential mediator for this predicted effect on deciding to persist in the task rather than opt-out: grittier individuals might have more positive emotions and expectations for the task. That is, we argue that grittier participants will be more positive in their emotional reactions and expectations following failure, and this will drive them to complete the task rather than quit.

Like in Studies 1 and 2, participants in Study 3 will also be incentivized for their performance on this game. In Study 1, because grittier participants attempt fewer problems (as expected) even though they would get a lottery entry for *each* correct answer, it seems that grittier individuals may be trading off greater chances at monetary gains to persist at the more difficult questions. We explore this more directly in Study 3 by giving participants a chance to either “change their direction in order to cut losses” or to “stay the course” even though they would likely incur a monetary loss for doing so. To do so, we therefore conducted an additional study in which MouseWars was modified. Specifically, participants in Study 3 were asked to complete math problems as quickly as they could (instead of clicking the mouse), and the number of problems solved correctly could serve as a measure of performance. Finally, due to the smaller sample size in Study 2, the effect may have been of marginal statistical significance because it was underpowered. We therefore increased the power of Study 3 substantially by increasing the sample size almost eight-fold.

4. Study 3

To investigate these possibilities, participants in Study 3 reported grit and then played a version of MouseWars where they solved math problems (MathWars). Participants completed 6 rounds of the game, during which they received rigged feedback about their success; that is, participants were randomly assigned to either win or lose during the game. After 6 rounds of winning or losing, participants were given the choice to continue the game or not. We predicted that grittier participants would persist in (rather than exit) the task when it was not going well even though they might forfeit a sure bonus by doing so. Additionally, we explore a potential mediator for this predicted effect on deciding to persist in the task rather than opt-out: grittier individuals might have more positive emotions and expectations for the task. That is, we argue that grittier participants will be more positive in their emotional reactions and expectations following failure, and this will drive them to complete the task rather than quit.

4.1. Methods

4.1.1. Participants

Eight hundred and thirty participants (473 men, 357 women) were recruited via Amazon's Mechanical Turk and paid at least \$2 (and could earn a bonus of \$1 or possibly \$2 based on their choices). This sample size was selected based on resource constraints. It was the number of subjects allotted for this study on the grant funding this research.

4.1.2. Procedure and materials

Participants completed all measures online from a computer. As in Studies 1 and 2, after consenting, participants were then asked to report demographic information and complete the Grit-S, which had an α of .85 in this study. Participants next completed a game that assessed math performance, and, for this game, were assigned to experience winning or losing. Before starting the game, participants completed a tutorial about how to play the game and a practice round. Participants ostensibly competed against another participant online in a variant of MouseWars from Study 2 called MathWars. MathWars is identical to MouseWars except that, to increase the percentage of the wheel that contains their color and thus chances of advancing, rather than clicking a mouse, they solve as many three-digit addition problems as possible in 30 s.

As in Study 2, we use a scripted game to manipulate the experience of winning or losing. Participants were randomly assigned to experience a win trajectory in which the participant jumps out to an early lead, or a loss trajectory, where the other player jumps out to an early lead. These scripts were pre-tested to manipulate the experience of winning/losing without creating suspicion. After 6 rounds of winning or losing, participants were stopped and completed 9 items measuring 9 dimensions of emotional response to and expectations for the task, using one item per dimension. Specifically, using a scale from 0 (none at all) to 100 (very much), participants first rated the extent to which they felt joy, hope, fear and disappointment, and then answered questions about how much effort they would expend during the task, how important the task was to them, how much control they had over the outcome of the task, the extent to which participants were looking forward rather than backwards, and the subjective chance they thought they had of winning the game. For example, they responded to items such as “I feel fear” and “How much effort did you devote to answering the math problems?”

Upon completion of these emotion and expectation items, participants were given the choice to stay and persist in the task, or exit the task. Participants knew they would get \$2 just for completing the study, but chose between two options for a potential bonus payment: either exit the game (and get a \$1 bonus) or continue with the game, where they could get a \$2 bonus if they ended up winning but no bonus if they lost. Three hundred and seventy five participants (45.2%) chose to exit the game.

4.2. Results and discussion

To test whether gritty participants chose to continue the task more often when losing, we predicted the binary choice to stay in the task (rather than exit) in logistic regression from the main effects of grit (centered), condition (dummy-coded: 0 = losing, 1 = winning) and the grit \times condition interaction. As depicted in Table 2, grit and condition significantly interacted to predict decision to stay ($B = -0.40$, $Wald(1) = 6.34$, $p = .01$). Follow-up simple slope analyses revealed grittier participants are more likely to stay than lower grit participants in the losing condition ($B = 0.26$, $Wald(1) = 6.20$, $p = .01$) but not in the winning condition ($B = -0.14$, $Wald(1) = 1.34$, *ns*).

