Predicting Effort:
Generalization and Extension of the
Conscientiousness × Interest Compensation (CONIC) Model

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ABSTRACT

Academic effort is an important prerequisite for achieving academic success, which sets essential framework conditions for cumulative advantages over the lifespan (Spengler et al., 2015). Therefore, understanding the determinants of effort is of great importance to researchers as well as various educational stakeholders. Psychologists identified two person characteristics as key determinants of academic effort, namely conscientiousness and interest (e.g., Jansen et al., 2016; Mammadov, 2022). Conscientiousness, a personality trait mainly researched in the field of personality psychology, involves being goal-oriented, orderly, self-controlled, and responsible across different contexts and situations (Roberts et al., 2014). Consequently, students with high conscientiousness tend to work hard and persistently across various school domains (e.g., Trautwein & Lüdtke, 2007). On the other hand, interest is a motivational construct primarily studied in educational psychology (e.g., Renninger & Hidi, 2016). It represents a positive relationship to an object (such as a topic or activity) and reflects the individual's enjoyment and desire to continue engaging with the object (Hidi & Renninger, 2006). Interest is associated with positive emotions and, therefore, has a self-reinforcing effect, leading individuals to engage with the object of their interest consistently and repeatedly (Murayama et al., 2019).

Despite the significant importance of both conscientiousness and interest within their respective disciplines, they have traditionally been studied independently due to their different research traditions. Addressing this gap, Trautwein et al. (2015) investigated the interplay of these two constructs in predicting academic effort. Their findings revealed a compensatory relation between the two, indicating that high interest can compensate for low conscientiousness and vice versa. As a result, they developed the Conscientiousness × Interest Compensation (CONIC) model (Trautwein et al., 2019).

Theoretically, the CONIC model proposes that conscientiousness and interest both function as driving, self-regulatory forces that lead individuals to make sustained efforts and, thus, to achieve their academic goals. Due to the distinct characteristics of conscientiousness and interest, they assume different mechanisms by which they operate. Conscientiousness acts as an internal "push factor" that pushes the individual through difficulties and obstacles. In contrast, interest acts as a "pull factor" that stimulates and energizes individuals to overcome difficulties and obstacles without being perceived as strenuous.

Empirically, there is already some research confirming the compensatory relation between conscientiousness and interest in the school setting among German-speaking high

school students across various subjects (Trautwein et al., 2015; Rieger et al., 2022; Song et al., 2020). In an initial extension study, this compensatory relation was not only observed in predicting academic effort but also in predicting school grades (Song et al., 2020). Furthermore, the model was expanded to include utility value as another predictor instead of interest (Song et al., 2020). Nonetheless, the CONIC model is still in its early stages, and further research is needed to consolidate it. The overarching goal of this dissertation is to contribute to this ongoing research and refine the validity and applicability of the model.

For this purpose, replication and generalization studies play a central role from a research theory perspective. They provide the opportunity to validate previous findings and explore the broader scope of the CONIC model, which contributes to the credibility of science by producing robust results. Moreover, applying Open Science practices can further enhance the impact and reliability of these contributions.

The present dissertation includes four studies that aim to replicate, extend, and generalize the CONIC model, focusing on exploring potential boundary conditions of the model. All of the dissertation's studies investigate the relationship between conscientiousness and interest in predicting effort-related outcomes but vary in terms of their research characteristics, encompassing different samples, study designs, measures, and contexts. More specifically, the studies include samples of different ages (university and college students, adults) and countries (U.S., Austria); observational and experimental studies conducted in the field, online, or in a laboratory; various measures of conscientiousness, interest, and effort, as well as related constructs; and different contexts (U.S. school system, occupational context, laboratory setting, online context). Furthermore, the studies were conducted with consideration of Open Science practices.

The first study (*Examining the Conscientiousness × Interest Compensation (CONIC) Model With Similar Constructs in High School and College Students*) tested the CONIC model in both a high school sample and a college sample from the United States using an observational study design. It aimed to replicate the extensions proposed by Song et al. (2020) by testing the inclusion of utility value as an additional predictor and achievement as another outcome variable. Additionally, the study explored whether the compensatory relationship holds when substituting grit for conscientiousness and overall task value or utility value for interest. Furthermore, the study examined the models for both science and math effort as well as achievement. Overall, the findings supported the replicability of the extensions proposed by Song et al. (2020), demonstrated the generalizability across U.S. American and older student

samples, and confirmed the extensivity of the CONIC model for incorporating grit and overall task value as additional predictor variables. However, the results also suggest that the predictive links are strongest when including interest and conscientiousness as predictors.

The second study (*The Interplay of Conscientiousness and Interest in Predicting Achievement Outcomes in a Lab Setting*) investigated the CONIC model using a sample of German university students within a laboratory setting. Conscientiousness, task-specific interest, and their interaction term were used to predict student performance in five different digital learning tasks (i.e., mastery of the task topic assessed with a knowledge test). Overall, task-specific interest positively predicted task performance, and the interactions of conscientiousness and interest negatively predicted task performance. However, there were no positive main effects of conscientiousness in predicting task performance; instead, the effects were either null or negative. The overall pattern of the results supports the generalizability of the compensatory mechanism for learning tasks in controlled laboratory settings. However, the results also point to the limitations of the predictive power of conscientiousness in this context.

The third study (*The Conscientiousness × Interest Compensation Model Predicting Effortful Behavior in an Experimental Task*) tested the CONIC model in adults using an experimental online setting. The experimental design included self-rated effort as well as several other indicators of effortful behavior (e.g., time measures) to assess generalizability across measures beyond self-report. The sample was recruited from the online platform Prolific. The results revealed that task interestingness predicted different measures of effort. Conscientiousness showed a positive relationship with some of the effort measures, though not across all measures. However, no compensatory relation was found between conscientiousness and interest predicting the different indicators of effortful behavior. Therefore, the results did not confirm the CONIC model in this study. Consequently, the experimental design of the study, the online context, and adulthood are discussed as boundary conditions of the CONIC model.

The fourth study (*Interest is a Stronger Predictor Than Conscientiousness For Teachers' Intensity in Engaging in Professional Development*) applied the CONIC model to predict teacher's professional development (PD) intensity using different interests (i.e., teachers' general interest in teacher activities, teachers' interest in specific areas of teacher activities, teachers' interest in PD) in a cross-sectional as well as a longitudinal design. The sample consisted of teachers from Austria. Overall, the different interests showed positive relations with PD intensity. However, no positive relations of conscientiousness and no compensatory

interaction effects were found. The results suggest that the CONIC model does not hold for teachers' PD intensity.

The findings are summarized and discussed in terms of their contribution to further consolidation and refinement of the CONIC model. Furthermore, implications for the validity of the CONIC model and directions for future research are discussed.

ZUSAMMENFASSUNG

Anstrengungsbereitschaft ist eine zentrale Voraussetzung für Schulerfolg, welcher wiederum zentrale Rahmenbedingungen für kumulative Vorteile über die Lebensspanne setzt (Spengler et al., 2015). Die Determinanten von Anstrengungsbereitschaft sind daher sowohl für Forschende als auch für die verschiedenen Akteure in der Bildungspraxis von zentralem Interesse. Als zwei zentrale Determinanten von schulischer Anstrengungsbereitschaft haben sich Gewissenhaftigkeit und Interesse erwiesen. Gewissenhaftigkeit ist eine Persönlichkeitseigenschaft und wurde bislang hauptsächlich in der Persönlichkeitspsychologie erforscht. Sie beschreibt die Tendenz von Individuen situations- und kontextübergreifend ordentlich, zielorientiert, verantwortungsbewusst und selbstkontrolliert zu sein (Roberts et al., 2014). Schüler*innen mit hoher Gewissenhaftigkeit arbeiten daher über verschiedene Schulfächer hinweg hart und ausdauernd (z. B. Trautwein & Lüdtke, 2007). Interesse ist ein motivationales Konstrukt und wird hauptsächlich in der Pädagogischen Psychologie erforscht. Interesse beschreibt eine positive Beziehung zu einem Gegenstand (z.B. Thema, Tätigkeit, Objekt). Es bezieht sich darauf wie viel Freude das Individuum daran hat und wie sehr es sich weiterhin damit beschäftigen möchte (Hidi & Renninger, 2006). Interesse geht mit positiven Emotionen einher und hat daher eine selbstverstärkende Wirkung inne, so dass Individuen sich anhaltend und immer wieder mit dem Objekt ihres Interesses beschäftigen (Murayama et al., 2019).

Obwohl beide in ihrer Disziplin von großer Bedeutung sind, wurden sie aufgrund ihrer unterschiedlichen Forschungstradition bislang hauptsächlich getrennt untersucht. Trautwein et al. (2015) haben diese Forschungslücke geschlossen und das Zusammenspiel der beiden Konstrukte in der Vorhersage von schulischer Anstrengungsbereitschaft untersucht. Als Ergebnis fanden sie, dass eine kompensatorische Beziehung zwischen den beiden Konstrukten besteht. Das bedeutet, dass Interesse für eine niedrige Gewissenhaftigkeitsausprägung kompensieren kann und andersherum. Anders ausgedrückt: Es genügt, wenn man entweder gewissenhaft oder interessiert ist, um sich anzustrengen. In der Folge entwickelten sie das Conscientiousness × Interest Compensation (CONIC) Modell.

Das CONIC Modell nimmt an, dass Gewissenhaftigkeit und Interesse beide als antreibende, selbstregulative Kräfte wirken, die Individuen dazu bringen sich anhaltend anzustrengen und damit ihre schulischen Ziele zu erreichen. Aufgrund der unterschiedlichen Eigenschaften von Gewissenhaftigkeit und Interesse, gehen sie von unterschiedlichen Wirkmechanismen aus. Gewissenhaftigkeit wirkt als interner „push-Faktor“, der Individuen

durch die Anstrengungen und Hindernisse hindurch treibt, während Interesse als „pull-Faktor“ wirkt, der Individuen begeistert und mitreißt und so Anstrengungen und Hindernisse bewältigt werden, ohne dass sie sich anstrengend anfühlen.

Es gibt bereits einige Forschung, die die kompensatorische Beziehung zwischen Gewissenhaftigkeit und Interesse für das schulische Setting mit deutschsprachigen Schüler*innen weiterführender Schulen für unterschiedliche Fächer bestätigt (Trautwein et al., 2015; Rieger et al., 2022; Song er al., 2020). In einer ersten Erweiterungsstudie wurde die kompensatorische Beziehung nicht nur für die Vorhersage von schulischer Anstrengungsbereitschaft gefunden, sondern konnte auch für die Vorhersage von Schulabschlussnoten gezeigt werden (Song et al., 2020). Des Weiteren wurde der Anwendungsbereich des Modells auch für die empfundene Nützlichkeit (anstatt Interesse) als Prädiktor erweitert (Song et al., 2020). Nichtsdestotrotz handelt es sich nach wie vor um ein junges Modell, dessen Konsolidierung weiterer Forschung bedarf. Die vorliegende Dissertation verfolgt das übergeordnete Ziel dazu einen Beitrag zu leisten.

Für diesen Zweck sind aus Sicht der Forschungstheorie Studien zur Replikation, Generalisierung und Erweiterung zentral. Sie bieten die Möglichkeit zur Bestätigung bisheriger Ergebnisse und weitergehenden Exploration des Gültigkeitsbereichs des CONIC Modells. Dieses Vorgehen trägt zu einer vertrauenswürdigen Wissenschaft mit belastbaren Erkenntnissen bei. Dieser Beitrag kann durch die Anwendung von Open Science Praktiken noch gesteigert werden.

Die vorliegende Dissertation beinhaltet vier verschiedene Studien, die das CONIC Modell replizieren, erweitern und generalisieren und dabei insbesondere auch auf mögliche Grenzen der Modellgültigkeit hinweisen. Alle Studien der Dissertation untersuchen die Beziehung zwischen Gewissenhaftigkeit und Interesse bei der Vorhersage von Anstrengungsbereitschaft oder verwandten Konstrukten, aber unterscheiden sich in ihren Forschungscharakteristika. Das heißt sie verwenden verschiedenen Stichproben, Studiendesigns, Maße und Kontexte. Konkret umfassen die Studien Stichproben unterschiedlichen Alters (Universitäts- und Hochschulstudierende, Erwachsene) und Länder (USA, Österreich); sie umfassen Beobachtungs- und experimentelle Studiendesigns, die als Feldstudien, online oder im Labor durchgeführt wurden. Des Weiteren wurden verschiedene Messungen von Gewissenhaftigkeit, Interesse und Anstrengungsbereitschaft sowie verwandten Konstrukten verwendet, und die Studien wurden in verschiedenen Kontexten durchgeführt (US-amerikanisches Schulsystem, beruflicher Kontext und Laborumgebung).

Darüber hinaus wurden bei der Durchführung der Studien Open-Science-Praktiken berücksichtigt.

Die erste Studie (*Examining the Conscientiousness × Interest Compensation (CONIC) Model With Similar Constructs in High School and College Students*) testete das CONIC-Modell in einer Beobachtungsstudie mit einer Stichprobe von High-School und College Studierenden aus den USA. Ihr Ziel war es, die von Song et al. (2020) vorgeschlagenen Erweiterungen (d.h. Nützlichkeit als weiterer Prädiktor und Leistung als weitere Zielvariable) zu replizieren und das CONIC-Modell über eine ältere Stichprobe (d.h. College-Studenten) und über Stichproben aus den Vereinigten Staaten zu generalisieren. Es wurde auch untersucht, ob die kompensatorischen Beziehungen bestehen bleiben, wenn Gewissenhaftigkeit durch „Grit“ und Interesse durch die Aufgabennützlichkeit oder den allgemeinen Aufgabenwert ersetzt wird. Des Weiteren wurden die verschiedenen Modelle sowohl für naturwissenschaftliche als auch für mathematische Anstrengungsbereitschaft und Schulnoten getestet. Insgesamt unterstützen die Ergebnisse die Replizierbarkeit der von Song et al. (2020) vorgeschlagenen Erweiterung, die Generalisierbarkeit über US-amerikanische und ältere Schüler*innen und die Erweiterbarkeit des CONIC-Modells für die Verwendung von „Grit“ und allgemeinem Aufgabenwert als zusätzliche Prädiktoren. Die Ergebnisse deuten jedoch auch darauf hin, dass der Push-Pull-Mechanismus bei den beiden Konstrukten Interesse und Gewissenhaftigkeit am stärksten vertreten ist.

