



Original

## Academic grit modulates school performance evolution over time: A latent transition analysis<sup>☆</sup>



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### ABSTRACT

Academic grit, known as passion and perseverance for long-term academic goals, has been widely studied in the educational context. However, few are the studies that analyze this variable as a specific domain and longitudinally. We used a sample of 4,853 students, assessing their levels of academic grit at two timepoints four years apart: in the fourth year ( $M=9.9$  years,  $SD=0.41$ ), and eighth year ( $M=13.87$  years,  $SD=0.82$ ) of compulsory education. We also evaluated their academic performance via their school grades in Spanish language and mathematics at three timepoints. Latent Class Analysis was used to identify underlying groups, and Latent Transition Analysis to examine the transitions between the latent groups at the different timepoints. We also performed a repeated measure ANOVA to analyse the influence of academic grit on school performance. We identified three groups, differentiated by the level of academic grit: *gritty*, *industrious*, and *careless* group. Over time (between 10 and 14 years old) we saw a clear transition of students towards the groups with lower levels of grit. School performance decreased between the ages of 10 and 14, although not in a straight line, and the change was modulated by the level of academic grit. Promoting academic grit from the primary stage could dampen school failure in later stages.

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## La tenacidad académica modula la evolución del rendimiento escolar: Un análisis de transiciones latentes

### RESUMEN

La tenacidad académica, conocida como la pasión y la perseverancia por objetivos escolares a largo plazo, ha sido ampliamente estudiada en el contexto educativo. Sin embargo, pocos son los estudios que analizan esta variable como dominio específico y de manera longitudinal. El objetivo del presente trabajo es analizar en qué medida la tenacidad académica influye en el rendimiento académico evaluado longitudinalmente. Se utiliza una muestra de 4.853 estudiantes evaluados en tenacidad en dos momentos temporales, separados por cuatro años: cuarto curso de educación primaria ( $M=9.9$  años,  $DT=0.41$ ), y segundo curso de educación secundaria obligatoria ( $M=13.87$  años,  $DT=0.82$ ). También se evalúa el rendimiento académico a través de las notas escolares en Lengua Castellana y Matemáticas en tres momentos temporales. Se utiliza un Análisis de Clases Latentes para identificar grupos subyacentes, y un Análisis de Transiciones Latentes para estudiar las transiciones entre los grupos latentes en los diferentes momentos temporales. Además, se realiza un ANOVA de medidas repetidas para analizar la influencia de la tenacidad académica en el rendimiento académico. Se identifican tres grupos diferenciados

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en función del nivel de tenacidad académica: Grupo *gritty*, *diligente* y *descuidado*. Con el paso del tiempo (10 a 14 años), se observa una transición clara de los estudiantes hacia los grupos de menor nivel de tenacidad. El rendimiento académico disminuye entre los 10 y los 14 años, si bien no lo hace linealmente, viniendo modulado el cambio por el nivel de tenacidad académica. Promover la tenacidad académica desde la etapa primaria podría amortiguar el fracaso escolar en las etapas posteriores.

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## Introduction

In the knowledge society, a population's level of education will limit a country's chances of economic development and social wellbeing (OECD, 2019a). Students in the 21<sup>st</sup> century live in an interconnected, diverse world which is changing rapidly; what Bauman defined as a fluid world (Bauman, 2017). New economic, digital, demographic, environmental, and cultural forces are changing the lives of young people all over the globe, which is why business and political leaders and those in education are asking schools more and more to include skills in their curricula such as problem solving, critical thinking, and collaboration (Pellegrino & Hilton, 2012). Large scale evaluations such as the Programme for International Student Assessment (PISA) have introduced variables such as collaborative problem solving, financial skills and self-concept in mathematics (OECD, 2013), health and subjective wellbeing, use of time, and personality traits from within the Big Five (OECD, 2016), as well as global competence, understood as the capacity to understand and appreciate others' views of the world and to work towards the collective good (OECD, 2019b). This complements the more classical evaluations, focused on cognitive aspects and academic performance, with others that include non-intellective dimensions (OECD, 2019a).

Richardson et al. (2012) propose five different domains that would encompass the non-intellective constructs related to academic performance: (1) personality traits, (2) motivational factors, (3) self-regulatory learning strategies, (4) students' approaches to learning, and (5) psychosocial contextual influences. In recent years we have witnessed an increase in research into the role of these domains in academic and professional success (Farrington et al., 2012; Heckman & Kautz, 2012; Morales-Vives et al., 2020; Richardson et al., 2012; Robbins et al., 2004; Smithers et al., 2018). This importance has encouraged their increasingly frequent inclusion in student curriculums (Eurydice, 2018; García, 2014).

In the context of education, one of the non-intellective variables that has piqued most interest in recent years is grit, which refers to students' perseverance and their passion and commitment to reaching a long term goal (Duckworth, 2016; Duckworth et al., 2007). Following Richardson et al. (2012), grit would fall within the personality traits domain, since it begins to be considered a facet of conscientiousness (Schmidt et al., 2020). Although initially it was considered a construct with two dimensions, persistence of effort and consistency of interests (Duckworth & Quinn, 2009), some recent studies have advocated considering it essentially unidimensional (Areepattamannil & Khine, 2017; González et al., 2020; Postigo et al., 2020). Another aspect of grit which is under debate is whether it is transversal or whether it depends on a specific context, such as general grit versus academic grit in an educational context (Clark & Malecki, 2019; Cormier et al., 2019). Clark and Malecki (2019) showed how grit measured as a specific domain (academic grit) increased the predictive validity of different school outcomes such as academic performance. Various studies have found clear relationships between students' levels of grit and their school performance in university students (Akos & Kretchmar, 2017; Fong & Kim, 2019), high school students (Duckworth & Quinn, 2009; Steinmayr et al., 2018), and middle school students (Clark & Malecki, 2019; Dumfart & Neubauer, 2016), although in other studies the results have not been as clear (see, Créde et al., 2017).

However, very few longitudinal studies have examined this relationship, notably Jiang et al. (2019) and Tang et al. (2019). Both of these studies found that the level of grit at the first timepoint predicted subsequent academic performance, even controlling for prior performance (Jiang et al., 2019) and variables such as conscientiousness and socioeconomic level (Tang et al., 2019).

