

# A moderated mediation analysis of conscientiousness, time management strategies, effort regulation strategies, and university students' performance<sup>☆</sup>

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## ABSTRACT

This paper examined the interplay of conscientiousness, two categories of learning strategies (i.e., time management and effort regulation), and academic performance in higher education. Based on data from two samples of first-year students ( $N_1 = 106$ ;  $N_2 = 355$ ), we aimed to validate previous results on a mediation model using a repeated measurement design. Second, we aimed to extend prior research by testing the hypothesis that the mediation process is conditional on the level of conscientiousness. Results of both studies indicate that the effect of conscientiousness on academic performance is mediated by using effort regulation strategies and time management strategies. Furthermore, for effort regulation strategies, the effect is moderated: the effect vanishes when conscientiousness is low (though this effect occurred only in Study 2). This study sheds light on the mechanisms through which both conscientiousness and the use of relevant learning strategies affect academic performance and implies practical applications to assist with greater achievement in higher education.

## 1. Introduction

Even if the global figures on enrolment rates show that universities and colleges nowadays count more first-year students than ever (UNESCO, 2017), the dropout statistics indicate that a large proportion of students is not able to complete their studies successfully (e.g., OECD, 2016, 2017). Hence, predictors of academic achievement (mostly operationalized as “academic performance”) are the focus of a considerable amount of research and of educational policies. To date, this research has largely aimed to understand how individual differences affect academic performance, how these effects can be explained, and, if possible, how they can be fostered. In this regard, the single best predictor set is cognitive variables such as intelligence, secondary school grades, and scores on standardized tests, the outcomes of which show

strong relations to academic performance (e.g., Broadbent & Poon, 2015; Chamorro-Premuzic & Furnham, 2003; Hoffman & Lowitzki, 2005; Richardson et al., 2012; Trapmann et al., 2007).

However, cognitive variables alone are no guarantee of successful learning (Heckman, 2011) and can be influenced to a limited extent. Therefore, recent research has found that the personality trait of conscientiousness and the use of internal resource-management learning strategies (i.e., the use of effort regulation strategies and time management strategies) are one of the best non-cognitive predictors, which, furthermore, are considered particularly relevant in higher education learning contexts due to the increased autonomy required there (Pintrich, 2004; Tirre, 2017). Fortunately, both variables are generally changeable at least on a state level (e.g., Hudson & Roberts, 2016; Trentepohl et al., 2022) and have been shown to predict university

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students' academic performance—even when cognitive variables are controlled for (e.g., Conard, 2006; Lee et al., 2017; Mammadov, 2022; Moren et al., 2020; Nofle & Robins, 2007; Schneider & Preckel, 2017; Van Bragt et al., 2011; Waldeyer et al., 2020; West & Sadoski, 2011). However, these central predictor variables are mostly discussed in different literature streams that are rarely brought together, even if its relation seems to be (at least implicitly) obvious and important to consider, e.g., when designing specific intervention programs. Less is known about how and to what degree they interact in their prediction of academic performance. For instance, it is possible that the learning strategies mediate the impact of conscientiousness on academic performance. However, it is also possible that conscientiousness strengthens the impact of the use of learning strategies on academic performance, or that conscientiousness compensates for a rather low level of strategy competency. In any cases, students could be better supported by means of scaffolding or trainings that match their specific prerequisites. Thus, to develop adequate practical implications to reducing dropout rates and fostering performance in higher education, e.g., through specific learning strategy trainings, it is important to know the underlying behavioural mechanisms in more detail.

Taking these mechanisms into account, our study attempts to contribute to the body of educational research literature by simultaneously examining the interaction of conscientiousness, the use of time management strategies and effort regulation strategies, and academic performance in two samples of first-year university students. We briefly review the literature on the interplay between conscientiousness, learning strategies, and academic performance in higher education, and develop a theoretical and testable model designed to elucidate their complex relationships adequately.

### 1.1. Mediating relation between conscientiousness, learning strategies, and academic performance: theoretical assumptions and first empirical evidence

The Big Five (Costa & McCrae, 1992), the most frequently used scientific classification of personality traits, assigns individual differences in experiencing and behaviour to five factors, namely: extraversion, neuroticism, conscientiousness, agreeableness, and openness to experience. Overall, personality traits are an important source of academic performance, whereby conscientiousness shows by far the strongest relation and should therefore be of particular interest in the context of study success and study dropout. Students with high scores on conscientiousness can generally be characterized as being purposeful, hard-working, well-organized, reliable, determined, and ambitious (Costa & McCrae, 1992). However, personality traits (i.e., conscientiousness) do not influence academic performance directly, but rather via characteristic adaptations (McCrae & Costa, 1996). Characteristic adaptations are contextual manifestations of traits that include a wide range of behaviours known to result in higher academic performance. Conceivably, such manifestation of the trait of conscientiousness could particularly be self-regulated learning behaviour. Specifically, conscientiousness encompasses several attributes that are part of the general domain of self-regulation and is therefore expected to be strongly associated with self-regulated learning (Koestner et al., 1992). Self-regulated learning in turn refers to a set of learning strategies which learners purposefully apply in an effective way when confronted with a learning task or situation (Pintrich & Garcia, 1991) and in consequence, is meaningfully related to student performance (Corno, 1986; Zimmerman & Martinez-Pons, 1988; it has to be noted that the relationship is complex and occurs through several different processes; for meta-motivational, meta-affective, and meta-behavioural role of self-regulated learning, e.g., see De la Fuente et al., 2017). In the literature, three different classifications are made for learning strategies: cognitive, metacognitive, and resource-management strategies (e.g., Boekaerts, 1999; McKeachie et al., 1990; Panadero, 2017). Regarding the specific requirements imposed on students by university learning, the management and regulation of the internal

resources of effort and time are most important for academic performance (see e.g., Richardson et al., 2012; Schneider & Preckel, 2017) and should therefore be the focus of the current research. These requirements include, for example, complex learning content, the need to study effectively in the face of the great autonomy offered to students, the comparatively low levels of external feedback, external regulation, and a lack of structure (see Dresel et al., 2015; Wolters et al., 2003). Students who successfully use effort regulation strategies show high persistence when faced with challenging academic pursuits (Richardson et al., 2012). Students who successfully use time management strategies in turn are aware of time and deadlines and show the tendency to use organizational aids such as lists and reminders to manage time and to plan tasks within a timeframe (Liu et al., 2009). As such, effort regulation and time management conceptually relate to conscientiousness characteristics representing, e.g., hard-working and well-organization of tasks (Costa & McCrae, 1992).