Die zweite Studie (*The Interplay of Conscientiousness and Interest in Predicting Achievement Outcomes in a Lab Setting*) untersuchte das CONIC-Modell in einer Stichprobe deutscher Universitätsstudierenden in einer Laborstudie. Dabei wurden Maße für Gewissenhaftigkeit, aufgabenspezifisches Interesse sowie ihr Interaktionsterm verwendet, um die Leistung der Studierenden in fünf verschiedenen digitalen Lernaufgaben vorherzusagen (d. h. die Aneignung des Themas, die mit einem Wissenstest geprüft wurde). Insgesamt wurde festgestellt, dass im Einklang mit den Annahmen des CONIC Modells, aufgabenspezifisches Interesse die Aufgabenleistung positiv vorhersagt und ein negativer Interaktionseffekt von Gewissenhaftigkeit und Interesse für die Vorhersage der Aufgabenleistung auftritt. Es wurden jedoch keine positiven Haupteffekte von Gewissenhaftigkeit bei der Vorhersage der Aufgabenleistung gefunden, sondern entweder kein oder ein negativer Effekt. Insgesamt unterstützt das Gesamtmuster der Ergebnisse die Generalisierbarkeit des Kompensationsmechanismus für Lernaufgaben in kontrollierten Laborumgebungen. Allerdings weisen die Ergebnisse auch auf die Grenzen der Vorhersagekraft von Gewissenhaftigkeit in diesem Kontext hin.

In der dritten Studie (*The Conscientiousness × Interest Compensation Model Predicting Effortful Behavior in an Experimental Task*) wurde das CONIC-Modell in einem experimentellen Online-Setting mit Erwachsenen getestet. Innerhalb des experimentellen Designs wurden nicht nur die selbst eingeschätzte Anstrengungsbereitschaft, sondern auch verschiedene andere Indikatoren für anstrengungsbereites Verhalten (z.B. Zeitmessungen) einbezogen, um zusätzlich die Generalisierbarkeit über andere Maße als die Selbsteinschätzung zu testen. Die Stichprobe wurde über die Online-Plattform Prolific rekrutiert. Die Ergebnisse zeigten, dass die Interessantheit einer Aufgabe verschiedene Maße der Anstrengungsbereitschaft vorhersagt. Auch Gewissenhaftigkeit sagt einige Maße von Anstrengungsbereitschaft vorher, jedoch nicht alle. Der kompensatorische Zusammenhang wurde nicht festgestellt, wodurch die Studienergebnisse das CONIC Modell nicht bestätigen. Als mögliche Gründe werden das experimentelle Design, die Online-Umgebung sowie die Stichprobe im Erwachsenenalter als Grenzen der Modellgültigkeit diskutiert.

Die vierte Studie (*Interest is a Stronger Predictor Than Conscientiousness For Teachers' Intensity in Engaging in Professional Development*) testete das CONIC-Modell für die Vorhersage der Fortbildungsintensität von Lehrkräften in einem Querschnitts- und einem Längsschnittdesign. Die Stichprobe bestand aus Lehrkräften aus Österreich. Es wurden dabei verschiedenen Interessen unterschieden (d.h. allgemeines Interesse der Lehrer an Lehrtätigkeiten, Interesse der Lehrer an bestimmten Bereichen der Lehrtätigkeit, Interesse der Lehrer an Fortbildung). Insgesamt zeigten die verschiedenen Interessen einen positiven Zusammenhang mit der Fortbildungsintensität. Es gab jedoch keine positiven Zusammenhänge mit Gewissenhaftigkeit und keine negativen Interaktionseffekte. Insgesamt deuten die Ergebnisse darauf hin, dass das CONIC-Modell nicht auf die Fortbildungsintensität von Lehrkräften anwendbar ist.

Die Ergebnisse werden zusammengefasst und im Hinblick auf ihre Implikationen für die weitere Konsolidierung oder Identifizierung von Grenzen des CONIC-Modells diskutiert. Es werden Implikationen für die Gültigkeit des CONIC-Modells und zukünftige Forschungsrichtungen abgeleitet.

CONTENTS

1 INTRODUCTION AND THEORETICAL BACKGROUND

"Continuous effort—not strength or intelligence—is the key to unlocking our potential." — Winston Churchill.

It is widely acknowledged that success does not happen overnight but results from hard work and perseverance. This principle becomes evident early on in school careers. The effort students devote to their studies contributes to their academic success, which sets essential framework conditions for their professional future, occupational success, and cumulative advantages over the lifespan (Spengler et al., 2015). However, it is a frequent occurrence in educational contexts that students have enough potential, but do not expend enough effort to succeed in school, which leads to adverse conditions for their future. This dilemma prompts many parents and educators to wonder how they can guide them to become students who utilize the educational opportunities offered to unlock their potential and improve their future prospects.

In this regard, a question of critical importance is "What drives people to continuous effort?" or in terms of the academic setting, "What drives *students* to continuous effort?" A number of researchers—each employing different lines of research, methodological approaches, and areas of interest—have addressed this question at various levels (e.g., Eccles & Wang, 2012; Lawson & Lawson, 2013). For example, at the community level, researchers have investigated local conditions like neighborhood safety (e.g., Daly et al., 2009). At the family level, parental influences on their children's willingness to expend effort have been examined (e.g., Bempechat & Shernoff, 2012). At the school level, researchers have focused on characteristics such as school climate as a determinant of academic effort (e.g., Fatou & Kubiszewski, 2018). At the class level, the influence of class size has been studied (Finn et al., 2003). At the teacher level, researchers have investigated the relationship between teacher-student relationship quality and students' effort (Hughes et al., 2008). At the instructional level, researchers have examined how teacher pedagogical approach affects the effort of students (e.g., Zhang, 2022). At the individual level, the emphasis has been on how students' characteristics, such as personality or various motivational factors, influence their tendency to show effortful behavior (Dietrich et al., 2017). Among all these approaches, this dissertation falls within research at the individual level, which means that it focuses on variation among individuals regarding inherent characteristics that predict academic effort. More concretely, this dissertation focuses on further investigation of the joint effect of conscientiousness and interest in the prediction of academic effort.

Conscientiousness and interest both have long research traditions. However, the longstanding research on both constructs took place in different psychological disciplines—conscientiousness originates from personality psychology and interest originates from motivational psychology. Conscientiousness is conceptualized as one of the five personality traits within the Five-Factor model, the most widely used model of personality (De Raad & Schouwenburg, 1996; Noftle & Robins, 2007). Among the five personality traits of the Five-Factor model, conscientiousness is most relevant for success in a wide variety of life domains such as school and work. Individuals high on conscientiousness are characterized by having a general tendency to be diligent, systematic, self-controlled, and hardworking. In other words, individuals high on conscientiousness show effortful behavior across different situations and life domains. Interest is another key personal characteristic when it comes to sustaining academic behavior. It is conceptualized as a relatively stable positive evaluative orientation toward a specific domain (Eccles & Wigfield, 2002; Schiefele, 1991), which is accompanied by positive affect and leads to reengagement with the content of this domain over time. The major difference between the two constructs is that conscientiousness is domain-general, while interest is domain-specific. The major similarity is that both hold the power to drive students to persistent effort.

Trautwein and colleagues (2015) aimed to cross the boundaries between the disciplines and investigated the two constructs together. This investigation revealed a compensatory effect between conscientiousness and interest when predicting academic effort. Subsequently, the Conscientiousness × Interest Compensation (CONIC) model was proposed. Although the CONIC model has received considerable empirical support in previous investigations (for more details see 1.2.3), it is still in its early stages of development. Therefore, additional research is essential to replicate and build on extant findings and to test its generalizability. The studies conducted for this purpose derive the greatest benefit for inferences about the model's generalizability when they cover a wide variety of research characteristics (Diener et al., 2022; Reichardt, 2019; Rosenbaum, 2015).

This is where my dissertation comes in. It aims to test the CONIC model in another five data sets and to generalize it across outcomes (i.e., teachers' professional development intensity, behavioral indicators of effort), predictors (i.e., grit, overall task value), samples (i.e., college students, university students, teachers), study designs (i.e., laboratory study, experimental study), and contexts (i.e., U.S. schools, occupational context, online context) to contribute to its further refinement and consolidation.

The dissertation is structured as follows: First, the key constructs of the CONIC model (i.e., conscientiousness, interest, and academic effort) are individually introduced and grounded in theory and empirical evidence (Chapter 1.1). In the subsequent section (1.2), the constructs are considered together by discussing their similarities and conceptual differences (1.2.1). Following this, two broader theoretical frameworks are described that aim to integrate the personality and motivation perspectives in explaining goal-directed behavior (1.2.2). Finally, the CONIC model is introduced, with its positioning within the broader self-regulation research framework and its current state of research (1.2.3). To conclude the theory section, I outline general theoretical issues and requirements for establishing a new model, addressing the concept of validity; the principles of replication, generalization, and extension; and the role of applying Open Science practices (1.3). Building upon this theoretical foundation, the research questions introduced in Chapter 2 are derived. Subsequently, in Chapters 3 to 5 the four empirical studies included in this dissertation are presented. In the final chapter a comprehensive discussion of the findings from the four empirical studies is provided, assessing their implications for the CONIC model, identifying strengths and limitations, and suggesting directions for future research.

1.1 Introduction of Main Constructs: Conscientiousness, Interest, and Academic Effort

The key constructs in the present work are conscientiousness, interest, and effort, each rooted in extensive research traditions and indisputably of great importance to educational research. The upcoming chapter introduces conscientiousness and interest, providing a theoretical and empirical conceptualization as important determinants of academic effort. Following this, academic effort is theoretically framed and contextualized.

1.1.1 Conscientiousness as a Personality Trait

Personality has been conceptualized from various theoretical perspectives, including behaviorist, biological, dispositional, humanistic, psychodynamic, social-cognitive, or transactional perspectives (e.g., Rauthmann, 2017). Among these, the dispositional (or trait) perspective has evolved as the most dominant and productive paradigm in personality psychology. This perspective suggests that personality refers to individual differences in the manifestation of personality traits (e.g., Deary, 2009). Personality traits are typically described as relatively enduring, habitual patterns of feelings, behaviors, and thoughts that arise in specific situations (John & Srivastava, 1999; Roberts, 2009). Different personality trait models propose different numbers and types of traits, with some overlap between them (Digman, 1996). For instance, conscientiousness is conceptualized as a trait in multiple taxonomies, such as in the Big Five taxonomies of Goldberg (1990) or McCrae and Costa (1985), the HEXACO model (Ashton & Lee, 2007), and the Multi-Language Seven factor model (Saucier, 2003). The most widely utilized trait model in personality research is the Five-Factor model developed by McCrae and Costa (1985), which identifies five core personality traits (De Raad & Schouwenburg, 1996). Besides conscientiousness, these traits include extraversion, openness to experience, agreeableness, and neuroticism.

Theoretical Conceptualization of Conscientiousness

Individuals with high levels of conscientiousness are generally described as goal-directed, self-controlled, hardworking, well-organized, disciplined, and responsible to others (John et al., 2008; Roberts et al., 2009). In contrast, individuals with low levels of conscientiousness are described as impulsive, lacking in self-control, lazy, disorganized, undisciplined, and irresponsible. Hill and Jackson (2016) conceptualized conscientiousness as a general disposition to invest resources (e.g., time or energy) toward long-term gains and to avoid short-term actions that might undermine those gains. Like all other personality traits,

conscientiousness is considered a hierarchically structured system, with conscientiousness as a broad category and several facets underlying the broad domain (Roberts et al., 2014). Regarding the lower-order structure of conscientiousness, the current consensus is that it consists of at least four facets: self-control, industriousness, orderliness, and responsibility (Roberts et al., 2004).

Despite the relative stability of conscientiousness (as well as other personality traits), within-person variability in the corresponding patterns of cognitions, affect, and behaviors has more recently attracted interest. As the originally proposed Five-Factor model is rather deterministic, it accounts merely for the stability of personality traits. An integrative model of personality that combines different perspectives (i.e., the trait model perspective and the social-cognitive perspective) and takes a more dynamic view is the sociogenomic model of personality traits (Roberts & Jackson, 2008). It proposes that personality manifests in traits as well as in states. States are made up of fluctuating, changing patterns of thoughts, feelings, and behaviors and represent the moment-to-moment fluctuations in those constituents in the presence of traits. The stable, enduring patterns of states, that is, thoughts, feelings, and behaviors that are shown repetitively, constitute the corresponding personality trait. The relationship between states and traits is proposed to be causal: When patterns of states become long-term, that is, when they are internalized, automated, and generalized, they result in traits (or modify existing traits) (Roberts, 2018).

Effects and Mechanisms

Conscientiousness is associated with numerous positive individual and social outcomes across the life course, such as marital stability (Bogg & Roberts, 2004), healthy lifestyle behaviors (Clark & Watson, 1999), and success across various achievement contexts (e.g., Barrick & Mount, 1991). Barrick, Mount, and Judge (2001) found in their second-order meta-analysis on the relationship between personality and job performance that conscientiousness is associated with performance measures across all occupations studied. Similarly, in educational contexts, there is a positive relationship between conscientiousness and academic success (De Raad & Schouwenburg, 1996; Poropat, 2009). Meta-analyses by Mammadov (2022) and Poropat (2009) have shown that conscientiousness predicts achievement at primary, secondary, and tertiary levels and largely independently of cognitive ability.

In attempting to uncover the reasons for the positive association between conscientiousness and academic success, researchers have pointed to the role of effort

(Bidjerano & Dai, 2007; Corker et al., 2012; Noftle & Robins, 2007). Noftle and Robins (2007) found that academic effort mediates the relationship between conscientiousness and academic performance both cross-sectionally and longitudinally. Corker and colleagues (2012) investigated the academic behavior, strategies, and goals of 347 college students over two semesters. They found that conscientiousness predicts performance by promoting engagement in effortful strategies (e.g., completing homework or learning—also when they are not interested in the materials) and setting achievement-related goals. Results point to the facet of self-discipline being the strongest predictor of effort and performance (Corker et al., 2012). Their results suggest that the behavioral mechanism is that individuals with high levels of conscientiousness are more able to plan their academic goals, exert effort and persistence, and resist temptations in pursuing these goals, leading to success in performance-related contexts. Affective involvement appears to play a subordinate role.

In research on the emotions accompanying conscientiousness, it has been shown that conscientiousness is associated with both negative and positive affect. The current state of research suggests that positive affect results from the positive long-term consequences of conscientious behavior, whereas conscientious endeavors are exhausting and accompanied by negative feelings (Fayard et al., 2012; Leikas & Ilmarinen, 2017). For the latter, it is assumed that guilt as a self-conscious emotion (Tangney, 2003) plays a key role and that there is no direct link between conscientiousness and basic emotions (anger, sadness, fear, joy, disgust, surprise; Ekman et al., 1987). This means that cognitive appraisal processes seem to be more central than primary triggered basic emotions are to the driving force behind conscientious behavior.

