



How grit is related to objectively measured moderate-to-vigorous physical activity in school student

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ABSTRACT This study aimed to estimate parameters of the model in which perseverance of effort and consistency of interest of grit scale are related directly to objectively measured physical activity (PA) and indirectly via PA intention in school students (N = 209) aged 12 to 14 years. The Grit Scale was used to estimate the consistency of interests and perseverance of efforts. The measure for intention consisted of two items from the Theory of Planned Behaviour Questionnaire. Actigraph was used to measure moderate-to-vigorous physical activity (MVPA) during seven consecutive days. A well-fitting structural equation model ($\chi^2 = 46.169$, $df = 31$; CFI = .958; RMSEA = .053) demonstrated the significant direct effect ($\beta = .286$, $p < .001$) from perseverance of efforts on intention to be physical active. Physical activity intention mediated the effect of the perseverance of efforts on moderate-to-vigorous physical activity (MVPA), but not the effect of consistency of interest. The total effect from the consistency of interest on MVPA was significant, but the perseverance of efforts was not. The dimension of the perseverance of efforts between groups with high and low MVPA was not statistically significantly different, whereas the intention was significantly higher in the high-MVPA group. The consistency of the interest dimension in the high MVPA group was significantly higher than in low group only at $p < .1$ level. The findings of the study may be used by physical education teachers for the promotion of physical activity, highlighting the role of consistency of interest on MVPA.

KEY WORDS grit, intention, moderate-to-vigorous physical activity, school students



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GRIT, INTENTION, AND PHYSICAL ACTIVITY

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Introduction

A large number of studies based on self-determination theory (SDT; Deci & Ryan, 1985) and theory of planned behaviour (TPB; Ajzen, 1985) have shown how cognitive factors are related to physical activity in leisure time (see for review Hagger & Chatzisarantis, 2016). However, less is known about whether non-cognitive factors like personality traits have the potential to influence physical activity. One of the personality traits that has been of interest recently is grit. Duckworth Matthews, and Kelly (2007) have defined grit as the perseverance of effort and passion for long term goals. According to this definition, grit entails the capacity to sustain effort and interest in an activity over a period of years. One of the goals of contemporary physical education is also to prepare students for long lasting physical activity. Although several researchers (Cosgrove, Chen, & Castelli, 2018; Larkin, O'Connor, & Williams, 2016) have demonstrated the positive effect of grit on different behavioural domains, including education (Sturman & Zappala-Piemme, 2017; Light & Nencka, 2019; Collaco, 2018; Wang & Baker, 2018), there is limited understanding of the impact of personality trait, such as grit, on student engagement and outcomes in respect of physical activity (Wang & Degol, 2014). Moreover, there is a lack of studies that have examined the independent effects of grit on physical education outcomes, such as objectively measured leisure-time physical activity. The current research aimed to estimate parameters of the model in which perseverance of effort and consistency of interest as two subscales of grit were proposed to be related directly to objectively measured moderate-to-vigorous physical activity (MVPA) and indirectly via physical activity intention in a sample of school students.