Under this conceptualization, conscientiousness can be assumed to influence university students' academic performance via its behavioural manifestation in the use of sufficient effort regulation and time management strategies (see also Pintrich, 2004). That is, one reason conscientiousness relates to performance is that conscientious students use more and better time management and effort regulation strategies, which help them to perform well (for a similar argumentation, see MacCann et al., 2012).

This assumed mediating process is also supported by Biggs' 3P model (Biggs, 1999), providing a theoretical foundation for the alignment of these factors in influencing academic performance (for an integration of self-regulated learning into Biggs' 3P scheme, see also De la Fuente et al., 2015, 2017). Specifically, the 3P model addresses the sequence of central factors in the learning process, describing presage (i.e., student factors and teaching context), process (i.e., learning-focused activities), and product (i.e., learning outcomes) variables and their multifaceted interrelationships. Accordingly, being a central student factor, students' conscientiousness is a presage variable of the learning process, whereas students' ways of using learning strategies represent process variables in that they refer to behaviours that are directly focused on their learning activities. Students' academic performance in turn refers to their learning outcomes, making it a product variable in this connection.

Overall, the relation between conscientiousness, the learning strategies, and academic performance is mostly discussed in different literature streams that are rarely brought together. Nevertheless, some empirical support is given for each direct relation and few studies already addressed the assumed mediating relation using cross-sectional data. Specifically, a series of previous studies has shown that, even when all Big Five personality traits were considered, conscientiousness showed the largest correlation with indicators of academic performance (e.g., Conard, 2006; De Raad & Schouwenburg, 1996; Hakimi et al., 2011; McIlroy & Bunting, 2002; Trapmann et al., 2007; Vedel, 2014). Moreover, research investigating the predictive validity of cognitive variables and personality traits for academic performance has shown that conscientiousness has an incremental predictive effect over and above cognitive variables (e.g., Kappe & van der Flier, 2012; Nofle & Robins, 2007; O'Connor & Paunonen, 2007; Poropat, 2009; Richardson et al., 2012; Wolfe & Johnson, 1995).

Similarly, a significant body of research has investigated the impact of learning strategies on academic performance, finding the strongest relationship of reported strategy use with performance for two internal resource-management strategies, namely effort regulation and time management strategies—even when cognitive variables are controlled for (Britton & Tesser, 1991; Broadbent & Poon, 2015; Chen, 2002; Crede & Phillips, 2011; Hoff Macan et al., 1990; Komarraju & Nadler, 2013; Neroni et al., 2019; Richardson et al., 2012; Schneider & Preckel, 2017; Waldeyer et al., 2020; West & Sadoski, 2011).

Addressing the relation between conscientiousness and the two categories of resource-management learning strategies, Bidjerano and Dai (2007) found that undergraduate college students who are highly

conscientious tend to report higher frequencies of time management and effort regulation strategy use. Similar results were shown by Moldasheva and Mahmood (2014), who found conscientiousness in undergraduate students to be positively correlated with the use of effort regulation strategies and time management strategies (for correlations between time management strategies and conscientiousness, see also Douglas et al., 2016; MacCann & Roberts, 2010). The strong relation between effort regulation strategy use and conscientiousness was also confirmed in Richardson et al.'s meta-study (2012). Moreover, the authors found that the effect of conscientiousness on academic performance was reduced after effort regulation strategies were added to the prediction model. This finding was suggestive of conscientiousness' effect on academic performance being mediated via the use of effort regulation strategies. This, however, was not tested in that study. Contrary, Nofle and Robins (2007) found empirical support for the mediated relation in that conscientiousness impacts academic performance because it is associated with increased academic effort among undergraduate students. Specifically, in their study, effort was significantly associated with conscientiousness and academic performance and, moreover, effort mediated the impact of conscientiousness on academic performance (for similar results see also Blicke, 1996, Study 2). Similarly, Bidjerano and Dai (2007) found that the use of effort regulation strategies mediated the predictive effect of conscientiousness on academic performance, whereas the authors found no mediation via time management strategy use. In contrast, MacCann et al. (2012) reported that time management strategy use mediated the relationship between conscientiousness and part-time students' academic performance.

Notable, to the best of our knowledge, all the above-mentioned studies testing for a mediating function of time management strategies and/or effort regulation strategies used cross-sectional and self-reported data (in most cases, this includes the performance measure) and did not control for measurement error by using latent structural equation modeling.

### 1.2. Moderating relation between conscientiousness, learning strategies, and academic performance: theoretical assumptions and first empirical evidence

It is empirically shown that the use of effort regulation strategies and time management strategies leads to better learning results in university studies (e.g., Britton & Tesser, 1991; Broadbent & Poon, 2015; Richardson et al., 2012; Schneider & Preckel, 2017; Trentepohl et al., 2022; Waldeyer et al., 2020), and in this way mediates the impact of conscientiousness on academic performance (at least partially; e.g., Bidjerano & Dai, 2007; Blicke, 1996; MacCann et al., 2012; Nofle & Robins, 2007). However, it is also clear that even if students study for hours, studying might not result in adequate performance if they use sophisticated learning strategies in an ineffective way (Engelschalk et al., 2017; Foerst et al., 2017; Wolters, 1998; see Miller, 2000 for quality-related deficits in learning strategy use). Referring to this, Blicke (1996) assumed that the effective use of learning strategies could be boosted by personality traits such as a high level of conscientiousness. Under these circumstances, one could argue that conscientiousness is pertinent to individual differences in students' effective use of the learning strategies, and thereby impacts the relation between these strategies and academic performance (i.e., moderates the relation). Referring to Biggs' 3P model (Biggs, 1999), in that case, the presage variable (i.e., conscientiousness) would not only lead to the use of the learning strategies but would also influence the path via which the process variable (i.e., the use of the learning strategies) impacts the product variable (i.e., academic performance).

Given this theoretical assumption, De Feyter et al. (2012) found empirical evidence that motivation regulation strategies (which are generally known as being effective in sustaining students' effort and persistence in the learning process and thus could be defined as internal resource-management strategies as well; see e.g., Wolters, 2003)

improved first-year students' academic performance, but that conscientiousness is crucial in turning motivation regulation into achievement successfully. More specifically, the authors found an indirect effect of conscientiousness on academic performance via motivation regulation strategy use, which was moderated by the level of conscientiousness. That is, the indirect effect was only activated if conscientiousness was high. Similarly, Schwinger and Otterpohl (2017) assumed that motivation regulation strategy use is affected by conscientiousness, which in turn functions as a moderator variable by influencing the effectiveness of the use of the strategies. However, the authors could not confirm this process empirically in their study.

