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Using Individual Interest and Conscientiousness to Predict Academic Effort: Additive, Synergistic, or Compensatory Effects?

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Although both conscientiousness and domain-specific interest are believed to be major determinants of academic effort, they have rarely been brought together in empirical studies. In the present research, it was hypothesized that both interest and conscientiousness uniquely predict academic effort and statistically interact with each other to predict academic effort. In 4 studies with 2,557, 415, 1,025, and 1,531 students, respectively, conscientiousness and interest meaningfully and uniquely predicted academic effort. In addition, conscientiousness interacted with interest in a compensatory pattern, indicating that conscientiousness is especially important when a student finds a school subject uninteresting and that domain-specific interest plays a particularly important role for students low in conscientiousness.

Keywords: conscientiousness, interest, academic effort

Eva's parents share a concern with many other parents of high school children around the world: They are worried about their daughter's progress in several school subjects. Despite her aptitude—Eva scored significantly above average on an IQ test—and excellent grades in her favorite subjects, her grades in most other subjects are below the class average. Eva complains that she is simply not interested in these subjects and that her teacher fails to make the work engaging. Not surprisingly, the family often ends up fighting over homework. Last week, Eva's parents talked to her teacher about the situation. The teacher criticized Eva's lack of academic effort, highlighting her low homework morale, and implied that Eva should cultivate a greater work ethic and learn to work hard even on tasks that she does not enjoy.

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The situation just described is familiar to millions of children—and parents—around the world. One reason for unsatisfactory academic achievement is a lack of sustained academic effort. However, the causes of this lack of effort remain a matter of controversy, both in general and with respect to specific students. Is interest a necessary precondition for academic effort, as Eva's explanation seems to imply? Or does Eva lack personal qualities that would help her meet academic challenges, as her teacher seems to suggest?

In this article, we examine the role that various person characteristics play in predicting high academic effort, an important aspect of academic learning. We consider two central predictors of academic effort: individual interest and conscientiousness. Lack of interest (e.g., Eccles & Wigfield, 2002; Hidi & Renninger, 2006; Sansone, Thoman, & Smith, 2010; Schiefele, 1991) and low conscientiousness (e.g., McCrae & Löckenhoff, 2010) are common explanations for underdeveloped academic effort, albeit explanations that have been explored relatively separately in the fields of education and psychology. The two concepts differ considerably, both on the conceptual level and in their practical implications. Unfortunately, there have been few attempts to date (e.g., Sansone & Thoman, 2006) to bring them together. This article helps to close this research gap by examining how interest and conscientiousness are associated with academic effort. Three competing models—an additive effects model, a synergistic effects model, and a compensatory effects model—are described and tested in four empirical studies.

Academic Effort and Achievement Outcomes

Students who report higher levels of academic effort work diligently and persist at a difficult task even when the work is hard. They try to finish all tasks set, and they do not copy from others to avoid difficult or unpleasant work (see Pintrich & de Groot, 1990; Zimmerman & Pons, 1986). Successful effort regulation is positively related to achievement: The more effort students put into their academic work, the better their achievement (e.g., Bidjerano & Dai, 2007; Dettmers, Trautwein, Lüdtke, Kunter, & Baumert, 2010; Noftle & Robins, 2007; Pintrich & de Groot, 1990; Trautwein, 2007).

Not surprisingly, high and sustained academic effort is a key variable in comprehensive theoretical models of academic learning (e.g., Boekaerts, Pintrich, & Zeidner, 2000; Eccles & Wigfield, 2002; Pintrich & de Groot, 1990; Schunk & Zimmerman, 2008; Wigfield, 1994). There are substantial interindividual differences in academic effort. For instance, Trautwein and Lüdtke (2007, 2009) asked more than 500 eighth- and ninth-grade students to describe their typical level of homework effort in various school subjects and found large between-students differences in the overall level of homework effort.

In this article, we attempt to explain between-students and within-student differences in academic effort by building on interest research and research on conscientiousness, two largely separate research streams. We are primarily interested in the combined predictive effect of these person characteristics on academic effort.

Interest: Motivating Achievement-Related Behaviors

In recent decades, interest has become a key concept in educational and psychological research, and much progress has been made in understanding its role as an outcome variable and a predictor of learning (e.g., Eccles & Wigfield, 2002; Hidi & Ainley, 2008; Krapp, 2002). Interest research is a highly productive yet also somewhat complex and fragmented field with several different, albeit overlapping, lines of theorizing (see Wigfield & Eccles, 2000).

Individual interest can be defined as a relatively stable evaluative orientation toward certain domains (Eccles & Wigfield, 2002; Schiefele, 1991) and "a relatively enduring predisposition to reengage with particular content over time" (Hidi & Ainley, 2008, p. 88). Hence, individual interest relates to specific content; for instance, a student may be highly interested in the content of mathematics lessons but less interested in biology. According to the Munich Interest School (e.g., Krapp, 2002; Schiefele, 1991), two aspects or components of individual interest can be distinguished: feeling-related and value-related valences. Similarly, expectancy–value theory (Eccles & Wigfield, 2002) distinguishes between intrinsic value and attainment value. *Intrinsic value* (sometimes called *interest value*) is defined as the enjoyment one gains from doing a task. "When individuals do tasks that are intrinsically valued, there are important psychological consequences for them, most of which are quite positive" (Wigfield & Eccles, 2000, p. 72). *Attainment value* has similarities with value-related valences as described by Schiefele (1991).

It is important to differentiate between individual interest and interest experience (see also Tsai, Kunter, Lüdtke, Trautwein, & Ryan, 2008). Whereas individual interest is a relatively stable evaluative orientation toward certain domains, *interest experience* is a state of interest. The psychological state of interest is triggered when contents are perceived as relevant to one's individual interests. Thus, interest experience is a momentary manifestation of this latent disposition (Krapp, 2002). It may be triggered by characteristics of the learning situation (e.g., a boring lesson vs. cognitively activating homework).

To date, there is no single standardized and widely accepted instrument for the assessment of individual interest. Instead, many different questionnaires with good face validity and, typically, good psychometric quality have been used.

Interest is strongly domain specific (Bong, 2001; Eccles, Wigfield, Harold, & Blumenfeld, 1993). Students often have favorite subjects at school and will happily volunteer reasons for preferring mathematics or sports, even if their objective performance in both subjects is the same. In fact, correlations among interests in different subjects are typically much lower than are correlations among corresponding grades or test scores (e.g., Nagy, Trautwein, Baumert, Köller, & Garrett, 2006). In particular, there is a strong distinction between verbal and mathematical subjects, with students tending to report more interest in either one or the other (Nagy et al., 2006; see also Marsh, 1986). Empirical evidence indicates that the domain specificity of interest increases with students' age (Denissen, Zarrett, & Eccles, 2007).

Conscientiousness: A Broad Personality Trait

The second central person characteristic considered in this article is the personality trait of conscientiousness. *Personality traits* are characterized as typical patterns of thoughts, feelings, and behaviors. Individuals reporting high levels of *conscientiousness* tend to follow socially prescribed norms for impulse control, be task- and goal-directed, be planful, delay gratification, and follow norms and rules (John, Naumann, & Soto, 2008; John & Srivastava, 1999). Together with neuroticism, extraversion, agreeableness, and openness to experience (the latter sometimes labeled as *imagination*, *intellect*, or *culture*), conscientiousness is one of the traits represented in the Big Five model of personality (Digman, 1990; Funder, 2001; Goldberg, 1993). The Big Five model is the most frequently used trait model in personality psychology. Despite ongoing controversies about the number of factors (e.g., Lee & Ashton, 2008) and the underlying definition of a trait (e.g., Mischel & Shoda, 1995), it is generally well accepted as a good working model (see McAdams & Pals, 2006).

In contrast to individual interest, most researchers have used just a few standardized questionnaires to assess conscientiousness, such as the NEO Personality Inventory (NEO-PI) and the NEO Five-Factor Inventory (NEO-FFI; Costa & McCrae, 1992) as well as the Big Five Inventory (BFI; John et al., 2008). Despite some debates about measurement issues (e.g., Marsh et al., 2010), these instruments have proved to be reliable and valid.

Conscientiousness is typically (e.g., Jackson, Hill, & Roberts, 2012; McCrae & Costa, 2008) conceptualized as a domain-general trait. Of particular relevance for the present study, there is evidence to show that students high in conscientiousness tend to work hard across a wide range of subjects (e.g., Trautwein & Lüdtke, 2007).

Conscientiousness is known to be associated with academic behavior and success outcomes (for an overview, see Poropat, 2009) and to have a number of adaptive effects (De Raad &

Schouwenburg, 1996). Noftle and Robins (2007) summarized the results of 20 studies examining the association between conscientiousness and grade point average or college grades. Conscientiousness was significantly positively related to the academic outcome variable in 15 of these 20 studies; the mean effect size was 0.26. Similarly, the relatively few studies that have examined the association between conscientiousness and academic outcomes in high school students have generally found positive links (e.g., Freudenthaler, Spinath, & Neubauer, 2008; Lounsbury, Sundstrom, Loveland, & Gibson, 2003; Lüdtke, Trautwein, Nagy, & Köller, 2004; Spengler, Lüdtke, Martin, & Brunner, 2013). These positive associations are thought to be mediated by academic effort (see De Raad & Schouwenburg, 1996); recent studies have provided initial empirical support for this idea (Bidjerano & Dai, 2007; Noftle & Robins, 2007).

Are high levels of conscientiousness equally important in all learning situations? In two empirical studies, Trautwein and colleagues tested the hypothesis that high conscientiousness is particularly important in situations characterized by low external supervision or control. In the first study, Trautwein, Lüdtke, Kastens, and Köller (2006) compared the association between conscientiousness and effort on homework (where there is no direct teacher supervision) with the association between conscientiousness and classwork (where there is more teacher supervision) in a sample of 571 high school students. They found conscientiousness to have stronger effects on self-reported homework effort than on self-reported classwork effort and interpreted this finding as indicating that the effects of external control on effort in academic tasks are less pronounced among conscientious students than they are among less conscientious students. In a more direct test of this hypothesis, in a second study with 511 high school students, Trautwein and Lüdtke (2007) examined the relationship between perceived homework control (i.e., the perception that the teacher monitors homework completion closely) and academic effort in students high and low in conscientiousness. They expected academic effort to be less affected by perceived homework control in students high in conscientiousness than in students low in conscientiousness. Indeed, perceived teacher control was found to have a weaker effect on self-reported academic effort in high-conscientiousness students than in low-conscientiousness students. In other words, the experience of external control was less relevant to the behavior of students high in conscientiousness than it was to the behavior of their less conscientious peers.

Interest, Conscientiousness, and Academic Effort

What are the associations among the three constructs of individual interest, conscientiousness, and academic effort? Unfortunately, with a small number of notable exceptions (e.g., Sansone et al., 2010; Sansone, Wiebe, & Morgan, 1999), there have been few attempts to answer this question empirically. As such, there is no established body of research on which we could directly base any predictions in the present research.