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Grit is operationalized as a construct consisting of two domains: perseverance of effort and consistency of interest (Duckworth & Quinn, 2009). Perseverance of effort is viewed as the tendency to overcome initial failures to achieve long-term goals, while consistency of interest focuses on an individual's tendency to pursue the same goals over time. Studies have shown that grit is associated with achievement motivation (Duckworth & Eskreis-Winkler, 2013), educational attainment (Duckworth & Quinn, 2009; Collaco, 2018), and professional achievement (e.g., Vallerand, Houliort & Forest, 2014). A recent meta-analysis by Credé, Tynan, and Harms (2016) demonstrated that grit was correlated at about 0.16 and 0.17 with GPA (Grade Point Average) at the high school and college levels, respectively. The perseverance factor was related to academic performance at a higher level (0.26) than the consistency factor (0.10) was. The perseverance of effort was also more strongly related to the well-being than the consistency of effort was (Disabato, Goodman, & Kashdan, 2019). It was also found that grit predicts retention in a challenging three-week military training course (Eskreis-Winkler, Shulman, Beal, & Duckworth, 2014). In the sport domain, Larkin, O'Connaor, and Williams (2016) exploring the influence of grit level on perceptual-cognitive skills tests demonstrated that grittier soccer players performed better than less gritty players on the assessment of decision making. Grittier players also dedicated more time to sport activities compared with less gritty players. Reed, Pritschet and Cutton (2012) examining the relationships of grit and conscientiousness dimension with respect to the different exercise intensity in the four stages of exercise behaviour (precontemplation; preparation; action, and maintenance) found that grit significantly predicted the high intensity and moderate intensity exercise stages while the conscientiousness did not. Based on the preceding, it can be assumed that the grit dimensions may have a different relationship with leisure-time physical activity.

There are many mechanisms that may explain the association between grit and different behavioural outcomes (Collaco, 2018). One widely used theory to explain behavioural outcomes is the theory of planned behaviour (Ajzen, 1985), according to which intention is the most proximal variable related to the self-reported physical activity in leisure time contexts (see, for review, Hagger and Chatzisarantis, 2016). To investigate the coincidence of behavioural intent and actual behaviour, or the mismatch, McBroom and Reid (1992) have categorized the actual behaviour into four types. Learners who intend to act will do so, and those who do not intend to do a certain behaviour will not do it. In such a case, the intentions and actions of the students are consistent; there is no discrepancy. Also, it may be that there is an intention to behave but not behave like this. There may also be a case in which there is no intention to operate, but in practice, it is done. Sheeran (2002) has stated that people may have incomplete control over whether they can engage in the behaviours they intend. Therefore, it is rational to assume that there may be unknown factors, such as personality traits, that can influence intention. To the best of our knowledge, only Wang and Degol (2014), have studied the relationship between learners' intention to complete a massive open online course (MOOC) and their actual completion status. The authors found that grit and goal orientation were associated with course completion, but grit predicted course completion independently from the intention to complete.

We can perhaps better understand why some of the students are more active than others by comparing their grit. In this case, we are interested in whether and how the students' grit dimensions (perseverance of effort and consistency of interest) are related to intention to be engagement in physical activities beyond compulsory school physical education. In previous studies, effort and interest have been found to be essential components of motivation (Ntoumanis, 2001; Standage, Duda, & Ntoumanis, 2006) that in turn are related to intention and latter with the behavioural outcome (Hagger & Chatzisarantis, 2016). The results of Ntoumanis (2001) showed that motivation was a strong predictor of perceived effort as students experiencing excitement and fun in physical education are likely to exert high effort to learn a new skill.

The dimensions of grit, the perseverance of effort and consistency of interest, have not been widely studied in the context of physical activity. Specifically, unanswered questions remain regarding the relationships between objectively measured MVPA and dimensions of grit. Based on SDT, Duckworth (2016) noted that for individuals to remain committed and driven towards their long-term goals, they must first to have an interest in that activity, specifically, that inspires individuals towards their lifelong allegiance, despite setbacks, mistakes, obstacles and alternatives. Therefore, we hypothesized that consistency of interest would relate more positively than the perseverance of effort to MVPA in leisure time. We also hypothesized that students with high MVPA would have a higher level of grit dimensions and behavioural intention compared to students with low MVPA.