One limitation of most of the longitudinal studies into the relationship between grit and academic performance is that they have not used new analysis models called person-centred approach analyses which, unlike classical correlational approaches, allow us to explore the possibility of the sample being made up of different subgroups characterized by different sets of parameters (Howard & Hoffman, 2018). These person-centred approach models have already been successfully used in other areas of educational research such as academic self-concept (Castejón et al., 2016), motivation (Chittum et al., 2019; Gillet et al., 2017), procrastination (Grunschel et al., 2013), and homework behaviour (Flunger et al., 2017).

In the field of grit, Tang et al. (2021) used a person-centred approach (Latent Profile Analysis) with a sample of Finnish students in the eighth and ninth years of compulsory education and found that a fifth of the students with high grit scores also had high academic goal commitment. They also examined the progression (transition) over two years, finding that the group of students with high grit scores and high academic goal commitment was stable in 63% of cases, and was the group which demonstrated the best academic performance. Within this context, the general objective of our study is to examine the influence of academic grit on school performance using a longitudinal approach. This gives us three specific objectives. The first is to identify the possible latent classes of students based on their academic grit at age 10 and at age 14, being a critical period of development. The second is to analyse the possible changes and transitions of the latent grit classes between the ages of 10 and 14. Lastly, the third objective is to examine how the progression of grit over time between ages 10 and 14 influences and modulates the students' academic performance. Apart from the intrinsic interest in these objectives, it is worth highlighting that we will use a methodology that has been hardly used to date in grit research, person-centred approach models, which will allow us to exactly and thoroughly explore our objectives (Gillet et al., 2017).

## Method

### Participants

The initial sample was composed of 7,479 students of the Principality of Asturias, a region in the North of Spain. Due to the longitudinal approach of the study, the final sample was made up of a total of 4,853 students attending 299 schools and institutes in the Principality of Asturias. The students were evaluated at two time-points separated by four years. The first evaluation was when the students were in the fourth grade of compulsory education, with a mean age of 9.9 years ( $SD = 0.41$ ). The second evaluation was when they were in the eighth grade of compulsory education, with a mean age of 13.87 ( $SD = 0.82$ ). The majority of students (92.7%) were of Spanish origin, and 49.6% were girls. Technically this is the

population as the evaluation was carried out on all of the registered students at the level studied in this geographical region.

### Instruments

The *Academic Grit Scale* is a brief measuring instrument with five items which measures grit in the school context. Students score each statement on a 4-point Likert scale (1–4) with the following meanings: “never or almost never”, “sometimes”, “often”, “always or almost always”. Academic Grit Scale shows good psychometric properties, excellent fit to unidimensional structure, and measurement invariance by sex (Postigo et al., 2021). In the present study, to make it easier to interpret the latent classes, we dichotomized the items so that 1 and 2 meant “little agreement” and 3 and 4 meant “strong agreement”. Once dichotomized, the instrument was essentially unidimensional (Calderón et al., 2019), with the main factor explaining 58% of the total variance and having appropriate indices of fit (GFI = .995 and RMSR = .048). At the second timepoint (14-year-old students), the main factor explained 52% of the variance, with excellent indices of fit (GFI = .998 and RMSR = .029). An example of item is “I work hard to get good grades”.

*School performance* was measured using the school grades in the corresponding school year in Spanish Language and Mathematics at three time-points (fourth, sixth and eighth grade of compulsory education). The grade is from 0 to 10 in both subjects, where 0 is very poor performance, and 10 is outstanding performance.

### Procedure

The data collection was carried out within the framework of the *Diagnostic Evaluation of the Education System* program of the Asturian Government Department of Education and Culture. It is a *large-scale group score assessment*, in which cognitive tests and student context questionnaires are applied to participating students. Participation was prescriptive for schools and voluntary for the student and their families. By law, the test is controlled by the Department of Education and Culture and is performed in accordance with the manual of *Instructions for carrying out the diagnostic evaluation* (Government of the Principality of Asturias, 2018). The school principals manage and coordinate paper-based application within their schools, and the school inspectorate monitors quality. The student context questionnaire, which included the items making up the *Academic Grit Scale*, was applied in the same conditions at the two time-points (fourth and eighth grade of compulsory education). School grades were obtained from the Department of Education and Culture records system at the three time-points (fourth, sixth and eighth grade of compulsory education).

### Data analysis

The descriptive statistics (mean, standard deviation, skewness and kurtosis) of the items as well as their correlations were calculated for both time points. In addition, Cronbach's  $\alpha$  coefficient, McDonald's  $\omega$  coefficient, Composite Reliability (CR) and Average Variance Extracted (AVE) were calculated. We produced a longitudinal model of latent variables as this was a study over time. Latent Transition Analysis (LTA) is an extension of Latent Class Analysis (LCA), a multivariate approach based on identifying non-observable groups (latent classes) through a mix of observable categorical indicators. The peculiarity of LTA is that because it deals with longitudinal data, it provides an estimation of the probability of subsequently changing group (latent class). The estimation procedure we used was Robust Maximum Likelihood (RML) as it is the most advisable for the type of data used in this study (Collins & Lanza, 2010).

Firstly, both at timepoint 1 and timepoint 2, we focused on different latent class models that would be used in the subsequent LTA. The idea was to group students with similar profiles of indicator variables (Vermunt & Magidson, 2002). We produced models of 2 to 5 latent classes and considered Bayesian Information Criterion (BIC) and its fit to the sample (ABIC) and the Akaike Information Criterion (AIC) as indices of fit in order to choose the number of latent classes in the most parsimonious model with the best fit. Lower values of BIC, ABIC, and AIC indicate better fit to the model. We also used entropy as another indicator of fit, the value of which is between 0 and 1. Higher entropy values indicate better separation between the latent classes (Collins & Lanza, 2010; Lanza & Cooper, 2016). Once the model was chosen, we defined the latent classes according to the probabilities of responses to the different items. The main goal is to seek the best description of the observed data via the identification of latent classes. Once the latent classes were calculated at both time points, the class invariance (full and partial) across time points was studied. For this, BIC, ABIC, and AIC and Loglikelihood Ratio Test (LRT) were used. Thresholds (response probabilities) are constrained to be the same for the items.