However, the existing literature provides some discussion about how individual interest and conscientiousness might be related, suggesting that the two constructs belong to different layers of personality and are located at different levels of analyses (e.g., Asendorpf & van Aken, 2003; Jackson, Hill & Roberts, 2012; McCrae & Costa, 2008; but see Kandler, Zimmermann, & McAdams, 2014). For instance, McAdams and Pals (2006) differentiated between dispositional traits and characteristic adaptations (including values and other motivational concerns), highlighting conceptual and developmental differences between traits (high stability, low plasticity in response to context variables, high domain generality; see McCrae & Costa, 2008) and characteristic adaptations (more amenable to external influences, more likely to change over time, more situation anchored). Similarly, Asendorpf and van Aken (2003) differentiated between *core* and *surface* characteristics, with traits (including conscientiousness) constituting the core of personality (relatively high "immunity to environmental influences," p. 636) and constructs such as self-worth, self-perceived peer acceptance, and loneliness constituting the surface characteristics, which evidence "high (but not total) susceptibility to environmental influences" (p. 636). According to Winter, John, Stewart, Klohnen, and Duncan (1998), who differentiated between *traits* and *motives*, "motives refer to people's wishes and desires" (p. 231); in contrast, traits refer to people's "stylistic and habitual patterns of cognition, affect, and behavior" (Emmons, 1989, p. 32). Hence, motives describe the personal evaluation of the consequences of specific, goal-directed actions.

Individual interests relating to school subjects have not been addressed specifically in the prior discussion of how constructs at different levels (traits/core characteristics vs. characteristic adaptations/surface characteristics) may relate to each other. However, it is conceivable that individual interests constitute a characteristic adaption or surface characteristic that is susceptible to environmental influences. Further, interests can be seen as one class of motives in which both the activity and the consequence of the activity are of importance. Similarly, in contrast to traits, which describe how individuals behave across situations, interests describe what individuals want to do.

What are the implications of the relative conceptual independence of trait conscientiousness and individual interest for their combined predictive effect on academic effort? Three main models of how interest and conscientiousness could be related to academic effort can be distinguished: an additive effects model, a synergistic effects model, and a compensatory effects model (for a detailed description, see Cohen, Cohen, West, & Aiken, 2003).

Intuitively, the additive effects model might best describe how conscientiousness and interest might be related to academic effort. The *additive effects model* suggests that both conscientiousness (Z) and individual interest (X) uniquely and independently predict academic effort. The combined effect of conscientiousness and interest equals the sum of their separate effects. In this model, the conceptual difference between the two constructs would be mirrored by statistical independence. A prototypical illustration of an additive effect is provided in Figure 1a. In this example, both predictors X (interest) and Z (conscientiousness) positively and additively predict the outcome Y (effort).

There is some conceptual and empirical support for additive effects. Conceptually, on the basis of the assumption that these constructs are located at different levels of analysis (Asendorpf & van Aken, 2003; Jackson et al., 2012), one might expect that they provide independent/additive prediction. Empirical support for additive effects was found, for instance, in one of our previous studies, in which—based partly on the same data sets as in the present study—we used conscientiousness and competence beliefs to predict academic effort and achievement (Trautwein, Lüdtke,

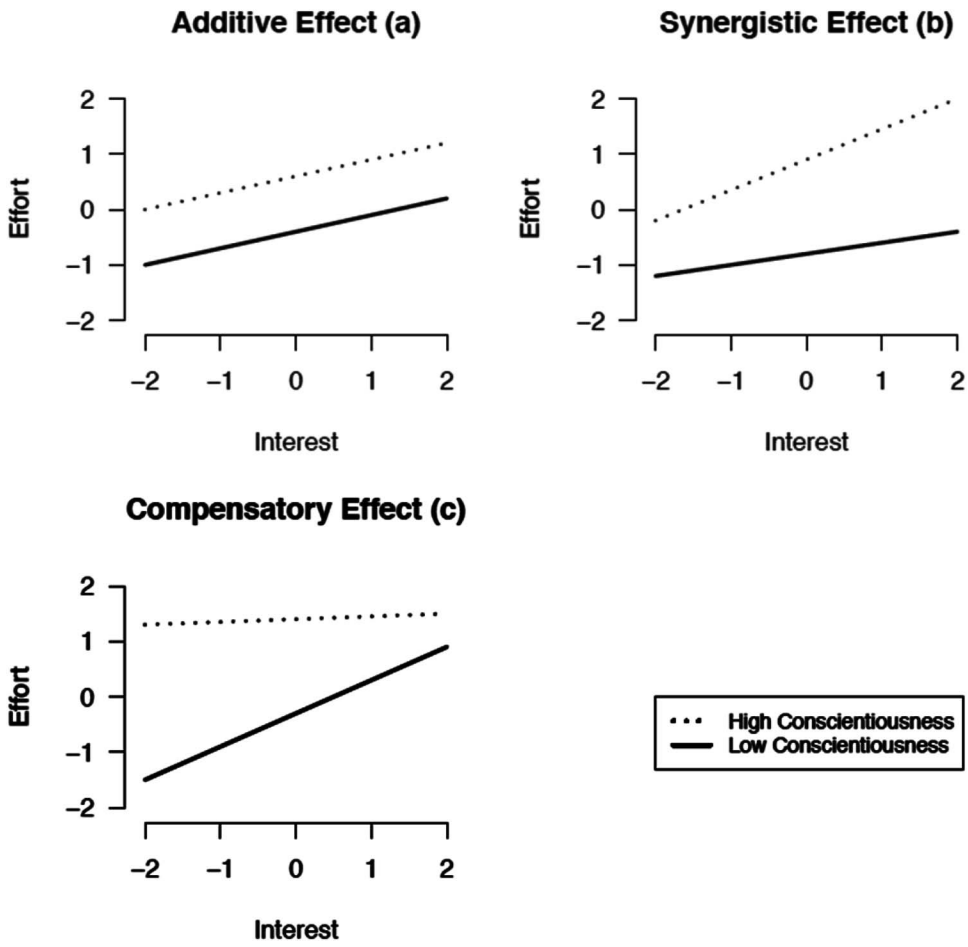

Figure 1. Illustration of prototypical cases of additive, synergistic, and compensatory effects. Interest, conscientiousness, and effort are z standardized ($M = 0$, $SD = 1$). Depicted are simple slopes at ± 1 standard deviation from the mean of conscientiousness (moderator).

Roberts, Schnyder, & Niggli, 2009). Similar to interest, competence beliefs are conceptualized as characteristic adaptations or surface characteristics. In this set of studies, conscientiousness and competence beliefs independently and additively predicted academic achievement and academic effort.

The two other models are based on the interactive effects perspective, which posits a statistical interaction between conscientiousness and individual interest in predicting academic effort. In these models, the combined effect of interest and conscientiousness differs from the sum of their two separate effects. Interaction effects can result in several different patterns of results, depending on the sign of the two predictors and the interaction effect. Because of the empirically established positive associations between conscientiousness/interest and academic effort, we concentrate on two patterns that differ only in the sign of the interaction effect. A *synergistic interaction* (also called an *enhancing interaction*; Cohen et al., 2003) is found when "both predictors affect the criterion *Y* in the same direction, and together they produce a stronger than additive effect on the outcome" (Cohen et al., 2003, p. 285). The empirical pattern resulting from a *synergistic effects model* is illustrated in Figure 1b. In the present case, a synergistic interaction would mean that academic effort is especially high when students are high in both conscientiousness and interest.

Of relevance to the main thrust of the present study, some recent studies (Nagengast et al., 2011; Trautwein et al., 2012) found synergistic effects between competence beliefs and interest/value beliefs when predicting academic outcomes such as achievement or engagement. However, conscientiousness was not included in these studies, and—given that competence beliefs and interest are both understood as characteristic adaptations/surface characteristics—the implication of this finding is not straightforward.

Finally, a *compensatory effect* (often called an *interference* or *antagonistic effect*; Cohen et al., 2003) is found when the sign of the interaction is opposite to that of the two main effects. This pattern is illustrated in Figure 1c. In this model, the negative effect of low *X* is buffered when *Z* is high. Cohen et al. argued that this pattern is indicative of a partial, "either/or" pattern of influence of the two predictors on the criterion. In such an interaction, the two predictors compensate for each other to a certain extent. In our case, a compensatory interaction would mean that individual interest is less important for academic effort in students who are high in conscientiousness, and that conscientiousness is of less impor-

tance for students who are high in interest. Hence, conscientiousness and individual interest compensate for each other.

Few prior studies have probed for interaction effects between conscientiousness and interest. One of the notable exceptions is the work by Sansone and colleagues (e.g., Sansone et al., 1999, 2010), who used a series of laboratory experiments to study the participants' persistence in more or less boring tasks. Sansone et al. (2010) speculated that "in individuals high in conscientiousness, the lack of motivation derived from the boring experience is not as critical for their persistence" (p. 210). Indeed, Sansone et al. (2010) found empirical support for such a compensatory effect. However, as it was based on laboratory experiments, Sansone and colleagues' work to date has been restricted to interest experience (and not individual interest) and has not considered real-life learning settings.

The Present Investigation

The evidence indicates that both conscientiousness and interest are, when considered separately, important predictors of academic effort. However, the unique and interactive predictive power of conscientiousness and interest with respect to academic effort has not yet been systematically examined. In this article, we perform reanalyses of four data sets to examine the empirical support for the three models described in the previous section.

All four studies drew on relatively large samples of high school students who were assessed during regular classroom hours. Studies 1, 2, and 3 used a latent variable approach to examine the predictive power of individual interest, conscientiousness, and their interaction. In addition to between-students analyses, Study 3 also used a within-student multilevel design to contrast the domain specificity of interest and the domain generality of conscientiousness. Finally, Study 4 used a diary approach and multilevel modeling to probe for the predictive effects of conscientiousness and interest experience in French as a foreign language with respect to day-to-day variations in academic effort within students.

Study 1

In Study 1, we used a latent variable framework to examine conscientiousness and individual interest in three subjects (mathematics, English, and German) as predictors of academic effort in these subjects in a large sample of high school students. Our research goal was to test the empirical support for the three models described earlier at the between-students level.

Method

Sample. We reanalyzed data from the fourth (and final) wave of the large-scale school achievement study Tradition and Innovation in School Systems (see Jonkmann, Rose, & Trautwein, 2013). A total of 2,557 eighth-grade students (54.7% male; age: $M = 14.02$ years, $SD = 0.61$) from 133 classes in 99 nongymnasium schools in two German states (Baden-Württemberg and Saxony) participated in this study, which was conducted during the 2011–12 school year. The schools were randomly selected and invited to participate in a school achievement study. More than 80% of the schools that were contacted agreed to participate. All students in each class were asked to participate, and the overall participation rate was above 80%. Trained research assistants administered the study materials during regular lesson time.