Although previous results empirically substantiate conscientiousness as a strong predictor of academic effort (e.g., Bidjerano & Dai, 2007; Corker et al., 2012; Noftle & Robins, 2007; Trautwein et al., 2015), there is evidence that external control is a mediating condition of the strength of this relationship. Trautwein and colleagues (2006) investigated the relationship between conscientiousness and effort on homework and classwork, revealing a stronger association in the homework context. Similarly, Trautwein and Lüdtke (2007) found that perceived homework control by teachers has a stronger effect on homework effort in students with lower levels of conscientiousness compared to those with higher levels. In line with these findings, Barrick and Mount (1993) observed a stronger association between conscientiousness and performance in jobs with high autonomy compared to low autonomy. Hence, conscientiousness may be particularly relevant in situations with low external supervision or control.

1.1.2 Interest as a Motivational Factor

Already at the beginning of the 20th century, interest was investigated as a motivational factor in learning and as a determinant of academic effort (e.g., Dewey, 1913). Since then, interest research has developed into a large research field with various theoretical approaches (Renninger & Hidi, 2019). Definitions of interest differ depending on the line of theorizing researchers apply. However, despite the existing theoretical fragmentation, there is some agreement on certain characteristics of interest that are consistent across different conceptualizations (Renninger & Hidi, 2011). These shared characteristics are outlined below.

Theoretical Conceptualization of Interest

Firstly, interest is inherently relational and always refers to a specific matter, which can be an object, a theme, or an activity (Hasselhorn & Gold, 2013). Broadly defined, interest reflects a positive evaluative orientation toward a specific domain (Eccles & Wigfield, 2002; Schiefele, 1991). Secondly, interest develops in interaction with the environment and is sustained by the interplay between the person and the characteristics of the environment (Barron, 2006; Sansone & Thoman, 2005). Thirdly, individuals may not always be consciously aware of their interest. In the early stages of interest development, individuals may not recognize that their interest has just been triggered and is beginning to develop. At later stages of interest development, learners may be so absorbed that they do not realize that interest is the driving force behind their engagement (Renninger & Hidi, 2002). Fourthly, there is a physiological foundation for interest, evidenced by differential brain activations in interested individuals compared to those who are not (Renninger & Hidi, 2011). Fifthly, the theoretical conceptualization of interest includes especially affective, but also cognitive components. For example, the Munich Interest School (e.g., Krapp, 2002; Schiefele, 1991) distinguishes between two aspects of individual interest: feeling-related and value-related valences (Krapp & Prenzel, 2011). According to Renninger and Hidi (2011), affect, value, and knowledge are core components of interest. Similarly, expectancy-value theory (Eccles & Wigfield, 2002) distinguishes between intrinsic value (sometimes also called interest value; i.e., enjoyment while engaging in the task) and attainment value (i.e., personal importance of a task). However, research has also found that the correlation between the affective aspects of interest and the more value-related aspects is typically relatively high (Gaspard et al., 2015; Trautwein et al., 2012).

Most theoretical approaches and conceptualizations can be broadly classified in terms of situational and individual interest (Schiefele, 2009). Situational interest is an

affective reaction involving focused attention and is aroused by specific contextual factors, such as features of an activity or a task (Hidi, 1990; Plass & Kaplan, 2016). It can be viewed as a temporary state of being interested triggered by external circumstances (e.g., by an exciting lecture), which may last and develop further or may fade away (Hidi, 2001). On the other hand, individual interest denotes a relatively stable preference towards certain domains (Eccles & Wigfield, 2002; Rounds & Su, 2014). Due to its stability, individual interest is more of a dispositional characteristic of a person. For example, Rieger et al. (2017) investigated students between grades 5 and 8 and found that individual interest in school domains is just as stable as personality traits. Similar to the state-trait discussion in personality psychology, it can be stated here that situational and individual interest are not mutually exclusive categorizations, but the transitions between the two categories are fluid. Situational characteristics not only have the potential to directly give rise to situational interest, but also have the potential to activate the corresponding individual interest (in the case that such individual interest already exists). Moreover, situational interest may maintain and lead to the development of individual interest (e.g., Hidi & Renninger, 2006; Schiefele, 2009). This, in turn, influences the strength of the situational interest experience. Further, both situational and individual interest may lead the individual to actively seek situational characteristics addressing the domain of their interest experience and, therefore, increase the probability of situational interest arising again or individual interest being activated. The reciprocal interrelations between situational interest, individual interest, and situational characteristics are depicted in the theoretical model proposed by Schiefele (2009; see also Figure 1), which integrates conceptualizations from several authors (Byman, 1995; Deci, 1998; Hidi, 2000; Krapp, 1999; Renninger, 2000).

Effects and Mechanisms

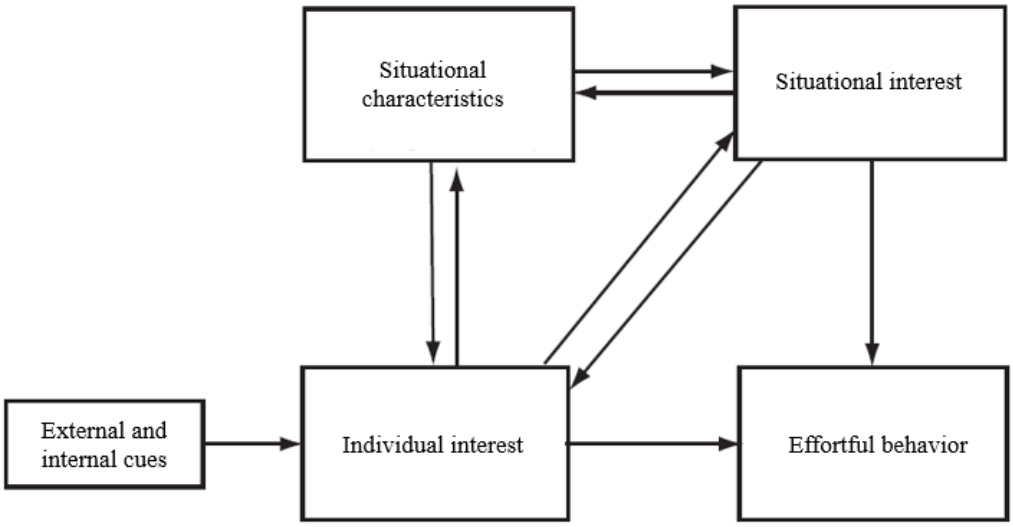
Similar to conscientiousness, interest has been found to correlate with many individual and social outcomes across the life course. These include aspects such as having a relationship, being married, and perceived health status (Stoll et al., 2017), as well as life goals (Stoll et al., 2020), job satisfaction (Hoff et al., 2020; Tsabari et al., 2005), and success across different achievement contexts (Nye et al., 2012, 2017; Van Iddekinge et al., 2011). Nye et al. (2012, 2017), Schiefele et al. (1992), and Van Iddekinge et al. (2011) conducted meta-analyses on the relationship between interest and performance and demonstrated the validity of interests for predicting performance in both work and academic settings.

The positive association between interest and performance is thought to stem from two main factors. Interest influences performance, firstly, by shaping individuals' choices of

activities and goals and, secondly, by motivating effort and persistence (Nye et al., 2012; Rounds & Su, 2014). For example, interests have been found to predict decisions such as college major or occupation (Holland, 1997; Päßler & Hell, 2012; Wille et al., 2020) as well as the endurance of these choices (Allen & Robbins, 2008; Van Iddekinge et al., 2011). In the realm of education, Dewey et al. (1913) highlighted interest as a key factor for academic effort over a century ago. Subsequent research has consistently revealed interest to be a robust predictor of effortful behavior across various domains (e.g., Cole et al., 2008; Hidi & Ainley, 2008; Nye et al., 2012; Xu, 2018). To illustrate how individual and situational interests translate into effortful behavior, I will outline the model proposed by Schiefele (2009). This model depicts the interrelations between situational characteristics, individual interest, and situational interest but also illustrates how they lead to intrinsic motivation. Intrinsic motivation, defined as a set of internal processes energizing, sustaining, and directing behavior across changing circumstances and over time (Kanfer, 1990; Nye et al., 2012), can be viewed as a driving force into effortful behavior (see also 1.1.3). Thus, the model elucidates how the interplay of situational and individual interests leads to effortful behavior (see Figure 1).

Figure 1

Interplay between individual interest, situational interest, and effortful behavior



Note. Figure adapted from Schiefele (2009).

The generation of situational interest not only directly leads to effortful behavior but also activates individual interest. Further, when individual interest is activated, it may

indirectly lead to effort through situational interest. Schiefele (2009) proposed that "the experience of interest is basically the same, no matter how it is created (through situational characteristics or the activation of individual interest)" (p. 217). This assumption supports that a distinction between individual and situational interest is dispensable for describing the underlying mechanism of the internal processes prompted by both individual and situational interest, leading to effortful behavior.

Regarding the emergence of these internal processes toward effort, the emotional involvement that accompanies interest seems to be a particularly crucial factor. Researchers have consistently emphasized the association of interest-driven engagement with positive feelings (Krapp, 2002). Thus, it is postulated that the rewarding nature of positive feelings reinforces people's information-seeking behavior and increases the likelihood of engaging again (Murayama et al., 2019). Furthermore, positive affect tends to replenish resources, which may, therefore, protect students from experiencing the exhaustion of demanding tasks when engaged in interest-driven effort (Thoman et al., 2011).

1.1.3 Academic Effort

Effort, as depicted earlier, is considered to play a central role in mediating various positive learning outcomes. Generally, it is conceptualized as the allocation of resources, for example, the amount of physical or mental energy and time that people expend, in the service of meeting some goal (Eisenberger et al., 1992; Inzlicht et al., 2018; Jansma et al., 2007; Rieger et al., 2022). Alternatively, effort is defined as the process that mediates the relation between how well an individual can perform and how well an individual actually performs (Shenhav et al., 2017).

Effort is related to, but different from motivation. Motivation can be seen as the driving force determining both (a) the intensity of behavior and (b) direction (e.g., a goal; Inzlicht et al., 2018), whereas effort refers exclusively to the intensity of behavior and not to a specific goal. In other words, effort includes no individual valence but corresponds to the intensity of the application of physical or mental work towards an outcome. The exertion of effort is typically accompanied by distinct phenomenology and can therefore be recognized by others and by oneself (de Morree & Marcora, 2010; Inzlicht et al., 2018).

In academic contexts, effort is mostly referred to as *academic effort*, defined as an evaluation of the intensity and persistence of a learner's behavior in educationally purposeful

activities (Nicholls, 1978; Pintrich & De Groot, 1990). On a phenomenological level, individuals who report high academic effort tend to choose not the simplest way, but the best way; they work accurately and show persistence when faced with challenging tasks. This can be captured by an attitude of "I do my best" (Rieger et al., 2022).

As effort is characterized by observable behavior, it is not typically theoretically conceptualized in the literature. In psychological research, terms like engagement, practice, determination, or perseverance are usually used with little distinction (e.g., Baumeister et al., 2006; Duckworth et al., 2007; Trautwein & Lüdtke, 2007). Given the large body of research on student engagement, it is briefly discussed here to differentiate it from effort.

The research on student engagement addresses questions of how and why (or due to what underlying factors) students are engaged. It has been conducted by researchers from many different disciplines and for quite a long time. Several books discuss unresolved definitional and application issues related to engagement theory and research (e.g., Christenson et al., 2012; Keengwe, 2022); conceptual clarity and methodological rigor have not been achieved to date. Nevertheless, there is sufficient consensus on a number of elements regarding student engagement to liken it to and distinguish it from academic effort. Similar to academic effort, student engagement is considered a central construct regarding desired academic learning outcomes (e.g., achievement or school completion). Engaged students, like effortful students, demonstrate sustained effort and self-regulate their behavior to achieve goals. However, the distinction lies in the multidimensional nature of student engagement. Student engagement, unlike effort, is viewed as a multidimensional theoretical construct (e.g., Lawson & Lawson, 2013). While there is no consensus on the specific types and number of engagement dimensions (Christenson et al., 2012), many conceptualizations encompass an affective dimension, such as a sense of belonging or a perceived connection to others (Lawson & Lawson, 2013; Mahatmya et al., 2012). This makes the concept of student engagement much broader than our understanding of effort.

Effort, as previously mentioned, is not intended to be a theoretical construct but rather an observable behavior reflecting the general attitude of doing one's best. Therefore, it corresponds to the behavioral dimensions (e.g., Mahatmya et al., 2012; Reschly & Christenson, 2012) of the broader concept of student engagement, but not with its other dimensions. Thus, effort is a crucial element of student engagement, whereas academic effort may coincide with student engagement, but it does not necessarily have to.

1.2 The Conceptual Conjunction of Conscientiousness and Interest

Traditionally, research on interest and conscientiousness has largely progressed independently within their specific disciplinary boundaries. Personality psychologists have primarily focused on personality traits—mainly the five dimensions included in the Five-Factor model, whereas motivational constructs such as personal interests are treated as consequences of underlying personality or are ignored (e.g., McCrae & Costa, 2008). At the same time, educational psychologists have emphasized the role of interest but have tended not to consider conscientiousness (e.g., Pintrich, 2003) or have treated personality as a distinct and minor influencing factor besides other person-related variables like sex or ethnicity (e.g., Wigfield & Eccles, 2020).

The result of this isolated practice is that the different fields separately developed independent theoretical assumptions about the relations between conscientiousness or interest and effortful behavior, presented in the preceding chapter.

In this chapter, the two constructs are considered together and conceptual similarities and differences of the two constructs are described. Further, two models are introduced that integrate the perspectives of personality and motivation psychology to explain academic endeavors, though they do not focus specifically on either conscientiousness or interest. Finally, the Conscientiousness × Interest Compensation (CONIC) model is presented. It captures the unique and combined effects of the two constructs and proposes a theoretical conceptualization of their interplay as predictors of academic effort.

1.2.1 Similarities and Conceptual Differences of the Constructs

As a common factor in the conceptualizations of conscientiousness and interest, it can be stated that both exist in a stable *dispositional manifestation* (i.e., conscientiousness trait or individual interest) that results in a certain behavioral tendency, as well as a less stable *situational manifestation* (i.e., conscientiousness state or situational interest) that is highly dependent on external cues. The interrelations of the *dispositional manifestation* and the *situational manifestation* are different for both constructs, but it is generally true that there is a reciprocal relationship in each case, with the *situational manifestations* influencing the development of the *dispositional manifestations*. Neither manifestation is deterministic but rather related to the environment.

Furthermore, both conscientiousness and interest can be conceptualized as internal driving forces resulting in exerting effort. Consequently, both constructs are crucial factors

in striving to meet life goals and are important predictors not only for academic outcomes but also for various important long-term life outcomes (e.g., Mike et al., 2015; Stoll et al., 2017).