Secondly, we performed the LTA which gave us the probabilities of transition between the latent classes at the two timepoints. In other words, it gave us the extent to which students changed groups over time. The LTA estimates the probability of each item response, the probability of remaining in each group, and the probability of transition between the different latent classes over time (Collins & Lanza, 2010). Once we had analysed the transitions between latent classes at the two timepoints, we went on to examine whether the groups making up the transitions differed in school performance over the four years in mathematics and Spanish language. To that end, we performed a mixed repeated measure ANOVA with one within-subject factor (school performance) with three levels (fourth, sixth, and eighth year of compulsory education), and one between-subject factor (academic grit groups) with nine levels (the nine possible combinations of grit at the two timepoints) for both mathematics and Spanish language. As a test statistic we used Pillai's Trace as it is the most robust test (Meyers et al., 2016). The effect size was analysed using Cohen's  $d$ , with values between 0.2 and 0.4 indicating a small effect, between 0.5 and 0.7 a moderate effect, and over 0.7 a large effect size (Cohen, 1988). All analyses were done using MPlus8 (Muthén & Muthén, 2017), apart from the repeated measure ANOVA for which we used the statistics package SPSS 24 (IBM Corp, 2016).

### Results

The descriptive statistics and the correlations of the items are in Table 1. All the items, at both time points, show adequate values of skewness and kurtosis. The instrument's reliability is adequate both at time 1 ( $\alpha = .82$ ,  $\omega = .82$ , AVE = .45, CR = .65), and at time 2 ( $\alpha = .77$ ,  $\omega = .77$ , AVE = .42, CR = .60).

We produced models with 2 to 5 latent classes at the two timepoints (Table 2). Although the 2-class model demonstrated better entropy, the models with 3 and 4 classes exhibited better fit, both at the first and second timepoint. We chose the model with 3 latent classes at both timepoints as it was the most parsimonious and made the interpretation easier (Lanza et al., 2010).

Once the 3-class model was chosen, we considered the item response probabilities in order to define them, both at timepoint 1 and timepoint 2 (Figure 1 and Figure 2 respectively). This model gave three well-differentiated groups. At both timepoints the black line represents the first latent class which we define as *gritty* ( $N_{T1} = 63\%$ ,  $N_{T2} = 16\%$ ), which is made up of students who are highly likely to be in “strong agreement” with the statements in the five items ( $M_{T1} = .95$ ,  $M_{T2} = .85$ ). We called the second latent

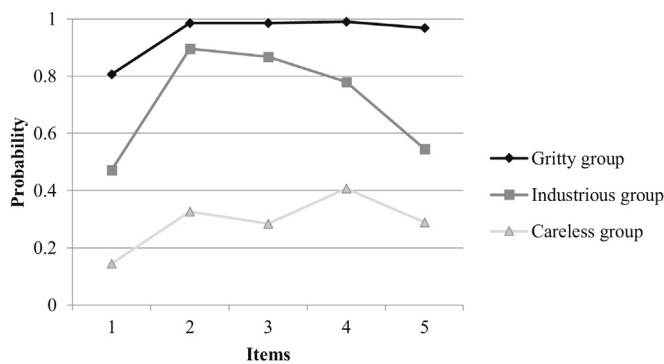
**Table 1**  
Descriptive statistics and correlations of the academic grit items

	Time 1				Time 2			
	Mean	Standard Deviation	Skewness	Kurtosis	Mean	Standard Deviation	Skewness	Kurtosis
Item 1	1.94	0.954	-0.401	-0.938	0.99	0.857	0.618	-0.209
Item 2	2.63	0.662	-1.754	2.323	2.16	0.861	-0.605	-0.669
Item 3	2.52	0.687	-1.244	0.736	2.07	0.821	-0.417	-0.710
Item 4	2.55	0.715	-1.443	1.129	2.24	0.859	-0.801	-0.383
Item 5	2.24	0.830	-0.748	-0.411	2.24	0.906	-0.875	-0.341
Correlations								
	Item 2	Item 3	Item 4	Item 5	Item 2	Item 3	Item 4	Item 5
Item 1	.294	.320	.260	.286	.318	.342	.254	.215
Item 2		.421	.377	.301		.433	.398	.325
Item 3			.359	.344			.419	.298
Item 4				.362				.349

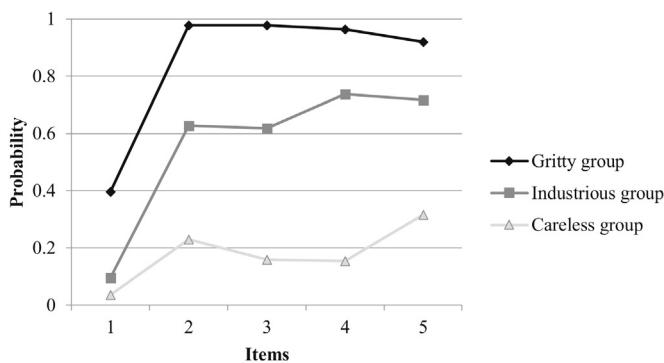
**Table 2**  
Fit in time 1 and time 2 of latent class analysis models

Class	Time 1				Time 2			
	2	3	4	5	2	3	4	5
G <sup>2</sup>	109.08	<b>41.49</b>	10.92	3.03	129.28	<b>26.65</b>	7.63	1.41
AIC	17,775.90	<b>17,720.31</b>	17,701.74	17,705.85	26,702.58	<b>26,611.95</b>	26,604.93	26,610.72
BIC	17,848.37	<b>17,832.32</b>	17,853.28	17,896.92	26,775.05	<b>26,723.96</b>	26,756.47	26,801.79
ABIC	17,813.42	<b>17,778.30</b>	17,780.20	17,804.77	26,740.10	<b>26,669.94</b>	26,683.39	26,709.64
Entropy	.737	<b>.682</b>	.734	.771	.644	<b>.567</b>	.514	.546
DF	20	<b>14</b>	8	2	20	<b>14</b>	8	2

Note. G<sup>2</sup> = Likelihood ratio chi-square; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; ABIC = Adjusted BIC; DF = Degrees of freedom.



**Figure 1.** Model with three latent classes in 4<sup>th</sup> year of compulsory education (age 10).



**Figure 2.** Model with three latent classes in 8<sup>th</sup> year of compulsory education (age 14).

class (the dark grey line) *industrious* ( $N_{T1} = 33.7\%$ ,  $N_{T2} = 59.9\%$ ) as it demonstrated moderate likelihood of agreeing with the five items, and low likelihood of agreeing with passion items (one and five) ( $M_{T1} = .71$ ,  $M_{T2} = .56$ ). The members of the third latent class (light

grey) were very unlikely to agree with the academic grit items ( $M_{T1} = .29$ ,  $M_{T2} = .18$ ), and we called this group *careless* ( $N_{T1} = 3.3\%$ ,  $N_{T2} = 24.1\%$ ).

