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A cross-cultural investigation on perseverance, self-regulated learning, motivation, and achievement

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ABSTRACT

Research on grit indicates that perseverance positively predicts academic achievement. Yet, the mechanisms through which perseverance might lead to academic success remain less explored, particularly in cross-cultural research. The current study investigated such mechanisms by examining possible mediating effects of students' use of self-regulated learning strategies (control, memorisation, and elaboration) on the predictive relation of students' perseverance on their academic achievement, in students from East Asian and Anglo-Saxon English speaking Western countries. The sample came from the OECD PISA study and included 24,352 population-representative 15-year-old students from Hong Kong, the Republic of Korea, Australia, New Zealand, Scotland, and the US. Results revealed that perseverance had a more positive association with achievement in East Asian cultures than Western cultures. Control strategy was stronger positive mediators of achievement in Western countries, whereas memorisation and elaboration strategy use and instrumental motivation more negatively mediated the effect of perseverance on achievement in Western countries.

1. Introduction

Duckworth et al. (2007) have defined grit as trait-level passion, perseverance of effort (PE), and consistency of interests (CI) needed to attain long-term goals, and showed that grit is a powerful predictor of achievement outcomes. Although the construct of grit is multi-dimensional (Guo, Tang, and Xu 2019), including both PE and CI (Datu, Yuen, and Chen 2018), it has been shown in recent meta-analyses (Credé, Tynan, and Harms 2017) that PE is a stronger predictor of achievement compared to CI. Credé, Tynan, and Harms (2017) suggested the PE facet of grit as the 'most promising avenue of future research' (p. 12). Indeed, being perseverant has also been studied as a character strength in relation to academic achievement among middle school students (Seider et al. 2013.

More recent research also showed the association between perseverance and achievement (Bettinger 2018; Xu et al. 2020). In the current study, we therefore focused on PE (from hereon referred to as perseverance).

Until recently, extensive research on achievement and grit has been based on samples from Western countries (Credé, Tynan, and Harms 2017). However, there has been an increase in research conducted among Asian students, for example on student emotion and wellbeing (Datu et al. 2019), and academic achievement (Jiang et al. 2019). While meta-analytic research based on primarily western student samples has indicated a positive association between the perseverance dimension of the grit construct and achievement in particular, research is still relatively limited in terms of the role of grit in achievement from East Asian countries. It is possible that culture plays a role in the development of grit and how it is associated with achievement-related outcomes (Li 2012). It appears that none of the empirical studies that simultaneously included various countries would enable researchers to determine both the culturally-universal and culturally-specific relations of grit to academic achievement.

Although perseverance has been shown to predict academic achievement (Duckworth et al. 2007), the process underlying this relation is relatively under-investigated. It has been suggested that dispositional traits such as perseverance are likely to enact coherent, goal-directed, achievement striving behaviours that naturally promote learning and achievement (Poropat 2009), for example planning and using learning strategies (Bidjerano and Dai 2007). To this end, self-regulated learning (SRL) strategies are highly relevant mediating variables that serve as plausible mechanisms through which grit influences achievement (Wolters and Hussain 2015).

The grit construct is hypothesised to be distinct from the personality trait conscientiousness in that it emphasises 'stamina' and 'long term goals' (Duckworth and Quinn 2009). This is also in line with the finding that grit could predict achievement beyond and above conscientiousness in multiple diverse samples (Duckworth et al. 2007; Duckworth and Quinn 2009). However, the two also share considerable overlap in that they emphasise hard-work, self-discipline/organisation and achievement striving. Consistent with this, it has been shown that conscientiousness substantially correlates with the grit perseverant aspect (r = 0.83 for perseverance, r = 0.61 for consistency of interest, Credé, Tynan, and Harms 2017). It is thus plausible that constructs that explain the relationship between academic achievement and conscientiousness (e.g. SRL) also function in similar ways for perseverance. Hence, in the current study we consider relevant literature based on both grit-perseverance and conscientiousness.

The present study examines how perseverance might affect achievement through possible mediating mechanisms via self-regulated learning (SRL) strategy and motivation, using large, population representative, cross-cultural (East Asian and Western countries) data of 24,447 15-year-olds from the OECD PISA data.