Instruments: Conscientiousness. Conscientiousness was measured using the nine conscientiousness items from the German version (Lang, Lüdtke, & Asendorpf, 2001) of the BFI (John, Donahue, & Kentle, 1991). Preliminary analyses showed somewhat low item-total correlations for the four negatively worded items (all rs $< .35$). For this reason, we only used the five positively worded items, which formed a scale with adequate internal consistency (Cronbach's $\alpha = .80$).[1]

Instruments: Individual interest. Two items with identical wording (except for the name of the subject) were used to assess individual interest in mathematics, German, and English. The items focused on the intrinsic value derived from activities in the respective subject ("Working on math [German, English] tasks is fun for me"; "I'm willing to sacrifice leisure time for math [German, English]"). Internal consistency ($.69 \leq \alpha \leq .74$) was acceptable.

Instruments: Academic effort. Four items focusing on effort in math, German, and English were used to tap students' self-reported academic effort (sample items: "In math [German, English], I diligently work on all tasks and my homework"; "I do my best when it comes to math [German, English]"). Internal consistency ($.87 \leq \alpha \leq .90$) was good.

Statistical analyses. We used structural equation modeling to predict academic effort. The basic model was quite simple, with all predictor variables predicting academic effort. The covariances between the predictor variables were freely estimated. Unfortunately, it is difficult to detect interaction effects in nonexperimental research for the following two reasons (Aiken & West, 1991; McClelland & Judd, 1993). First, the effect sizes for interaction effects in observational studies are usually of small to moderate size. Whereas in experimental studies the distribution of the independent variables can be manipulated by the researcher, cases with pronounced profiles (i.e., individuals with high or low values on both variables) are rare in observational studies. McClelland and Judd demonstrated that this scarcity of cases with pronounced profiles negatively affects the power of observational studies to detect interaction effects. Second, when the two individual predictors X and Z are measured with error, the cross-product term XZ (used to assess the interaction) is even more unreliable than the individual predictors. Thus, estimates of true interaction effects are complicated by the problem of unreliable predictor variables.

Large sample sizes and highly reliable predictor variables both help to avoid Type II errors (i.e., not finding evidence for a statistically significant interaction although one exists). In Study 1, we used structural equation modeling to overcome the reliability problem. Because all constructs were measured by at least two indicators, we were able to specify these constructs as latent variables to correct for measurement error. In addition, we applied latent moderated structural (LMS) equations, which were especially developed for the analysis of nonlinear structural equation models such as latent interactions (Klein & Moosbrugger, 2000).

[1] We repeated the analyses with the full set of conscientiousness items. Whereas the pattern of results was unchanged, the fit of the models decreased because of the low factor loadings of the four negatively worded conscientiousness items on the latent conscientiousness factor.

The LMS approach was implemented in Mplus 7.1 software (Muthén & Muthén, 1998–2013), which was used for the analyses. In a study by Cham, West, Ma, and Aiken (2012; for a comparison of different approaches to modeling latent interactions, see also Kelava et al., 2011), the LMS approach compared favorably with three other approaches as long as the violations of nonnormality were not severe.

In the present data set, students were nested within classes, yielding a multilevel structure of the data. To account for this multilevel structure, the "type = complex" option in Mplus 7.1 was used, which automatically takes into account the multilevel structure when computing standard errors.

In line with the approach proposed in Aiken and West (1991), we standardized all item indicators of our three central constructs (conscientiousness, interest, and academic effort) before running the analyses in Mplus 7.1 to increase the interpretability of the results.

Missing data represent a potentially serious methodological problem in many empirical studies. For the item indicators considered here, the average percentage of missing data was less than 5%. In the methodological literature on missing data (Enders, 2010; Schafer & Graham, 2002), there is growing consensus that multiple imputation or full information maximum likelihood (FIML) estimations are preferable to casewise or listwise deletion. FIML takes all available information (i.e., also cases with missing values) into account when estimating model parameters (see Enders, 2010). We therefore used the FIML approach implemented in Mplus 7.1 to deal with missing values.

Results

Means, standard deviations, intraclass correlation coefficients (ICCs), and correlations for the manifest variables used in Study 1 are presented in Table 1. All ICCs for conscientiousness as well as interest and academic effort were below .10, indicating that most of the variance was within classrooms. Skewness for the item indicators for interest and conscientiousness ranged from −0.37 to 0.39, and kurtosis ranged from −1.04 to −0.21, indicating a modest deviation from normality.

We next specified two structural equation models for each of the three subjects under study. In Model 1, academic effort was regressed on sex, conscientiousness, and interest, whereas the interaction term Conscientiousness × Interest was included as an additional predictor in Model 2. Model fit for this first set of analyses was acceptable, with $\chi^2(51, N = 2{,}557) = 643.14$, $p < .001$, Tucker–Lewis index (TLI) = .912, standardized root mean square residual (SRMR) = .047, and RMSEA = .067 (90% confidence interval [CI] [.063, .072]) for math; $\chi^2(51, N = 2{,}557) = 325.46$, $p < .001$, TLI = .959, SRMR = .034, and RMSEA = .046 (90% CI [.041, .051]) for German; and $\chi^2(51, N = 2{,}557) = 374.41$, $p < .001$, TLI = .966, SRMR = .034, and RMSEA = .050 (90% CI [.045, .055]) for English. As reported in Table 2, both conscientiousness and academic interest significantly predicted academic effort in each of the three subjects.

We next tested whether support could be found for the synergistic effects model or the compensatory effects model by adding the latent interaction term Conscientiousness × Interest as an additional predictor variable. The parameters for this model are also reported in Table 2 (Model 2). The interaction term had a statistically significant regression weight in all three subjects (math: $B = -.20$; German: $B = -.17$; English: $B = -.22$), indicating that conscientiousness and interest mutually moderated each other's predictive effects on academic effort. The interaction term explained between 2% and 3% of the variance in academic effort, over and above the main effects.

Simple slopes of the effect of interest on effort were calculated for students with a high (+1 standard deviation above the mean) or low (−1 standard deviation below the mean) value in conscientiousness (Cohen et al., 2003; see also Bauer & Curran, 2005). For mathematics, students high in conscientiousness showed a lower (but still positive) effect ($B = .35$, 95% CI [.29, .42], $p < .001$) than students low in conscientiousness ($B = .65$, 95% CI [.58, .71], $p < .001$). Similar results were obtained for German (high conscientiousness: $B = .40$, 95% CI [.33, .48], $p < .001$; low conscientiousness: $B = .66$, 95% CI [.56, .76], $p < .001$) and English (high conscientiousness: $B = .45$, 95% CI [.38, .51], $p < .001$; low conscientiousness: $B = .77$, 95% CI [.69, .84], $p < .001$).

The significant interaction effects are plotted in Figure 2. As can be seen, students high in both conscientiousness and interest reported the highest academic effort, whereas students low on both conscientiousness and interest reported the lowest effort. More important, however, the figure illustrates a compensation effect: At very high levels of individual interest, conscientiousness did not add much to academic effort, and, even if their conscientiousness was low, students high in interest reported above-average academic effort.

We next performed a set of robustness checks (Roisman et al., 2012). First, to exclude the possibility that the significant multiplicative term in fact reflects nonlinear predictive effects in its two components (conscientiousness and interest), we added quadratic terms for conscientiousness and domain-specific interest to Model

Table 1
Descriptive Results and Intercorrelations Between Study 1 Variables (Correlations Among Manifest Variables)

Variable	*M*	*SD*	ICC	1	2	3	4	5	6	7
1. Conscientiousness	3.42	0.78	.05	—						
2. Math interest	2.38	0.90	.05	.23	—					
3. German interest	2.29	0.81	.08	.24	.43	—				
4. English interest	2.38	0.84	.04	.24	.33	.57	—			
5. Math effort	3.02	0.70	.05	.37	.53	.26	.22	—		
6. German effort	3.06	0.69	.05	.41	.26	.46	.36	.65	—	
7. English effort	3.07	0.71	.05	.37	.16	.27	.54	.52	.70	—

Note. $N = 2{,}557$. ICC = intraclass correlation coefficient.

Table 2
Predicting Academic Effort in Mathematics, German, and English in Study 1: Results From Structural Equation Modeling

Variable	Model 1			Model 2		
	B	*SE*	*p*	*B*	*SE*	*p*
Dependent variable: Effort in mathematics[a]						
Conscientiousness	.25	.03	<.001	.28	.03	<.001
Math interest	.49	.03	<.001	.50	.03	<.001
Conscientiousness × Math Interest				−.20	.03	<.001
Sex: Male	−.08	.03	.005	−.08	.03	.006
Dependent variable: Effort in German[b]						
Conscientiousness	.36	.03	<.001	.37	.03	<.001
German interest	.51	.04	<.001	.53	.04	<.001
Conscientiousness × German Interest				−.17	.04	<.001
Sex: Male	−.11	.03	.001	−.11	.03	.001
Dependent variable: Effort in English[c]						
Conscientiousness	.29	.03	<.001	.32	.03	<.001
English interest	.60	.03	<.001	.61	.03	<.001
Conscientiousness × English Interest				−.22	.03	<.001
Sex: Male	−.07	.03	.016	−.07	.03	.014

Note. $N = 2{,}557$.
[a] Variance explained: .70 (Model 1) and .73 (Model 2). [b] Variance explained: .60 (Model 1) and .62 (Model 2). [c] Variance explained: .64 (Model 1) and .67 (Model 2).

2 (Ganzach, 1997; MacCallum & Mar, 1995). Despite these additions, the interaction term Conscientiousness × Interest remained statistically significant (math: $B = -.17$, $p < .001$; German: $B = -.12$, $p = .040$; English: $B = -.19$, $p < .001$). Second, we included prior achievement (school grades) as a further predictor variable, but this had negligible impact on the other coefficients. Third, because it has been argued that latent moderated structural equation modeling might be sensitive to even moderate levels of nonnormality in the indicators that are used (Cham et al., 2013), we also repeated the analyses using manifest indicators. Because of the unreliability that typically characterizes interaction terms, this analysis may underestimate the size of the respective regression coefficient (Marsh, Wen, Hau, & Nagengast, 2013). However, in the present case, when repeating Model 2 with manifest indicators, the resulting interaction terms were statistically significant in all three subjects (math: $B = -.10$, $p < .001$; German: $B = -.06$, $p = .001$; English: $B = -.10$, $p < .001$).

In a final analysis, we checked for the existence of a compensatory effect when interest was replaced by self-concept in latent moderated structural equation modeling. In this analysis, we found support for a compensatory effect in math ($B = -.10$, $p < .001$) but nonsignificant interaction terms in German ($B = -.06$, $p = .056$) and English ($B = -.06$, $p = .145$).

Summary

Study 1 supported the compensatory effects model. Both conscientiousness and individual interest statistically significantly and uniquely predicted academic effort in three school subjects, and the statistically significant interaction term Conscientiousness × Interest indicated that conscientiousness and interest might—to a certain degree—compensate for each other in promoting academic effort.

Study 2

In Study 2, we applied the same analytical approach as in Study 1 to reanalyze a data set with a fairly large sample of high school students from gymnasium schools (the academic track). Although this data set has been used in prior analyses (see Trautwein, Lüdtke, Schnyder, & Niggli, 2006, Study 1; Trautwein et al., 2009, Study 2), the research question of the present article (the possible interaction effect between conscientiousness and interest) has not been addressed before.