With respect to conceptual differences, interests are contextualized and strongly domain-specific, whereas conscientiousness is domain-general. Interests, per definition, always refer to an object of interest (e.g., an activity or a school subject; Renninger & Hidi, 2011), whereas conscientiousness describes a pattern of thoughts, emotions, and behaviors across different situations. This does not mean conscientiousness has the same implications for all outcomes across all situations. For instance, conscientiousness is an important predictor in academic achievement contexts but not necessarily in social contexts. However, in contrast to interest, there is no domain-specificity. More concretely, related to the example of students' academic effort, this means that students with high conscientiousness tend to work hard in all school subjects. In contrast, students' interest leads to high effort exclusively in the subject to which their interest relates.

Another difference between conscientiousness and interest is the affective value associated with each construct. Interest is directly linked to positive emotional affect, whereas conscientiousness does not necessarily result in either negative or positive emotional states. Conscientiousness is related to outcomes that may result in positive affect, such as academic success, or may prevent individuals from experiencing adverse events, such as marital divorce, and resultant negative affect. However, there is no direct evidence of conscientiousness being linked to positive emotional experiences.

1.2.2 Theoretical Models Combining the Personality and Motivation Perspectives to Explain Academic Endeavors

It can be stated that interest and conscientiousness differ considerably in their conceptualizations and practical implications, but they also share significant similarities. However, research on these two constructs and the broader strands of motivation and personality research associated with them have primarily been conducted independently, impeding theoretical and practical progress toward addressing multifaceted problems, such as academic underachievement.

Therefore, there is a pressing need for integrative theories. The following section will introduce two theoretical approaches that aim to incorporate personality and motivational perspectives in explaining academic endeavors. The first approach is an ambitious attempt by Carol Dweck (2017) to unite personality, motivation, and the development of both into a

"grand" theory (Wigfield & Koenka, 2020). This approach offers a developmental perspective, which involves process-oriented considerations at a subordinate level at which both constructs can be composed with similar constituents and thus operationalized in an integrative manner. These considerations contribute to a cohesive understanding of how each of the constructs operates independently and in conjunction, which helps anticipate the underlying processes of the compensatory effect described in the CONIC model. The second approach is a model that combines personality and motivational perspectives to comprehensively explain self-regulation in the context of learning (Wortha et al., 2021). This approach acknowledges that both constructs, conscientiousness and interest, serve a similar function: promoting a willingness to exert academic effort towards achieving academic goals, which is also the core of the CONIC model presented subsequently.

A Theoretical Framework to Unify Personality, Motivation, and Development by Dweck (2017, 2021)

Theory's Description

Dweck (2017, 2021) proposes a theoretical framework integrating personality, motivation, and development. She aims to bridge the gap between isolated research practices and establish one set of principles to explain overall human functioning. According to Dweck, motivational as well as personality processes consist of four constituent elements: (1) basic needs; (2) goals; (3) stored beliefs, emotions, and action tendencies (BEATs); and (4) online acts and experiences.

She suggests that basic needs drive behavior and affect its intensity, while goals provide direction and step-by-step guidance toward fulfilling those needs. She defined goals as follows: "mental representations of desired end states, not necessarily explicit or conscious, and most often probably not" (Dweck, 2017, p. 697). She posits that while individuals experience needs and strive for need-fulfilling goals, they form mental representations of their experiences called BEATs. BEATs consist of goal-relevant beliefs, emotions, and action tendencies and serve as future guides for selecting and pursuing goals. Online acts and experiences represent the person's actual behaviors, feelings, and thoughts while pursuing the goal.

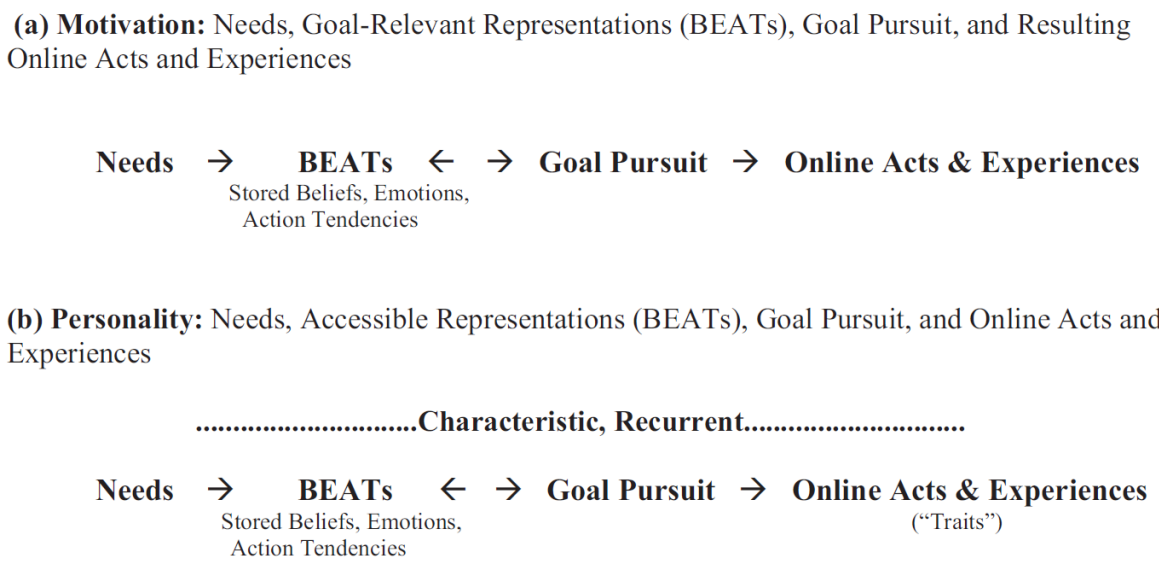
When a need is aroused, BEATs get activated to help individuals decide what to do. Once the individual has decided on a goal, goal pursuit involves online acts and experiences. The online acts and experiences that come with goal pursuit can modify the BEATs by adding new representations to the stored mental representations of past experiences. BEATs

shape motivation by playing a role in goal selection and pursuit, and they form the basis of personality by creating characteristic, recurrent patterns of acts and experiences. For a visual depiction of these processes, see Figure 2.

Dweck's model proposes that personality and motivation develop out of the same elements: needs, goals, BEATs, as well as online acts and experiences. However, Dweck (2017) further argues to add the words *characteristic* and *recurrent* for the personality processes: There are characteristic and recurrent online acts and experiences that constitute the more stable part of personality and can be thought of as traits. Those are underpinned by characteristic and highly accessible BEATs that encompass important beliefs, representations of strong emotional tendencies, and representations of high-probability action tendencies. These represent the dynamic and state-like aspect of personality.

Figure 2

Depiction of the (a) Motivational and (b) Personality Processes Proposed by Dweck (2017)



Note. Reprinted from "From Needs to Goals and Representations: Foundations for a Unified Theory of Motivation, Personality, and Development" by C. Dweck, 2017, Psychological Review, 43, p. 699. Copyright 2017 by the American Psychological Association.

Implications for the Conceptual Conjunction of Conscientiousness and Interest

Dweck (2017) herself has emphasized that her theoretical approach is intended to be stimulating and thought-provoking rather than a definitive statement. Nevertheless, I have

chosen to present her approach in this work because it conceptualizes several aspects that appear relevant to the conceptual conjunction of conscientiousness and interest.

Based on her theoretical considerations, both interest (a motivational construct) and conscientiousness (a personality trait) lead to and play a role in goal-striving processes. These processes include the same elements: BEATs, goals, and online acts and experiences. Although the online acts and experiences are similar in both motivation and personality, they are not identical (i.e., both show effortful behavior but with a different "feel", as discussed in section 1.2.1). The somewhat different online acts and experiences activated by each construct suggest that different needs underlie the respective processes and different BEATs are therefore actuated. Dweck (2017) proposes that conscientiousness is rooted in the need for competence and especially in the need for control and that a key BEAT associated with conscientiousness is perceptions of control. Therefore, individuals who score high on conscientiousness tend to pursue their need-fulfilling goals by engaging in online acts such as being thorough and careful, exerting self-control, following norms, and showing perseverance.

Dweck's (2017) article does not explicitly mention interest. However, given that the online acts and experiences of interest are also substantially characterized by effortful behavior, I suggest that interest is similarly rooted in a need for competence/understanding. Moreover, positive emotional involvement is another key characteristic of online acts and experiences of interest. Therefore, I propose that interest is additionally rooted in a need for spontaneity and play, which is also a basic need (e.g., Arntz et al., 2021). This need captures the positive emotions associated with interest-driven experiences and underlies phenomena such as curiosity, lust, and creativity (e.g., Meier, 2019).

According to Dweck's conceptualization, the BEATs as stored mental representations of past experiences could also be considered as "predictive models" because they are used to generate predictions about what is likely to happen when a specific goal is pursued. This information is then used to determine which need-fulfilling goal should be prioritized. According to Dweck's theoretical framework, an individual with high conscientiousness who faces a challenging math problem is likely to accept the challenge of solving the problem (i.e., goal) and show high persistence and effort (i.e., online acts and experiences). This is because individuals with high levels of conscientiousness prioritize being proficient in school (i.e., need for competence) and avoiding appearing unprepared

(i.e., need for control). They do their tasks as a matter of principle, which means they have a great belief in their reliability and perseverance (i.e., BEATs).

Similarly, an individual who experiences interest when faced with a challenging math problem is also likely to accept the challenge of solving the problem (i.e., goal) and exhibit high levels of persistence and effort (i.e., online acts and experiences). This is because an interested person would enjoy figuring out the problem (i.e., need for spontaneity and play) and be eager to understand how to solve it (i.e., need for competence). Additionally, the person would anticipate feeling a sense of satisfaction and positive emotions after solving such a challenging problem (i.e., BEATs).

It is important to note that conscientiousness and interest are just two of the many factors that can influence behavior, as different basic needs may also come into play. In such cases, it is essential to consider which need is most salient or important for an individual. However, when trait expression is high with strong underlying needs, these will likely take precedence in decision-making, as people tend to make choices that maximize the fulfillment of their needs.

Dweck's theoretical approach has some limitations regarding interest, as it conceptualizes motivational constructs, including interest, as generally unstable and thus neglects the dispositional version of interest, i.e., individual interest. However, as the motivational and personality processes proposed by Dweck (2017) consist of the same elements, this could simply be addressed by applying the terms *characteristic* and *recurrent* also when modeling the interest-driven process. In summary, we can draw from the framework that while the processes of goal pursuit of conscientiousness and interest share similarities, they are fuelled by different content.

A Machine-Learning Approach Empirically Integrating Different Perspectives on Self-Regulation in Education (Wortha et al., 2021)

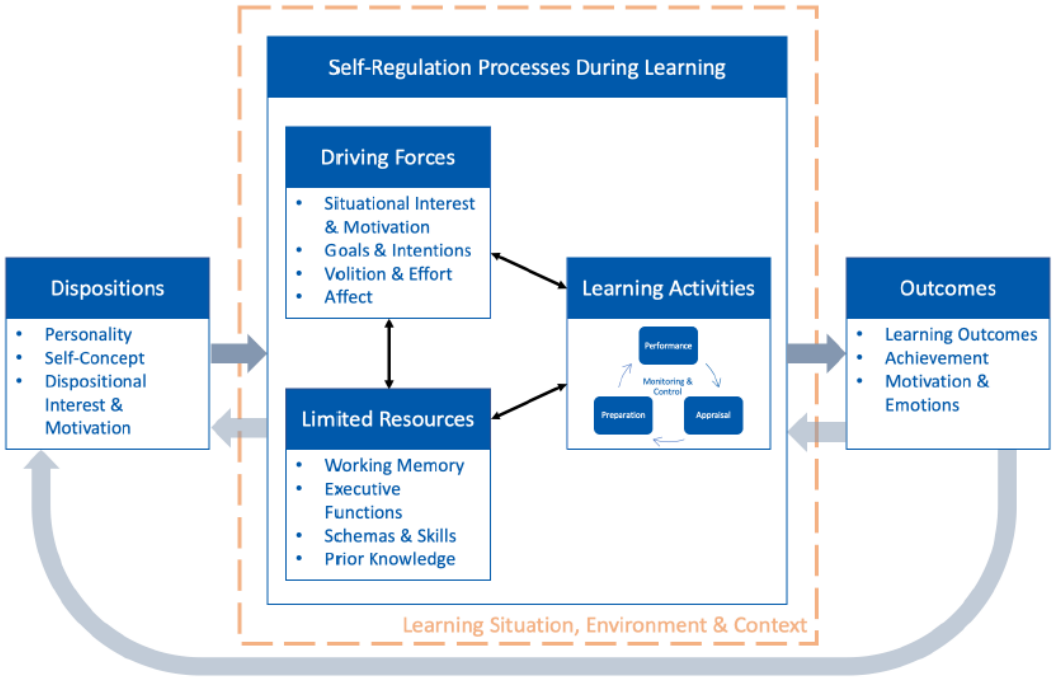
Description of the Theoretical Framework

Wortha et al. (2021) have also developed a framework that integrates personality and motivation within the context of self-regulation and with a specific focus on the process of achieving academic goals. Similar to Dweck (2017), they take a holistic approach to integrate current knowledge from different areas of psychology. They propose that the self-regulation process towards educational outcomes involves four groups of self-regulation constructs (see also Figure 3). The four groups were distinguished according to if their subconstructs address (1) personal dispositions (e.g., personality or individual interest), (2)

driving forces (e.g., affect), (3) limited resources (e.g., working memory), or (4) learning activities (e.g., cognitive strategies). To empirically relate the different subconstructs of each group to different educational outcomes, Wortha et al. (2021) used a machine-learning approach. They found that the optimal prediction of the educational outcomes requires predictors from all four groups, demonstrating their complementary value. However, the specific constructs that best predict educational results vary depending on the outcome being evaluated. Overall, Wortha et al. (2021) suggest that self-regulation toward outcomes at different levels (i.e., task level or grade level) has the same underlying structure (i.e., personal dispositions, driving forces, limited resources, and learning activities), but the specific interplay of the different components is context-dependent.

Figure 3

An Integrative Framework for Self-Regulation in Education Proposed by Wortha et al. (2021)



Note. Reprinted from "Beyond Self-Regulated Learning: Integrating Approaches to Self-Regulation in Education" by F. Wortha, 2021, Doctoral dissertation, p. 22. Copyright 2021 by the University of Tübingen.