1.1. Grit and self-regulated learning strategy use

Self-regulating pupils display a high level of autonomy in their learning and are able to control and monitor motivational, cognitive, and behavioural aspects of the learning process (Zimmerman 2002). It has been suggested that individuals' personality traits might consistently influence the way information is processed, thus forming specific

learning behaviours (Messick 1984). Further, there is strong evidence showing positive associations between SRL and academic performance (Dignath, Büttner, and Langfeldt 2008). Based on this it seems plausible that SRL may serve as a mediator of the effect of pre-existing individual differences among students, such as dispositions on academic performance (Pintrich 2004).

In personality literature, conscientiousness has been particularly linked to SRL strategy use (e.g. Bidjerano and Dai 2007; Geisler-Brenstein, Schmeck, and Hetherington 1996), given the consistent positive association of conscientiousness with achievement. Conscientious individuals have innate achievement motivation and are self-disciplined, and therefore it is expected that they are more likely to use SRL strategies in order to enhance their learning performances and achieve their goals (Chamorro-Premuzic and Furnham 2003).

Previous studies in personality (Komarraju et al. 2011; also see Wolters and Hussain 2015) examining the mediating effect of SRL in the pathway of conscientiousness/grit to achievement, showed that the effect size of conscientiousness on achievement was reduced after controlling for SRL as a predictor. In a study based on a sample of college students, Bidjerano and Dai (2007) reported that effort regulation (ability to deal with setback and failure and invest effort to unsuccessful tasks, and a component of SRL), mediated the effect of conscientiousness on achievement measured by grade point average (GPA). Eilam, Zeidner, and Aharon (2009) found that a composite measure of SRL (self-reported strategy use and associated relevant learning modes) partially mediated the effect of conscientiousness on GPA in a small sample of junior high school students. The only study we are aware of that studied the mediating effect of grit was based on a moderately-sized sample of American college students. In this study, Wolters and Hussain (2015) reported that the perseverance facet of the grit scale positively predicted all indicators of SRL, and that SRL, in particular time and study environment management strategies, fully mediated the effect of perseverance on self-reported GPA.

Furthermore, self-efficacy and value are also integral parts of SRL, with value referring to interest, importance and usefulness (Wigfield and Cambria 2010). The activation and execution of SRL both require and reciprocally relate to motivation (Zimmerman, Schunk, and Dibenzedetto 2017). Hence, it is also important to control for motivation when investigating the indirect relationship between grit and achievement via SRL strategy use. Wolters and Hussain (2015) controlled for self-efficacy and value when looking at the mediation effect of strategy use on the effect of perseverance on self-reported GPA. However, their study used an overall measure for cognitive strategy use instead of looking at the effect of specific strategy use separately, and the outcome measure was based on school grades rather than objective achievement test scores.

From the above discussion it becomes clear that several aspects remain unexplored in prior research. In particular, the mediating effect of learning strategy use (e.g. memorisation, elaboration, and control) remains understudied. This information is important to understand how different strategies might mediate the process of perseverance on achievement. Furthermore, existing studies have mostly used convenience samples with course grades or GPA measures. It would be stronger to use population-based samples based on objective achievement measures such as those offered by the PISA OECD, which is the basis for the current investigation. Lastly, the existing research primarily used student samples from Western cultures to study the mediating effect of

SRL strategy in relation to perseverance and achievement. However, there can be distinct differences across cultures. Below, we elaborate on cultural perspectives.

1.2. Cross-cultural comparison: Western and East Asian cultures

Recent research has shown that the perseverance dimension of grit is psychometrically comparable across diverse cultures (Disabato, Goodman, and Kashdan 2019), thus providing a sound measurement basis to explore further relationships with other constructs. In the context of learning and achievement related outcomes, the perseverance aspect of grit is a particularly interesting construct for cross-culture examination. Some studies suggested that effort and perseverance may have different meanings across cultures. In the East, especially in Confucian heritage cultures, effort has a strong moral significance (Li 2004, 2006). Demonstrating high levels of perseverance is deemed a sign of moral virtue, and students are expected to exert high levels of effort in order to fulfil their moral obligation to their parents (Salili 1996). Cross-cultural differences have also been shown in research related to attributions as studies have shown that East Asian students are more likely to attribute their success/failure to effort while Western students are more likely to attribute theirs to ability (Stevenson and Stigler 1992).

In terms of association with other constructs, Disabato, Goodman, and Kashdan (2019) measured grit across six continents, and found that perseverance positively predicted well-being across diverse cultures. In terms of academic achievement, other studies in non-Western contexts also found that the perseverance dimension of grit is a positive predictor of achievement and optimal learning-related outcomes (Datu et al. 2019; Li et al. 2018). However, to our knowledge little research has simultaneously assessed grit and analysed its relationships with achievement from multiple cultures.