Methods

Research Participants and Design

The participants were school children; 59 boys (M age = 13.07, SD = .99) and 150 girls (M age = 13.26, SD = .95) from Estonia. Students were enrolled in physical education as a compulsory lesson twice per week. Permission to carry out the study was obtained from the head teacher, and ethical approval was granted from the university ethics committee. Next, consent from class teachers was obtained in lieu of parental consent. The purpose of the study was explained, and the guidelines for completing the questionnaire were provided. The questionnaire took approximately 5-10 minutes to complete. The students were assured that their responses would remain confidential. The data were collected at two points in time. First, the participants completed the self-reported questionnaires about grit scale and intention. Second, five weeks later, the MVPA for the seven following days was recorded by accelerometers

Measures

The Grit Scale. The present study included the eight-item short Grit Scale (Duckworth & Quinn, 2009) to assess learners' consistency of interests and perseverance of efforts. Consistency of interests was measured with four items, such as "I have difficulty maintaining my focus on projects that take more than a few months to complete". These items were a reverse-coded. Perseverance of effort was measured with items such as "I'm a hard worker." The grit scores were calculated by averaging across items on a scale of 1 to 5. The measure of intentions comprised two items from Theory of Planned Behavior Questionnaire (Ajzen, 1985) ("I intend to do active sports and/or vigorous physical activities during my leisure time in the next 5 weeks" and "I plan to do active sports and/or vigorous physical activities during my leisure time in the next 5 weeks") rated on seven-point scales anchored by 1 ("strongly agree") to 7 ("strongly disagree").

Objective measure of physical activity. Actigraph GT3X (ActiGraph LLC, Pensacola, FL) was used to measure MVPA. The participants had to wear the accelerometer on their waist for seven consecutive days, and to remove the device for sleeping and water activities (e.g., bathing, swimming). The data files were downloaded using ActiLife software 6.13.3. The sampling interval was set at 15 s. Accelerometer data were considered valid if over 600 min (10 hours) of recorded data per day at least four days out of seven were present. Zero counts of consecutive 60 min were classified as non-wear time. The PA intensity level in the accelerometers was measured using the cut-off points of Evenson, Catellier, Gill, Ondrak, and McMurray (2008), which have been used to evaluate the level of PA during adolescence (Hinckson et al., 2017).

Translation procedures. Standardized back-translation techniques (Brislin, 1986) were used to translate the English version questionnaire into Estonian. The first step consisted in having the items translated by a bilingual translator into Estonian and then translated back by independent bilingual translators who had no access to the original questionnaires. The back-translation procedure was repeated iteratively until the original and back-translated English versions of the questionnaires were virtually identical.

Data analyses

Data analyses were conducted using SPSS 23 and AMOS 23 software. First, descriptive statistics for all study variables were calculated. Second, confirmatory factor analyses (CFA) was used to test the factorial validity of the grit scale and measurement model of the study variables. Third, the structural equation model (SEM) for predicting the objectively measured physical activity was used. Finally, the independent t-test was used to compare the group with low and high physical activity regarding grit dimensions and intention.

TABLE 1 Descriptive statistics of the items of grit scales and intention

Subscale	Items	Mean±SD	Skewness	Kurtosis	ρ
Perseverance of efforts					0.784
Grit1	I have overcome setbacks to conquer an important challenge.	3.21±.653	-0.453	0.216	
Grit6	I am a hard worker.	3.09±.761	-0.675	0.405	
Grit9	I finish whatever I begin.	2.86±.794	-0.271	-0.394	
Grit12	I am diligent.	3.14±.733	-0.749	0.748	
Consistency of interest					0.668
Grit 2	New ideas and projects sometimes distract me from previous ones.	2.22±.748	-0.288	0.335	
Grit5	I have been obsessed with a certain idea or project for a short time but later lost interest.	2.65±.848	-0.458	-0.341	
Grit8	I have difficulty maintaining my focus on projects that take more than a few months to complete.	2.69±.823	-0.151	-0.497	
Grit7	I often set a goal but later choose to pursue a different one.	2.56±.830	-0.208	-0.484	
Int1	I intend to do active sports and/or vigorous physical activities during my leisure time in the next 5 weeks	5.96±1.168	-1.187	1.409	
Int2	I plan to do active sports and/or vigorous physical activities during my leisure time in the next 5 weeks.	5.92±1.210	-1.149	1.019	

Note: SD = standard deviation; ρ = composite coefficient. Consistency of interest item describes are shown after reverse coding. Composite coefficient with three items was 0.740.