Once the latent classes were found in both time moments, the invariance between the groups was calculated (Table 3). The full measurement invariance was not met, so the partial measurement invariance was studied. Item 1 was freely estimated across time, while equality constraints are imposed on the rest of the items. Partial invariance was satisfied, indicated by BIC, ABIC, and LRT (Table 3).

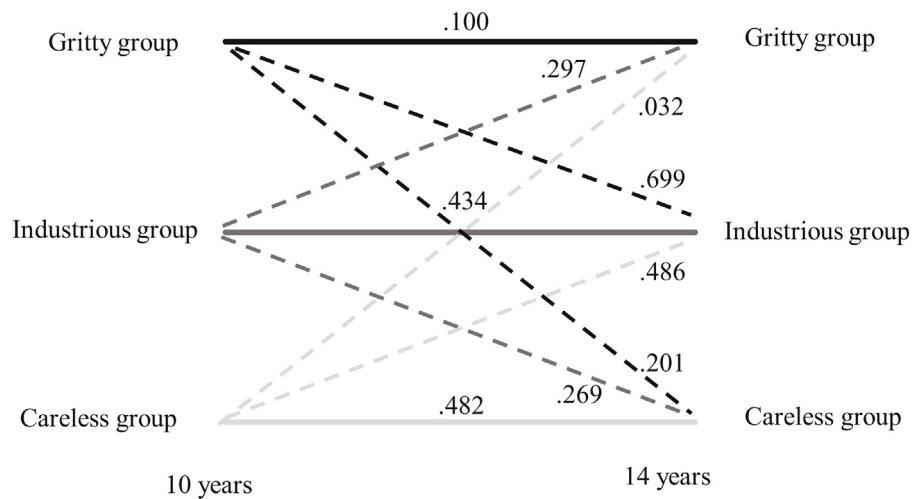
Once we defined the groups, we examined the students' transitions between the two timepoints. The probabilities of transition between the latent classes are given in Figure 3. It shows how students' academic grit falls over the four years of schooling. The least stable group over time is the *gritty* group, with a .70 probability of transition to the *industrious* group. It is also important to note that the transitions from the *careless* group are not particularly representative, as this group contained only 3.3% of the students at the first timepoint.

Lastly, we examined the progression of school performance for each transition group, that is, when were there differences in Spanish language and Mathematics? For both subjects the interaction was statistically significant ( $p < .001$ ), and although the effect size was small ( $d = 0.31$ ), we proceeded to simple effects analysis. Between the first and second measurements only three groups exhibited statistically significant differences ( $p < .001$ ; *gritty-careless*, *gritty-industrious* and *industrious-careless*) in both subjects. Between the first and third measurements in Spanish language, all the groups exhibited statistically significant differences ( $p < .001$ ) except for *careless-industrious* and *careless-gritty*. In mathematics, the only group not exhibiting differences between the first and the third measurement was *careless-industrious*. Figures 4 and 5 show the longitudinal relationship of grades in Spanish language and mathematics, respectively, at the three measurement timepoints (fourth, sixth, and eighth year of compulsory education) based on the academic grit transition group. Both figures show

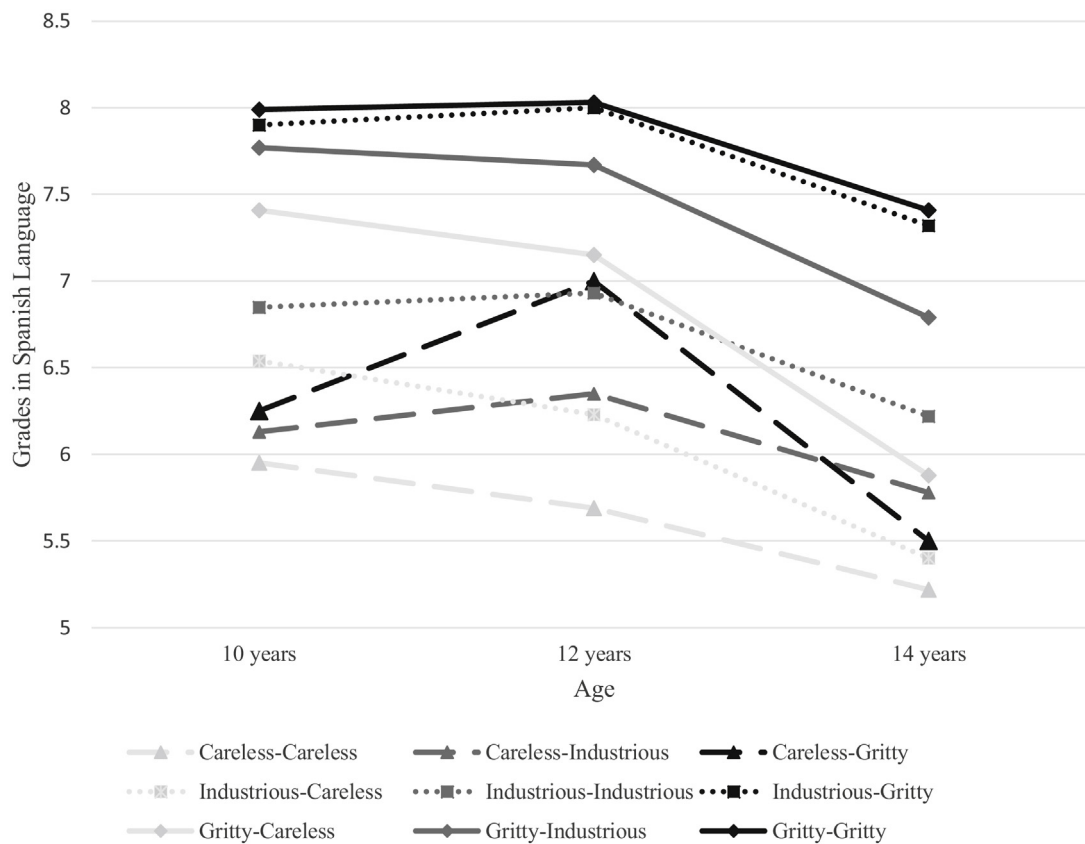
**Table 3**  
Full and partial measurement invariance for latent classes over time

	Measurement Invariance		Partial Measurement Invariance	
	Non-invariance model	Invariance model	Non-invariance model	Invariance model
AIC	43,990.044	44,035.288	32,515.343	32,525.106
BIC	44,345.838	44,325.194	32,805.248	32,762.301
ABIC	44,174.243	44,185.376	32,665.430	32,647.905
LRT		<.05		.08