Aside from the cultural differences regarding grit or more specifically the perseverance dimension, the effect of students' self-regulation on academic performance may also be subject to cultural influences, given that the social-cognitive theory of SRL emphasises social modelling and feedback (McInerney and King 2017). In particular, relevant cultural differences have been reported regarding the use of specific SRL strategies such as memorisation, which has been found to be negatively related with achievement in Western cultures (McInerney 2011). However, in East Asian contexts, this pattern does not seem to hold (Watkins 2000). When considered from a culturally-nuanced perspective, categorising memorisation as a surface learning strategy that is maladaptive seems to be too simplistic (Chiu, Chow, and Mcbride-Chang 2007; Purdie and Hattie 1996). Research is not clear on whether Asian students use memorisation more than Westerners with some studies reporting that Asians do not use memorisation any more than non-Asians (e.g. Chiu, Chow, and Mcbride-Chang 2007) and other studies showing a greater reliance on memorisation among Asians (e.g. Purdie and Hattie 1996). What seems clear, however, is that memorisation is not necessarily harmful for East Asian students and it has been more strongly associated with deep instead of surface approaches to learning (Purdie and Hattie 1996). Furthermore, some learning strategies, such as control strategy use, are known to positively associate with achievement while others, such as elaboration and memorisation, are less consistent or even negatively associated with achievement (Richardson, Abraham, and Bond 2012).

The effect of motivation on achievement is also subject to cultural variations (King and McInerney 2014, 2016a). Studies have shown that, although certain motivational orientations may be considered maladaptive in the West (e.g. performance-avoidance which involves avoiding showing others one's lack of competence, seeking for social approval, obeying authority figures, and fulfiling social obligations), they are not always maladaptive in Asian cultures (Cheng and Lam 2013; Tao and Hong 2014). These differences have been attributed to cultural variations in individualistic Western versus more collectivistic East Asian cultures. In collectivist contexts, the distinction between self and significant others is not that sharp. This makes collectivist students experience extrinsic types of motivation (e.g. instrumental motivation) which are rooted in the expectations of significant others to be more internalised. For example, a student may internalise an external goal such as gaining a college degree in order to obtain a prestigious job when it is expected by the parents. This can account for why extrinsic types of motivation share a large overlap with more intrinsic types and why extrinsic motivational orientations are not necessarily maladaptive in East Asian contexts (Cheng and Lam 2013; Tao and Hong 2014).

Not all types of motivation, however, show cultural variability. The predictive effect of self-efficacy on achievement seems to be culturally universal. Numerous studies in both Western (Caprara et al. 2011; Joët, Usher, and Bressoux 2011) and non-Western contexts (Kim et al. 2015; Wang et al. 2013) have shown that self-efficacy is positively associated with academic outcomes.

In sum, the above reviewed literature suggests that cultural differences are likely to exist in terms of perseverance, motivation, and SRL. Nevertheless, the reviewed studies focused primarily on samples from a single culture rather than using comparable samples from different cultures measured with the same measurement instrument. Furthermore, no previous study to our knowledge has examined cross-cultural differences in the mediating effect of motivation and SRL on the association between perseverance and learning. The current investigation aims to examine cross-cultural comparisons of the learning process proposed in the mediational (indirect effect) model of perseverance, SRL, and achievement, using population-representative samples drawn from the Programme of International Student Assessment (PISA) study. We hypothesise that the use of SRL strategy variables will explain the effect of perseverance on academic achievement, and that these effects will vary by culture.

2. Method

2.1. Sample

For the present study, the OECD PISA 2000 data was used (Adams and Wu 2002). We chose PISA 2000 as the basis of our study, because this is the only wave that includes both data on perseverance and subject-general SRL, which enables examination of association with achievements in maths, science, and reading. The PISA 2000 study collected data from more than 127,000 15-year-old students from 43 different countries. For cultural comparisons (Western vs. East Asia), we selected Western countries based on their shared Anglo-Saxon cultural background as well as the homogeneity of the English language spoken and East Asian countries stemming from the mutual

culture background in Confucianism (there were no East Asian countries in the PISA study with the same language). In such case, *only* four English-speaking Western culture countries (US, *n* = 3845; New Zealand, *n* = 3650; Australia, *n* = 5140; and Scotland, *n* = 2336) and two East Asian countries (Hong Kong, *n* = 4405 and the Republic of Korea, *n* = 4976) matched the selection criterion in PISA 2000 data. Therefore, in the present study, the target population comprised 15-year-old students who participated in PISA 2000 from the six countries described above. In total, the study included data from 24,388 students (49 % girls; see Table S1 for more information on gender distributions across countries).