Table 2
Results from the full logistic regression model in Study 3 predicting choice to opt-out.

Parameter	B value	Wald value	Df
Intercept	-.68	41.67***	1
Condition (COND)	1.82	136.26***	1
Z-scored grit (GRIT)	.26	6.20**	1
COND × GRIT	-.40	6.34**	1

*** $p \leq .001$.

** $p \leq .01$.

We next explored whether this effect of grit in the losing condition was mediated by positive emotions and expectations. To do so, we first needed to summarize our construct of positive emotions and expectations. We conducted a factor analysis on all emotion and expectation self-report items using maximum likelihood extraction with quartimax rotation, which revealed that a primary rotated factor including joy, hope, reverse-coded disappointment, control, forward-looking and chance explained most of the variance.² Accordingly, we use an average of these items that load on the primary factor as our measure of positive emotions/expectations for subsequent mediation analyses.

To establish mediated moderation through such emotions/expectations, the grit × condition interaction term would need to predict positive emotions/expectations, and, when entered simultaneously, positive emotions/expectations should significantly predict choice to stay while the effect of the grit × condition interaction term on choice to stay is significantly reduced (Baron & Kenny, 1986). As depicted in Table 3, when we predicted positive emotions/expectations from the main effects of grit (centered), condition (dummy-coded: 0 = losing, 1 = winning), and the grit × condition interaction, grit significantly interacted with condition to predict more positive emotions/expectations ($\beta = -0.10$, $t(826) = -2.69$, $p = .007$), such that grit predicts more positive emotions/expectations in the losing condition ($\beta = 0.22$, $t(826) = 5.91$, $p < .001$). As depicted in Table 4, in the logistic regression predicting binary choice to stay from grit (centered), condition (dummy-coded: 0 = losing, 1 = winning), and the grit × condition interaction while controlling for positive emotions/expectations (centered), positive emotions/expectations significantly predicted staying in the task ($B = 0.51$, $Wald(1) = 27.47$, $p < .001$), and although the grit × condition interaction remained significant ($B = -0.33$, $Wald(1) = 4.22$, $p = .04$), the indirect association of grit × condition on choice to stay through emotions/expectations was significant. Specifically, Preacher and Hayes' (2004) SPSS macro for testing mediation using bootstrapping techniques (Shrout & Bolger, 2002) revealed that the 95% BC (bias corrected) bootstrap confidence intervals did not include 0 (-0.03 to -0.15 ; based on 1000 resamples). Therefore, there is evidence that the effect of grit × condition interaction is partially mediated by positive emotions/expectations.

Furthermore, simple effects tests revealed that controlling for positive emotions/expectations reduced the effect of grit on likelihood of staying to persist on the task in the losing condition to non-significance ($B = 0.15$, $Wald(1) = 1.96$, ns). Thus, these emotions/expectations at least partially explain the effect of grit in the losing condition. We also considered whether grittier participants were more positive in their emotions and expectations overall. Indeed, higher grit significantly predicted greater joy and hope, reduced fear and disappointment, intentions to expend more effort during the math task, as well as rating the task as more important and more under their control. Grittier participants also reported

Table 3
Results from the full regression model in Study 3 predicting emotions/expectations.

Parameter	β value	t value	Df
Intercept		33.78***	826
Condition (COND)	.60	21.95***	826
Z-scored grit (GRIT)	.22	5.91***	826
COND × GRIT	-.10	-2.69**	826

*** $p \leq .001$.

** $p \leq .01$.

Table 4
Results from the full logistic regression model in Study 3 predicting choice to opt-out while controlling for emotions/expectations.

Parameter	B value	Wald value	Df
Intercept	-.40	11.36***	1
Z-scored emotions/expectations	.51	27.47***	1
Condition (COND)	1.26	45.93***	1
Z-scored grit (GRIT)	.15	1.96	1
COND × GRIT	-.33	4.22*	1

*** $p \leq .001$.

** $p \leq .01$.

* $p \leq .05$.

looking marginally more forward and felt their chances of winning were significantly better than lower grit participants (Table 5). However, grittier participants in reality solved no more math problems than those who were lower in grit, $r(822) = -.03$, $p = .47$.

Overall, Study 3 extended the findings of Study 2. By experimentally manipulating failure, these studies demonstrate that grittier participants not only increase effort when failing (Study 2), but also are more likely to persist when they are failing (Study 3). Lower grit individuals seem to have no problem persisting when things are going well, but it is exactly under conditions of adversity that grit should differentiate behavior (Duckworth et al., 2007). And it does: our findings confirm that grittier individuals are more likely to persist when they are failing. Specifically, gritty participants were more likely to continue the game when they were losing even though they could have quit and taken the \$1 bonus. Therefore, as in Study 1, they chose to risk a monetary loss to persist in this task. The results also provided a partial explanation for why participants decide to continue a task when they could quit. Grittier participants have more positive emotions and expectations than less gritty participants, especially when failing, and this tendency toward more positive feelings and expectations explains (in part) why they choose to persist rather than quit the task.