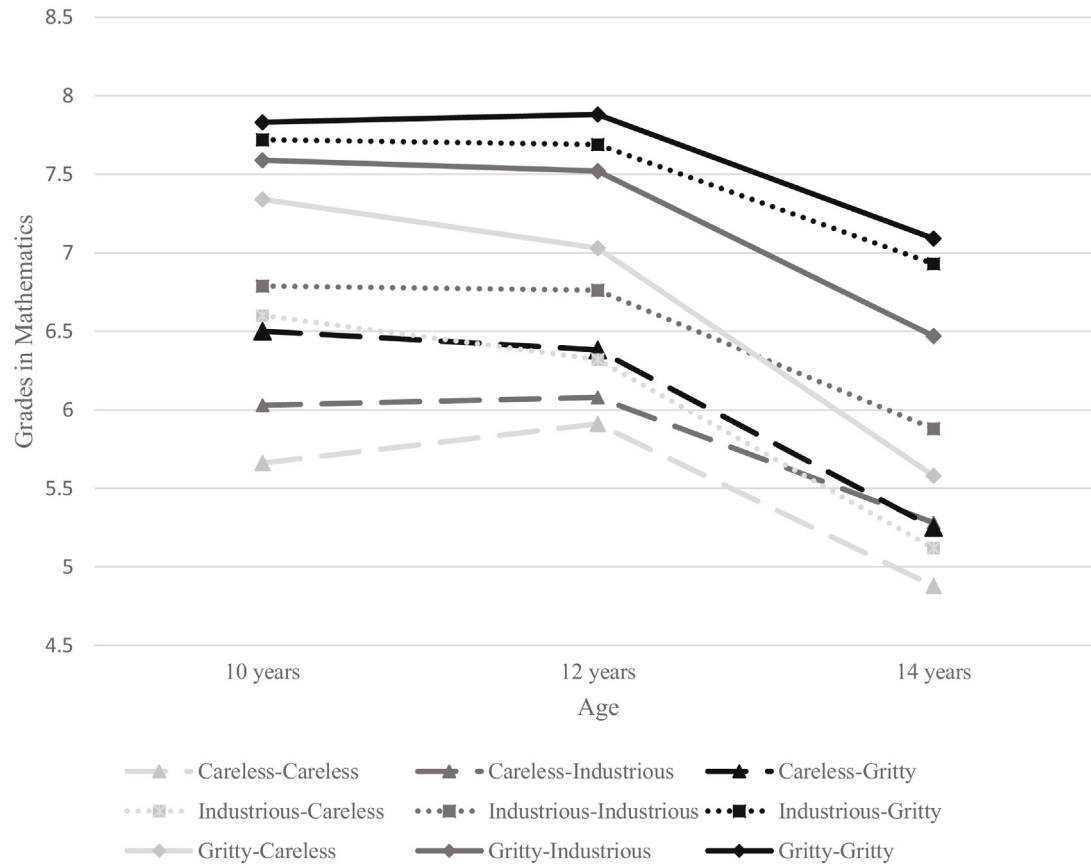
Note. LRT = Likelihood ratio test; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; ABIC = Adjusted BIC.



**Figure 3.** Transitions of academic grit types.  
Note. The numbers are probabilities to change or maintain of academic grit type over time. These ages correspond to the following academic years: 10 years = 4<sup>th</sup> grade of compulsory education; 14 years = 8<sup>th</sup> grade of compulsory education.



**Figure 4.** Relation between academic grit and scores in Spanish language over four years.  
Note. These ages correspond to the following academic years: 10 years = 4<sup>th</sup> grade of compulsory education; 12 years = 6<sup>th</sup> grade of compulsory education; 14 years = 8<sup>th</sup> grade of compulsory education.



**Figure 5.** Relation between academic grit and scores in mathematics over four years.  
 Note. These ages correspond to the following academic years: 10 years = 4<sup>th</sup> grade of compulsory education; 12 years = 6<sup>th</sup> grade of compulsory education; 14 years = 8<sup>th</sup> grade of compulsory education.

that the students with the worst progression in academic grit were those exhibiting worse progression in school performance. In order to make interpretation easier, the y axis in both figures only shows values between 4.5 and 8.5 as there were no scores outside this range.

## Discussion

The aim of this study was to examine the influence of the variable academic grit on school performance in a school context using a longitudinal approach. To that end, we used, firstly, a person-centred approach via LCA to examine possible latent classes of academic grit, to subsequently analyse the transitions over different timepoints via LTA. The results indicate that it is possible to use this approach to study latent classes of academic grit and the transitions between them longitudinally, which allows us to study the influence of academic grit on the progression of school performance. We can say that academic grit is a variable that can be studied using a person-centred approach, permitting a more comprehensive snapshot of the possible interactions that occur, similar to what has happened in recent years in the literature with other non-intellective variables (Castejón et al., 2016; Chittum et al., 2019; Gillet et al., 2017; Tang et al., 2021).

We organized the analysis around three objectives. The first was to determine whether it was possible to identify students with similar types of academic grit both at 10 years old and at 14. The results of the latent class analysis offered a model of three types of students according to their level of academic grit; *gritty*, *industrious*, and *careless* group. The *gritty* group stood out for their high level of agreement with the item statements, they are a class of students who enjoy studying and have consistency of interests at school, they make an effort to get good results, they pay attention in class, they persist in tasks to complete them, and they try to keep clean and tidy notebooks. The second group, which we called *industrious*, exhibited a moderate level of agreement with the item statements, recognizing that study is not a hugely appealing activity but nonetheless, and one that they make an effort in and persevere with school related activities. For that reason, they are industrious but not gritters because they are hard-working and persistent, but they do not show consistency and passion. Finally, the third group, *careless*, is a worrying profile that is unlikely to agree with the items in the academic grit scale. This group of students does not recognize study as a responsibility or commitment, exhibiting minimal effort and persistence in the school environment. In terms of proportions of students in each group, at the first timepoint most students were in the *gritty* group (63%) and the *careless* group had the fewest (3.3%). However, at the second timepoint, the predominant latent class was *industrious* group (60%), and the proportion of students in the *Careless* group rose to 24%, leaving the *gritty* group reduced to 16% of students. This confirms that it is possible to determine the existence of latent classes of academic grit in both the fourth (age 10) and eighth (age 14) year of compulsory education, which is similar to what the literature has reported with other non-intellective variables (Chittum et al., 2019; Gillet et al., 2017).