2.2. Measurement

For the present analysis, the following six constructs from the PISA were utilised: perseverance, control strategies, memorisation strategies, elaboration learning strategies, instrumental motivation, and self-efficacy. The values of students' responses were based on latent factor scale scores from the PISA dataset derived from item response theory analysis using Weighted Likelihood Estimator (Adams and Wu 2002). All constructs were measured on a 4-point Likert scale ranging from *almost never* to *almost always* (see Table S1 for construct reliability measured by Cronbach's alpha ranging between 0.73 and 0.85). We also calculated Omega coefficients which range between 0.79 and 0.86 across all scales.

The scales used in the current study were part of the constructs measured in the PISA 2000 assessment framework (Baumert et al. 1998). These constructs are closely linked to various desirable academic outcomes and have sound psychometric properties (Baumert et al. 1998; Marsh et al. 2006; Peschar and Waslander 1997). In particular, these instruments have been subject to extensive selection and pilot testing procedures by PISA. Marsh et al. (2006) psychometrically evaluated and validated these constructs in the PISA 2000 across all 23 participating countries from 107,899 students. These constructs have shown good psychometric properties and comparability across diverse cultures and therefore can serve as a standard set of instruments for assessing students' academic-related psychological traits.

2.2.1. Perseverance

Perseverance in the PISA study was measured with four items specific to learning (e.g. 'I keep working even if the material is difficult', 'I work as hard as possible.', 'I try to do my best to acquire the knowledge and skills taught.', 'I put forth my best effort.'). These items' wordings are comparable to the perseverance item wordings in the Duckworth Grit scale and in particular the Short Grit Scale (Duckworth et al. 2007; e.g. 'am a hard worker', 'Setbacks don't discourage me'), as well as other scales which have been used to measure perseverance such as the Values in Action Strength Survey (Peterson and Seligman 2004; e.g. 'I am a hard worker', 'Whenever I do something, I put all my effort into it'; Usher et al. 2018).

2.2.2. SRL strategies

For students' control strategies, there were five items (e.g. 'I start by figuring out exactly what I need to learn.'). The memorisation construct (e.g. 'I try to memorise everything

that might be covered.') and the elaboration measure (e.g. 'I try to relate new material to things I have learned in other subjects.') each contained four questions

2.2.3 Self-efficacy and instrumental motivation

The instrumental motivation index was based on three items regarding students' reports on how often they study to insure future career and financial success (e.g. 'I study to increase my job opportunities.'). Self-efficacy was measured by three items (e.g. 'I'm certain I can understand the most difficult material presented in texts.').

2.2.4. Academic achievement

Academic achievement in the PISA data was based on five *plausible values* with OECD mean = 500, standard deviation = 100 (Von Davier, Gonzalez, and Mislevy 2009). Plausible values more accurately reflect the underlying latent construct (i.e. academic ability) as this approach takes into account measurement errors. Since correct analysis of the plausible values requires all measures to be taken into account and summarised through appropriate formulae (OECD 2009a), the present study complies with the corresponding procedures in all aspects of the data analysis by using the TYPE = IMPUTATION in Mplus (Muthén and Muthén 2015).

Internal consistency and means of the scales included in the current study were presented in Table S1 for each country. In terms of effect size estimation from regression analysis, all measures except for achievements were standardised to have a mean of zero and standard deviation of 1 across all participants included in the present study. This approach preserves mean differences between countries but still creates a comparable metric of variance. Thus, a regression coefficient of 50 would indicate that for one standard deviation increase in the predictor variable, there is an increase of 50 points in the achievement score. Since the achievement scores have already been standardised by OECD to be on a metric of a mean of 500 and a standard deviation of 100, a regression coefficient of 50 would correspond to a change of half of a standard deviation. We chose to construct the effect size in this way, because it is more easily interpretable in the metric of the outcome variable under investigation.

2.3. Analysis

All analyses were conducted in statistical software Mplus 7.4 (Muthén and Muthén 2015). Due to the complex sampling design procedure (OECD 2009b), a complex design option in Mplus was utilised (TYPE = COMPLEX) to take into account the effect of school clustering (Stapleton 2006). Sampling weight was incorporated in the analysis, consistent with previous studies based on the PISA database (Nagengast et al. 2011).