Method

Sample. A total of 415 Grade 8 students (58.5% female; age: $M = 13.45$ years, $SD = 0.58$) from 20 classes in 11 academic track (gymnasium) schools in Berlin, Germany, participated in this study, which was conducted during the 2003–04 school year. The schools were randomly selected and invited to participate in a study on academic effort. About two thirds of the schools that were contacted agreed to participate. Within schools, up to three classes were selected on the basis of availability. All students in each class were asked to participate, and the participation rate was above 85% in all classes. Trained research assistants administered the study materials during regular lesson time.

Instruments: Conscientiousness. Conscientiousness was measured using the 12 conscientiousness items from the German version of the NEO-FFI (Borkenau & Ostendorf, 1993 [original version by Costa & McCrae, 1992]). The results of numerous studies using the German translation attest to its high reliability, validity, and comparability with the English original (Borkenau & Ostendorf, 1993; Lüdtke et al., 2004). Internal consistency (Cronbach's alpha) was satisfactory ($\alpha = .84$). Four item parcels were created for the analyses; we averaged Items 1, 5, and 9; Items 2, 6,

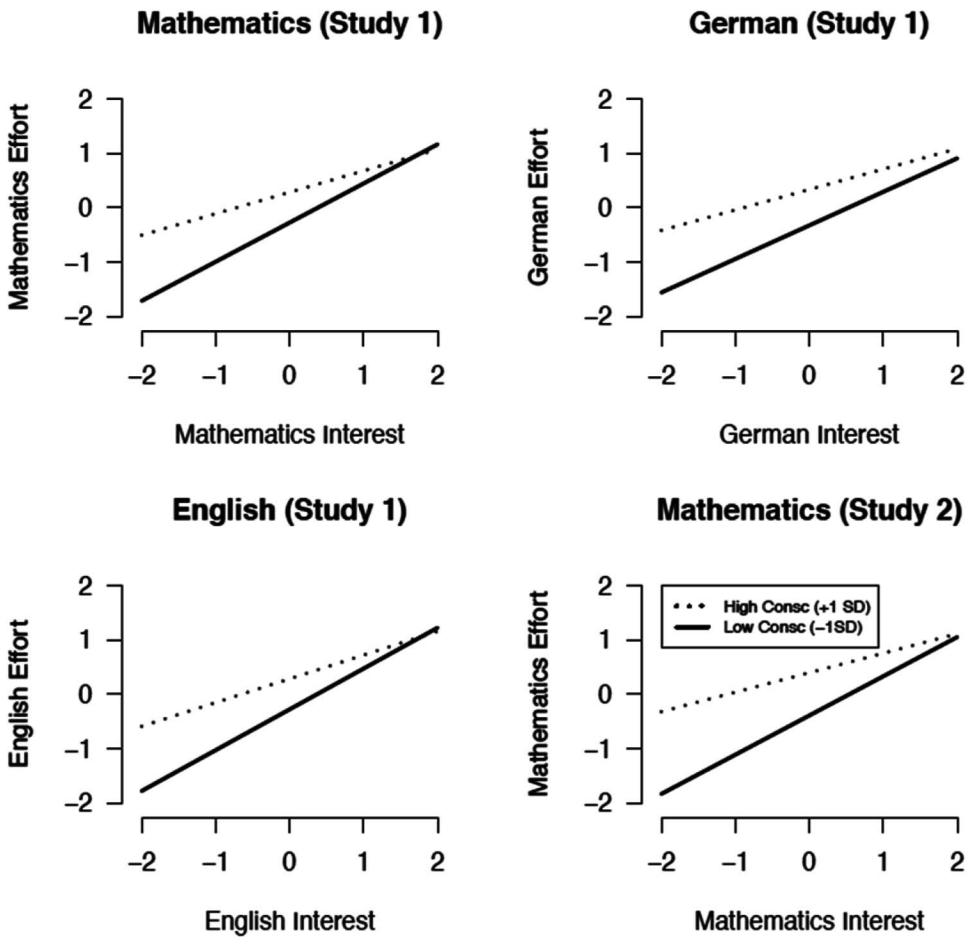

Figure 2. Plots of the moderating effect of conscientiousness (Consc) on the relationship between interest and effort in Studies 1 and 2. Depicted are simple slopes at ±1 standard deviation from the mean of conscientiousness. All effects are between students. The independent variable (interest) and the dependent variable (effort) range from −2 to +2 standard deviations of the mean (see Aiken & West, 1991).

and 10; Items 3, 7, and 11; and Items 4, 8, and 12.[2] The use of parceling meant that fewer model parameters were estimated, resulting in a better ratio of variables to sample size and more stable parameter estimates (Bandalos, 2002; Kishton & Widaman, 1994; for the consequences of and issues associated with parceling, see Little, Cunningham, Shahar, & Widaman, 2002).

Instruments: Individual interest. Seven items were used to assess individual interest in mathematics and English. The items focused on the intrinsic value derived from mathematics- and English-related activities and the personal relevance of mathematics and English (e.g., "I find mathematics [English] very interesting"; "I like doing mathematics [English] very much"). With Cronbach's alphas of .90 (mathematics) and .88 (English), internal consistency was high.

Instruments: Academic effort. Six items focusing on mathematics and English homework compliance were used to tap students' self-reported academic effort (sample items: "I always try to complete my mathematics [English] homework"; "I do my best when it comes to math [English] homework"; "I often copy math [English] homework from others" [reverse scored]). Students high in homework compliance do their assignments carefully and do not copy from others. Cronbach's alphas were .85 for mathematics and .72 for English, indicating acceptable internal consistency.

Statistical analyses. We again used the LMS method for modeling the latent interaction between interest and conscientiousness to predict academic effort. Unlike in Study 1, because of the relatively low number of classes and the high number of parameters to be estimated, the "type = complex" option available in Mplus 7.1 to correct for the clustered sample may not be fully trustworthy. We therefore set the level of statistical significance to $p < .01$ in the following analyses.

As in Study 1, to increase the interpretability of the results, we standardized all item indicators before running the analyses in

[2] We also applied two additional parceling schemes (i.e., neighboring items forming the parcels and parceling based on item-total correlations); these alternative approaches yielded essentially identical results (see also Sterba & MacCallum, 2010).

Mplus 7.1. On average, less than 3% of the data were missing. FIML, which takes all available information (i.e., also cases with missing values) into account when estimating model parameters (see Enders, 2010), was again used to deal with this low percentage of missing values.

Results

Means, standard deviations, ICCs, and correlations for the variables used in Study 2 are presented in Table 3. ICCs for conscientiousness as well as math interest and math academic effort were all below .10, indicating that most of the variance was within classrooms, but they were slightly higher for English interest and English academic effort. Except for one English interest item ("I hate everything that is related to English"), skewness and kurtosis were moderate (skewness: from −0.95 to 0.35; kurtosis: from −1.08 to 0.65) for the item indicators of conscientiousness and interest. Conscientiousness was moderately associated with interest in math ($r = .25$) and English ($r = .37$).

We next specified two structural equation models for each of the two subjects under study. In Model 1, academic effort was regressed on sex, conscientiousness, and interest, whereas in Model 2, the interaction term Conscientiousness × Interest was included as an additional predictor. The results are reported in Table 4. Model fit for this first set of analyses was acceptable, with $\chi^2(132, N = 415) = 439.36$, $p < .001$, TLI = .885, SRMR = .066, and RMSEA = .075 (90% CI [.068, .083]) for math and $\chi^2(132, N = 415) = 418.51$, $p < .001$, TLI = .086, SRMR = .060, and RMSEA = .073 (90% CI [.065, .081]) for English.

We next tested whether support could be found for the synergistic effects model or the compensatory effects model by adding the latent interaction term Conscientiousness × Interest as an additional predictor variable. The parameters for this model are also reported in Table 4 (Model 2). The interaction term had a statistically significant regression weight in math ($B = -.20$) but not in English ($B = -.04$), indicating that conscientiousness and interest mutually moderated each other's predictive effects on academic effort in mathematics but not in English. In math, the interaction term explained 3% of the variance. Again, simple slopes of the effect of interest on effort in mathematics were calculated for students with a high (+1 standard deviation above the mean) or low (−1 standard deviation below the mean) value in conscientiousness. The effect was smaller for students with a high value ($B = .41$, 95% CI [.28, .53], $p < .001$) than for students with a low value ($B = .69$, 95% CI [.54, .83], $p < .001$) in conscientiousness. An illustration of the interaction effect for mathematics is given in Figure 2.

Table 3
Descriptive Results and Intercorrelations Among Study 2 Variables (Correlations Among Manifest Variables)

Variable	*M*	*SD*	ICC	1	2	3	4	5
1. Conscientiousness	2.76	0.48	.06	—				
2. Math interest	2.81	0.72	.05	.25	—			
3. English interest	3.05	0.58	.10	.37	−.01	—		
4. Math effort	3.14	0.65	.01	.48	.58	.06	—	
5. English effort	3.04	0.58	.12	.53	.15	.40	.50	—

Note. $N = 415$. ICC = intraclass correlation coefficient.

We again performed a set of robustness checks. First, to exclude the possibility that the multiplicative term in fact reflected nonlinear predictive effects in its two components (conscientiousness and interest), we added quadratic terms for conscientiousness and domain-specific interest to Model 2. Despite these additions, the interaction term Conscientiousness × Interest remained statistically significant in math ($B = -.22$, $p < .001$). For English, the size of the regression coefficient increased ($B = -.14$) but remained statistically nonsignificant ($p = .09$). Second, we included prior achievement (school grades) as a further predictor variable, but the interaction effect in math remained stable ($B = -.20$, $p < .001$). Third, when repeating the analyses using manifest indicators, the regression coefficient (B) for the interaction term Conscientiousness × Math Interest was −.10 ($p = .007$).

Finally, we again checked for the existence of a compensatory effect when interest was replaced by competence beliefs. For mathematics, we found a negative interactions effect ($B = -.11$, $p = .022$), which bordered the $p < .01$ significance level we had adopted for Study 2, whereas the coefficient (B) for English was −.06 ($p = .360$).

Summary

Study 2 supported the compensatory effects model in mathematics. Both conscientiousness and individual interest statistically significantly and uniquely predicted mathematics effort, and the statistically significant interaction term Conscientiousness × Interest indicated that conscientiousness and interest might—to a certain degree—compensate for each other in promoting academic effort. No statistically significant interaction effect was found for English as a second language.

Study 3

In Study 3, a fairly large number of high school students were asked to report their interest in a set of five subjects as well as the academic effort they typically invested in those subjects. This data set has been used for studies on the association among competence beliefs and achievement (Marsh et al., 2015) and on teacher ratings of achievement goals (Dicke, Lüdtke, Trautwein, Nagy, & Nagy, 2012); conscientiousness, interest, and academic effort have not been part of any prior analyses.

We again performed analyses at the between-students level. In other words, for each of the five subjects, we probed for a statistically significant interaction between conscientiousness and academic interest in predicting academic effort.