Scale reliability was calculated based on the composite reliability index for each subscale that reflects the proportion of shared variance to error variance in a construct (Li, Rosenthal & Rubin, 1996). The bootstrap-generated bias-corrected confidence approach was used to investigate the direct and indirect relationships between study variables (Byrne, 2010; Preacher & Hayes, 2008).

The adequacy of the CFA and SEM models was evaluated by using multiple goodness-of-fit indexes: comparative fit index (CFI), the non-normed fit index (NNFI), normed fit index (NFI), and the root mean square error of approximation (RMSEA). A cut-off value greater than .95 for the CFI, NFI, and NNFI, and a cut-off value less than or equal to .08 for the RMSEA indicated adequate model fit (Hu & Bentler, 1999).

To compare the influence of the grit dimensions and physical activity intention on moderate-to-vigorous physical activity, the participants were divided into two groups based on one standard deviation of the mean MVPA value. The high moderate-to-vigorous physical activity group was formed with one standard deviation above and low group with one standard deviation below the mean value.

Results

The mean scores, standard deviations, skewness, and kurtosis for each of the three subscale scores are presented in Table 1. Univariate skewness and kurtosis values indicated to the normal distribution of the observed variable. The composite reliability coefficients for the perseverance of efforts, consistency of interest, and intention were 0.784, 0.668, and 0.895, respectively.

The discriminant validity CFA model for grit with two latent factors and eight items (Table 2, Model 1) met the criterion for fit. However, considering the confidence interval values for RMSEA, and low factor loading (0.38) for one item "New ideas and projects sometimes distract me from previous ones" from the consistency of interest scale, it was decided to remove it. After removing the item with low factor loading, the composite reliability coefficient of this scale increased from 0.668 to 0.740. The exclusion of this item also resulted in improved psychometric parameters (Table 2, Model 2).

TABLE 2 Goodness-of-fit statistics for confirmatory factor analyses and structural equation models

Models	χ^2	d.f.	CFI	NNFI	NFI	RMSEA	CI95RMSEA
Model 1	37.019	19	0.956	0.916	0.936	0.068	0.034 - 0.100
Model 2	21.112	13	0.979	0.965	0.947	0.055	0.000 - 0.096
Model 3	30.488	24	0.990	0.984	0.953	0.036	0.000 - 0.070
Model 4	46.169	31	0.971	0.958	0.927	0.053	0.021 - 0.080

Note: Model 1 = discriminant validity of Short Grit Scale (GRI-S) with two factors and 8 items; Model 2 = discriminant validity of modified Short Grit Scale (GRI-S) with two factors and 7 items; Model 3 = measurement model with all study variable; Model 4 = structural equation model; χ^2 = chi-square; d.f. = degrees of freedom; CFI = comparative fit index; NNFI = non-normed fit index; NFI = normed fit index; and RMSEA = root-mean squared error of approximation; CI95RMSEA = 95% confidence interval of RMSEA.

The results from the CFA revealed that the measurement model based on nine observed measures and three latent constructs was appropriate (Table 2, Model 3); each factor was adequately explained by its respective set of indicator items. In addition, factor correlations among the constructs were significantly different from a unified state according to the criteria specified by Bagozzi and Kimmel (1995), supporting the discriminant validity of the constructs.