Implications for the Conceptual Conjunction of Conscientiousness and Interest

The study related to Wortha et al.'s integrated framework underscores the significance of interdisciplinary approaches for predicting educational outcomes. They employed a data-driven machine learning approach to reveal the complementary value of

considering constructs from different research traditions to predict educational outcomes. The suggested framework explicitly includes conscientiousness (resp. personality) and dispositional interest (i.e., individual interest) within the group of dispositions, as well as situational interest and effort within the group of driving forces. The subcomponents "goals and intentions" within the group of driving forces capture the more situational aspect of conscientiousness. However, in contrast to the previous understanding that effort can also result from driving forces (see 1.1.3), this framework sees effort exclusively as a driving force. However, I consider effort as both a result of a self-regulation process (e.g., working hard on a task) and a prerequisite of an outcome (e.g., task performance). Therefore, I would suggest classifying effort as an adjunct between the self-regulatory process and the outcomes.

To sum up, the framework proposes that conscientiousness and individual interest lead to and play a role in the self-regulatory process on the way towards learning outcomes. The model, however, does not offer any specific assumptions about how these constructs interact within the self-regulatory process. On a more general level, the study's results indicate that the predictive value of the different predictors and the interplay between them differ depending on the learning situation. This observation aligns with the principles of the CONIC model.

1.2.3 The Conscientiousness × Interest Compensation Model as an Integrative Model to Predict Academic Effort

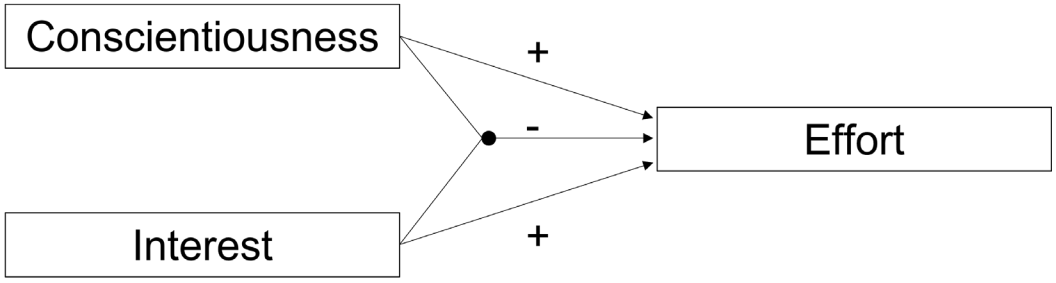
The previous chapters have established a sophisticated understanding of the nature of conscientiousness and interest, as well as their conceptual similarities and differences. Two theoretical frameworks were presented that have already brought together interest and conscientiousness regarding goal-striving. However, both frameworks remained at a rather general theoretical level and treated interest and conscientiousness distinctly without examining their potential interaction processes. To address this limitation, I will now zoom in further and specifically examine the interplay of interest and conscientiousness in the prediction of academic effort.

Understanding the joint effects of conscientiousness and interest is important for identifying each construct's unique contributions and overlap. Doing so makes it possible to create synergy by bringing together two separate research areas. In recent years, various studies have explored the joint effects of these constructs on academic effort and found

evidence of a compensatory effect (Trautwein et al., 2015). As a result, a compensatory effects model was proposed to explain these findings. This model, named the Conscientiousness × Interest Compensation (CONIC) model, postulates that high conscientiousness can partly compensate for a lack of interest in a domain, and vice versa, in predicting academic effort (Song et al., 2020; Trautwein et al., 2019). Statistically, this compensatory effect is expressed in the regression model of conscientiousness, interest, and their interaction (Conscientiousness × Interest) predicting academic effort: The two main effects are positive, while the interaction effect is negative. This finding (i.e., opposing signs of main effects and interaction effect) supports the existence of a compensatory effect (also "interference or antagonistic effect"; Cohen et al., 2003, p. 285). In educational practice, the effect indicates that concerning academic effort, conscientiousness is more important for students with low interest. On the other hand, interest is more critical for students with low levels of conscientiousness. The relations within the CONIC model are graphically depicted in Figure 4.

Figure 4

The Conscientiousness × Interest Compensation (CONIC) Model (Trautwein et al., 2019)



Proposed Mechanisms

Bringing together the differences and similarities of the constructs, as well as considering the existing broad theoretical frameworks by Dweck (2017) and Wortha et al. (2021), can provide some guidance on the possible mechanism by which this compensatory effect can be explained. Conscientiousness and interest are both driving forces that lead to self-regulating and effortful behavior. Because of their conceptual differences, such as domain-specificity/generality and emotional involvement, we assume this process occurs along different pathways. The path via conscientiousness toward academic effort is driven by an orientation toward the outcome rather than the learning process itself (Sansone et al., 2010). It is obtained through different processes facilitated by conscientiousness and may be activated in achievement-related situations across different domains. For one, individuals

with high conscientiousness set more goals to improve and challenge themselves; for another, they are also able to resist distractions and temptations (e.g., delaying or suppressing gratification) because they can inhibit behaviors. These tendencies are closely related to the construct of *self-control* and can either restrict impulsive behavior or initiate and sustain effort (McCrae & Löckenhoff, 2010). This explains why the conscientiousness-driven process makes people work without hesitation and stick to tasks even if negative emotions accompany them. However, the conscientiousness-driven process lacks positive affectivity, can be exhausting, and may trigger feelings of effortfulness. Therefore, it can be conceptualized as a "built-in push factor" that pushes individuals to work hard (Trautwein et al., 2015; Song et al., 2019).

Unlike the conscientiousness-driven process, the path to academic effort via interest is driven by the learning process itself. Interest prompts automatic attention and positive affectivity, which then leads to a self-reinforcing process making the interest-driven activity feel pleasant and effortless (Murayama et al., 2019; Sansone et al., 2010), and in turn facilitates goal-oriented behavior, such as persistence and academic effort (Ainley et al., 2002; Hidi et al., 2004; Renninger & Wozniak, 1985). Therefore, interest can be conceptualized as a "pull factor" that attracts and inspires individuals to work.

While interest is a domain-specific driving force and works only in situations where interest is generated or activated, the driving force of conscientiousness works across various situations and domains. Consequently, conscientiousness can be especially influential in uninteresting or monotonous contexts where interest is not naturally elicited or activated. Moreover, recent research has shown that the effect of conscientiousness on academic effort is mediated by external control (Trautwein & Lüdke, 2007). It can, therefore, be hypothesized that this effect is strongest in situations with a high degree of autonomy and low external control, where individuals rely on their self-regulation to achieve their goals.

Taken together, following the theoretical frameworks presented by Dweck (2017) and Wortha et al. (2021), it can be stated that the exhibited behavior (i.e., self-regulated behavior) is the same, but the path via conscientiousness and the path via interest to get there differ because they are motivated by different desires and needs. Depending on the situation and environment (i.e., How boring is it, and how high is the degree of external control?), one of the paths will be prioritized while the other loses significance, resulting in a compensatory relation. This compensatory relation is captured in the CONIC model.

Empirical Evidence on the CONIC Model

In 2015, Trautwein and colleagues conducted a series of four studies which provided the initial evidence of a compensatory effect of interest and conscientiousness in predicting academic effort. Using latent moderated structural equation modeling, they probed for interaction effects in four cross-sectional data sets collected in school settings with similar age groups and across different subjects. Further details on the four studies are presented below.

In Study 1, eighth-grade students from non-academic track schools in two German states participated. The CONIC model was examined across three subjects: mathematics, English, and German. The findings demonstrated significant positive main effects and a consistent compensatory effect in all three subjects, supporting the CONIC model.

In Study 2, Trautwein and colleagues tested the CONIC pattern using data from high school students in German academic track schools. The analyses were conducted for the domains of mathematics and English. The interaction term for mathematics was found to be statistically significant, indicating a compensatory relationship; the interaction term for English did not reach statistical significance.

In Study 3, they analyzed a data set comprising a sample of seventh- and tenth-grade high school students. The analyses were conducted across five subjects: mathematics, English, German, biology, and a second foreign language. The compensatory interaction effect was found for the three "main subjects" (mathematics, English, and German), supporting the CONIC model. However, no compensatory effect was observed for biology and the second foreign language. Additionally, they tested the CONIC model at the within-subject level using multilevel modeling and found the compensatory pattern within students. This indicates that the relationship between interest and academic effort is stronger among students low in conscientiousness than among students high in conscientiousness and vice versa.

In Study 4, the compensatory effect was examined for situational interest rather than individual interest. The data set consisted of high school students from Switzerland, and their situational interest was assessed on a day-to-day basis in the subject French. The analyses were conducted at the within-subject level using multilevel modeling. The results provided further support for the assumptions of the CONIC model. There were positive effects of conscientiousness and situational interest. Additionally, the cross-level interaction term for conscientiousness and situational interest significantly predicted academic effort.

Cumulatively, the studies showed robust—albeit not perfect—evidence for a compensatory interplay between conscientiousness and interest in predicting academic effort, indicating that students with low levels of one construct may compensate with higher levels of the other in terms of academic effort. The pattern was observed across multiple school subjects, in relation to both individual and situational interest, and also at the within-subject level. Overall, the evidence presented in these studies supports the CONIC model as a useful framework for conceptualizing the complex interplay between individual traits and academic outcomes. However, it is important to note that no contextual evidence is available from these initial studies to explain why the effect was not observed in all cases.

Rieger and colleagues (2022) tested the statistical pattern of the CONIC model using longitudinal data. They analyzed data from four measurement points of fifth- to eighth-graders from Germany to examine whether changes in academic effort were predicted by conscientiousness, interest, and their interaction term. Using latent moderated structural (LMS) equation modeling, they found a negative interaction effect in all models, with statistical significance in five out of nine models. When interest was high, the positive predictive effect of conscientiousness was weaker, and vice versa. These findings support the assumptions of the CONIC model in longitudinal samples and provide further evidence for the compensatory interplay between conscientiousness and interest in predicting academic effort.

In a study by Song et al. (2020), the original CONIC model was extended by adding utility value as an additional predictor and achievement as an outcome variable. The study involved German students from academic track schools in grades five to 12. The results showed that the Conscientiousness × Interest interaction term significantly predicted all tested domains, including mathematics, German, English, and biology. The same pattern of results was observed for the Conscientiousness × Utility value interaction term. When they replaced academic effort with achievement scores (school grades), they found that the Conscientiousness × Interest interaction term was a significant predictor for German and English but not for mathematics and biology. On the other hand, the Conscientiousness × Utility value interaction term was a significant predictor for German and biology grades but not for mathematics and English grades. The results of Song et al. (2020) extend the CONIC model for a broader age group and two additional constructs, namely utility value and academic achievement. However, they also suggest stronger evidence for academic effort as an outcome than for academic achievement.

Overall, the findings from six different data sets involving students in grades five to 12 and across various domains, including both cross-sectional and longitudinal analyses, confirm the statistical pattern of the CONIC model. The model holds also when replacing interest with utility value and when predicting academic achievement instead of academic effort. Table 1 provides an overview of previous studies investigating the CONIC model.

Table 1

Overview of Studies Supporting the CONIC Model

Study	Design	Data type	Sample size	Age	Participant pool	Predictors	Domains	Outcomes
Trautwein et al. (2015) – Study 1	Between-person	Cross-sectional survey data	N = 2,557	Grade 8 (M = 14.02 years)	133 classes in 99 non-gymnasium schools in two German states	Conscientiousness, Individual interest	Math, English, German	Domain-specific effort
Trautwein et al. (2015) – Study 2	Between-person	Cross-sectional survey data	N = 415	Grade 8 (M = 13.45 years)	20 classes in 11 gymnasium schools in Berlin, Germany	Conscientiousness, Individual interest	Math, English	Domain-specific effort
Trautwein et al. (2015) – Study 3	Between- and within-person	Cross-sectional survey data	N = 1,025	Grades 7 & 10 (M = 14.29 years)	51 classrooms in six high schools in Berlin, Germany	Conscientiousness, Individual interest	Math, English, German, Biology, second language	Domain-specific effort
Trautwein et al. (2015) – Study 4	Within-person	Cross-sectional survey and diary data	N = 1,530	Grade 8 *(*M = 13.79 years)	89 classrooms in three Swiss cantons	Conscientiousness, Situational interest	French	Daily effort
Song et al. (2020)	Between-person	Cross-sectional survey data	N = 830	Grades 5 through 12 (M = 13.93 years)	51 classes in two gymnasium schools in Baden-Württemberg, Germany	Conscientiousness, Individual interest, Utility value	Math, English, German, Biology	Domain-specific effort, Grades
Rieger et al. (2022)	Between-person	Longitudinal survey data	N = 3,880 (pooled data set)	Grade 5 at T1 (M = 11.1 years)	136 classes in 99 non-gymnasium schools in two German states	Conscientiousness, Individual interest	Math, English, German	Domain-specific effort

Note. In addition, results from the studies by Sansone et al. (1999) and Di Domenico and Fournier (2015) align with the main assumptions of the CONIC model. As these studies were not designed to test the CONIC model, they are not listed here.

Anchoring the Model in the Self-Regulation Framework

The approach of considering conscientiousness and interest together is based on the idea that both lead to similar behavior, namely academic effort or, at a broader level, self-regulated behavior. Therefore, the CONIC model can also be understood as a model that predicts self-regulated behavior, thereby positioning it within the framework of self-regulation. Consequently, the concept of self-regulation will be introduced below.

Self-regulation refers to an "active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior guided and constrained by their goals and the contextual features in the environment" (Pintrich, 2000, p. 453). As such, self-regulation is neither a cognitive ability nor an academic skill but rather a self-directive process that enables learners to transform their cognitive abilities into academic skills (Zimmerman, 2001). It is considered both a central educational resource and an educational goal (e.g., Corte et al., 2000).

This definition of self-regulation may sound like a previous definition of academic effort in this dissertation. As discussed earlier, Shenhav et al. (2017) defined academic effort as the process that mediates the relation between an individual's ability to perform and their actual performance. However, this does not imply that effort and self-regulation are synonymous. Effort solely describes a behavioral intensity without the encompassing theoretical framework of self-regulation. Another distinction is that self-regulation refers to a comprehensive process that is consistently tied to a goal to be achieved.

Research on self-regulation has flourished since the mid-1980s, attracting attention from different areas of psychology and beyond (Boekaerts et al., 2000; Vohs & Baumeister, 2016; Zimmerman & Schunk, 2001). Self-regulation has been identified as a crucial predictor of various outcomes in educational settings, including academic achievement (Duckworth et al., 2010), and other important outcomes across the life course like health, wealth, and criminal offending outcomes (McClelland et al., 2013; Moffitt et al., 2011). However, the concept of self-regulation remains fragmented due to varying definitions and measures across different research fields (Zeidner et al., 2000).