2.3.1. Missing data

There are small percentages of missing data across all constructs (less than 5%). About half of all participants were not assessed for mathematics and science achievement, but this missingness was randomised (Adams and Wu 2002) or Missing Completely at Random (MCAR). According to Rubin's framework of missing data mechanisms (Rubin 1976), if the missing data is MCAR, then a wide range of analyses derived from the observed data are unbiased under this assumption. Furthermore, in the present study

we used a robust maximum likelihood estimator, which is a form of full information maximum likelihood and a recommended approach for dealing with missing data under less ideal conditions (Schafer and Graham 2002; West 2001).

2.3.2. Mediation (indirect effect) analysis and cross-cultural comparison

Based on the Sobel method (Hayes 2009; Sobel 1986), mediation (indirect) effects were also derived in terms of the total effect of perseverance on achievement and the total and specific indirect effects specific to each mediator. Analysis based on the whole sample included dummy variables to account for country specific effects, with the US as the reference group. To calculate the mediation (indirect) effects for cross-culture comparison, Western and East Asian countries were separated into two groups accordingly as the basis of the analysis. With this approach, regression parameters within each country were estimated, then cultural specific aggregation statistics were calculated and used to estimate the total and indirect effect for each culture group using MODEL CONSTRAINT function in Mplus.

Furthermore, multiple group measurement invariance analysis was conducted and showed that measurements of the constructs used in the present study are indeed comparable across cultures. The results are presented in online supplement A (https://osf.io/8wbxy).

3. Results

3.1. Descriptive statistics

Correlation matrices of achievement, SRL strategies, and motivation variables are presented in Table S2 for across all countries and for each individual country in online supplement (Table S3, https://osf.io/8wbxy). Both overall and for each country separately (Table S3), perseverance was highly correlated with control, memorisation and elaboration strategies (with overall correlations of 0.79, 0.61, and 0.68, respectively). Perseverance was also positively and significantly correlated to self-efficacy (0.57 overall) and instrumental motivation (0.63 overall). The correlation between perseverance and instrumental motivation was stronger in Western countries (between 0.51 to 0.63) than in East Asian countries (Hong Kong: 0.32; Korea: 0.37), with the cultural difference being statistically significant ($t = 46.31$, $p < 0.01$). Perseverance was moderately correlated with achievement (between 0.10 to 0.15 across all countries). For the East Asian countries, however, perseverance was more strongly correlated to the achievement variables across the three subjects (0.23 to 0.25 for both Hong Kong and Korea) than in the Western countries (values between 0.09 and 0.16). The cultural differences of the correlations were statistically significant for maths achievement ($t = 3.66$, $p < 0.01$), science achievement ($t = 2.05$, $P < 0.01$), as well as for reading achievement ($t = 2.058$, $p = 0.04$).

3.2. Perseverance, SRL, and achievement

Based on samples from all countries, four regression models were estimated to evaluate the effect of a sequential set of predictors on achievement in reading (Table S4). Model 1 assesses the effect of perseverance on achievement without controlling for SRL strategies

or motivation. Models 2 and 3 test the predictive effect of SRL and motivation separately. Model 4 includes perseverance, SRL, and motivation as predictors of achievement.

Results of Model 1 indicated that perseverance was a significant predictor on achievements in reading. Both SRL strategy use (Model 2) and motivation (Model 3) were significant predictors of achievement, but in both models perseverance no longer predicted achievement. This indicates a mediation (indirect) effect since including SRL or motivation variables completely accounted for the direct effect of perseverance on achievement as shown previously in Model 1. Specifically, there were substantial and positive effects for control strategies (33.74, Model 2) and self-efficacy (29.29, Model 3), and moderate negative effects for memorisation (−18.69, Model 2) and instrumental motivation (−11.75, Model 3). In Model 4, both SRL and motivation predictors were included in the same analysis. The pattern of effects remained similar to those seen in Models 2 and 3. Elaboration strategy, on the other hand, had a small but negative effect. The effect of perseverance remains insignificant.

3.2.1. Culture specific effects

To assess cultural differences, multiple group analysis of Model 4 was carried out to investigate cultural specific effects of the association between perseverance, SRL, and achievement (Table 1). The country-average effect of perseverance on achievement was not significant for any of the three school subjects (All column, Table 1). Closer examination of cultural specific effects showed that this was actually masked by a negative effect in Anglo-Saxon countries (−5.14; Anglo-Saxon column, Table 1) while there was a non-significant effect in East Asian countries (East Asia column, Table 1).