Our second objective was to explore the transitions from one class of academic grit to another over time. The students in the *Industrious* group in fourth year demonstrated a certain amount of stability over time, exhibiting the same probability of changing to the *gritty* latent class as to *careless*. In contrast, students in the *gritty* group stood out for their low stability in staying in this group over time, with a high probability of moving to the *industrious* group. This indicates that grittier students in the primary stage tend to maintain perseverance but not passion (*industrious* group) in the secondary stage. Essentially, we found a strong tendency towards

a transition to *industrious* and *careless* profiles, indicating lower academic grit at the second timepoint (eighth year of compulsory education). This means a fall in academic grit between the ages of 10 and 14, which is in line with the study by West et al. (2016), whose longitudinal study with middle school students found that grit scores fell over two years. Our results contradict studies reporting grit increasing with age (Peña & Duckworth, 2018), as well as the initial findings from Duckworth et al. (2007) which concluded that grit seemed to be maintained consistently over time. Thus our results call into question the idea that grit can be considered a stable trait, and outline a path towards a concept of dynamic, and changeable grit.

Having three classes of students gave nine possibilities of transitions between groups. We examined whether exhibiting a particular academic grit transition was related to better or worse progress in school performance, which was measured in the fourth year (age 10), sixth year (age 12), and eighth year (age 14) of compulsory education. Those students who demonstrated low academic grit at one of the two measurement points (*careless-careless*, *careless-industrious* and *industrious-careless*) had the lowest performance over time. At the opposite end of the spectrum, students who maintained higher academic grit scores, at least perseverance (*gritty-gritty*, *gritty-industrious* and *industrious-gritty*) had better grades in mathematics and Spanish language over those four years. Along these lines, the largest falls in performance in eighth year were in groups where academic grit declined over time (*gritty-careless* and *industrious-careless*), as these students had notably worse performance compared to students whose perseverance did not decrease (*industrious-industrious*). This indicates that although all groups had lower performance in eighth year, the fall in school performance was more pronounced as a function of the transition in academic grit. This applied both to mathematics and Spanish language. So, in line with prior longitudinal studies (Jiang et al., 2019; Tang et al., 2019, 2021), our results drive us to consider the importance of the role of academic grit in school performance over time.

The evidence we found in our study has important educational implications, both for those responsible for education policy and for classroom implementation, as not only does it show a fall in academic grit over four years of schooling (fourth year to eighth year), but also that the progression of this non-intellective variable modulates school results to a certain extent, showing the importance of the role it plays in the educational context (Clark & Malecki, 2019; Cormier et al., 2019). Various causes can be put forward for the fall in academic grit between the ages of 10 and 14 years old. Firstly, it is logical to think that children's interests and objectives are different at these different ages, it is very common for 14-year-old adolescents to have non-academic aims and interests, which would be related to academic goal commitment (Tang et al., 2021). Another explanation may be due to the change of school phase, as moving from the fourth year to the eighth year of compulsory education means the transition from primary to secondary school, a significant change due to, among other things, increased academic demands, and at least in Spain, changing school (Eurydice, 2018; Government of the Principality of Asturias, 2018). Along these lines, there is a general drop in academic performance, since even the student who remains in the *gritty* group at both times suffers a small decrease. Increased demands may cause a fall in academic performance, which is an external factor that affects other important psychological variables such as motivation (Chittum et al., 2019; Gillet et al., 2017), and academic self-concept (Castejón et al., 2016). The fall in grit could be interpreted as a consequence of other personality and motivational factors (Richardson et al., 2012). In short, in the educational area, there need to be interventions with learning programs that work on grit (Kirchgasler, 2018), using new dynamics that awaken students' passion and interest. This is because of

the important role of motivation and interest at 13 and 14 years old, an age when it is very difficult to motivate children to make additional effort without resorting to the incentive of school grades (Park et al., 2018). These interventions should be aimed at encouraging a growth mindset (Dweck, 2012), which consists of having a mindset related to the possible modification of personal skills, in other words, thinking that with your effort and perseverance you can reach long term goals. As Yeager and Dweck (2012) concluded, what students need is a mentality that sees challenges as situations that can be overcome and successfully completed with time and effort. This mentality is particularly important in adolescence, where the students face a multitude of challenges, and intervention in it has been successfully demonstrated in the transition to high school (Yeager et al., 2016).

One general limitation of the study are the possible biases inherent in the self-reports used, such as social desirability and acquiescence bias (Abrahams et al., 2019; Duckworth & Yeager, 2015; Vigil-Colet et al., 2020). Another limitation deals with the AVE and CR values of the scale, which, although close, do not reach the corresponding limit (.50 and .70 respectively). Also, in future studies it will be important to consider other non-intellective variables which have demonstrated strong relationships with grit, such as self-concept (Castejón et al., 2016), self-efficacy (Usher et al., 2019), and the facets of conscientiousness (Schmidt et al., 2020) in order to study the possible reciprocal effects between grit and those variables. Finally, it would be useful to consider students' socio-economic levels (Tang et al., 2019) to be able to establish profiles of resilient students (educational resilience; García-Crespo et al., 2019) and examine whether grit is a notable characteristic in this type of student.

### Conflicting interests

The authors declare that there are no conflicts of interest.

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### Referencias

Abrahams, L., Pancorbo, G., Primi, R., Santos, D., Kyllonen, P., John, O. P., & De Fruyt, F. (2019). Social-emotional skill assessment in children and adolescents: Advances and challenges in personality, clinical, and educational contexts. *Psychological Assessment*, 31(4), 460–473. <https://doi.org/10.1037/pas0000591>

Akos, P., & Kretschmar, J. (2017). Investigating grit at a non-cognitive predictor of college success. *The Review of Higher Education*, 40(2), 163–186. <https://doi.org/10.1353/rhe.2017.0000>

Areepattamannil, S., & Khine, M. S. (2017). Evaluating the psychometric properties of the original Grit Scale using rasch analysis in an arab adolescent sample. *Journal of Psychoeducational Assessment*, 36(8), 856–862. <https://doi.org/10.1177/0734282917719976>

Bauman, Z. (2017). *Liquid times. Living in an age of uncertainty*. Tusquets.