Given the extensive body of research on self-regulation, it is beyond the scope of this dissertation to provide a comprehensive account of the literature, which is vast and fragmented. However, due to its high relevance, the integration of the CONIC model into the self-regulation framework should be highlighted at this point. The fragmentation of research on self-regulation has impeded progress in understanding this construct and its relationship with academic

outcomes. Bridging the gaps between sub-disciplines and integrating diverse perspectives are crucial for advancing knowledge and achieving a broader understanding of self-regulation (Posner & Rothbart, 2000). By combining conscientiousness and interest in the CONIC model, artificial boundaries between personality and motivational psychology are bridged, offering a more comprehensive understanding of these two aspects of self-regulation and shedding new light on how conscientiousness and interest contribute to individuals' behavioral regulation in pursuit of their goals. One approach towards interdisciplinary and integrative research is the comprehensive framework presented by Wortha et al. (2021) (presented in chapter 1.2.2) which can also be utilized to incorporate the CONIC model into the concept of self-regulation.

1.3 Issues and Requirements for Establishing a New Theoretical Model

As discussed in the previous chapter, the CONIC model has already received substantial empirical support. However, it is still in its early stages of development. To identify areas where further research is needed, I will outline below where the CONIC model can be located in the empirical research process to develop a psychological theory. For this purpose, I will first introduce the concepts of phenomenon, data, and theory, as well as briefly describe the process of research and theory building.

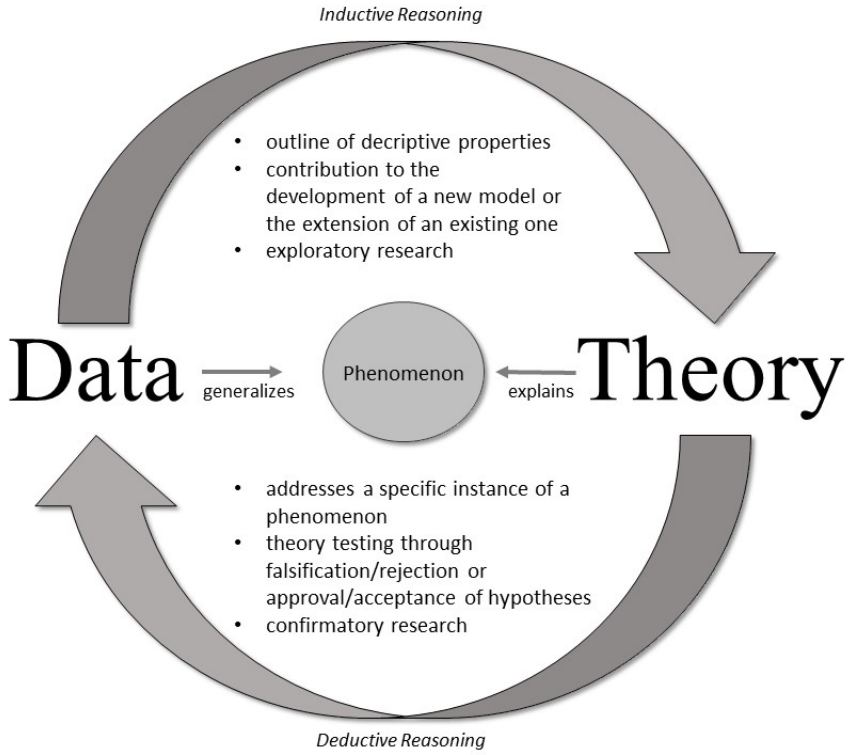
Empirical phenomena can be defined as relatively consistent, recurring, and general features of the world that scientists strive to explain (Bogen & Woodward, 1988; Borsboom et al., 2021; Eronen & Bringmann, 2021; Haig, 2013). Therefore, a phenomenon can be understood as robust generalizations of patterns in empirical data. In the present work, the phenomenon under investigation is the compensatory effect between interest and conscientiousness predicting academic effort. While phenomena are observable in many situations, data refer to a particular context of inquiry. Thus, data is a collection of observations or reports of a specific research object. For example, a typical data set in research on the CONIC model would consist of structured reports on how a particular group of participants answered items on conscientiousness, domain-specific interest, and domain-specific effort. There has yet to be a consensus on the definition of theory. The common core of many definitions is that a theory/model represents a set of propositions about the relationship(s) between two or more concepts or constructs with the goal of explaining, describing, and predicting phenomena (e.g., Guest & Martin, 2021; Hollander, 1978; Jaccard & Jacoby, 2020; Lakatos, 1976). For example, the compensatory effect between conscientiousness and interest has been explained by proposing two different driving forces that operate on different self-regulating paths. Therefore, only one is needed to attain academic effort. This constitutes a general explanatory principle because it explains a general psychological mechanism that is not limited to a specific context of inquiry. There is some debate around the notion of *model* and *theory* (e.g., Bailer-Jones, 2009; Fried, 2020). In this work, I follow the approach of using both terms synonymously (e.g., Jaccard & Jacoby, 2020).

The relations between the concepts of theory, phenomenon, and data can be represented in the following framework (also depicted in Figure 5): Data provide evidence for the presence of empirical phenomena, whereas a theory, in turn, is formulated to explain the empirical phenomena that are evidenced by data (e.g., Borsboom et al., 2021).

In order to move from theory to data and from data to theory (to detect and explain a phenomenon), two types of scientific reasoning can be distinguished: Deductive and inductive reasoning (see Figure 5). Deductive reasoning involves using an already-established theory to generate a specific hypothesis that is then tested using data from a specific instance of a phenomenon. This allows researchers to assess the fit of the theory to the observed data. The deductive approach is confirmatory and relies on the falsification of hypotheses by the use of inferential statistics (Popper, 1959). Inductive reasoning involves starting with an observation or set of data and using it to generate hypotheses or theories about the underlying structures, relationships, or mechanisms that produced the data (Salmon, 1963). The inductive approach employs the use of descriptive statistics. It aims to contribute to the detection of psychological phenomena, the development of a new theory, or the extension of an existing theory (Döring & Bortz, 2016).

Figure 5

Theory Building Process



By a long research tradition, the deductive path with the confirmatory approach has been associated with quantitative research, whereas the inductive path with the exploratory approach has been associated with qualitative research (e.g., Grounded-Theory-Methodology, Glaser & Strauss, 2010). More recently, however, this system—especially concerning the (merely quantitative) psychological science—has been criticized and called into question. Criticisms

concern, on the one hand, that the different approaches are not cleanly distinguished. This leads to research that is not theory-driven but rather data-driven (i.e., exploratory), yet still employs deductive reasoning (Nosek et al., 2018). On the other hand, the lack of implementation of certain principles on a structural level is criticized, such as the insufficient acknowledgment of non-significant findings and replication studies (e.g., Mehler et al., 2019; Zwaan et al., 2018). This debate was triggered and driven by the so-called *replication crisis*, in which it was found that several published scientific results could not be replicated (Pashler & Harris, 2012; Schooler, 2014; Shrout & Rodgers, 2018).

While the importance of replication studies and other approaches to research practice that the replication crisis has highlighted will be discussed below, it is worth noting here that this debate has served to make it generally recognized and acknowledged today that almost no quantitative psychological research in traditional research practice has been conducted in a purely confirmatory manner (Kerr, 1998; Wagenmakers et al., 2011). Instead, confirmatory conclusions were drawn from exploratory findings, which undermines the purpose of significance testing because it leads to inflated Type I error[1] rates (what contributed to the replication crisis). As a suggestion to remedy this, quantitative researchers should more accurately and transparently refer to their analyses as *confirmatory* when it is a genuine theory-driven, hypothesis-testing process in which they have pre-specified the analyses they intend to conduct. Other analyses should be referred to as *exploratory* (e.g., Wagenmakers et al., 2012). Which approach is followed should be decided and made transparent prior to data analysis to ensure the reliability and validity of research findings.

Regarding the positioning of the CONIC model in the process of theory building (see Figure 5), it must be stated that theory building is an ongoing process that requires both exploratory and confirmatory research. This is also illustrated by the cycle depicted in Figure 5. Shoemaker et al. (2004) propose that we should think of theories "as moving through stages—young, middle-aged, and mature" (p. 167). Even a *young* theory, such as the CONIC model, can be helpful in application to solve problems. However, the research cycle should continue as the theory should still be subject to revision and further testing, generalization, and extension (e.g., Bechtel & Richardson, 1993; Craver & Darden, 2013; Eronen & Bringmann, 2021). Regarding the CONIC model, it can be said that the phenomenon of a compensatory effect has been revealed as a robust pattern in different data sets (i.e., the multi-study paper by Trautwein et al., 2015), and a theoretical model has been proposed in the book chapter of

[1] false positive conclusion, i.e. the rejection of the null hypothesis when it is true

Trautwein et al. (2019). Initial confirmatory research was conducted, replicating the model in another data set (Song et al., 2020) and a longitudinal design (Rieger et al., 2022). In addition, more exploratory research was conducted, extending the model for utility value instead of interest as another predictor and achievement instead of effort as another outcome (Song et al., 2020).

In summary, the CONIC model is at the beginning of the theory testing process towards maturity. A theory may be considered mature when it has been around for some time, is well advanced in the development of concepts and hypotheses, has been extensively tested to determine its scope and boundary conditions, and can, therefore, be applied to solve the problems from which it arose (Shoemaker et al., 2004). The present dissertation aims to contribute to this "maturation process" and advance the theory further. This is directly related to theory validation, which will be elaborated briefly in the following section.

1.3.1 The Concept of Validity in the Process of Theory Evaluation

Theory validation refers to the process of confirming that the theory serves its intended purpose, which means investigating the *validity* of a theory (van der Merwe et al., 2007). Following the definition of Shadish, Cook, and Campbell (2002), validity refers to the correctness of inferences. Therefore, validity represents a concept that captures the methodological quality of research findings. Cook and Campbell (1979) distinguish between four different criteria of validity: construct validity, internal validity, external validity, and statistical conclusion validity. Construct validity refers to the appropriateness of measures and depends on the quality of the theoretical foundation (concept specification) and the operationalization of the concept. Internal validity, on the other hand, refers to the extent to which the observed cause-and-effect relationship represents the truth in the studied population and does not depend on methodological errors or alternative factors. It depends on the quality of the research design and its implementation. External validity contrasts with internal validity, as it refers to the generalizability of results across different elements of an investigation. Thus, external validity also depends primarily on the quality of the study design and the sampling. Finally, statistical conclusion validity refers to the degree to which inferences about relationships proposed by the results of statistical data analyses are correct or reasonable. It depends mainly on the quality of statistical data analysis and aspects of study planning, such as a sufficiently large sample size.

This typology of validity in the tradition of Campbell has been established in quantitative social research for decades. However, there is also some criticism, in particular regarding the distinction of the four validity types (Döring & Bortz, 2016). It has been argued that construct validity can also be seen as a partial aspect of external validity (Campbell, 1957, p. 38; Shadish et al., 2002). More precisely, external validity, in the sense of generalizability of empirical findings, requires that it is possible to generalize from the measured values to the theoretical constructs (construct validity) before the effect can be transferred to other contexts. Similarly, statistical validity can be regarded as a partial aspect of internal validity. This is because internal validity, in the sense of the truth of a causal interpretation, is only possible if a statistically valid correlation has been demonstrated beforehand. Thus, Reichardt (2011) proposes a different typology for evaluating research quality that consists of three criteria instead of the four validity types of the Campbell tradition: validity (analogous to internal validity), precision (accuracy of effect size estimation), and generalizability (generalizability of effects in reference to external validity). One major advantage of this typology is that it emphasizes the difference between generalizability and external validity. For instance, a randomized-controlled field trial (i.e., a field study where participants are randomly assigned to the experimental group receiving the intervention or to the control group) with volunteer participants could score well on all four types of validity proposed by Campell et al., including external validity, if the inferences drawn were correct. However, if the findings cannot be applied to non-volunteers, the generalizability of the results is low despite high validity. This example highlights the importance of distinguishing between validity and generalizability. In practice, though, it is usually the other way around, where generalizability often helps to draw conclusions about validity.

In the context of theory validation, which concerns not only the validity of inferences drawn from individual study results but also the validity of the theory as a whole, including its assumptions, hypotheses, and explanations, it is more appropriate to refer to Reichardt's typology for evaluating its quality. When considering the assessment of the validity, precision, and generalizability of a theory, it becomes apparent that generalization and replication studies are indispensable elements in this pursuit. Although they cannot guarantee the validity of a theory, they can help identify sources of invalidity. In practice, conducting replication and generalization studies means making efforts to identify threats to validity, such as the lack of validity of measurements, treatments, and other study characteristics used to generate the existing evidence or research practices that undermine statistical evidence (Nosek et al., 2022).

Hence, the concepts of generalization and replication are introduced in the following section, which outlines their roles in theory validation.

1.3.2 Replication, Generalization, and Extension of the CONIC Model

The replication of research results is a critical part of the scientific process, as it helps to promote the generalizability and stability of psychological phenomena. Therefore, it is indispensable to scientific endeavor (Crüwell et al., 2019; Zwaan et al., 2018). While replication has always been essential, its importance became especially clear in the aftermath of the replication crisis, highlighting the need for increased rigor and transparency in research. Through replication, researchers can clarify when they can trust the results of previous studies, which is essential for theory building and for ensuring that psychology remains aligned with the scientific method (Crüwell et al., 2019). Sometimes, a distinction is made between direct and conceptual replication (e.g., Schmidt, 2009). A direct replication is an attempt to recreate the critical elements (e.g., samples, measures) of an original study to evaluate whether similar findings can be reproduced. A conceptual replication evaluates whether previous findings are reproduced when tested under different conditions (Zwaan et al., 2018). However, there is an ongoing debate on whether this distinction should be made or if it is counterproductive. Some argue that no direct replications are possible in psychological research because there will always be innumerable differences in contexts, study designs, samples, and measures (e.g., Nosek et al., 2022; Shadish et al., 2002). Thus, they propose dispensing with this distinction and understanding replication as a theoretical commitment (Nosek & Errington, 2020; Shadish et al., 2002). The theoretical understanding of the phenomenon and existing theories can help to conclude that the replication meets all the necessary conditions to obtain results in line with the prior evidence. When differences are believed to be irrelevant for obtaining the same results as in the original study, a study can be seen as replication. When applying this framework, a distinction is usually made between replication and generalizability tests instead of between conceptual and direct replication. This distinction is based on the different conclusions drawn from the research rather than the content of the study itself. It is argued that every replication is a test of generalizability, but the reverse is not true. Therefore, a study should be seen as a generalizability test if positive outcomes increase the confidence in the original finding and increase generalizability, whereas an inconsistent finding is interpreted as a boundary condition and does not decrease confidence in the original finding (Nosek & Errington, 2020). To put it in other words, replications always have a confirmatory, hypothesis-testing nature, while generalizability tests can also have an exploratory nature. For example, Trautwein et al. (2015) conducted an exploratory test of the CONIC model using self-concept instead of interest as a

predictor and found that the compensatory effect could not be confirmed. This finding identified a boundary condition of the model without questioning the validity of the original theory because the results referring to self-concept do not affect the original rationale of the theory (referring to interest). Thus, this test was not about replication but about generalizability. Furthermore, and more specifically, this test can also be classified as a test of extension. An extension study can be seen as a specialized form of a generalization study. Extension studies also contribute to the generalization and refinement of theory. These studies aim to extend the scope of a theory or to identify boundary conditions to advance the existing theoretical framework further. For example, the CONIC model was extended beyond its original scope by including the constructs of utility value and school performance instead of interest and effort, respectively, in addition to conscientiousness (Song et al., 2020).