Although previous studies have not specifically taken effort regulation strategies and time management strategies into account, a similar effect can be assumed since in this case a qualitative and conscientious use of such strategies should be an important prerequisite for a positive effect on performance as well. Thus, learners with high scores on conscientiousness should be better at applying these strategies effectively and show greater academic performance. Furthermore, to clarify the mixed results of previous studies concerning the mediating role of time management strategies (i.e., Bidjerano & Dai, 2007; MacCann et al., 2012), taking a possible moderating role of conscientiousness into account could be fruitful as well.

All considered then, an important question that emerges from the research conducted so far is whether the theoretically postulated and empirically partially tested *mediation process* and the postulated and at least for the category of motivation regulation strategies empirically tested *moderation processes* can be integrated in one model. In an integrated model, both processes would be combined, resulting in a significant conditional indirect effect meaning that the mediation, in which conscientiousness predicts academic performance via the use of time management strategies and effort regulation strategies, would vary in strength depending on students' level of conscientiousness (Preacher et al., 2007). To the best of our knowledge, our research is the first to examine the open question regarding a possible moderated-mediated relationship of conscientiousness, effort regulation strategies, time management strategies, and academic performance. Only the above-described study of De Feyter et al.'s (2012) has taken such an integrated process into consideration, focusing on motivation regulation strategies while applying a slightly different moderated mediation model than the one used in the present study.

### 1.3. The present study

We aimed to validate and extend prior research by gaining more detailed insights into the interplay between conscientiousness, the use of effort regulation strategies, time management strategies, and performance in order to develop more effective teaching or training strategies to foster academic performance and reduce dropout rates. Specifically, we investigated whether the prediction of academic performance by conscientiousness is mediated by the use of time management strategies and effort regulation strategies, and whether the mediation in turn is moderated by the level of conscientiousness. Addressing both mediation and moderated mediation will extend the existing findings insofar as we (a) replicate and thereby validate prior cross-sectional mediation findings using a repeated measurement design. Moreover, we aimed to address the above-mentioned limitations on prior mediating findings by taking qualitative aspects of (self-reported) learning strategy use into account and using an objective measure of academic performance. Going beyond replication, we will (b) seek to confirm whether the moderated mediation results found by De Feyter et al. (2012) are generalizable across the use of further learning strategies and thereby also contribute to a better understanding of the mixed results concerning mediation via time management strategies (Bidjerano & Dai, 2007; MacCann et al., 2012).

Based on the literature review and on our theoretical considerations, we hypothesized the following relations:

*Hypothesis 1* states that conscientiousness will predict academic performance positively, but that this prediction will be mediated by the use of effort regulation strategies and time management strategies. Since conscientious learners tend to be disciplined and achievement-oriented, we expect that conscientiousness will be positively related to time management and effort regulation strategies, which in turn will have positive effects on academic performance (Fig. 1, left).

*Hypothesis 2* states that this mediation will be moderated by students' level of conscientiousness (Fig. 1, right). We suggested that conscientiousness is pertinent to individual differences in students' effective use of the learning strategies, and thereby impacts the relations between these strategies and academic performance. In other words, we assumed that the indirect effect of conscientiousness on performance using effort regulation strategies and time management strategies depends on the level of students' conscientiousness. In accord with the results of De Feyter et al. (2012) we proposed that the indirect effect will be stronger for students with higher levels of conscientiousness.

We conducted two studies with first-year students using a repeated measurement design over the term of one semester: The first study was designed to test our hypotheses in a “smaller” setting, using data from only one study domain and one specific performance test. The second study was conducted to proof for generalizability and strengthening of the findings using data from different study domains and an objective performance measure, while controlling for prior learning strategy use and high-school grades.

We focus on first-year university students because the so-called ‘first-year experience’ (i.e., the transition from school to university) is generally considered to be the most crucial period of higher education (Haarala-Muhonen et al., 2017). Specifically, with 30 %, the majority of study dropout occurs during the first year (Heublein, 2014), and the underlying reasons and processes are manifold. For example, early dropouts are often traced back to personal variables such as a lack of motivation or low performance, while later dropouts are often traced back to contextual factors (Heublein et al., 2017). In their study entry phase, students often struggle about workload, (low) performance, and regarding self-regulated learning. Specifically, the transition from a well-organized high-school program to university studies may lead to time wasting, and (at least at German universities) many students start deliberating learning very late at the end of the semester. Overwhelmed by the volume and the complexity of the learning material and the short time available, they fail in reaching the required performance. Consequently, internal resource-management strategies (i.e., effort regulation and time management strategies) are particularly important during this period (e.g., Dresel et al., 2015; Gibney et al., 2011).

## 2. Study 1

### 2.1. Sample

The sample consisted of  $N = 106$  first-year students from the domain of civil-engineering (71.7 % male,  $M_{age} = 20.8$  years,  $SD_{age} = 3.1$  years) who participated in an optional course over one full semester. Inclusion criteria: All first-year students from the domain of civil-engineering

were theoretically allowed to participate in the course and students who completed all questionnaires during the whole course (note that some of them are not part of this manuscript) received € 100. All students participated voluntarily. Exclusion criteria: Initially, 123 first-year students had begun participation of the course and filled out the learning strategy questionnaire in the mid of semester but did not conduct the exam at the end of the course, so that they were excluded from the analyses.

### 2.2. Measures

Conscientiousness was measured with one subscale of the well-established German version of the NEO-PI-R (Ostendorf & Angleitner, 2004). Students indicated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) to what extent the statement was descriptive of their personality. Example items are “I am someone who does a thorough job”, and “I try to perform all tasks very conscientiously”. Internal consistency was excellent with  $\omega = 0.90$ .