TABLE 3 Standardized parameter estimates and variability statistics for the model of the effect of students' perceptions of the dimensions of grit on moderate-to-vigorous physical activity with intention as a mediator

Independent variable	Dependent variable	Mediator	β	95% CI	
				LL	UL
Direct effects					
Perseverance of efforts	Intention	-	0.286**	0.086	0.480
Consistency of interest	Intention	-	0.153	-0.045	0.337
Perseverance of efforts	% in MVPA	-	-0.023	-0.194	0.135
Consistency of interest	% in MVPA	-	0.162*	-0.025	0.327
Intention	% in MVPA	-	0.149*	-0.032	0.318
Indirect effects					
Perseverance of efforts	% in MVPA	Intention	0.042*	0.002	0.113
Consistency of interest	% in MVPA	Intention	0.023	-0.003	0.081
Total effects					
Perseverance of efforts	% in MVPA	-	0.020	-0.144	0.176
Consistency of interest	% in MVPA	-	0.185*	0.002	0.346

Note: CI = 95% confidence intervals of parameter estimates; LL = Lower limit of 95% CI; UL = Upper limit of 95% CI. * $p < 0.05$; ** $p < 0.001$; % in MVPA = moderate-to-vigorous physical activity.

The results of the structural model for the full sample demonstrated a good fit to the data (Table 3, Model 4). The results of the SEM model presented in Figure 1 revealed a significant direct effect ($\beta = .286, p < .001$) from the perseverance of efforts on the intention to be physically active. Consistency of interest and intention to be physically active were not directly related to the MVPA. However, the intention to be physically active mediated the effect of the perseverance of efforts on MPVA whereas consistency of interest did not. It was notable that the total effect from the consistency of interest was significant.

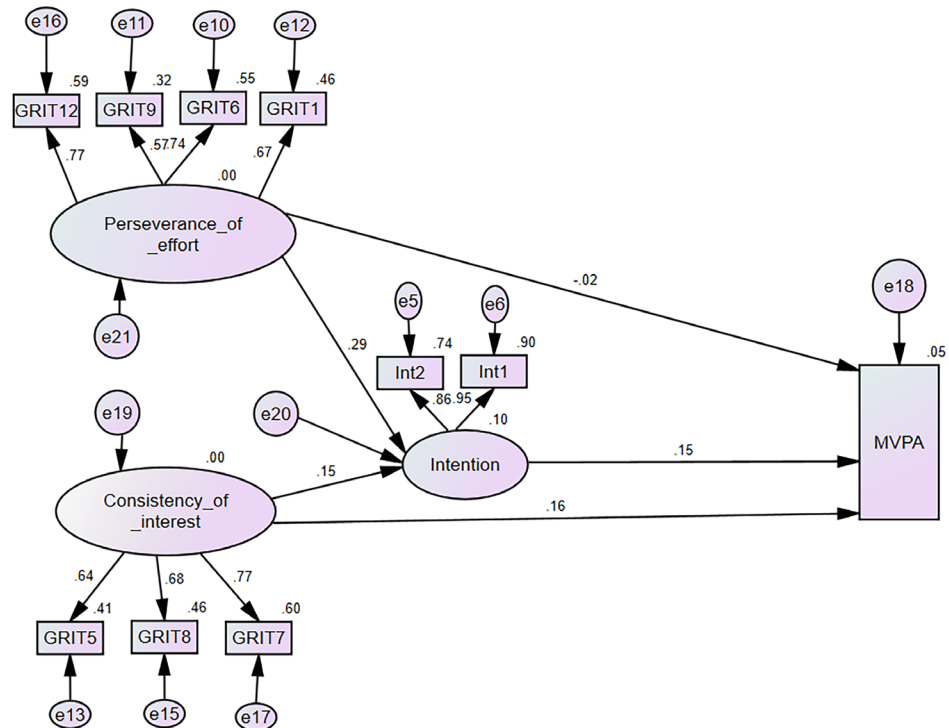


FIGURE 1 Structural model predicting moderate-to-vigorous physical activity regarding the dimensions of grit and intention. Abbreviations in boxes are measured variables; e10, e12, e11, e16, e13, e15, e17, and e18 are error terms associated with each measured variable. MVPA = moderate-to-vigorous physical activity.

The differences related to the dimensions of the grit and intention in groups with high and low MVPA are presented in Table 4. The dimension of the perseverance of efforts between groups with high and low MVPA activity was not statistically significant, whereas the intention was. The consistency of the interest dimension in the high MVPA group was significantly higher than in the low group only at the $p < 0.1$ level.