In summary, generalizing an existing theory is essential for theory consolidation and, therefore, contributes to scientific progress. Replication studies are an essential part of this process, as they confirm or disconfirm the theory's validity in different study contexts. To be distinguished from replication are approaches that do not aim solely to test the existing theory but also to extend and conceptually refine it by applying the model to new domains. An inconsistent result in these new domains does not call into question the validity of the original model but instead points to potential boundary conditions of the model.

1.3.3 Application of Open Science Practices

As mentioned earlier, the so-called replication crisis has challenged psychological research with the non-replicability of many published findings and questioned the research system and practices (Nosek et al., 2022). A resulting shift since then is that the significance of replication has come into focus, and attempts at replication are gaining increasing appreciation. Another attempt that might help to increase the replicability of study results has already been referred to: a clear and transparent distinction between confirmatory and exploratory research before a study is conducted. A valuable tool to make this prior commitment to a type of research visible and verifiable is preregistration. Preregistration of a study means that researchers specify in advance which analyses they will perform before they see the data and document them in a time-stamped, locked file in an online registry (Wagenmakers et al., 2012). This approach favors theoretically-based rather than data-driven hypothesis formation and protects researchers from the influence of misguided incentives (Crüwell et al., 2019).

Scientific endeavor should aim to keep the research cycle turning, driven by both data and theory, but always transparent, open, and accessible with the goal of accumulating robust knowledge rather than generating the most surprising findings. This attitude and research practice can be summarized under the umbrella term *Open Science* (for an overview see, e.g., Crüwell et al., 2019). In addition to the topics mentioned earlier, other important components of Open Science include *Open Access* and *Open Data, Materials, and Code*.

The reason for my considerations on Open Science here is to bring together the principles of good science (practices) under this umbrella term. And on the other hand, I want to highlight that the thoughts and attitudes of the Open Science movement were fundamental to the outline and procedure of this dissertation and, finally, to my personal motivation to conduct the present work.

2 AIMS AND RESEARCH QUESTIONS

The current dissertation aims to advance the CONIC model along the path of theory testing to greater maturity and consolidation. This theory testing process benefits most from accumulating results across various studies when the methods of these studies are diverse and complementary in their weaknesses and strengths (Diener et al., 2022; Reichardt, 2019; Rosenbaum, 2015). To describe study variation with respect to different elements of an investigation, Cook and Campbell (1979) use the term *sampling particulars*. More specifically, they distinguish outcomes, units, treatments, and settings. Outcomes represent the different measures used for collecting data on a particular construct (e.g., effort). Units refer to the subjects of investigations and, therefore, represent the specific sample of a study (e.g., 9th-grade students). Treatments refer to the design of a study, which may be, for example, experimentally manipulated conditions in an experimental study or a naturally occurring event in an observation study (Matt et al., 2010). Settings refer to the context in which a study is conducted, which includes the organizational, social, historical, or cultural context (e.g., German academic track schools). The studies in this work are, therefore, considered with respect to these sampling particulars, which are hereafter referred to as *research characteristics*. Further, for ease of understanding, I use the terms *samples* instead of units, *study designs* instead of treatments, *measures* instead of outcomes, and *contexts* instead of settings.

Assessing the characteristics of previous research on the CONIC model reveals some constraints. So far, all existing studies on the CONIC model relied on observational survey research with self-reported measures in classroom contexts, covered only the age group from grades 5 to 12, and included exclusively German-speaking students from Europe. The four studies included in this dissertation address these constraints and generalize and extend the results on the CONIC model in several ways.

The purpose of the first study is twofold: first, in a confirmatory manner, to test the replicability of the CONIC model, and second, to test for additional generalization and extension in an exploratory manner to identify potential boundary conditions of the model. The replication refers to testing the CONIC model in a U.S. high school sample (i.e., different context), using other measures for collecting data on the constructs of interest (i.e., different measures for interest, effort, and achievement), and replicating for the first time the extensions proposed by Song et al. (2020) (i.e., school grades instead of effort and utility value instead of interest). The generalization refers to testing the CONIC model for U.S. college students, an older student sample than the previously tested students (i.e., a different sample). The extension

refers to assessing whether compensatory relations occur when grit is substituted for conscientiousness and students' overall task value for interest.

The second study addresses the limitation that previous studies were conducted exclusively in classroom environments and limited to school subject domains. Therefore, the study explores the CONIC model in a laboratory setting under more controlled conditions. The study investigates to what extent conscientiousness, interest, and their interplay predict achievement across five different digital learning tasks with varying topics. The sample used for this study consists of university students. Thus, the second study tests the generalization of the CONIC model across a different study design and context (i.e., participants are instructed to work on different tasks in a lab setting) as well as a different measure (i.e., task achievement) and sample (i.e., university students).

The third study focuses on the limitation that previous studies (i.e., Rieger et al., 2022; Song et al., 2020; Trautwein et al., 2015) exclusively used self-assessments for the predictor variables in the context of observational studies. The study is designed to test the CONIC model across different indicators of effortful behavior using an experimental online setting. To do so, we adapted the experimental matrix paradigm developed by Sansone and colleagues (described in Sansone et al., 1992) to test the CONIC model. Specifically, we designed an online experimental study where participants work on an interesting task and a boring task. By presenting these two different tasks, we aimed to manipulate the interestingness of a situation (i.e., the task). The goal of the third study is to examine the extent to which the interestingness of a task moderates the relation between conscientiousness and multiple indicators of effortful behavior in an experimental setting. It adds to existing evidence by testing the CONIC model's generalization across a different study design (i.e., experimental design) and context (i.e., online), different measures (i.e., different indicators of effortful behavior), and a different sample (i.e., adults).

In the fourth study, the CONIC model is applied to the question of what drives teachers to participate in professional development (PD) activities. Specifically, we examined interest and conscientiousness, as well as their interaction, as predictors of teachers' PD intensity in both a cross-sectional and longitudinal setting. Given that the compensatory relation between interest and conscientiousness proposed by the CONIC model is supposed to be a basic psychological mechanism, it is plausible that the effect applies to all people in demanding situations. Thus, as participation in PD activities requires teachers' effort, we tested the assumption that a compensatory relation also exists at the teacher level when predicting teachers' PD intensity.

Hence, the fourth study tests the CONIC model's generalizability and extensiveness across another context (i.e., occupational context), other measures (i.e., different operationalizations of conscientiousness and interest, as well as PD intensity as another outcome), and a different sample (i.e., Austrian teachers).

3 STUDY 1

EXAMINING THE CONSCIENTIOUSNESS × INTEREST COMPENSATION (CONIC) MODEL WITH SIMILAR CONSTRUCTS IN HIGH SCHOOL AND COLLEGE STUDENTS

Bareis, A., Spengler, M., Rieger, S., Gladstone, J., Seung Yang, J., Nagengast, B., Trautwein, U., & Wigfield, A. (2024). Examining the Conscientiousness × Interest Compensation (CONIC) model with similar constructs in high school and college students. *Journal of Research in Personality*, 104462. https://doi.org/10.1016/j.jrp.2024.104462

This study's analysis plan was preregistered with OSF. Moreover, data and analysis scripts can also be found on OSF (https://osf.io/3qfa8/).

The version of the article displayed here does not exactly replicate the final version published in the journal.

Abstract

The Conscientiousness × Interest Compensation (CONIC) model (Trautwein et al., 2019) assumes that the two constructs conscientiousness and interest can (partly) compensate for each other in predicting academic effort and achievement. We extend previous work by testing the CONIC model in two independent U.S. samples from different age groups (high school sample: N = 1,246, M_{age} = 14.86 years; college sample: N = 581, M_{age} = 19.83 years). We also assessed whether the compensatory relations occur when grit is substituted for conscientiousness and students' overall task value or utility value for interest. We preregistered the study and tested the various models for both science and math effort as well as achievement, using latent variable regression analyses. Overall, we found some support for the CONIC model in the U. S. samples. There was also some support for the extensions of the model to the other constructs; however, the predictive links were not as strong.

Keywords: conscientiousness, interest, grit, academic effort, academic achievement

Examining the Conscientiousness × Interest Compensation (CONIC) Model With Similar Constructs in High School and College Students

To succeed in school, students need to learn not only course content and strategies for effective learning but also how to control and maintain the effort they put into their schoolwork. Two constructs that have received much attention with respect to individuals' effort and achievement are students' interest in the subject area and whether they approach it conscientiously. Interest refers to how much individuals enjoy an activity and want to continue to engage in it or exert effort (Hidi & Renninger, 2006), and conscientiousness is a personality trait that involves being orderly, goal oriented, responsible, and self-controlled across different contexts or subjects (Roberts et al., 2014). Conscientious students exert academic effort presumably because they pursue their goals and work hard in most settings (Poropat, 2009; Spengler et al., 2013).

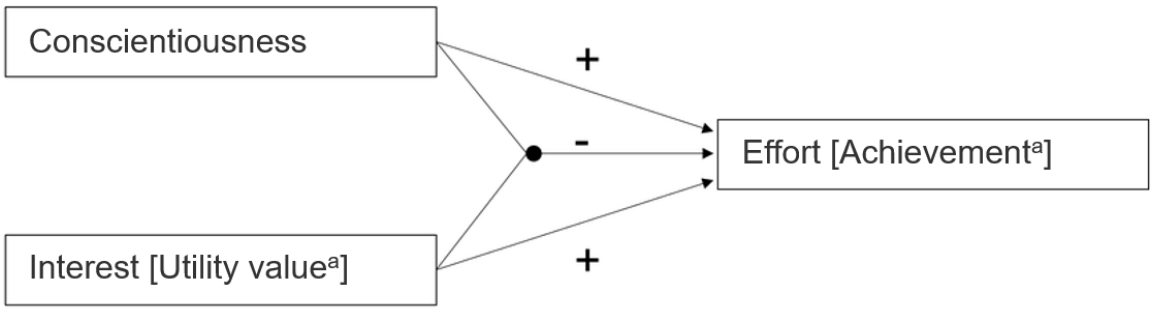
But does a student need both a high level of conscientiousness and a high level of interest to be engaged in a particular school subject? Because interest has been studied primarily in the field of educational psychology and conscientiousness in personality psychology, for many years there were few studies that examined both constructs together as predictors of academic effort. To address this research gap, Trautwein et al. (2015) conducted several studies to investigate the separate and joint influences of students' interest and conscientiousness on academic effort. They found a compensatory effect between the two constructs: high levels of conscientiousness can compensate for a lack of interest, and vice versa. That is, students who are high in conscientiousness will try hard even when they lack interest in what they are doing. Also, students interested in what they are doing put in effort even if they report low conscientiousness. Based on these findings, they subsequently proposed the Conscientiousness × Interest Compensation (CONIC) model (Trautwein et al., 2019) to explain the findings.

Researchers have begun assessing whether the same compensatory processes occur when other variables are included. For instance, Song et al. (2020) assessed an extension of the model that included utility value instead of interest and achievement as another outcome to assess the model's generalizability and found that the compensatory links operated with the other variables (see further discussion below). Their results suggested that the CONIC model has broader applicability than originally proposed (see Figure 1). However, because most of the work assessing the model has been done in Germany further work is needed to assess it in other countries, and with other constructs. Thus, in this study we test the replicability and

generalizability of the CONIC model by assessing it in a different country, a different age group, and by including other personality and motivation constructs: grit and overall task value. We return to the rationale for these choices following description of extant findings regarding the CONIC model.

Figure 1

Summary of Previous Empirical Results for the CONIC Model (Trautwein et al., 2015) and its Extension by Song et al. (2020)



Note. [a] Extended by Song et al. (2020)

The Conscientiousness × Interest Compensation (CONIC) Model

Integrating different theorists' definitions of interest, Trautwein et al. (2019) stated that interest concerns positive orientations and affect towards specific activities or activity domains that can become relatively stable and also lead the interested person to re-engage in such activities (see also Hidi & Renninger, 2006; Schiefele, 2009). Thus, interests generally are thought of as relatively specific, referring to particular activities (e.g., reading a certain book) or activity areas (e.g., being an avid reader). They further stated that interest leads individuals to engage in certain activities (Trautwein et al., 2019; see also Ainley et al., 2002; Renninger, 1992, 2000). When individuals are engaged in activities that interest them, they have positive affect and persistence (e.g., Renninger & Hidi, 2019). Therefore, interest usually results in increased academic effort for such activities (Ainley, 2012; Hidi & Renninger, 2006; Reeve et al., 2015; Trautwein & Lüdtke, 2007; Trautwein et al., 2015). Furthermore, because interest is accompanied by positive affect, interest-driven engagement feels effortless (Lipstein & Renninger, 2007) and individuals will return to those activities (Murayama et al., 2019). Interest is similar in certain respects to the construct of intrinsic value as defined by expectancy-value theorists (e.g., Eccles & Wigfield, 2020; Wigfield & Eccles, 2020); as discussed below,

researchers have utilized the expectancy-value theory construct of intrinsic value (or also referred to as interest value) in empirical work on the CONIC model.

Conscientiousness is one of the five personality traits of the Five-Factor model (FFM), the most widely accepted model of the structure of personality (De Raad & Schouwenburg, 1996; Komarraju & Karau, 2005; Noftle & Robins, 2007). Personality traits are typically conceptualized as relatively enduring, habitual patterns of feelings, behaviors, and thoughts, which are relatively consistent across relevant situations (John & Srivastava, 1999; Roberts, 2009). In contrast to domain-specific interest, conscientiousness is defined as generalizable across different situations. According to McCrae and Löckenhoff's (2010) definition, conscientiousness describes the tendency to "control one's behavior in the service of one's goals" (p. 146). Individuals low in conscientiousness tend to be disorganized, can be unreliable, and can find it hard to keep to a schedule, whereas those high in conscientiousness are generally described as goal-directed, self-controlled, and hardworking. Conscientiousness is associated with better academic achievement even when cognitive ability is controlled (Higgins et al., 2007; Noftle & Robins, 2007). It is assumed that this positive association is mediated by academic effort (De Raad & Schouwenburg, 1996), and there is some initial empirical support for this assumption (Bidjerano & Dai, 2007; Noftle & Robins, 2007).