In terms of SRL strategy use variables, control strategy use had a large positive effect on achievement in all domains (All column Table 1), but this was primarily driven by the large positive effect specific to the Anglo-Saxon countries (Anglo-Saxon column, Table 1). The cultural specific differences in effects of control strategy were −17.32 indicating that the use of the control strategy for a student from East Asian countries may not be as effective as for their counterpart from a Western country. Memorisation on average had a negative effect on achievement but the effect was less strong in East Asian countries than in Western countries (with cultural differences of 12.60 for reading, Difference column, Table 1). There was also a rather large cultural difference in terms of the effect of elaboration strategy use. There were small positive effects in East Asian countries (5.44, Table 1) whereas the effects were negative in Anglo-Saxon countries (−10.38, Table 1). Further analyses (Table S5)

Table 1. Culturally specific effects of SRL variables on achievement.

| | Reading | | | | | | | |
| | All | | East Asia | | Anglo-Saxon | | Difference | |
	Est	SE	Est	SE	Est	SE	Est	SE
Intercept	**511.68**	2.13	**522.24**	3.41	**501.12**	2.47	**21.11**	4.15
Gender	**24.29**	2.23	**15.40**	3.64	**33.18**	2.48	**−17.78**	4.36
Perseverance	−1.51	1.09	2.13	1.43	**−5.14**	1.72	**7.28**	2.28
Control Strategy	**22.14**	1.22	**13.48**	1.67	**30.80**	1.73	**−17.32**	2.39
Memorisation	**−9.53**	0.95	**−3.23**	1.23	**−15.83**	1.40	**12.60**	1.82
Elaboration	**−2.47**	1.02	**5.44**	1.36	**−10.38**	1.46	**15.82**	1.94
Instr Motivation	**−1.77**	0.88	1.99	1.03	**−5.54**	1.30	**7.53**	1.55
Self-efficacy	**16.62**	0.93	**6.65**	1.30	**26.59**	1.44	**−19.94**	2.02

Values in bold have a statistical significance of p < 0.05.

based on results from individual countries showed that, whereas for Hong Kong students the effects were not significant, for Korean students there were rather consistently large positive effects of elaboration strategy use (15.01 for reading, Table S).

There were also large cultural differences in terms of the effect of self-efficacy on achievement (a difference of 19.94 points in reading Difference column, Table 1). The effects were small yet still positive in East Asian countries (6.65; Table 1) but much larger effects were observed in Anglo-Saxon countries (26.59, Table 1). Instrumental motivation did not predict achievement in East Asian countries, while there were small but negative effects in Anglo-Saxon countries (−5.54, Table 1).

3.3. Mediation (indirect effect) analysis

Based on the same multiple group analysis results, we formally tested mediation effects regarding the full sample as well as cross-cultural specific effects (Table S6).

3.3.1. The total effects of perseverance on achievement
There was positive total effect of perseverance on achievement in both cultures (18.93 in East Asian countries and 14.64 in Anglo-Saxon countries). The overall total effects were stronger in East Asian countries than in Anglo-Saxon countries (4.29, Difference column, Table S6). Since cultural specific differences in the indirect effects of perseverance on achievement were non-significant, the difference in total effect was mainly a result of the negative direct effects of perseverance in Anglo-Saxon countries as compared to non-significant or positive effects in East Asian countries.

3.3.2. Total and specific indirect effects
The total indirect effect of perseverance on achievement was positive for both East Asia (16.79) and Anglo-Saxon countries (19.78). In terms of cross-cultural differences, although the differences in total indirect effects were non-significant between cultural groups, a closer examination of specific indirect effects revealed that there were different effect sizes associated with each mediator. Control strategy and self-efficacy had relatively large positive indirect effects for Anglo-Saxon countries but the magnitude was much smaller in East Asian countries (see 'Specific indirect effect' section, Table 3). On the other hand, memorisation and elaboration, as well as instrumental motivation, had negative indirect effects on achievements in Western countries. Nevertheless, the effects of these three variables were much smaller in magnitude (memorisation), non-significant (instrumental motivation) or even positive (elaboration) in East Asian countries.

All results were also comparable across achievements in mathematics, and science (corresponding results presented in online supplement Tables S7-S10 downloadable from https://osf.io/8wbxy).