Calderón, C., Navarro, D., Lorenzo-Seva, U., & Ferrando, P. (2019). Multidimensional or essentially unidimensional? A multi-faceted factor-analytic approach for assessing the dimensionality of tests and items. *Psicothema*, 31(4), 450–457. <https://doi.org/10.7334/psicothema2019.153>

Castejón, J. L., Gilar, R., Miñano, P., & González, M. (2016). Latent class cluster analysis in exploring different profiles of gifted and talented students. *Learning and Individual Differences*, 50, 166–174. <https://doi.org/10.1016/j.lindif.2016.08.003>

Chittum, J. R., Jones, B. D., & Carter, D. M. (2019). A person-centered investigation of patterns in college students' perceptions of motivation in a course. *Learning and Individual Differences*, 69, 94–107. <https://doi.org/10.1016/j.lindif.2018.11.007>

Clark, K. N., & Malecki, C. K. (2019). Academic Grit Scale: Psychometric properties and associations with achievement and life satisfaction. *Journal of School Psychology*, 72, 49–66. <https://doi.org/10.1016/j.jsp.2018.12.001>

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Erlbaum.

Collins, L. M., & Lanza, S. T. (2010). *Latent class and latent transition analysis. With applications in the social, behavioral, and health sciences*. Wiley.

Cormier, D. L., Dunn, J. G. H., & Dunn, J. C. (2019). Examining the domain specificity of grit. *Personality and Individual Differences*, 139, 349–354. <https://doi.org/10.1016/j.paid.2018.11.026>

Credé, M., Tynan, M. C., & Harms, P. D. (2017). Much ado about grit: A meta-analytic synthesis of the grit literature. *Journal of Personality and Social Psychology*, 113(3), 492–511. <https://doi.org/10.1037/pspp0000102>

Duckworth, A. L. (2016). *Grit – The power of passion and perseverance*. Scribner.

Duckworth, A. L., & Quinn, P. D. (2009). Development and validation of the Short Grit Scale (GRIT-S). *Journal of Personality Assessment*, 91(2), 166–174. <https://doi.org/10.1080/00223890802634290>

Duckworth, A. L., & Yeager, D. S. (2015). Measurement matters: Assessing personal qualities other than cognitive ability for educational purposes. *Educational Researcher*, 44(4), 237–251. <https://doi.org/10.3102/0013189X15584327>

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology*, 92(6), 1087–1101. <https://doi.org/10.1037/0022-3514.92.6.1087>

Dumfart, D., & Neubauer, A. C. (2016). Conscientiousness is the most powerful noncognitive predictor of school achievement in adolescents. *Journal of Individual Differences*, 37(1), 8–15. <https://doi.org/10.1027/1614-0001/a000182>

Dweck, C. (2012). *Mindset: Changing the way you think to fulfil your potential*. Random House.

Eurydice. (2018). *Home education policies in europe: Primary and lower secondary education. Eurydice report*. Publications Office of the European Union. <https://doi.org/10.2797/04352>

Farrington, C. A., Roderick, M., Allensworth, E., Nagaoka, J., Keyes, T. S., Johnson, D. W., & Beechum, N. O. (2012). *Teaching adolescents to become learners. The role of noncognitive factors in shaping school performance: A critical literature review*. University of Chicago Consortium on Chicago School Research.

Flunger, B., Trautwein, U., Nagengast, B., Lüdtke, O., Niggli, A., & Schnyder, I. (2017). A person-centered approach to homework behavior: Students' characteristics predict their homework learning type. *Contemporary Educational Psychology*, 48, 1–15. <https://doi.org/10.1016/j.cedpsych.2016.07.002>

Fong, C. J., & Kim, Y. W. (2019). A clash of constructs? Re-examining grit in light of academic buoyancy and future time perspective. *Current Psychology*. <https://doi.org/10.1007/s12144-018-0120-4>. Advance online publication

García, E. (2014). *The need to address noncognitive skill in the education policy agenda (EPI Briefing Paper No. 386)*. Economic Policy Institute.

García-Crespo, F. J., Fernández-Alonso, R., & Muñoz, J. (2019). Resilient and low performer students: Personal and family determinants in European countries. *Psicothema*, 31(4), 363–375. <https://doi.org/10.7334/psicothema2019.245>

Gillet, N., Morin, A. J., & Reeve, J. (2017). Stability, change, and implications of students' motivation profiles: A latent transition analysis. *Contemporary Educational Psychology*, 51, 222–239. <https://doi.org/10.1016/j.cedpsych.2017.08.006>

González, O., Canning, J. R., Smyth, H., & MacKinnon, D. P. (2020). A psychometric evaluation of the Short Grit Scale. *European Journal of Psychological Assessment*, 36, 646–657. <https://doi.org/10.1027/1015-5759/a000535>

Government of the Principality of Asturias (2018). <https://www.educastur.es/-/evaluacion-de-diagnostico-educacion-primaria-y-eso-2018-2019>

Grunschel, C., Patrzek, J., & Fries, S. (2013). Exploring different types of academic delayers: A latent profile analysis. *Learning and Individual Differences*, 23, 225–233. <https://doi.org/10.1016/j.lindif.2012.09.014>

Heckman, J. J., & Kautz, T. (2012). Hard evidence on soft skills. *Labour Economics*, 19, 451–464. <https://doi.org/10.1016/j.labeco.2012.05.014>

Howard, M. C., & Hoffman, M. E. (2018). Variable-centered, person-centered, and person-specific approaches: Where theory meets the method. *Organizational Research Methods*, 21(4), 846–876. <https://doi.org/10.1177/1094428117744002>

IBM Corp. (2016). *IBM SPSS statistics for windows, version 24.0 [Computer software]*.

Jiang, W., Xiao, Z., Liu, Y., Guo, K., Jiang, J., & Du, X. (2019). Reciprocal relations between grit and academic achievement: A longitudinal study. *Learning and Individual Differences*, 71, 13–22. <https://doi.org/10.1016/j.lindif.2019.02.004>

Kirchgasler, C. (2018). True grit? Making a scientific object and pedagogical tool. *American Educational Research Journal*, 55(4), 693–720. <https://doi.org/10.3102/0002831217752244>

Lanza, S. T., & Cooper, B. R. (2016). Latent class analysis for developmental research. *Child Development Perspectives*, 10, 59–64. <https://doi.org/10.1111/cdep.12163>

Lanza, S. T., Patrick, M. E., & Maggs, J. L. (2010). Latent transition analysis: Benefits of a latent variable approach to modeling transitions in substance use. *Journal of Drug Issues*, 40(1), 93–120. <https://doi.org/10.1177/002204261004000106>

Meyers, L. S., Gamst, G., & Guarino, A. J. (2016). *Applied multivariate research: Design and interpretation* (3rd ed.). Sage Publications.