Effort regulation strategies and time management strategies were measured with two subscales of the ReMI (Waldeyer et al., 2020). The ReMI is a situational-judgement-based instrument that assesses learning-strategy knowledge and the ability of strategy use, and thereby takes quality-related aspects of the learning strategy use into account. Specifically, students were confronted with a learning scenario which is not domain-specific and were asked to choose one of five presented learning strategies that would be the most beneficial to manage the scenario. Afterwards, for the chosen strategy, students were instructed to rate their expertise regarding this strategy, and the probability with which they would apply it (effectively) in this situation. Not knowing a given beneficial strategy, or not knowing how to use it in the given scenario, indicates that the student does not have strategy knowledge (declarative or procedural). Knowing a beneficial strategy but having low probability of using it effectively in the given scenario, indicates that the student has strategy knowledge, but that he or she has deficits in respect of the quality of use of this strategy. Results of both ratings (i.e., the strategy knowledge and the ability to use the strategy) were combined into a strategy competency score for each item, ranging from 0 (deficits in strategy knowledge), over 1 (strategy knowledge but deficits in its use), to 2 (strategy knowledge and no deficits/high efficacy of use). Finally, all scores were added up and divided by the number of items (i.e., 7 for time management, 8 for effort regulation) so that each participant had one mean score for each subscale. Internal consistency was acceptable ( $\omega = 0.63$  for effort regulation,  $\omega = 0.71$  for time management).

To provide additional evidence of the ReMI's validity, we furthermore assessed students learning strategy use via two subscales of the German adaptation of the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1993; Wild & Schiefele, 1994). Specifically, effort regulation strategy use was assessed with 8 items (e.g., “I work hard to do well in my studies, even if I don't like what we are doing”) and time management strategy use was assessed with 4 items (e.g., “I start learning as early as possible, so that I don't get in a stressful situation”). Responses ranged from 1 (rarely) to 5 (very often) and internal

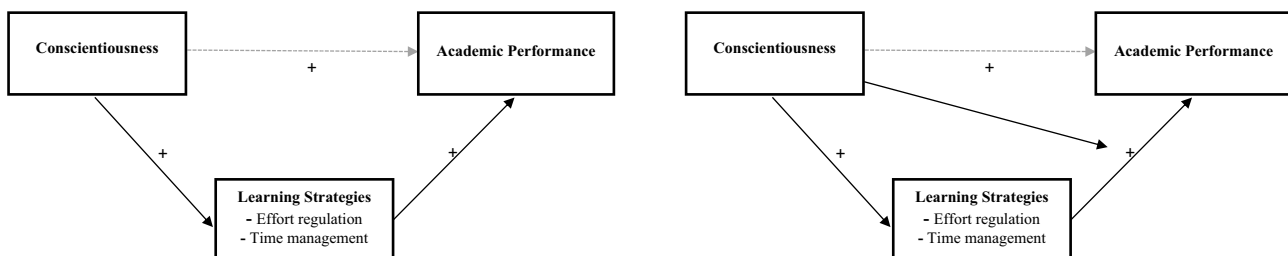


Fig. 1. Proposed conceptual process models: mediation (left) and moderated mediation (right).

consistency was acceptable ( $\omega = 0.75$  for effort regulation,  $\omega = 0.69$  for time management).

Academic performance was measured via students' performance in an exam on the course content at the end of the semester. The exam included 30 multiple-choice questions, each providing one correct answer and three distractors. Each correct answer was worth one point, resulting in a maximum score of 30 points and a minimum score of zero points. Internal consistency was good with  $\omega = 0.83$ .

### 2.3. Procedure

The course was specifically designed for the study and included lessons on human memory and multimedia learning, with regular practice questions in between lessons, one comprehensive homework assignment, and a final exam on the course content. All participants were instructed on the procedure of the study and the course and filled in a set of questionnaires during the whole term. At the first session of the course the participants filled in a paper-and-pencil-based questionnaire including demographic questions and questions on the Big-Five personality factor conscientiousness (Wave 1). The use of effort regulation strategies and time management strategies was measured in a computer-based questionnaire in the middle of the semester (Wave 2), and students' performance was assessed at the last session of the course (i.e., at the end of the semester) via a paper-and-pencil-based exam (Wave 3). In accordance with German legislation, institutional review board approval is not required for this type of study. This study complies with human subject guidelines of national research committees, as well as the APA Ethics Code Standards. Written consent for participation was collected from all students.

### 2.4. Statistical analyses

All analyses were conducted with R 3.2.1 package lavaan (Rosseel, 2012). Due to the small sample size in Study 1, we tested manifest path models, using the Robust Maximum Likelihood Estimator (MLR). All variables were z-standardized across participants prior to the path analyses. As model fit indices, the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and the Root-Mean-Square Error of Approximation (RMSEA) are reported. For TLI and CFI, values of 0.90 or higher show a satisfactory fit, while values above 0.95 show an excellent fit (Hu & Bentler, 1999; McDonald & Marsh, 1990). For the RMSEA, values of  $<0.05$  are taken to reflect a good fit, between 0.05 and  $<0.08$  an adequate fit, and between 0.08 and 0.10 a mediocre fit, whereas values of  $>0.10$  are not acceptable (Browne & Cudeck, 1993). Model comparisons (i.e., measurement invariance) followed the suggestions of Cheung and Rensvold (2001), and Chen (2007): a change of  $-0.010$  or more in CFI and TLI, or of 0.015 or more in RMSEA, indicates non-invariance between a model in which parameters across the two measurement points are free to take on unique values, and a model in which they are constrained to be equal.

### 2.5. Results

#### 2.5.1. Preliminary analyses

The mean scores, standard deviations, McDonald's  $\omega$  reliabilities, and correlations between all variables used in the main analyses of Study 1 are presented in Table 1. The results indicate that all data were at least satisfactory reliable and meaningfully correlated to each other. Specifically, in line with our assumption, conscientiousness was positively correlated to time management and effort regulation strategies and all these variables were positively correlated to academic performance. Furthermore, supporting validity of our mediator measure, correlation analyses between the data of the German version of the MSLQ and the data of the ReMI showed meaningful correlation for time management strategies,  $r = 0.24$ ,  $p = .013$ , and for effort regulation strategies,  $r = 0.43$ ,  $p < .001$ .

**Table 1**

Descriptive statistics, McDonald's omega reliabilities, and intercorrelations of all variables of Study 1.

	No. of items	M (SD)	McDonald's $\omega$	1	2	3
1 Time management strategies	7	0.62 (0.51)	0.71			
2 Effort regulation strategies	8	0.65 (0.45)	0.63	0.53		
3 Conscientiousness	48	3.43 (0.39)	0.90	0.38	0.43	
4 Performance	30	18.91 (5.75)	0.83	0.30	0.35	0.23

Note. All correlations are significant at  $p < .005$ .