4. Discussion

Previous research has demonstrated that perseverant students are more likely to achieve better academic outcomes (Credé, Tynan, and Harms 2017; Richardson, Abraham, and Bond 2012). The current study examined this across six countries in Western and East Asian cultures, investigating how the effect perseverance has on achievement may be

mediated by SRL and motivation. Findings indicate that for students from both East Asian and Western countries, motivation to learn and SRL strategy use serve as mediating pathways through which perseverance impacts achievement. These effects are similar across maths, reading, and science.

Perseverance and achievement had a strong positive correlation across all samples, and this relationship is stronger in Asian countries compared to Western countries, confirming the hypothesis that perseverance may be more positively associated with achievement for East Asian students. This is likely due to their attribution of success to effort (Datu, Yuen, and Chen 2016; King and McInerney 2016b) rather than innate ability, as their Western counterparts do (Stevenson and Stigler 1992).

Nevertheless, when controlling for SRL strategy use and motivation constructs, there was a negative association between perseverance and achievement for Western students. This finding aligns with research conducted on Western students, suggesting that sometimes spending too much time studying is not considered effective learning (Elliot and Murayama 2008). The phenomenon regarding effort has been coined as a 'double-edge sword' (Marsh et al. 2016) such that when taking into account prior motivation and achievement, effort has a negative effect on subsequent performance and motivation. Marsh et al. (2016) demonstrated with longitudinal data that while it is expected that effort investment leads to better achievement, it is also associated with a negative effect on motivation, in particular self-evaluation of one's ability and consequently one's subsequent achievement. The negative effect of perseverance on achievement in Western students, after controlling for both SRL and motivation, is consistent with the previous finding. It is likely due to the possibility that Western students tend to attribute school success and failure to ability rather than effort. This mindset can very easily influence students to refrain from investing effort in order to protect their self-esteem. And when they do, there is a damning effect on their self-worth (Covington 1998).

However, it is important to note that the zero-order correlations showed positive associations with motivation and SRL strategy use variables. The finding of a negative association only emerges after controlling for motivation and SRL strategy use. Thus, the negative effect observed in the current study does not contradict previous literature where there is often a positive association between perseverance and achievement (Credé, Tynan, and Harms 2017; Richardson, Abraham, and Bond 2012). To a large extent the present study showed consistent findings with previous research in that there is a substantial and positive mediation (indirect effect) effect between perseverance and achievement, through motivation and SRL.

When controlling for SRL strategy use and motivation constructs, the strength of the relationship between perseverance and achievement decreased and became statistically insignificant in the whole sample, indicating the presence of a complete mediation. This is in agreement with the previously discussed literature (Wolters and Hussain 2015). However, there were marked culturally specific differences in such effects. The effect of control strategy being weaker in Asian countries, may be due to the possibility that East Asian culture students are not encouraged as much to engage in certain control strategies such as '[when] I don't understand something I look for additional information to clarify this'. The curriculum and teachers may be more rigid, adopting only more traditional classroom approaches. East Asian students also tend to display very high levels of respect for their teachers, following what they are instructed to do (Kim 2005). For example, in

a study comparing American students of Caucasian and Korean background, Jung and Stinnett (2005) reported that in comparison to American students, Korean pupils behave in a less self-reliant manner. Thus, such factors may decrease the likelihood of students utilising control strategies.

Memorisation strategy use was negatively related to achievement across subjects, although the effect was stronger among Western students compared to East Asian students. This finding is in line with previous studies which found that memorisation strategies seemed to be more detrimental for achievement for Western students, comparatively to Asian students (McInerney 2011; Purdie and Hattie 1996). A study conducted by Dahlin and Watkins (2000) found that Asian students couple memorisation or repetition with 'attentive effort' which led students to discover new meanings in the material studied. It may be the case that East Asian students engage in a mild form of memorisation even for subjects such as mathematics and science. For example, students are often not allowed access to formula sheets during mathematics exams. As such, all formulae need to be memorised which may be beneficial for learning complex mathematics materials. This may be reflected in the less negative effect of memorisation on achievement for mathematics and possibly science. Correspondingly, House (2006) revealed that Japanese students showed higher beliefs that mathematics achievement is related to text book or note memorisation than American students, and this belief was also positively related to higher achievement test scores. As such, memorisation might be more useful for maths across East Asian students than for Western culture students.

Interestingly, elaboration, which is considered a deep-level approach to learning (Karpicke, Lehman, and Aue 2014), was a negative predictor of achievement across subjects for Western countries. The only exception to this was for Korean students, where elaboration positively predicted achievement in all subjects. It is possible that this is due to the way the elaboration strategy was assessed in PISA. For example, two items were worded 'I try to relate new material to things I have learned in other subjects' and 'I figure out how the information might be useful in the real world'. As much as this still reflects a positive interest in general learning, such learning preferences might impede deep learning of course materials. Further research is required to rule out that this is not a chance finding for Korean students.