More important, however, using a multilevel design, we complemented the analyses at the between-students level with analyses at the within-student level. Over time, most students develop specific interest profiles, showing a marked interest in some subjects and a dislike of others. These interest profiles are likely to correspond with profiles of academic effort, with students putting more effort into their favorite subjects and less into their least liked subjects. At the same time, students high in conscientiousness can be expected to report more academic effort overall than students low in conscientiousness.

We tested for interaction effects at both the between-students level (as in Studies 1 and 2) and the within-student level. In the context of a within-student multilevel design, the enhancing effects

Table 4
Predicting Academic Effort in Mathematics and English in Study 2: Results From Structural Equation Modeling

Variable	Model 1			Model 2		
	B	*SE*	*p*	*B*	*SE*	*p*
Dependent variable: Effort in mathematics[a]						
Conscientiousness	.34	.06	<.001	.37	.06	<.001
Math interest	.53	.07	<.001	.55	.06	<.001
Conscientiousness × Math Interest				−.20	.05	<.001
Sex: Male	−.09	.07	.191	−.08	.07	.247
Dependent variable: Effort in English[b]						
Conscientiousness	.34	.06	<.001	.34	.06	<.001
English interest	.22	.05	<.001	.22	.05	<.001
Conscientiousness × English Interest				−.04	.06	.531
Sex: Male	−.10	.06	.135	−.10	.06	.131

Note. $N = 415$.
[a] Variance explained: .77 (Model 1) and .80 (Model 2). [b] Variance explained: .78 (Model 1) and .78 (Model 2).

model predicts that high interest in a specific subject coupled with overall high conscientiousness will result in especially high academic effort in that subject. Conversely, the compensatory effects model predicts that the relationship between interest and academic effort is weaker in students high in conscientiousness than in students low in conscientiousness (i.e., that conscientiousness can compensate for lack of interest), and vice versa.

Method

Sample. Initially, 1,140 students from 51 Grade 7 (56%) and Grade 10 (44%) classrooms in six high schools in Berlin, Germany, participated in the current study (the participation rate was >.90). Of these, 115 students were excluded because of language difficulties that prevented them from understanding the questionnaire, insufficient motivation to follow instructions, or lack of information on all relevant variables. The remaining 1,025 students (54% female; age: $M = 14.29$ years, $SD = 1.61$) constituted the sample for the present investigation.

The data were collected via a questionnaire administered during a regular lesson. In each class, two survey administrators read the standardized instruction to the students. Student participation was anonymous and voluntary, and written parental consent was obtained for all students. The study was conducted in the second half of the 2005–06 academic year. Two cinema vouchers were raffled off in each class; all participants received candy.

Measures: Conscientiousness. Conscientiousness was measured using the 12 conscientiousness items from the German version of the NEO-FFI (Borkenau & Ostendorf, 1993 [original version by Costa & McCrae, 1992]). Internal consistency (Cronbach's alpha) was satisfactory ($\alpha = .85$). For the analyses at the between-students level, four item parcels were created, as in Study 2.[3]

Measures: Domain-specific individual interest. Three interest items tapped students' individual interest in each of the five subjects (e.g., "I am very interested in the content of . . . lessons"). Strictly parallel wording was used for all domain-specific items; that is, the items for German, English, biology, mathematics, and the second foreign language were the same except for the name of the subject. Four-point Likert-type scales ranging from 1 (*completely disagree*) to 4 (*completely agree*) were used. Internal consistencies of the scales (Cronbach's alphas) were satisfactory, ranging from .69 to .83.

Measures: Academic effort. Four items were used to assess students' self-reported academic effort (e.g., "I almost always work hard in . . ."") in each of the five subjects. Again, strictly parallel wording and four-point Likert-type scales ranging from 1 (*completely disagree*) to 4 (*completely agree*) were used. Internal consistencies (Cronbach's alphas) ranged from .56 to .79.

Statistical analyses. In Study 3, we used two different analytical approaches. First, paralleling the approach reported in Studies 1 and 2, we performed analyses at the between-students level using Mplus 7.1. In other words, for each of the five subjects, we probed for a statistically significant interaction between conscientiousness and academic interest in predicting academic effort.

Second, we used multilevel modeling (Raudenbush & Bryk, 2002) to predict self-reported academic effort as a within-student variable. In other words, we applied a design in which school subjects were hierarchically nested within students (for a similar strategy, see Denissen et al., 2007; Trautwein & Lüdtke, 2007). The computer program Hierarchical Linear and Nonlinear Modeling (HLM) 6 (Raudenbush, Bryk, Cheong, & Congdon, 2004) was used for these analyses.

More specifically, on the first level (level of school subjects or within-student level), regression equations were modeled for within-student variables—that is, students' domain-specific academic effort and interest. At the second level (between-students level), regression equations were modeled for characteristics that differ between students (conscientiousness). The third level (classes) was included to take into account the clustering of students within classes when estimating standard errors.

For these analyses, we had five effort measures for each student, giving 1,016 Level-2 variable observations (students) and 4,961 Level-1 observations; nine additional students had to be excluded because of missing data. Further, students were nested within 51 classes.

[3] Alternative parceling schemes again did not have any substantial effect on the results.

For the sake of interpretability, all variables (except sex) were standardized prior to multilevel modeling. In addition, the Level-1 predictor interest was group-mean centered (here, person centered) before standardization. That is, the Level-1 values were centered on the students' own mean scores across subjects. This procedure allows for testing specifically whether effort in a subject is explained by different interest in subjects relative to an individual students' own baseline. In contrast to alternative procedures, such as grand-mean centering, this approach allows effects purely at the within level to be disentangled (see Hofmann & Gavin, 1998).

In the following, we present our modeling approach in more detail (see Raudenbush & Bryk, 2002). The regression equation with one Level-1 predictor variable (domain-specific interest), one Level-2 predictor variable (conscientiousness), and academic effort as the dependent variable would be

$$Y_{ijk} = \pi_{0j} + \pi_{1j} \times \text{Domain-Specific Interest} + e_{ijk},$$

where Y_{ijk} represents the academic effort score of the jth student in the kth class in the ith subject, treated as a continuous variable; π_{1jk} represents the effect of domain-specific interest on effort for the jth student in the kth class; π_{0jk} represents the average academic effort score of the jth student in the kth class; and e_{ijk} denotes residual error within students.

Turning to the between-students level, two equations with conscientiousness as a predictor variable were modeled:

$$\pi_{0jk} = \beta_{00k} + \beta_{01k} \times (\text{Conscientiousness}) + r_{0jk},$$

and

$$\pi_{1jk} = \beta_{10k} + \beta_{11k} \times (\text{Conscientiousness}) + r_{1jk},$$

where β_{00k} can be interpreted as the (conscientiousness-adjusted) average academic effort across all students, β_{01k} represents the effect of conscientiousness on the student's specific intercept, and r_{0jk} represents residual across students. In the second equation, the person-specific regression slopes π_{1jk} are predicted by the coefficient β_{10k}, which can be interpreted as a conscientiousness-adjusted average slope, and the coefficient β_{11k}, which predicts variation in the person-specific slopes. r_{1jk} represents variation in the slopes not explained by the predictor.

The Level-3 model represents the variability in effort among classes—

$$\beta_{00k} = \gamma_{000} + u_{00k},$$

$$\beta_{01k} = \gamma_{010},$$

$$\beta_{10k} = \gamma_{100},$$

and

$$\beta_{11k} = \gamma_{110}$$

—where γ_{000} can be interpreted as the grand mean of effort across all classes, and u_{00k} represents residual error across classes. The person-specific regression parameters β_{01k}, β_{10k}, and β_{11k} are predicted by the coefficients γ_{010}, γ_{100}, and γ_{110}, which are treated as fixed across classes. Note that a significant coefficient γ_{110} indicates an interaction (cross-level interaction) between a Level-1 variable (domain-specific interest) and a Level-2 variable (conscientiousness). A negative value for γ_{110} would mean that the person-specific relation between effort and interest is weaker for students with high conscientiousness scores.

We assessed model fit using the deviance values provided by the computer program HLM 6 (Raudenbush et al., 2004), which can be regarded as measures of lack of fit between model and data (Snijders & Bosker, 1999). Deviance values are not usually interpreted directly; rather, differences in deviance values are calculated for several models from the same data set. The difference in deviance between two models has a chi-square distribution with degrees of freedom equal to the difference in the number of parameters estimated. The chi-square statistic can be used to evaluate the change in model fit when either a fixed or a random effect is added. Large values of the chi-square statistic indicate that the model with more estimated parameters provides a better fit to the data than the more parsimonious model.

There were very few missing data. A total of 44 students enrolled in two of the participating classes did not receive biology instruction during the school year in which the study took place. Hence, they were able to provide meaningful reports of interest and academic effort for only the other four subjects. Moreover, there was a small amount of additional missing data for specific subjects at the within-student level. As a result, the number of Level-1 units was reduced from 5,125 to 4,961.

Results

Descriptive results for Study 3 are reported in Table 5. The mean score for conscientiousness amounted to 2.82 ($SD = 0.50$). Means for interest varied between 2.46 for German and 2.65 for biology, and means for academic effort varied between 2.69 for biology and 2.94 for mathematics. The correlations of individual interest across subjects ranged between .13 (biology and English) and .39 (German and English), and those for academic effort ranged between .30 (biology and English) and .52 (English and second foreign language). The correlations between conscientiousness and interests ranged between .24 and .30, and those between conscientiousness and academic effort varied between .38 and .46. The ICCs ranged between .05 and .18, indicating a low to moderate amount of variance at the between-classrooms level. Ranging from −0.49 to 0.14, skewness for the item indicators for interest and conscientiousness was generally low; kurtosis ranged from −1.18 to 0.03.

Predicting academic effort at the between-students level. Applying the analytical strategy used in Studies 1 and 2, we next performed a set of analyses to predict academic effort at the between-students level. The model fit for Model 1 was acceptable in all five subjects (math/German/English/biology/second foreign language), χ^2s(57, $N = 1{,}025$) = 276.11/158.46/202.10/166.58/241.89, $ps < .001$, TLIs = .923/.962/.960/.964/.931, SRMRs = .047/.029/.031/.029/.040, and RMSEAs = .061/.042/.050/.043/.056 (90% CIs [.054, .069/.034, .049/.042, .057/.036, .051/.049, .064]). In Model 2, the interaction term Conscientiousness × Interest was added.

The results are reported in Table 6. In all five subjects, conscientiousness and interest statistically significantly predicted academic effort. Further, we found support for the compensatory effects model in the three main subjects (math, German, and English). For the other two subjects (biology and second foreign language), no compensatory effects were found.