#### 2.5.2. Mediation

We computed two simple mediation models in which performance was regressed on conscientiousness, mediated by either time management strategies or effort regulation strategies. We additionally used bootstrapping with 1000 samples to evaluate the significance of the indirect effects of conscientiousness on performance. Table 2 displays the standardized regression coefficients of the direct and indirect effects. It also displays the upper and lower limits of the percentile bootstrap 95 %-confidence intervals of the indirect effects, and the fit statistics of all mediation models. Overall, results showed that conscientiousness predicted time management strategies with  $\beta = 0.38$  ( $SE = 0.12$ ),  $p < .001$ , while in turn time management strategies predicted performance with  $\beta = 0.25$  ( $SE = 0.98$ ),  $p = .006$ .

In line with our first hypothesis, a significant indirect effect of  $\beta = 0.09$  ( $SE = 0.62$ ),  $p = .027$  was observed. Furthermore, conscientiousness predicted effort regulation strategies with  $\beta = 0.43$  ( $SE = 0.11$ ),  $p < .001$ , while in turn effort regulation strategies predicted performance with  $\beta = 0.31$  ( $SE = 1.27$ ),  $p = .003$ . In line with our first hypothesis, a significant indirect effect of  $\beta = 0.13$  ( $SE = 0.73$ ),  $p = .010$  was observed.

#### 2.5.3. Moderated mediation

To test the assumed moderated mediation, we added the interaction of the predictor variable and the mediator variables (conscientiousness x effort regulation strategies; conscientiousness x time management strategies; all were mean centred before) into the mediation model to predict performance. Contrary to our second hypothesis, results showed that the indirect effect of conscientiousness on performance via time management strategies was not significantly moderated by students' conscientiousness,  $\beta = 0.03$ ,  $SE = 2.87$ ,  $p = .735$ . Also, for the mediation model concerning the effect of conscientiousness on performance via effort regulation strategies, the interaction was not significant  $\beta = 0.14$ ,  $SE = 2.79$ ,  $p = .130$ . Consequently, we did not test for conditional indirect effects of the mediation models in Study 1.

### 3. Study 2

Although the results of Study 1 partially supported our hypotheses, they are limited by the rather "laboratory" design since we only obtained one performance indicator of one specific (and not study content-related) course. Second, we only obtained data from students of one study domain (i.e., civil engineering students, since this field of study is highly affected by dropout from university; see e.g., Chen, 2009; Heublein, 2014). Third, conscientiousness was only assessed at Wave 1 since this variable was expected to be relatively stable over the term of one semester. However, the learning strategy use in turn may of course have changed during the semester and therefore, it should be critically noted that we assessed this variable only once at Wave 2. Finally, the sample size and hence the statistical power of Study 1 might have been too low to have a sufficient chance of detecting the moderation effect. Moreover, the reliability of the effort regulation measure was rather low, which should also be considered critically when interpreting the results.

**Table 2**

Results of mediation analyses of Study 1 predicting academic performance via effort regulation strategies and time management strategies.

Mediator	Indirect effect $\beta$	95 % CI (indirect effect)	Direct effect $\beta$	df	CFI	TLI	RMSEA
1 Time management strategies	0.09	[0.276, 2.971]	0.14 (n.s.)	3	1.00	1.00	0.00
2 Effort regulation strategies	0.13	[0.416, 3.828]	0.10 (n.s.)	3	1.00	1.00	0.00

Note. All  $\beta$  of indirect effect are significant at  $p < .05$ . CI = bias-corrected confidence interval (95 %).

Therefore, in Study 2, we aimed to replicate the main findings of Study 1 with a new and larger sample, addressing its major limitations by means of a more objective measure of academic performance and different domains of university first-year students to test for generalization of our findings. Furthermore, we collected prior learning strategy use at the beginning of the semester and prior grades from high school as it is one of the strongest predictors for academic performance according to numerous meta-analytic studies (e.g., Richardson et al., 2012; Robbins et al., 2004) to further strengthen the (direction of the) findings by controlling for these variables.

### 3.1. Sample

The sample comprised  $N = 355$  first-year students from two German universities studying different domains (59 % female,  $M_{age} = 20.51$ ,  $SD_{age} = 2.49$ ). Inclusion criteria: All first-year students from the domain of civil-engineering or educational science with any combination of subjects (dual-subject Bachelor program) were theoretically allowed to participate in the study and students who completed all questionnaires (note that some of them are not part of this manuscript) received € 100. All students participated voluntarily. Exclusion criteria: Initially, 380 first-year students had begun participation of the study but few of them either did not complete all questionnaires or did not conduct any exam at the end of the semester, so that they were excluded from the main analyses. Proving for representativity of our data was realized by comparing our sample with the overall population of first-year students at both universities regarding age, gender, mother tongue, GPA from A-level, and previous study and work experience showed no statistically significant differences (for information on the specific analyses, see Fleischer et al., 2019).

### 3.2. Measures

Conscientiousness, effort regulation strategies, and time management strategies were measured via the same scales as in Study 1. Internal consistency of all data ranged between  $\omega = 0.75$  and  $\alpha = 0.91$ . Again, we assessed effort regulation strategies and time management strategies via the German version of the MSLQ to support the ReMI's validity. Here, internal consistency was good for time management with  $\omega = 0.85$  and for effort regulation with  $\omega = 0.84$ .

Academic performance was measured via students' cumulative grade point average across all available exam-grades (GPA) at the end of the semester (individual grades were z-standardized across participants prior to cumulation). Furthermore, previous academic performance was taken into account as a covariate by asking students to report their GPA from high school (HSGPA). For ease of interpretation, we recoded both university and high school GPAs such that high scores indicated better performance (like Study 1).

### 3.3. Procedure

The procedure was the same as in Study 1 excepted for grades, that were accessed from the universities' student records office at the end of the semester (Wave 3; a condition, that students had agreed to). Additionally, we assessed students' time management strategies and their effort regulation strategies at the beginning of their studies (Wave 1). Again, we conducted the study in accordance with human subject guidelines of national research committees as well as the APA Ethics

Code Standards, and consent for participation was collected from all students.

### 3.4. Statistical analyses

While all of the previously mentioned studies have analyzed the mediation models and the moderated mediation model at a manifest level only (this includes Study 1 reported above), in Study 2, we used latent structural equation modeling (SEM) to examine the hypothesized relations, controlling for measurement errors (Dicke et al., 2014; Preacher et al., 2007). All data analyses were conducted with R 3.2.1 and the Lavaan package (Rosseel, 2012). Due to the ordinal character of the mediator variables, we used the Diagonally Weighted Least Square (DWLS) estimator. Methodologically, the learning strategies and conscientiousness were represented by latent factors, while performance and HSGPA were represented as manifest mean scores (all indicators were standardized prior to the analyses; for further information on the specific analyses, see Supplemental Materials). We tested for longitudinal measurement invariance of the mediator variables (results are reported in the Supplemental Materials). We used the same model cut-off criteria as in Study 1.