5. General discussion

Across three studies, we found that higher grit individuals invest more effort and persist in tasks that are not going well. Grittier participants were less willing to give up when failing even though they were likely to incur a cost for their persistence. In Study 1, grittier participants were able to complete fewer problems in an anagram task where some of the items should have been passed over (i.e., unsolvable items). This provides initial evidence that they persisted at a cost to themselves, in this case the cost of getting to attempt more problems. Because we incentivized performance (with entries into a lottery for \$100), it seems that grittier participants were specifically trading off greater chances at monetary gains to persist at the more difficult questions.

Compared to participants with lower grit, grittier participants not only increase effort when they are losing a game (Study 2), but also are more likely to stay and keep fighting a losing battle when they could quit (Study 3). Specifically, Study 3 provided additional evidence that gritty individuals engage in costly persistence.

² A proto-version of MathWars without false feedback was run with 876 participants, and a parallel factor analysis of all participants confirmed this factor structure.

Table 5

Pearson zero-order correlations among grit and emotion/expectation variables in Study 3.

	1	2	3	4	5	6	7	8	9
(1) Grit	–								
(2) Joy	.17***	–							
(3) Hope	.13***	.85***	–						
(4) Fear	–.15***	–.20***	–.19***	–					
(5) Disappointment	–.18***	–.61***	–.65***	.47***	–				
(6) Effort	.11***	.23*	.31***	–.39***	–.45***	–			
(7) Importance	.07*	.28***	.28***	.21***	–.02	.58***	–		
(8) Control	.09**	.60***	.60***	–.18***	–.50***	.24***	.27***	–	
(9) Forward-looking	.06 ^{††}	.36***	.41**	.04	–.26***	.24***	.27***	.29***	–
(10) Chance	.08*	.70***	.78**	–.26***	–.66***	.25***	.26***	.71***	.41***

Note.

^{††} $p \leq .08$.*** $p \leq .001$.** $p \leq .01$.* $p \leq .05$.

When given feedback that they were failing, grittier participants were more likely to persist rather than take the option to “quit while they were ahead,” thereby risking a monetary loss to persist in the math task. When given feedback that they were succeeding, participants who were high or low in grit chose to persist rather than quit. When facing the possibility of failure, grittier individuals pushed through their fear of failing to “stay the course,” whereas their less gritty counterparts were more likely to “change their direction in order to cut losses.”

Additionally, we explored a possible mediator of this relationship: positive emotions and expectations for the task. First, we found evidence that grittier participants’ emotional reactions and expectations of those tasks were more positive than their less gritty counterparts. While this suggests that grit may engender more positive emotions and expectations, it is also possible that one is more likely to exhibit grit when already drawing on positive affect and expectations as resources. Although directionality of the relationship between grit and positive emotions/expectations remains unclear, this positive “attitude” toward difficult tasks did help to explain why grittier participants chose to persist in a losing battle. Specifically, positive emotions and expectations partially mediated the relationship between grit and decision to persist when losing. Therefore, part of the reason grittier participants chose to persist at the math task (when they could have just taken the \$1 bonus) was *because* they had more positive emotions and expectations toward the task.

Although grit is defined as “maintaining effort and interest... despite failure, adversity, and plateaus...” (Duckworth et al., 2007, p. 1088), research examining important life goals could not pinpoint that such difficulty is a necessary condition because researchers do not have experimental control over failure at such important goals. However, afforded such control, we establish experimentally that failure is a necessary condition to differentiate the behavior by grit. We found that individuals high or low in grit engage equally when succeeding, but, when facing a losing battle, grittier participants persist to a greater extent. Therefore, by manipulating failure in Studies 2 and 3, this work contributes through experimentally isolating the conditions under which grit has an impact, confirming that grit is indeed characterized by persistence and perseverance *under pressure* (Duckworth et al., 2007).

5.1. Limitations, implications and future directions

Several implications of this work stem from the use of experimental manipulation to induce a fear of failure in this research. First, the finding that grit differentiated behavior under these

conditions suggests that such manipulations can be useful in work on grit. Future work should continue to explore the impact of grit in such controlled settings so that important contributing factors (like failure and adversity) can be identified and isolated. Second, this finding also has potential relevance for differentiating theoretical conceptualizations of grit. This finding appears obviously in line with the perspective that grit acts as courage to push through fear of failure, because authors who use this conceptualization directly assert that, because of this courage, grittier individuals resist changing direction specifically *when losses could be cut* (e.g., Maddi et al., 2012). However, while this tendency to resist changing direction when losses could be cut may not follow *quite* as directly from the conceptualization of grit as a facet of the broader construct of conscientiousness, it is certainly compatible with it. Future studies could be designed to determine which conceptualization of grit better explains this tendency.