Table 5
Descriptive Results and Intercorrelations Among Study 3 Variables (Correlations Among Manifest Variables)

Variable	*M*	*SD*	ICC	1	2	3	4	5	6	7	8	9	10	11
1. Conscientiousness	2.82	0.50	.05	—										
2. Math interest	2.61	0.87	.08	.25	—									
3. Biology interest	2.65	0.88	.16	.24	.23	—								
4. German interest	2.46	0.77	.07	.27	.20	.22	—							
5. English interest	2.52	0.90	.12	.30	.23	.13	.35	—						
6. Language interest	2.62	0.82	.06	.28	.24	.14	.39	.39	—					
7. Math effort	2.94	0.68	.07	.46	.54	.19	.14	.23	.16	—				
8. Biology effort	2.69	0.76	.16	.38	.15	.70	.15	.11	.08	.42	—			
9. German effort	2.81	0.68	.12	.45	.06	.17	.57	.25	.20	.42	.43	—		
10. English effort	2.81	0.79	.18	.38	.11	.09	.23	.68	.20	.41	.30	.49	—	
11. Language effort	2.91	0.67	.07	.43	.10	.13	.23	.27	.55	.44	.33	.52	.47	—

Note. *N*s ranged between 985 and 1,024. ICC = intraclass correlation coefficient; Language = second foreign language.

A set of robustness checks was again performed. First, to exclude the possibility that the significant multiplicative term reflects nonlinear predictive effects in its two components (conscientiousness and interest), we added quadratic terms for conscientiousness and domain-specific interest to Model 2 for math, English, and German. When the quadratic terms were added, the interaction term Conscientiousness × Interest remained statistically significant in math ($B = -.17$, $p = .009$) but not in English ($B = -.05$, $p = .258$) or German ($B = -.03$, $p = .711$). However, as indicated earlier, there does not seem to be a full agreement among researchers on whether the inclusion of the quadratic terms is always justified or whether it may lead to some form of overcontrol. Second, we included prior achievement (school grades) as a further predictor variable to Model 1, but the interaction effect remained stable in math ($B = -.20$, $p < .001$), German ($B = -.12$, $p = .010$), and English ($B = -.12$, $p < .001$). Third, we repeated the analyses using manifest indicators which—because of the reduced reliability of the interaction term (see Marsh et al., 2013)—may lead to an underestimation of the size and statistical significance of the interaction term. However, the regression coefficient for the interaction term Conscientiousness × Interest remained statistically significant for math ($B = -.07$, $p = .003$). For German ($B = -.03$, $p = .259$) and English ($B = -.04$, $p = .075$), the regression coefficients did not reach statistical significance.

We finally replaced interest in Model 2 (see Table 6) with a three-item measure of competence beliefs and repeated the analyses. Whereas competence beliefs statistically significantly predicted academic effort in all five subjects, the interaction term Conscientiousness × Competence Beliefs did not reach the level of significance in any subject, and its size was negligible (all ps $> .30$) except for math ($B = -.09$, $p = .06$).

Predicting academic effort at the within-student level. We next performed a set of multilevel analyses to predict academic effort at the within-student level (see Table 7). We first estimated the degree of within-student variance in academic effort relative to between-students and between-classes variance—the so-called empty model (also known as the null model). As indicated by the variance components reported in Table 7, about 4% of the variance in academic effort was between classes, 37% was located at the between-students level, and 60% was at the within-student level. In other words, whether students reported investing effort in a specific subject depended both on their general tendency to invest academic effort and on certain characteristics of the subject in question, whereas only a smaller amount of variance was located at the between-classes level. The fact that substantial amounts of variance were located at both the within-student and the between-students levels also supports our use of a multilevel framework.

In the next model (Model 1), we added predictor variables at Levels 1, 2, and 3. Interest positively predicted academic effort. The coefficient (B) of .40 ($p < .001$) at Level 1 indicates that students put comparatively more effort into those school subjects that interested them. Thus, profiles of interest and academic effort were positively associated. Students high in conscientiousness reported comparatively high levels of academic effort ($B = .25$, $p < .001$). Thus, conscientiousness and interest uniquely predicted academic effort.

The other (control) variables included in Model 1 were also statistically significantly associated with academic effort. Male students and Grade 10 students reported somewhat less effort than did female students and Grade 7 students. Inspection of the variance components reveals that the variables included in Model 1 explained a substantial amount of the variance (33% at Level 1, 7% at Level 2, and almost 100% at Level 3; see Raudenbush & Bryk, 2002). Moreover, the deviance statistics indicated that the fit of Model 1 was much better than that of the empty model, $\Delta\chi^2(4) = 1{,}788.52$, $p < .001$.

The next model (Model 2) allowed us to test for interaction effects. To this end, we first (not in Table 7) checked whether there was a significant variation in the slope of within-student interest across students. In other words, we estimated the variance of the slope for domain-specific interest. The variance component of the slope coefficient proved to be significant, $\chi^2(973) = 1{,}757.74$, $p < .001$.[4] We next tested whether conscientiousness partly explained the variation in the interest slope across students. Indeed, the cross-level interaction effect Conscientiousness × Domain-Specific Interest proved to be statistically significant ($B = -.04$, $p = .006$). Moreover, the model fit of Model 2 was markedly better

[4] The chi-square statistics reported by HLM for this analysis are based on data from 973 of the 1,016 students in the sample. There was no variation in domain-specific interest for the other 43 students; their data were therefore automatically excluded from this part of the analysis. Fixed effects and variance components are based on the full set of data, however.

Table 6
Predicting Academic Effort in Study 3: Results From Structural Equation Modeling (Between-Student Level)

Predictor	Model 1			Model 2		
	B	*SE*	*p*	*B*	*SE*	*p*
Dependent variable: Effort in mathematics[a]						
Conscientiousness	.35	.04	<.001	.41	.05	<.001
Math interest	.58	.04	<.001	.57	.04	<.001
Conscientiousness × Math Interest				−.19	.04	<.001
Sex: Male	−.21	.05	<.001	−.19	.05	<.001
Grade level: 1 = Grade 10	−.15	.05	.005	−.14	.05	.007
Dependent variable: Effort in German[b]						
Conscientiousness	.34	.04	<.001	.34	.04	<.001
German interest	.67	.05	<.001	.67	.05	<.001
Conscientiousness × German Interest				−.11	.05	.015
Sex: Male	−.26	.05	<.001	−.25	.05	<.001
Grade level: 1 = Grade 10	−.10	.05	.050	−.09	.05	.061
Dependent variable: Effort in English[c]						
Conscientiousness	.20	.04	<.001	.20	.04	<.001
English interest	.71	.05	<.001	.71	.05	<.001
Conscientiousness × English Interest				−.12	.03	<.001
Sex: Male	−.32	.06	<.001	−.33	.06	<.001
Grade level: 1 = Grade 10	−.02	.05	.680	−.01	.04	.806
Dependent variable: Effort in biology[d]						
Conscientiousness	.21	.03	<.001	.21	.03	<.001
Biology interest	.84	.05	<.001	.85	.05	<.001
Conscientiousness × Biology Interest				−.01	.03	.783
Sex: Male	−.20	.04	<.001	−.20	.04	<.001
Grade level: 1 = Grade 10	−.02	.04	.594	−.02	.04	.615
Dependent variable: Effort in second foreign language[e]						
Conscientiousness	.29	.04	<.001	.29	.04	<.001
Language interest	.64	.04	<.001	.65	.04	<.001
Conscientiousness × Language Interest				−.06	.05	.244
Sex: Male	−.34	.05	<.001	−.34	.05	<.001
Grade level: 1 = Grade 10	−.12	.05	.012	−.11	.05	.014

Note. $N = 1{,}025$.
[a] Variance explained: .73 (Model 1) and .75 (Model 2). [b] Variance explained: .76 (Model 1) and .77 (Model 2). [c] Variance explained: .80 (Model 1) and .81 (Model 2). [d] Variance explained: .86 (Model 1) and .86 (Model 2). [e] Variance explained: .76 (Model 1) and .76 (Model 2).

than that of Model 1, $\Delta\chi^2(3) = 1{,}190.15$, $p < .001$. The explanatory power of the cross-level interaction was assessed by calculating the proportion of variability of the slope of effort on interest across students that could be explained by the person predictor conscientiousness (Aguinis, Gottfredson, & Culpepper, 2013); 2% of the slope variance across students was explained by including conscientiousness in Model 2.

The statistically significant interaction between conscientiousness and domain-specific interest is illustrated in the left panel of Figure 3. We again calculated simple slopes of the effect of interest on effort for students with a high (+1 standard deviation above the mean) or low (−1 standard deviation below the mean) value. As shown in Figure 3, both conscientiousness and domain-specific interest were positively related to academic effort. However, the slope for interest was steeper for students low in conscientiousness ($B = .45$, 95% CI [.42, .47], $p < .001$) than it was for those high in conscientiousness ($B = .35$, 95% CI [.29, .42], $p < .001$). At the same time, the difference in academic effort between students high and low in conscientiousness was smaller in the subjects that the students found interesting. In other words, high conscientiousness compensated to some degree for low interest, and vice versa.

We again performed a number of robustness checks. First, to exclude the possibility that the multiplicative term in fact reflects nonlinear predictive effects in its two components (conscientiousness and interest), we added quadratic terms for conscientiousness (at the between-students level) and interest (at the within-student level) to Model 2. Despite these additions, the interaction term Conscientiousness × Interest remained statistically significant (math: $B = -.04$, $p = .002$). Second, we included prior achievement (school grades) as a further predictor variable at Level 1, but the interaction effect remained unaltered ($B = -.04$, $p = .001$).

Finally, we examined whether any compensatory effect would also be evident when interest was replaced by competence beliefs. To this end, we repeated Model 2 with competence beliefs instead of interest as a Level-1 variable. Although competence beliefs ($B = .25$, $p < .001$) and conscientiousness ($B = .36$, $p < .001$) proved to be significant predictors of academic effort, their interaction was not significant ($B = -.02$, $p = .17$).

Table 7
Predicting Academic Effort at the Within-Student Level in Study 3: Results From Hierarchical Linear Modeling

Predictor	Empty model			Model 1			Model 2		
	Estimate	*SE*	*p*	Estimate	*SE*	*p*	Estimate	*SE*	*p*
Intercept	.00	.03	.930	.20	.03	<.001	.19	.03	<.001
Level 3									
Grade level: 1 = Grade 10				−.30	.04	<.001	−.29	.04	<.001
Level 2									
Sex: Male				−.16	.05	.001	−.15	.05	.001
Conscientiousness				.25	.02	<.001	.25	.02	<.001
Level 1									
Interest				.40	.01	<.001	.41	.01	<.001
Cross-level interaction									
Conscientiousness × Interest							−.04	.01	.006
Variance component									
Between class (Level 3)	.04			.00			.00		
Between students (Level 2)	.37			.34			.35		
Within student (Level 1)	.60			.40			.34		
Slope interest (Level 2)							.05		
Deviance statistic									
Deviance	13,002.91			11,214.39			10,024.24		
Estimated parameters	4			8			11		

Note. *N*s = 51 (Level 3), 1,016 (Level 2), and 4,961 (Level 1).