Morales-Vives, F., Camps, E., & Dueñas, J. M. (2020). Predicting academic achievement in adolescents: The role of maturity, intelligence and personality. *Psicothema*, 32(1), 84–91. <https://doi.org/10.7334/psicothema2019.262>

Muthén, L. K., & Muthén, B. O. (2017). *Mplus user's guide* (8th edn.). Muthén y Muthén.

OECD. (2013). *Programme International for Student Assessment (PISA) 2012. Assessment and analytical framework: Mathematics, reading, science, problem solving and financial literacy*. OECD Publishing. <https://doi.org/10.1787/9789264190511-en>



- OECD. (2016). *Programme International for Student Assessment (PISA) 2015. Assessment and analytical framework: Science, reading, mathematics and financial literacy*. OECD Publishing. <https://doi.org/10.1787/9789264255425-en>
- OECD. (2019a). *OECD skills strategy 2019: Skills to shape a better future*. OECD Publishing. <https://doi.org/10.1787/9789264313835-en>
- OECD. (2019b). *Programme International for Student Assessment (PISA) 2018. Assessment and analytical framework*. OECD Publishing. <https://doi.org/10.1787/b25efab8-en>
- Park, D., Yu, A., Baelen, R. N., Tsukayama, E., & Duckworth, A. L. (2018). Fostering grit: Perceived school goal-structure predicts growth in grit and grades. *Contemporary Educational Psychology*, 55, 120–128. <https://doi.org/10.1016/j.cedpsych.2018.09.007>
- Pellegrino, J., & Hilton, M. L. (2012). *Education for life and work. Transferable knowledge and skills for the 21st Century*. National Research Council.
- Peña, P. A., & Duckworth, A. L. (2018). Economics of education review the effects of relative and absolute age in the measurement of grit from 9th to 12th grade. *Economics of Education Review*, 66, 183–190. <https://doi.org/10.1016/j.econedurev.2018.08.009>
- Postigo, Á., Cuesta, M., Fernández-Alonso, R., García-Cueto, E., & Muñoz, J. (2021). Temporal stability of grit and school performance in adolescents: A longitudinal perspective. *Psicología Educativa*, 27(1), 77–84. <https://doi.org/10.5093/psed2021a4>
- Postigo, Á., Cuesta, M., García-Cueto, E., Menéndez-Aller, Á., González-Nuevo, C., & Muñoz, J. (2020). Grit assessment: Is one dimension enough? *Journal of Personality Assessment*, <https://doi.org/10.1080/00223891.2020.1848853>. Advance online publication
- Richardson, M., Abraham, C., & Bond, R. (2012). Psychological correlates of university students' academic performance: A systematic review and meta-analysis. *Psychological Bulletin*, 138(2), 353–387. <https://doi.org/10.1037/a0026838>
- Robbins, S. B., Lauver, K., Le, H., Davis, D., Langley, R., & Carlstrom, A. (2004). Do psychosocial and study skill factors predict college outcomes? A meta-analysis. *Psychological Bulletin*, 130(2), 261–288. <https://doi.org/10.1037/0033-2909.130.2.261>
- Schmidt, F. T. C., Lechner, C. M., & Danner, D. (2020). New wine in an old bottle? A facet-level perspective on the added value of grit over BFI-2 conscientiousness. *PLoS One*, 15(2), Article e0228969 <https://doi.org/10.1371/journal.pone.0228969>
- Smithers, L. G., Sawyer, A. C. P., Chittleborough, C. R., Davies, N. M., Smith, G. D., & Lynch, J. W. (2018). A systematic review and meta-analysis of effects of early life non-cognitive skills on academic, psychosocial, cognitive and health outcomes. *Nature Human Behaviour*, 2, 867–880. <https://doi.org/10.1038/s41562-018-0461-x>
- Steinmayr, R., Weidinger, A. F., & Wigfield, A. (2018). Does students' grit predict their school achievement above and beyond their personality, motivation, and engagement? *Contemporary Educational Psychology*, 53, 106–122. <https://doi.org/10.1016/j.cedpsych.2018.02.004>
- Tang, X., Wang, M., Guo, J., & Salmela-Aro, K. (2019). Building grit: The longitudinal pathways between mindset, commitment, grit, and academic outcomes. *Journal of Youth and Adolescence*, 48, 850–863. <https://doi.org/10.1007/s10964-019-00998-0>
- Tang, X., Wang, M. T., Parada, F., & Salmela-Aro, K. (2021). Putting the goal back into grit: Academic goal commitment, grit, and academic achievement. *Journal of Youth and Adolescence*, 50, 470–484. <https://doi.org/10.1007/s10964-020-01348-1>
- Usher, E. L., Li, C. R., Butz, A. R., & Rojas, J. P. (2019). Perseverant grit and self-efficacy: Are both essential for children's academic success? *Journal of Educational Psychology*, 111(5), 877–902. <https://doi.org/10.1037/edu0000324>
- Vermunt, J. K., & Magidson, J. (2002). *Latent class cluster analysis*. In J. Hagenars, & A. McCutcheon (Eds.), *Applied latent class analysis* (pp. 89–106). Cambridge University Press.
- Vigil-Colet, A., Navarro-González, D., & Morales-Vives, F. (2020). To reverse or to not reverse Likert-type items: That is the question. *Psicothema*, 32(1), 108–114. <https://doi.org/10.7334/psicothema2019.286>
- West, M. R., Kraft, M. A., Finn, A. S., Martin, R. E., Duckworth, A. L., Gabrieli, C. F., & Gabrieli, J. D. (2016). Promise and paradox: Measuring students' non-cognitive skills and the impact of schooling. *Education Evaluation and Policy Analysis*, 38(1), 148–170. <https://doi.org/10.3102/0162373715597298>
- Yeager, D. S., & Dweck, C. (2012). Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational Psychologist*, 47(4), 302–314. <https://doi.org/10.1080/00461520.2012.722805>
- Yeager, D. S., Romero, C., Paunesku, D., Hulleman, C. S., Schneider, B., Hinojosa, C., O'Brien, J., Flint, K., Roberts, A., Trott, J., Greene, D., Walton, G. M., & Dweck, C. (2016). Using design thinking to improve psychological interventions: The case of the growth mindset during the transition to high school. *Journal of Educational Psychology*, 108(3), 374–391. <https://doi.org/10.1037/edu0000098>