Regarding motivation, the effect of instrumental motivation was a negative predictor of achievement across all subjects in Western countries. However, it was not associated with achievement in East Asian countries. This is in agreement with previous literature which suggests that extrinsic motivation, such as instrumental motivation, is less detrimental for students in East Asian cultures. The present findings demonstrated that self-efficacy was a positive predictor of achievement adjusting for perseverance and SRL strategy use. The effect was similar across subjects but was stronger for Western students. The positive association between self-efficacy and achievement indicates the universal importance of self-efficacy beliefs.

4.1. Strengths and limitations

The present study provides several key contributions to the literature. Using population based, large samples of secondary school students, the present enables the result to be interpreted with strong validity and generalisability. Additionally, results were based on

academic achievement rather than on self-reported expected grades as in previous studies (Wolters and Hussain 2015). The current study also examined facets of SRL strategy use and task value more specifically instead of combining effects of constructs which may have opposite effect directions.

We compared cross-subject relationships in mathematics, reading, science, and assessed cross-cultural differences in East Asian and Western students. Both cross-subject and cross-cultural research has been identified as some of the most important research gaps needing to be addressed in current motivational research (Dweck and Master 2008; Graham and Weiner 2012; Schunk 2005).

The present investigation included gender as the only control variable. As gender has been previously shown to be a potential variable of measurement bias in attitudinal and belief constructs (Beyer and Bowden 1997; Xu et al. 2017, 2018), we performed a sensitivity analysis to assess whether measurement properties of the motivation and self-regulated learning variables were stable across gender groups. We found the factor loadings and item intercepts of all constructs hold equal across male and female participants thus ensuring that the results are consistent across gender groups in terms of measurement confound (detailed results are available from the first author upon request).

It is also important to further examine other psychological constructs that share close resemblance and relevance to grit. There is shared aetiology between grit and personality traits such as conscientiousness (Rimfeld et al. 2016). In particular, the effect of grit on achievement could be accounted for by self-control (see also Vazsonyi et al. 2019; Xu et al. 2013) and conscientiousness (Muenks et al. 2017; Schmidt et al. 2017). In order to better differentiate the unique effect of grit, it is important for future research to include measurements of conscientiousness and self-control. Similarly, future research can also benefit from better control of background variables by including measurements on well-known factors linked to academic achievement such as general intelligence (Lounsbury et al. 2003) and socioeconomic status (Sirin 2005).

Although the findings are limited in terms of the cross-sectional nature of the data, perseverance is a personality-like trait and is therefore likely to remain a stable predictor of SRL and achievement in longitudinal settings. Future studies with a longitudinal study design are needed to further confirm the relationship between these constructs. In particular, the mediational (indirect) effect examined in the present investigation is limited by the cross-sectional nature of the PISA data. Future replication research in longitudinal settings will provide stronger inference in terms of the causal ordering of the constructs under investigation. Furthermore, the reliance on self-reported data also increased potential common method bias as a result. Future research aiming to verify our findings can benefit from using objective measures (e.g. computer log files indicating SRL). Lastly, the consistency of interest dimension of the grit construct, was absent from the present investigation. Future research can further contribute to cross-cultural literature by examining both dimensions of grit.

4.2. Future research directions

The present study focused on observing differential effects of perseverance and SRL strategies. In future studies, it would be interesting to explicitly measure the potential source of cultural differences. For example, values and beliefs related to Confucianism,

which have a profound influence in East Asian countries such as China, Korea and Japan (Datu, Yuen, and Chen 2016; Tu 1990). Confucian values downplays the role of innate characteristics such as more genetically determined talent and emphasise the role of effort in learning and in improving oneself (Li 2005). Such values foster an approach towards learning based on mastery, which emphasises effort and hard work (King and McInerney 2016b). In contrast, students from Western cultural contexts may be more likely to attribute academic success or failure to innate abilities and disabilities (Stevenson and Stigler 1992); thus less emphasis is placed on perseverance. It has been suggested that in Western society, studying for too long to outperform classmates is even considered a maladaptive approach to learning (Elliot and Murayama 2008). These culturally relevant differences may render perseverance a less salient predictor of achievement in Western cultures compared to East Asian cultures. Future studies can measure these value beliefs to further the understanding of the differences observed in the current study.

Disclosure statement

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