### 3.5. Results

#### 3.5.1. Preliminary analyses

The mean scores, standard deviations, McDonald's  $\omega$  reliabilities, and correlations between all variables of the main analyses of Study 2 are presented in Table 3. The results indicate that all data were highly reliable. Again, supporting validity of the mediator measure, correlation analyses between the data of the German version of the MSLQ and the data of the ReMI showed meaningful correlation for time management strategies,  $r = 0.48$ ,  $p < .001$ , and for effort regulation strategies,  $r = 0.39$ ,  $p < .001$ .

Prior to examining mediation and moderated mediation effects, a confirmatory factor analysis (CFA) of conscientiousness, time management strategies, effort regulation strategies, and students' GPA was performed to assess the validity of the measurement models. Since the conscientiousness questionnaire included a mixture of positively and negatively worded items, we added correlated uniqueness between all negatively recoded conscientiousness items (Marsh, 2007; Marsh & Hau, 1996). The tested CFA provided an excellent fit of  $\chi^2 = 2215.881$ ,  $p < .001$ , CFI = 0.97, TLI = 0.96, RMSEA = 0.03. Correlations indicated that all variables were meaningfully correlated to each other. Specifically, in line with our assumption, correlations indicated that time management and effort regulation strategies were positively correlated to conscientiousness while students' GPA was positively correlated to conscientiousness and the learning strategies.

#### 3.5.2. Mediation

We performed mediation models in which performance was regressed on conscientiousness, mediated by either time management strategies or effort regulation strategies. Both mediation models showed excellent fit statistics (Table 4). The results of the analyses indicated that conscientiousness predicted time management strategies, with  $\beta = 0.32$  ( $SE = 0.02$ ),  $p < .001$ , while in turn time management strategies predicted GPA, with  $\beta = 0.21$  ( $SE = 0.10$ ),  $p < .001$ . A significant indirect effect of  $\beta = 0.07$  ( $SE = 0.02$ ),  $p < .001$ , was observed, which is in line with our first hypothesis. Furthermore, conscientiousness predicted

**Table 3**  
Descriptive statistics, McDonald's omega reliabilities, and intercorrelations of all variables of Study 2.

	No. of items	M (SE)	McDonald's $\omega$	1	2	3
1 Time management strategies	7	0.64 (0.55)	0.77			
2 Effort regulation strategies	8	0.89 (0.55)	0.75	0.33 (SE = 0.01)		
3 Conscientiousness	48	2.54 (0.44)	0.91	0.32 (SE = 0.01)	0.38 (SE = 0.01)	
4 Performance	1	-3.17 (1.09)	-	0.22 (SE = 0.01)	0.47 (SE = 0.02)	0.14 (SE = 0.01)

Note. All correlations are significant at  $p < .001$ ; results of time management strategies and effort regulation strategies are based on Wave 2.

**Table 4**  
Results of mediation analyses of Study 2 predicting academic performance via effort regulation strategies and time management strategies.

Mediator	Indirect effect $\beta$	SE	95 % CI (indirect effect)	Direct effect $\beta$	SE	df	$\chi^2$	CFI	TLI	RMSEA
1 Time management strategies	0.07	0.02	[0.063, 0.148]	0.09	0.04	1206	1674.915	0.97	0.96	0.04
2 Effort regulation strategies	0.18	0.04	[0.219, 0.352]	-0.03 (n.s.)	0.05	1261	1805.379	0.97	0.96	0.04

Note. SE = standard error. All  $\beta$  of indirect effects as well as the direct effect regarding time management are significant at  $p < .001$ . CI = bias-corrected confidence interval (95 %).

effort regulation strategies, with  $\beta = 0.37$  ( $SE = 0.03$ ),  $p < .001$ , while in turn effort regulation strategies predicted GPA, with  $\beta = 0.48$  ( $SE = 0.10$ ),  $p < .001$ . In line with our first hypothesis, a significant indirect effect of  $\beta = 0.18$  ( $SE = 0.03$ ),  $p < .001$ , was observed. We additionally used bootstrapping with 1000 samples to evaluate the significance of the indirect effects of conscientiousness on GPA.

The fit statistics and standardized path coefficients of direct and indirect effects of both mediation models are displayed in Table 4.

### 3.5.3. Moderated mediation

To test Hypothesis 2, we added the interaction of the predictor variable and the mediator variables into the mediation models to predict performance. Contrary to our prediction, however, results showed that the indirect effect of conscientiousness on GPA via time management strategies was not significantly moderated by students' conscientiousness (moderation path:  $\beta = 0.11$ ,  $SE = 0.10$ ,  $p = .151$ ). In contrast, a significant moderation path was found for the mediation model concerning the effect of conscientiousness on GPA via effort regulation strategies, which is in line with our second hypothesis. Results showed that conscientiousness predicted effort regulation strategies, with  $\beta = 0.37$  ( $SE = 0.02$ ),  $p < .001$ , while in turn effort regulation strategies predicted GPA, with  $\beta = 0.17$  ( $SE = 0.09$ ),  $p < .001$ .

A significant indirect effect of  $\beta = 0.06$  ( $SE = 0.03$ ),  $p < .001$ , and a significant moderation path of  $\beta = 0.20$  ( $SE = 0.08$ ),  $p < .001$ , were observed, together with a satisfactory model fit ( $\chi^2 = 4609.424$ ,  $p < .001$ , CFI = 0.90, TLI = 0.89, RMSEA = 0.07).

Taken together, these findings imply that conscientiousness appears to moderate its indirect effect via the use of effort regulation strategies in a mean level of conscientiousness, but not via the use of time management strategies. To test the conditional indirect effect of conscientiousness via effort regulation strategies, we tested the simple slopes at five levels of conscientiousness (+1/+2 SD, mean, -1/-2 SD). As can be seen in Table 5, results indicate that the effect of conscientiousness on

**Table 5**  
Conditional indirect effects of Study 2.

Level of conscientiousness	Academic performance			
	ab	SE	p	95 % CI (conditional indirect effect)
Effort regulation strategies				
-2 SD	-0.08	0.07	0.159	[-0.218, 0.036]
-1 SD	-0.01	0.04	0.963	[-0.082, 0.089]
Mean	0.06	0.03	<0.001	[0.050, 0.146]
+1 SD	0.13	0.02	<0.001	[0.157, 0.228]
+2 SD	0.21	0.03	<0.001	[0.224, 0.351]

Note. ab = regression coefficient of the indirect effect. CI = bias-corrected confidence interval (95 %). All effects are standardized.