More generally, additional research on the role of grit in performance should consider the impact of the broader construct of conscientiousness. The current work is limited in that it did not measure conscientiousness of participants, and research could not only benefit from including a measure of conscientiousness, but also measures of other big five traits (including relevant facets like positive emotionality, a facet of extraversion) and even general measures of cognitive ability (such as IQ). Because of its known associations with lower intelligence test scores (Moutafi et al., 2004), conscientiousness is a prime candidate for future research into how grit interferes with completing tasks where it is beneficial to skip items (e.g., difficult items on the SAT).

We employed a time limit on the task in Study 1 to test whether grittier participants persist on difficult questions to the detriment of answering easier ones or completing the task. Employing a timed task has the benefit of better approximating many real world testing situations, like the SAT. In addition to using a time limit to create a benefit for skipping difficult items, future research could employ different tasks that included easy and difficult items in order to test whether less gritty participants were actually more likely to skip difficult problems for easier ones.

Overall, these findings could have other potential real world implications for grittier individuals. Research suggests that, in spite of completing fewer items on timed tasks, gritty people surpass their less gritty counterparts in education and employment settings (Duckworth et al., 2007, 2009, 2011; Eskreis-winkler et al., 2014; Robertson-Kraft & Duckworth, 2014). Their tendency to persevere on solving the more difficult questions over completing as many problems does not seem to inhibit their ability to succeed. Future research could explore how grittier individuals are able to overcome this handicap.

Because of such success at important life goals, it seems that persisting in the face of failure is a useful strategy. However, it is possible that there are times when it is less beneficial to persist in the face of failure. Indeed, “blind persistence is not ideal... there is also value in knowing when to quit” (Baumeister, Campbell, Krueger, & Vohs, 2003, p. 14). As high grit individuals persist more when they are already losing, it is possible that they could risk incurring bigger losses by “not knowing when to quit.” For example, in Study 2, from the perspective of Expected Utility Theory, participants *should* have exited the game, as the likelihood and value of additional monetary gains are both low. Specifically, for participants who are losing, the choice to stay is not rational, based on its expected monetary payoff: given they are losing, there is a low chance of getting the \$2 bonus, and the difference in value at stake between the \$1 and \$2 bonuses is small. Instead of quitting while they were ahead (with the \$1 bonus), grittier participants valued persistence over material gain. Specifically, they chose to risk suffering material loss (of the \$1 bonus) to persist in the task (with a small chance of earning a \$2 bonus instead). Although this game had relatively low stakes, it is possible that such “blind persistence” could occur in real-world situations where grittier individuals could risk incurring bigger losses for not “knowing when to quit.”

While this work is suggestive that there may be times in which gritty people persist when it might be better to quit, future work should verify such tendencies and also explore other possible downsides to grit. Indeed, researchers have speculated that there might be “some cost to being gritty that must be traded off against its benefits. There may be contexts in which grit begets lower achievement” (Duckworth & Eskreis-winkler, 2013, p. 2). Likewise, the US Department of Education reports that “little systematic research has explored the potential costs or risks of grit under certain circumstances for academic achievement, educational attainment, and emotional well-being... Potential risks should be explored.” (Shechtman, DeBarger, Dornsife, Rosier, & Yarnall, 2014, p. xvi). While our research touches on some ways that grit may be counterproductive, future research should more fully flesh out such possibilities.

6. Conclusions

The current research not only provides experimental evidence that the power of grit unfolds under difficult conditions, it also begins to identify mechanisms by which grit affects persistence under such pressure. Considering the benefits of grit, we might envision interventions that strengthen these mechanisms: in the face of failure, individuals could focus on and foster positive emotional reactions and expectations. Indeed, under conditions of threat, inducing individuals to focus on positives increases engagement in difficult social interactions (Lucas, Knowles, Gardner, Molden, & Jefferis, 2010; Richeson & Trawalter, 2005). These findings where simple primes impact behavior in real-life situations are heartening, as only small modifications may be needed to shift emotions and expectations to thereby increase persistence when people face the fear of failure. It is questionable, however, whether it is always good to do so: although grittier individuals persist in the face of failure, they could end up enduring longer than they should and risk losses (including monetary ones) to do so. Perhaps

infusions of persistence should be balanced out with reminders that “there is also value in knowing when to quit.”

Funding

Preparation of this manuscript was supported by Grant FA9550-09-1-0507 from the Air Force Office of Scientific Research and the U.S. Army RDECOM. The content does not necessarily reflect the position or the policy of the Government, and no official endorsement should be inferred.

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