TABLE 4 Mean differences in the grit dimensions and physical activity intention among groups with low and high moderate-to-vigorous physical activity

Study variables	Group with low MVPA (n = 42)	Group with high MVPA (n = 46)	t value	P - value
	Mean ± SD	Mean ± SD		
Consistency of interest	2.59 ± .78	2.84 ± .67	-1.640	0.105
Perseverance of efforts	3.04 ± .66	3.20 ± .63	-1.166	0.247
Intention	5.48 ± 1.28	6.19 ± 1.05	-2.900	0.005

Discussion

The current research aimed to estimate how the perseverance of effort and consistency of interest as two subscales of grit are related to objectively measured moderate MVPA and whether these relationships are mediated by the physical activity intention.

Prior to testing hypotheses, we needed to confirm the validity of the psychological measures constructs for use with the current Estonian sample. At first, the results of CFA of the grit scale with eight items for both subscales indicated to the room of improvement. The factor loading of the item “New ideas and projects sometimes distract me from previous ones” was below an acceptable value (Tabachnick & Fidell, 2007); with the elimination of that item, the composite reliability coefficient of the scale increased. Also, the psychometric parameters were better for seven than for eight items. Disabato et al. (2019) also noted the need for an overview of the items of the consistency of interest scale. For instance, they proposed the item “I become interested in new pursuits every few months”. However, in general, the two factor model of grit, with eight items has been confirmed by several studies (Duckworth & Quinn, 2009; Collaco, 2018; Wang & Baker, 2018; Wang & Diegol, 2014).

The proposed model showed that the consistency of interest was strongly directly related to MVPA and indirectly via physical activity intention. This is inconsistent with several previous studies, in which the role of the perseverance of effort in academic performance is emphasized (Collaco, 2018; Wang & Diego, 2014). The results of this study are not congruent with those of the study of Disabato et al. (2019), in which perseverance of effort was more strongly related to life satisfaction than the consistency of interest. Obviously, to encourage physical activity, it is important that the activity for students would be of constant interest and offer an enjoyable experience. In contrast, the persistence of efforts may seem to be irrelevant to certain activities, such as MVPA. Consequently, to be moderately to vigorously physically active does not need so much effort than interest for that activity.

However, Disabato et al. (2019) have noted that maintaining consistent interests over some time does not specify whether or not interests are involved. It may be that the high level of continuity of interest is less focused on engaging in activities because they do not want to try new things. Nevertheless, this is not a case for long-lasting physical activity in which the focus is mainly on engagement. Such a statement can be confirmed by the findings that the total effect from the consistency of interest was significant, but the perseverance of efforts was not.

The comparison of low and high physical activity groups regarding grit dimensions and intention revealed that a statistically significant difference was found only in intention. Students who scored higher on the MVPA reported higher scores in intention than lower active students did. Although the scores of the consistent of interest as well in the perseverance of effort were higher in a group with high MVPA compared to the group with low MVPA, the differences were not significant at a more conservative level ($p < 0.05$). To some extent, the results corroborate the finding obtained in the previous study by Larkin et al. (2015) who found that gritty soccer players invested more time within specific soccer activities.

The study was correlational in nature; therefore, cause and effect could not be followed. In this study, the dimensions of grit predicted directly and indirectly via physical activity intention objectively measured MVPA for a short period. Therefore, there is an urgent need to verify it for a much longer period. It should also be mentioned that this study looked at grit and intention relationships with MVPA, but including other psychological variables, such as attitude, perceived behavioural control, and motivation, may shed additional light on these connections.

In conclusion, our study has demonstrated that students' consistency of interest, but not perseverance of effort were significantly directly related to MVPA. The present research makes a unique contribution to the literature, providing the initial evidence about the relationships between grit and MVPA. These results also suggest that grit should be more widely considered by physical education teachers for promotion students' long-lasting physical activity.

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