GPA is mediated by effort regulation strategies when the level of conscientiousness is medium or high, but not when the level is low. In other words, the indirect effect of conscientiousness on GPA via effort regulation strategy use varied with different levels of conscientiousness. Additionally, bootstrapping with 1000 samples was used to evaluate the significance of the conditional indirect effects.

### 3.5.4. Covariates

To investigate the consistency of the moderated mediation result found, we included students' HSGPA as a covariate in the analyses. HSGPA did have a strong positive effect on GPA ( $\beta = 0.50$ ,  $SE = 0.10$ ,  $p < .001$ ), indicating that those students who had performed better at school also had a better performance in university. To further test our assumptions regarding the pattern of (moderated) mediation directions (i.e., conscientiousness impacts changes in learning strategy use), we additionally included effort regulation strategy use at the beginning of the first semester (Wave 1) as covariate, predicting the mediator variable, respectively, at mid semester (Wave 2; for measurement invariance see Supplemental Materials). Here, results showed that the corresponding variable at Wave 1 did have a strong positive effect on the mediator variable ( $\beta = 0.78$ ,  $SE = 0.05$ ,  $p < .001$ ), indicating that the higher the strategy score was at the beginning of the semester, the better students scored at mid semester. All in all, by including both covariates into the analysis, all path coefficients still showed a similar pattern of results compared to the model without covariates (see Fig. 2). Furthermore, including covariates resulted in similar CFI, TLI, and RMSEA for the model.

## 4. Overall discussion

Both conscientiousness and the use of specific learning strategies (i.e., effort regulation strategies and time management strategies) are believed to be highly important non-cognitive predictors of academic performance in higher education. Given this, the aim of the present study was to obtain a more differentiated view of the interplay between these variables in two samples of first-year university students. Our goal was to replicate and validate the mediating roles of time management strategies and effort regulation strategies on the relation between conscientiousness and academic performance using a repeated measurement design. Another goal was to identify the potential moderating role of the level of conscientiousness for this mediation process. Understanding more deeply the relationship between conscientiousness, the use of the learning strategies, and academic performance, may be central to the development of effective teaching strategies or trainings that enhance students' performance and reduce dropout rates in higher education.

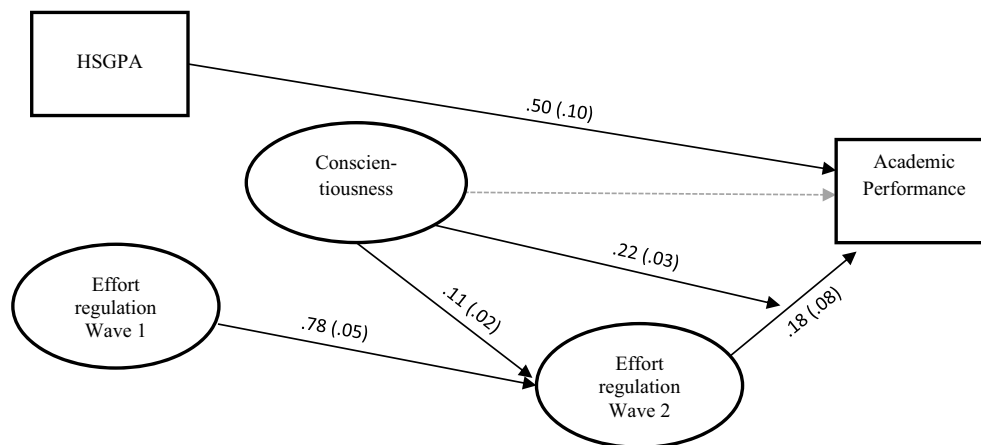


Fig. 2. Moderated mediation model including covariates. HSGPA = secondary school grades; all coefficients are significant at  $p < .01$  ( $SE$  in brackets).

#### 4.1. Main findings

Our results suggest that conscientiousness is a strong predictor of the use of time management strategies and effort regulation strategies, and that by the use of these learning strategies conscientiousness positively influences academic performance. The respective correlation patterns are similar to those found in previous studies, which have indicated that conscientiousness is a salient predictor of time management as well as effort regulation strategy use (e.g., Bidjerano & Dai, 2007; MacCann & Roberts, 2010; Moldasheva & Mahmood, 2014; Richardson et al., 2012), and academic performance (e.g., Conard, 2006; Nofle & Robins, 2007; Poropat, 2009; Trapmann et al., 2007; Vedel, 2014), and that the use of these learning strategies enhances students' ability to achieve better (e.g., Britton & Tesser, 1991; Broadbent & Poon, 2015; Schneider & Preckel, 2017; West & Sadoski, 2011).

We also tested whether the students' level of conscientiousness moderates the mediation of conscientiousness on academic performance via the use of the learning strategies. We found partial support for a moderated mediation model. As expected, high levels of conscientiousness activated the indirect effect of conscientiousness on academic performance via the regulation of effort in Study 2 (with a large sample and with taking measurement error into account by latent modeling), but not in Study 1 (with a small sample and without taking measurement error into account). Conditional indirect effects were statistically significant at medium levels of conscientiousness and above; this is consistent with De Feyter et al.'s (2012) findings on motivation-regulation strategies.

Indicating the strong validity of our findings in Study 2, adding prior school grades as a covariate did not have an impact on this pattern of results, despite prior school grades having a significant effect on academic performance. The pattern of directions of our moderated mediation model was furthermore strengthened by controlling for prior effort regulation strategy use at the beginning of students' first semester. Controlling for this, and thereby predicting the change in strategy use, resulted in the same pattern of results.