Summary

Study 3 showed that both conscientiousness and domain-specific interest are substantially associated with academic effort. We found (partial) support for the compensatory effects model at the between-students level. Further, turning to the within-student level, intraindividual differences in domain-specific interest added substantially to the prediction of academic effort. Moreover, the statistically significant cross-level interaction effect Conscientiousness × Domain-Specific Interest provided further support for the compensatory effects model.

Study 4

In Study 4, we examined whether the compensatory effects model also holds when interest experience—rather than individual interest—is examined. Our major research question was to what degree conscientiousness moderates the association between interest experience and academic effort. To that end, we tested whether students high in conscientiousness were more likely than students low in conscientiousness to invest academic effort on days on which their interest experience was comparatively low. We reanalyzed a large data set that had been used in our research before (most importantly, Trautwein, Lüdtke, Schnyeder et al., 2006; Trautwein et al., 2009); however, no prior study had targeted the interaction effect that is the central topic of the present article.

As in the second part of Study 3, which examined intraindividual differences in interest and academic effort across five school subjects, the primary focus of Study 4 was on intraindividual variation. This time, however, we examined the determi-

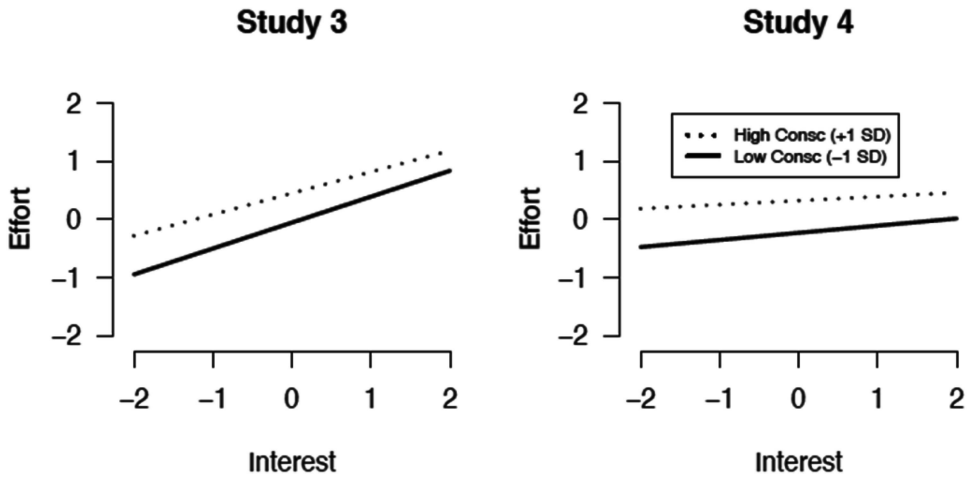

Figure 3. Plots of moderating effect of conscientiousness (Consc) on the relationship between interest and effort in Studies 3 and 4. Depicted are simple slopes at ±1 standard deviation from the mean of conscientiousness. Both effects are within student. The independent variable (interest) and dependent variable (effort) range from −2 to +2 standard deviations of the mean.

nants of intraindividual variation in academic effort over time. More specifically, we investigated how interest experience and conscientiousness predicted academic effort in French as a foreign language on a day-to-day basis. Such a design assessing intraindividual short-term variation across days is also known as a *measurement-burst design* (Nesselroade, 1991; Rast, MacDonald, & Hofer, 2012).

In Study 4, both interest experience and academic effort were assessed via the diary method, which involves students reporting their beliefs and behaviors at fixed intervals or during and after certain events. Several studies (e.g., Möller & Husemann, 2006; Reis, Sheldon, Gable, Roscoe, & Ryan, 2000; Schmitz & Skinner, 1993) have shown that diary methods have good reliability and validity, although the instruments used are typically single-item measures or very short scales.

We expected interest experience to be associated with academic effort, with students reporting more academic effort on days on which they experienced high interest relative to their own baseline (i.e., a within-student effect). In addition, we expected to find a positive association between conscientiousness and the average effort a student reported over the course of the observation (i.e., a between-students effect). To test for interaction effects, we examined whether students high in conscientiousness were more (or less) likely than students low in conscientiousness to invest academic effort on days on which their interest experience was comparatively low (i.e., a cross-level interaction effect).

Method

Sample. The sample for this reanalysis came from a large study on French as a second language (see Trautwein, Lüdtke, Schnyder, et al., 2006, Study 2; Trautwein et al., 2009, Study 3). The study was conducted in schools in three Swiss cantons during regular lesson hours. All participating students were taking compulsory lessons in French as a foreign language. The instruments were administered by their French teachers, who were provided with detailed written instructions on how to collect data. The present study draws on data from the student questionnaire administered at the end of the 2004 school year (May–June 2004) and from two 1-week diary components administered in January 2004 and April 2004. Students were asked to fill out the diary immediately after completing each of their homework assignments.

The total sample consisted of 1,915 students in 112 Grade 8 classrooms. One special education class was excluded from the present analyses. Further, we excluded all classes and students who missed both administrations of the diary component or did not complete the student questionnaire at the end of the school year. The remaining sample consisted of 1,530 students (53.0% female; age at first measurement point: $M = 13.79$ years, $SD = 0.58$) in 89 classrooms. On average, each student made diary entries on 5.98 days; a total of 9,157 units were available at the within-student level. Students in the remaining sample had somewhat higher values on conscientiousness ($p = .008$, $d = 0.22$) than the students who were excluded, but their French achievement (French midterm grade) was comparable ($p = .462$).

Instruments: Conscientiousness. Conscientiousness was measured using the 12 conscientiousness items from the German version of the NEO-FFI (Borkenau & Ostendorf, 1993 [original version by Costa & McCrae, 1992]). Internal consistency (Cronbach's alpha) was satisfactory ($\alpha = .78$).

Instruments: Interest experience (diary instrument). One item was used to tap students' interest experience: "I found these tasks interesting." Students were asked to indicate their endorsement of the statement immediately after doing homework on a four-point Likert-type scale ranging from 1 (*completely disagree*) to 4 (*completely agree*) for a total of 2 weeks. In addition to using the within-student variation on these items, we created a between-students variable by aggregating the interest ratings for each student.

Instruments: Academic effort (diary instrument). One additional item that students were asked to fill out immediately after having finished their homework on each day described their academic homework effort: "I did my best to answer all of the questions." Again, a four-point response format was used.

Statistical analyses. We again used multilevel modeling to predict self-reported academic effort in French as a within-student variable. In other words, we used the separate assignments rated in the homework diary as the Level-1 variable (within-student level), the 1,530 students constituted Level 2 (between-students level), and the 89 classes constituted Level 3 (between-classes level). The modeling approach was very similar to that used in Study 3, the major difference being the focus on within-student variation across days rather than across scholastic domains. In other words, within-student (day-to-day) variation in interest constituted the Level-1 units, and within-student variation in the relation between daily interest and daily effort ratings were examined by specifying the cross-level interaction term Conscientiousness × Interest.

We again standardized each variable before starting with the analyses. To this end, we followed the exact same procedure as in our within-student analyses for Study 3. Again, the computer program HLM 6 (see Raudenbush et al., 2004) was used for the multilevel analyses, and model fit was assessed using the deviance values provided by HLM 6.

Results

Although the students rated their interest in the homework tasks as relatively low (the mean score of 2.37 [$SD = 0.85$] was slightly below the midpoint of the scale), their reported effort ($M = 3.31$, $SD = 0.74$) on these assignments was relatively high. We also calculated correlation coefficients at the within-student level on the basis of a total of 9,157 observations. Interest experience ($r = .28$, $p < .001$) was statistically significantly associated with homework effort. At the between-students level, the mean conscientiousness score was 2.73 ($SD = 0.44$).

We next specified a set of multilevel models (see Table 8) similar to those reported in Study 3. We first estimated the degree of within-student variance in academic effort relative to between-students variance and between-classes variance, the so-called empty model (also known as the null model). Given the standardization of academic effort, the variance estimates can also be directly translated into the ICC. It was observed that 56% of the variance in academic effort was located at the within-student level, 41% at the between-students level, and only 4% at the between-classes level.

Next (in Model 1), we introduced predictor variables at the within-student and between-students levels. At the within-student level, interest experience statistically significantly predicted academic effort. In other words, students reported more academic

Table 8
Predicting Academic Effort at the Within-Student Level in Study 4: Results From Hierarchical Linear Modeling

Predictor	Empty model			Model 1			Model 2		
	Estimate	*SE*	*p*	Estimate	*SE*	*p*	Estimate	*SE*	*p*
Intercept	.00	.02	.784	.04	.03	.211	.04	.03	.189
Level 2									
Sex: Male				−.10	.04	.025	−.10	.04	.019
Conscientiousness				.28	.02	<.001	.28	.02	<.001
Level 1									
Interest experience				.09	.01	<.001	.10	.01	<.001
Cross-level interaction									
Interest Experience × Conscientiousness							−.03	.01	.003
Variance component									
Between class (Level 3)	.04			.02			.02		
Between students (Level 2)	.41			.34			.35		
Within student (Level 1)	.56			.55			.51		
Slope interest (Level 2)							.03		
Deviance statistic									
Deviance	23,256.83			22,876.82			22,733.94		
Estimated parameters	4			7			10		

Note. *N*s = 89 (Level 3), 1,530 (Level 2), and 9,157 (Level 1).

effort on days on which they experienced comparatively high interest. A positive regression weight was also found for conscientiousness at the between-students level. This pattern of results is in line with our first hypothesis. With respect to sex, we found a negative predictive effect, indicating that male students put less effort into their work than did female students. Compared with the empty model, Model 1 provided a much better fit to the data, $\Delta\chi^2(3) = 380.01$, $p < .001$.

We next tested for a significant cross-level interaction of a between-students-level variable (conscientiousness) and a within-student-level variable (interest experience). To this end, we first estimated whether there were statistically significant differences in the interest slopes across students. This was indeed the case, $\chi^2(1{,}274\ N) = 1{,}888.62$, $p < .001$. Next, we specified the cross-level Conscientiousness × Interest Experience interaction (see Model 2 in Table 8), which significantly predicted academic effort ($B = -.03$, $p = .002$). The deviance statistics showed that Model 2 had a much better fit than did Model 1, $\Delta\chi^2(3) = 142.88$, $p < .001$. The inclusion of conscientiousness at the person level explained 3% of the random slope variation across students.

The interaction effect is illustrated in the right panel of Figure 3. Simple slopes of the effect of interest on effort for students with a high (+1 standard deviation above the mean) or a low (−1 standard deviation below the mean) value in conscientiousness show that students low in conscientiousness revealed a steeper slopes ($B = .12$, 95% CI [.08, .16], $p < .001$) than those high in conscientiousness ($B = .07$, 95% CI [.03, .11], $p < .001$). Both high conscientiousness and high interest experience were associated with high academic effort. However, they also compensated for each other, as indicated by the (relatively) high academic effort scores when only conscientiousness or interest experience was high.