#### 4.2. Strengths and practical implications

A key strength of our methodological approach of both studies is that the dependent variables (academic performance) were not self-reported by students but were measured via a specific performance test (Study 1) and received from the universities' student records office directly (Study 2; a condition that students had agreed to prior to the study). Moreover, we applied a situation-specific strategy competency approach to assess learning strategy use in both studies (see also Trentepohl et al., 2022). Although there were several options to measure the use of learning strategies, classic self-report questionnaires were used in most of the

studies reported above that were not applied to specific learning tasks or situations. Specifically, classic strategy questionnaires focus on the quantity rather than the quality of strategy use. Hence, these questionnaires are not well suited to assessing the adequate and optimized usage of the learning strategies (see Wirth & Leutner, 2008 for quantitative vs. qualitative standards in learning strategy assessment). Furthermore, by applying a situation-specific approach to measure the competency of learning strategy use we aimed to avoid common biases associated with traditional self-reports, such as response bias (Paulhus & Vazire, 2007), a lack of context (Boekaerts & Corno, 2005), and accuracy issues (Winne & Jamieson-Noel, 2002; for self-reports in the context of self-regulated learning see also Rovers et al., 2019).

Overall, our studies have confirmed and extended previous research in several ways. First, we validated the effect of conscientiousness on academic performance mediated via the use of selected learning strategies (Bidjerano & Dai, 2007; Blicke, 1996; MacCann et al., 2012; Nofle & Robins, 2007) using a repeated measurement design. Second, we extended the previous findings of De Feyter et al. (2012) by testing moderated mediation models for the use of different types of learning strategies.

Our results have important implications for future research and practice. A key argument for focusing on conscientiousness and the use of learning strategies as highly important non-cognitive predictors of academic performance, is that both reflect what a learner *will* do, whereas cognitive variables such as intelligence or prior school achievement only reflect what a learner *can* do (Chamorro-Premuzic & Furnham, 2003). However, since conscientiousness refers to a more stable psychological construct (at least on a trait level), this predictor variable might not be optimally to influence e.g., via trainings (but see Hudson & Roberts, 2016, for changes in conscientiousness in young adulthood). On the other hand, the use of learning strategies can and will be influenced through trainings in practice (e.g., Cambridge-Williams et al., 2013; Donker et al., 2014; Dörrenbächer & Perels, 2016; Jansen et al., 2019), and therefore it is important to know about the differential impacts of the strategies on the relation to academic performance for students with varying levels of conscientiousness. Taking the (non-)moderating function of the students' level of conscientiousness on the mediation into account, strategy training programs need to be closely matched to students' personality. This is crucial insofar as we found that the mediation process via the use of effort regulation strategies is not activated for those participants scoring low on conscientiousness (though this effect occurred only in Study 2). Consequently, this indicates that using learning strategies to regulate effort is less successful in predicting performance in students' first-year university studies when students are low on conscientiousness. Thus, providing learning strategy training to struggling students could set them up for failure if they do not have the requisite level of conscientiousness to



make those strategies work. However, students low on conscientiousness should of course also be supported in achieving optimal study outcomes; future research needs to take a closer look at different forms of external support that could be provided for less conscientious students, to possibly compensate for this deficit. Nevertheless, our second study has successfully confirmed that the use of effort regulation strategies enhances academic performance for students high on conscientiousness. Therefore, it seems promising to support those students regarding their strategy competency, to give rise to higher achievement.

On the other hand, the effect of conscientiousness on academic performance mediated via the use of time management strategies seems not to be moderated by the level of conscientiousness, which should, however, be the key lever that interventions could target to enhance academic performance for those students low on conscientiousness. While individual differences in trait conscientiousness are rather stable across time and situations, students can learn to control and influence their time management, and teachers can instruct and support them in doing so.

In summary, with this knowledge of the relationship between conscientiousness and the two types of learning strategies, university teachers will be in a better position to explain and predict students' behavioural patterns in learning settings, and to design individualized interventions to enhance students' performance.

#### 4.3. Limitations and future research

Our studies have limitations that are suggestive of future research directions. First, while academic performance was assessed using objective measures in both studies, conscientiousness and the use of the learning strategies were assessed subjectively. We attempted to reduce this shortcoming by using a situational-judgement instrument, which is relatively concrete: This makes it easier for students to respond accurately with regard to specific learning strategy use. Previous research has revealed higher correlations between learning strategies and learning success when students are asked to report their learning strategy use in specific learning situations, compared to studies without such situation-specific assessments (e.g., Leopold & Leutner, 2002). Although we consider student reports to be highly valid sources of information on these constructs, future studies should aim to gather more objective data. Future research should address this issue by taking actual *behavioural data* into account to make the findings still stronger.

Second, our results were based on correlative data. The possibilities for interpretation with regard to causal directions are therefore limited, due to the lack of experimental control. Nevertheless, the repeated measurement design made possible controlling for previous points of measurement of the mediator, thus strengthening our assumptions with regard to the operating direction of the mediator (at least in Study 2). However, future studies could address this limitation by experimentally manipulating state conscientiousness to further analyse its mediating and moderating impact on the relation between learning strategies and academic performance.

Third, with special regard to the result that students low on conscientiousness are less likely to effectively use effort regulation strategies, and even when they do it doesn't work anyway, further research needs to investigate whether the use of sophisticated internal resource-management learning strategies is the only path by which conscientiousness influences academic performance. In this context, future research could also address a possibly opposite mediating relationship of neuroticism, the learnings strategies, and academic performance, since neuroticism is known to negatively correlate with effort regulation and with performance (e.g., Chamorro-Premuzic & Furnham, 2003; even these results are mixed).

Finally, it should critically be noted that we tested a very focused model. That is, we did not include important environmental factors such as positive social interactions between students and lecturers or teachers' elocutionary skills or other motivational constructs (e.g., self-

efficacy) that are important as predictors of academic performance (sometimes even more than other variables, see, e.g., Schneider & Preckel, 2017). Accordingly, without including such relevant variables, we might have overestimated the importance of the (moderated) mediated relationship between conscientiousness, the two categories of learning strategies, and academic performance. Future research could investigate this limitation by extending our tested model with other relevant variables.

## 5. Conclusion

Our results shed further light on the interplay between conscientiousness, the use of two relevant learning strategies, and academic performance, by showing that the use of effort regulation strategies will only mediate the impact of conscientiousness on academic performance if students are highly conscientious. In contrast, the indirect effect via the use of time management strategies is not dependent on the level of conscientiousness. Consequently, three important implications appear to emerge from our results. First, students who are highly conscientious are optimally supported by means of effort regulation strategies. Second, students who are less conscientious or not conscientious at all, might probably not benefit from such trainings, because the respective strategies appear to have no effect in these cases. Thirdly however, these students might of course need instructional support also, and this could be given within the framework of time management strategies, because its effect is independent of the level of conscientiousness.

## Declaration of competing interest

None.

## Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.lindif.2022.102228>.

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