A set of robustness checks was again performed. First, to exclude the possibility that the multiplicative term reflects nonlinear predictive effects in its two components (conscientiousness and interest experience), we added quadratic terms for conscientiousness (at the between-students level) and domain-specific interest (at the within-student level) to Model 2. The addition of the quadratic terms did not affect the interaction term Conscientiousness × Interest Experience ($B = -.03$, $p = .002$). Second, we included prior achievement (a standardized test of French as a second language) as a further predictor variable to Model 2, but the interaction effect again remained stable ($B = -.03$, $p = .002$).

The main focus of Study 4 was on the question of how conscientiousness would moderate the within-student association between interest experience and effort (a so-called cross-level interaction). In an additional analysis with the interest indicators, we tested for the interaction effect Conscientiousness × Interest at the between-students level. To this end, we aggregated the within-student level variable of interest experience to the person level. In other words, starting with the standardized values at the within-student level, we computed one interest score per student, which reflected the average of his or her responses to the interest diary question. We then computed the interaction term Conscientiousness × Interest at the between-student levels and added it to Model 2. In this model, the Conscientiousness × Interest term at the between-students level did not reach conventional levels of statistical significance ($B = -.03$, $p = .083$), although the regression coefficient of the interaction effect was in the expected direction. The other coefficients in Model 2 were virtually unchanged. When adding the quadratic effects for interest and conscientiousness at the between-students level and interest experience at the within-student level, the Conscientiousness × Interest term at the between-students level was statistically significant ($B = -.04$, $p = .048$), again indicating a compensatory effect.

In a final set of analyses, we replaced interest with competence beliefs and repeated all relevant models. A one-item measure was used for situational competence beliefs ("I have the skills needed to solve these tasks"). In these models, competence beliefs at the within-student and between-students level and conscientiousness predicted academic effort (all *p*s < .001). However, neither the cross-level interaction term Conscientiousness × Competence Experience ($B = -.01$, $p = .54$) nor the interaction term Conscientiousness × Competence Beliefs at the between-students level ($B = -.01$, $p = .61$) proved to be statistically significant. This

indicates that the compensatory mechanism applied only to interest, not to competence beliefs.

Summary

In Study 4, we examined the extent to which academic effort varies from day to day (see Schmitz & Skinner, 1993) and analyzed whether situational variation in interest can help explain fluctuation in academic effort. Interest experience and conscientiousness statistically significantly predicted academic effort. Moreover, conscientiousness moderated the association of interest experience and academic effort, with students high in conscientiousness investing more academic effort in situations in which their interest experience was low and students high in interest experience putting much effort into their work despite low levels of conscientiousness. Further, at the between-students level, we found partial support for compensatory effects.

Discussion

In this article, we examined the unique and joint power of interest and conscientiousness to predict academic effort by reanalyzing four large data sets obtained from high school students. In all four studies, conscientiousness and interest uniquely predicted academic effort. Moreover, the finding that the interaction term between conscientiousness and interest was negatively associated with academic effort in all four studies supported the compensatory (or antagonistic) effects model: Conscientiousness was less important in predicting academic effort when individual interest was high, and the level of interest was less important in predicting academic effort when students were high in conscientiousness.

Conscientiousness and Interest: Compensatory Effects on Academic Effort

Our findings are in line with research by Sansone (e.g., Sansone et al., 2010), although she used a quite different research design in which interest was experimentally manipulated. Interestingly, the compensatory effects found in the present study complement recent studies in which synergistic effects were found for the interaction between competence beliefs and interest/value beliefs (Nagengast et al., 2011; Trautwein et al., 2012) and studies that yielded support for additive effects for conscientiousness and competence beliefs (Trautwein et al., 2009; see also the robustness checks in the present study). How can this different pattern of results be explained?

In our view, it is important to highlight the fact that conscientiousness and interest are quite distinct on a conceptual level (see also Jackson et al., 2012; Roberts & Pomerantz, 2004). From a phenomenological point of view, activities driven by conscientiousness have a very different "feel" than do "interesting" activities. A major element of conscientiousness is self-control. People high in conscientiousness are able to overcome internal barriers and regulate negative emotions when confronted with undesirable tasks. To a certain extent, the internal self-regulation system operating in people high in conscientiousness may act like a built-in "push" factor, motivating them to tackle objects or tasks with no intrinsic value. However, forcing oneself into an activity consumes mental energy. In contrast, the driving force behind interest-provoked activities is an actual or hoped-for positive emotional condition. Students are drawn toward fields that interest them; the activities are often pleasurable and may seem to energize students rather than consume their energy. In fact, interest may act like a powerful emotional "pull" factor. Of course, students' favorite subjects also have their uninteresting aspects, but these are not typically as onerous as they are in other subjects. Interest is a motivational resource that helps people to cope with unfavorable learning conditions (Katz, Assor, Kanat-Maymon, & Bereby-Meyer, 2006). When working on boring tasks, people with higher individual interest are more likely to engage in interest-enhancing strategies and to transform the activity into something more enjoyable (Sansone, Weir, Harpster, & Morgan, 1992). In a somewhat similar vein, Duckworth and Gross (2014) recently argued that high self-control might not be enough to explain personal success, but they highlighted the need to complement research on self-control (as the capacity to handle temptations) by research on *grit* (a valued goal that gives a person's behavior a direction). We believe that research is needed that addresses the conceptual and empirical overlap between interests and grit.

The present article not only confirms that both conscientiousness and interest predict academic effort, it additionally provides evidence that the two constructs may substitute for each other. This stands in contrast with the synergistic interactions that have been found lately (e.g., Nagengast et al., 2011) for interest and competence beliefs (and the lack of a statistical interaction between conscientiousness and competence beliefs, as documented in the present article.) In our view, this compensatory effect is quite conceivable given that (a) conscientiousness and interest represent two different levels of personality and (b) domain-specific interest pulls people in a specific direction, whereas high conscientiousness makes them act somewhat more similarly across domains. In contrast, when both competence beliefs and interest are high, the combined effect further fuels the tendency to work hard (and perhaps specialize) in a specific domain.

Traits, Interests, and Situations: Broadening the Perspective

One specific feature of our article is the combination of analyses at the between-students and the within-student level. As highlighted by West, Ryu, Kowk, and Cham (2011), such a data situation brings with it important conceptual consequences that also translate into statistical challenges. In all four studies, we examined effects at the between-students level. In other words, we found that students high in conscientiousness and high in domain-specific interest reported high domain-specific academic effort and that either one compensated (to some degree) for the lack of the other. In addition, however, we also probed for within-student effects in two of the four studies. In part 2 of Study 3, in which we focused on within-student differences across subjects (i.e., math, English, German, biology, and a second foreign language), we found that high domain-specific interest predicted academic effort in the specific domain, whereas students high in conscientiousness reported more academic effort in general; however, the cross-level interaction effect we found implies that academic effort was more equal across students who were high in conscientiousness and that even students low in conscientiousness evidence relatively high effort in school subjects in which they are interested. Finally, in

Study 4, we again focused on within-student effects, there using a measurement-burst design (Nesselroade, 1991; Rast et al., 2012) assessing intraindividual short-term variation across days. When probing for day-to-day variations in academic effort in one school subject, we again found a statistically significant and negative cross-level interaction effect implying that—to a certain extent—high conscientiousness can substitute for low interest experience and that high interest experience can substitute for a lack of conscientiousness.

It has been pointed out by several scholars (Cervone, 2005; see also Borsboom, Mellenbergh, & van Heerden, 2003) that theories and models supported by interindividual analysis will not necessarily be substantiated by intraindividual analysis. Thus, the consistency of the compensatory effect across analytical levels is quite remarkable, because it indicates that the compensatory mechanism generalizes across different levels of analyses (also see West et al., 2011). Considering the importance of academic effort for real-life consequences, this consistency across levels further increases the importance of this effect from a practical point of view.

Moreover, in addition to our empirical findings, our study also adds conceptually to the person–situation debate (e.g., Sherman, Nave, & Funder, 2010). In this debate, a differentiation is made among person characteristics (traits), situations, and behavior. Roberts and Pomerantz (2004) highlighted the possibility of further distinguishing between various levels of *person breadth* and *situation breadth* (see their Table 1, p. 408). In a similar vein, we believe that interests have the potential to provide important differentiations in the person–situation debate, given that one can easily collect data in various subjects and at various points of time. First, we used measures of individual interest (e.g., "I'm interested in subject X") in a number of different school subjects. When treating domain-specific interest as "situations," our analyses showed that behavior across these situations correlated, albeit not perfectly. Moreover, the compensatory effect between conscientiousness and interest was most consistently found for mathematics. Hence, there is some important variation across these situations. Second, we used indicators of interest experience (e.g., "I found these tasks interesting") and performed within-student analyses. Again, there was considerable variation across situations. Further studies of how behavior is specific to or generalizes across school subjects and school days promise to shed more light on how stable or variable behavior is across situations.

Limitations and Further Research

Some critical issues should be borne in mind when interpreting the results of this study. Importantly, conscientiousness, interest, and academic effort were measured by means of student questionnaires and diary data. Self-reports are commonly used to assess these constructs—they seem to be the preferable approach for interest and are clearly acceptable for conscientiousness. Teacher reports would be an alternative assessment approach for effort. However, there may also be disadvantages to using teacher reports in that teachers may confound academic effort with other predictor variables. For instance, it is difficult for teachers to distinguish whether students do not finish homework tasks because of a lack of effort or because they lack crucial knowledge. Hence, we believe student reports to be a highly valid source of information for these constructs, although alternative approaches may include teacher reports that are "purified" by covariates such as student reports. Clearly, including reports from additional sources has the potential to make the data even stronger. For instance, Wagerman and Funder (2007) found that peer-rated conscientiousness was even more highly associated with grades than was self-reported conscientiousness.

In line with the literature (e.g., Pintrich & de Groot, 1990; Zimmerman & Pons, 1986), we defined academic effort as behavior that may vary from one domain or context to the next. Conscientiousness, conversely, is characterized by typical patterns of thoughts, feelings, and behaviors. Moreover—according at least to the conceptualization of McCrae and Costa (2008)—conscientiousness is rooted in temperament, which limits its domain specificity. Yet it is important to note that if conscientiousness is conceptualized differentially (e.g., as domain-specific conscientiousness or as a behavioral dimension), the distinctions between conscientiousness and academic effort may become somewhat blurred. Notwithstanding the conceptual differences, it would have been interesting in Study 4 to have assessed state conscientiousness in the way it was measured by and Fleeson and Gallagher (2009).

The extent to which the present results generalize is also an issue. It is unclear to what extent cultural differences might affect the results. Although no previous studies have documented major differences in conscientiousness, interest, and academic effort between Germany and, for instance, the United States, cross-cultural studies might detect such differences.

Concerted effort is needed to cast light on how conscientiousness and interest develop and predict academic effort and achievement in various domains. Future research should, for instance, examine the role of specific facets of conscientiousness in explaining academic effort. It would have been possible to use the NEO-FFI to measure some facets of conscientiousness in the current study (see Saucier, 1998), but a broader instrument (e.g., the NEO-PI) would probably be preferable. Further, there is a need to analyze whether all facets of conscientiousness are equally responsible for the compensation effect documented in our four studies. We see this as another important avenue for future research of considerable theoretical and practical value.

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