Theoretically, both constructs are seen as driving forces that cause individuals to exert effort. However, due to their different characteristics, Trautwein et al. (2015) stated that the two constructs produce effort along different paths: Interest acts like a powerful "pull" factor that energizes students, creating effort accompanied by positive emotions and little stress, whereas conscientiousness acts like a built-in "push" factor, motivating students to persist on a task even when the task appears to have no intrinsic value. Given the positive associations between both interest and conscientiousness with academic effort, the question arises as to whether both are needed to result in high levels of effort. As noted earlier, Trautwein et al. proposed that interest and conscientiousness can (partly) compensate for each other in predicting effort. Thus, the CONIC model is in line with compensatory effects models (Cohen et al., 2003) that have documented that a negative score on one predictor can be partly buffered when the score on the other predictor is high (Cohen et al., 2003).

Empirical Studies of the CONIC Model

Trautwein et al. (2015) tested the CONIC model in several studies done with German and Swiss adolescents. They examined main effects and interactions of interest value and conscientiousness on students' reported academic effort, in four different samples of 7th- through 10th-grade students. Within the four sub-studies, they included the subject domains of

math, English, German, biology, and a second foreign language. They found in the majority of their cross-sectional analyses that conscientiousness compensated for a lack of interest in predicting academic effort and vice versa; that is, the interaction term of conscientiousness and effort was statistically significantly negative in the various analyses they did.

Song et al. (2020) further studied the CONIC model in a sample of 5th- through 12th-grade German students; they included the subject areas of German, English, math, and biology. They also assessed whether similar compensatory effects would be found when another component of task value defined in expectancy-value theory, utility value, replaced interest in their analyses. Eccles and colleagues (Eccles & Wigfield, 2020; Wigfield & Eccles, 2020) defined utility value as how useful individuals believe a certain activity or subject area is to them. Song et al. (2020) chose utility value because of its "instrumental" nature; if individuals believe an academic subject domain is useful to them because of this instrumentality they should be more likely to exert effort in it. Song et al. (2020) found the same pattern of results for the Conscientiousness × Utility value interaction term for predicting academic effort. As another extension of the original empirical work on CONIC, they also examined school grades rather than academic effort as the outcome. The Conscientiousness × Interest as well as the Conscientiousness × Utility value interaction terms were significant predictors of school grades in several different subject areas (Song et al., 2020).

Further, Rieger et al. (2022) found support for the compensatory mechanism of interest and conscientiousness in predicting academic effort in a longitudinal study of German high school students that included three school subjects. Results showed that in all subject areas conscientiousness and interest significantly and positively predicted future perceived academic effort (while controlling for previous levels). In addition, conscientiousness and interest interacted in a compensatory manner in nine out of 12 tested interaction effects.

In summary, research to date on the CONIC model has found substantial support for the predicted compensatory effect of the interaction of conscientiousness and interest in predicting academic effort in several samples of 5th- through 12th-grade German-speaking high school students. Song et al. (2020) also found that such effects occurred when utility value was included rather than interest, and when academic achievement was substituted for academic effort. The present study provides further tests of the extensivity of the model.

Is the CONIC Model Generalizable?

In this first test of its generalizability outside of Germany we assessed the model in two different age groups of students (high school, college) in the U.S. We also assessed whether

the model extends to other personality characteristics and a different task value variable, as a way to examine its robustness.

How much should we expect the results to generalize? Berliner et al. (2002) and others have discussed how it often is difficult to find results of studies done in one setting to generalize to others. Given this challenge we chose the U. S. as the initial country in which we would assess generalizability/replication rather than a country more culturally different, for two main reasons. First, most of the research done on the personality and motivation variables we are studying has been done in Western countries, particularly the U. S. and Germany. That knowledge base provides us a means to interpret any differences that might occur in the strength of the relations in the CONIC model across the two countries. Second and more broadly, we decided that doing a comparison of the model with a country that have many cultural similarities with Germany would be a good first test of replicability. Given the previous empirical support for German high school students and the many similarities between the countries, we are conducting a confirmatory test of the CONIC model for the U.S. high school sample. This test is based on the theoretical assumption that the CONIC model holds for this age group regardless of the cultural variation.

On the other hand, even though Germany and the U.S. share cultural similarities there are also notable differences in some broad cultural values and the educational systems in the two countries that makes the comparison interesting. Researchers studying cultural differences in the broad "orientation" of different cultures have focused on the extent to which cultures are more individualistic versus more collectivist. Triandis (2001) described individualism as a tendency for cultures to prioritize personal interests, value independence, and personal achievement. In contrast, collectivist cultures place higher value on interdependence, cooperation, and group achievement. These different emphases could impact relations among the personality and motivation variables in this study. German culture is considered more collectivistic compared to the U.S., although these differences are smaller than when comparing vastly different countries, such as those adhering to Eastern and Western values (Hofstede, 2001).

There also are key differences in the education systems in the two countries that may in part reflect the broader cultural differences just noted. In Germany school curricula are more standardized, and there is greater stratification of students across schools (Allmendinger, 1989; Kerckhoff, 2001; Schissler & Soysal, 2005). In the U. S. curricula vary more across different parts of the country, and students have more choices of which classes to take. Students in the two countries appear to perceive and to react to instructional practices differently as well

(Roach & Byrne, 2001). Levesque et al. (2004) found that German students report significantly lower levels of academic pressure and tend to provide more positive evaluations of the feedback they receive compared to American students. These differences all could impact the variables that impact students' academic effort and achievement striving, such as those contained in the CONIC model. There is empirical evidence of differences between American and German students in the extent of autonomous motivation—which is similar to interest (Levesque et al., 2004) and also aspirations towards different intrinsic and extrinsic goals (Schmuck et al., 2000)—which may impact conscientiousness (Cianci et al., 2010). So given this combination of similarities and differences in broad cultural values and aspects of their educational systems, we decided that a test of the CONIC model using both a college and a high school sample from the U.S. provides a good initial investigation of its generalizability/replicability outside of Germany.

We chose college students as the different age group because students choose to attend college, making it more likely that their interests have a more prominent role in their effort and performance. College students also are higher in conscientiousness than high school students (Denissen et al., 2013) and their interests become more stable (Low et al., 2005). Thus, the interplay of conscientiousness and interest may differ between these age groups.

This study is the first to test the CONIC model across another personality characteristic, an important way to assess its generalizability. We chose Duckworth and colleagues' (2007) grit construct (defined as individuals' passion and perseverance in the pursuit of long-term goals), for several reasons. First, grit has received a great deal of attention in the personality and educational psychology literature. Second, Duckworth and colleagues have stated that grit is related to conscientiousness but distinct from it due to its focus on the long term. Further, Duckworth et al. (2007) suggested that grit might relate more strongly to different measures of achievement than conscientiousness because of its focus on the long term. Given this, it might be expected that the compensatory effects of grit on effort and achievement would be stronger than those of conscientiousness.

However, over the last few years grit has come under closer scrutiny and critique. Credé et al. (2017) pointed out problems in its factor structure (see also Muenks et al., 2017). Researchers also have begun to examine Duckworth and colleagues' claim that grit and conscientiousness are distinct constructs. Ponnock et al. (2020), using the sample used in the present study, and Schmidt et al. (2018) using a German sample, investigated the factor structure of grit and conscientiousness by including items from the grit scale and items from a conscientiousness scale in the same analysis. They both found that the items loaded together,

and so concluded that grit and conscientiousness are not distinct constructs. Examining each construct's relations to the motivational variables included in this study provides a different type of evidence regarding grit (predictive validity); few studies have examined it in relation to other constructs such as the ones included here. Given both grit's popularity on the one hand and the increasing questions about it on the other, results from the present study can further clarify whether it is a construct worthy of continuing to be considered in the literature. Finding that grit and conscientiousness relate to the motivation constructs in similar ways would provide further evidence that grit is not distinct from conscientiousness.

The second psychological variable to which we extended the CONIC model is students' overall task value, in order to build on the work of Trautwein and colleagues (2015) who focused on interest value, and Song et al. (2020) who focused on utility value. Both groups of researchers found that the proposed compensatory effects operated both for interest and utility value's interactions with conscientiousness. This led us to the question of whether this can be extended to a composite measure that combines the interest, utility, and attainment value aspects. We chose overall task value because it has been used in many studies that use the expectancy-value theory framework (e.g., Bong, 2004; Chow et al., 2012; Husman et al., 2004; Liem et al., 2008). Because overall task value is determined by a complex interplay among its components, it is difficult to predict whether compensatory effects of it will be stronger or weaker than those for interest value or utility value observed in the work just discussed.

The Present Study

In the present study, we assessed the generality of the CONIC model by examining it in different age groups in the U.S. and assessing whether the compensatory effects observed in previous work occur when a different personality variable and overall task value are the predictor variables. We also looked at both perceived effort and individuals' grades as outcome variables. Thus, this study provides a replication of the earlier findings of Trautwein et al. (2015), Song et al. (2020) and Rieger et al. (2022). It evaluates whether previous findings are reproduced when tested under different conditions (Zwaan et al., 2018). Nosek and Errington (2020) differentiate between replication and generalizability tests. They understand replication primarily as a theoretical commitment (Nosek & Errington, 2020; Shadish et al., 2002). When differences are believed to be irrelevant for obtaining the same results as in the original study, a study can be seen as a replication. Accordingly, a study should be seen as a generalizability test if it is an approach where positive outcomes increase the confidence in the original finding and increase generalizability, while an inconsistent finding is interpreted as a boundary condition and does not decrease confidence in the original finding (Nosek & Errington, 2020). In addition to these, extensivity tests represent a particular type of generality test that aims to broaden the generalizability of a model beyond its originally intended domain of application. To put it in other words, replications always have a confirmatory nature, while generalizability and extensivity tests can also have an exploratory nature. This is also reflected in the preregistered hypothesis of our study (see https://osf.io/3qfa8/).

Empirical evidence supports the "CONIC pattern" when the predictors (e.g., conscientiousness and interest) have positive effects and the product term of the interaction (e.g., Conscientiousness × Interest) shows a negative effect. We predicted that the hypothesized CONIC pattern would be found for both U.S. samples in this study because the compensatory effect is supposed to be a basic psychological mechanism that applies across age groups and nationalities. Based on Song et al.' (2020) findings regarding achievement, we predicted that the hypothesized CONIC pattern for the different models will be present for course grades as well as effort as an outcome. The specific hypotheses were as follows:

1. U.S. high school and U.S. college students' conscientiousness and domain-specific interest will significantly predict their effort and course grades in this domain. There will be a negative interaction effect for the Conscientiousness × Interest interaction term.

2. U.S. high school and U.S. college students' grit and domain-specific interest will significantly predict their effort and course grades[2] in this domain. There will be a negative interaction effect for the Grit × Interest interaction term.
3. U.S. high school and U.S. college students' conscientiousness and domain-specific task value will significantly predict their effort and course grades in this domain. There will be a negative interaction effect for the Conscientiousness × Task value interaction term.
4. U.S. high school and U.S. college students' conscientiousness and domain-specific utility value will significantly predict their effort and course grades in this domain. There will be a negative interaction effect for the Conscientiousness × Utility value interaction term.

As so far only the original CONIC model (conscientiousness and interest as predictors, effort as outcome) has been tested several times and only in high school samples, we considered Hypothesis 1 for predicting effort in the high school sample to be confirmatory, whereas all other hypotheses were preregistered exploratory. Confirmatory hypotheses aim at replicability in the context of justification, while exploratory hypotheses aim at generalizability and extensivity in the context of discovery (e.g., Abt, 1987; Jaeger & Halliday, 1998).

[2] The hypothesis of grit and interest predicting course grades was not preregistered.

Method

This research was approved by the institutional review board at the university where the study was conducted.

Procedure

The data were collected via a 15–30-minute questionnaire, which was completed either on paper during a lesson which was set aside for this purpose (high school sample) or online during students' own time (college sample). The students were informed that their responses would be kept confidential and that their participation was voluntary. In addition to the items described here, the instrument also contained several measures that are not relevant to the current analyses and therefore are not reported here. The first part of the questionnaire consisted of the domain-general measures (conscientiousness, grit), and the second part of the questionnaire consisted of the domain-specific measures (interest, utility value, task value, effort). For the second part, the participants were instructed to choose to answer the following questions on either a science or a math class they were currently taking. They indicated which course or subject they had chosen, so that the corresponding grades could later be requested from the school or college.

Sample 1 (U.S. High School)

Participants

A total of 1,246 students in 9th and 10th grade (M_{age} = 14.86; 45.1 % female) from one public and six private high schools in the mid-Atlantic region of the United States participated. They were recruited via their science or math classes in partnership schools of the researchers. In the public school, the parents and the children consented to participate in the study. The participation was rewarded with a $5 gift card.

Measures

Conscientiousness. Conscientiousness was measured by the nine items of the Big Five Inventory (BFI; John et al., 1991). Participants responded to each item on a 5-point rating scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). A sample item is "I see myself as someone who perseveres until the task is finished."

Grit. Grit was measured using the eight items of the Grit-S (Duckworth & Quinn, 2009) scale. Four items of the instrument measure consistency of interests (e.g., "I have been obsessed

with a certain idea or project for a short time but later lost interest") and four items measure perseverance of effort (e.g., "I am a hard worker"). A 5-point rating scale ranging from 1 (*not at all like me*) to 5 (*very much like me*) was used.

Task Value, Interest, Utility Value. The subscale "task value" of the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991) was used. Within this subscale, two items refer to interest, two items refer to utility, and two items refer to attainment. We used the two items referring to interest as a measure of interest, the two items referring to utility value as a measure of utility value, and all six items of the subscale as a measure of general task value. Participants indicated the answers on a 7-point rating scale ranging from 1 (*not at all true of me*) to 7 (*very true of me*). A sample item for interest is "I am very interested in the content area of this course," and a sample item for utility is "I think the course material in this class is useful for me to learn."

Effort. Effort was operationalized by the four items of the subscale "effort regulation" of the MSLQ (Pintrich et al., 1991). Again the 7-point rating scale ranging from 1 (*not at all true of me*) to 7 (*very true of me*) was used. A sample item is "When course work is difficult, I give up or only study the easy parts."

Grades. At the end of the semester, the schools reported the students' grades in mathematics and science. The grades were provided in percentages (scale from 1 to 100).

For the domain-specific self-assessment measures (effort, interest, utility value, overall task value), the participants were advised in the instruction that they should select a math or science class they are currently taking and refer to it for the subsequent questions.

Sample 2 (U.S. College)

Participants

A total of 581 undergraduate students (M_{age} = 19.83; 46.3 % female) from a mid-Atlantic university participated in the study. In order to recruit participants, professors teaching math and science undergraduate courses were approached. The professors who agreed told their students about the study and sent them a link to the online survey. They either offered them extra credit for participating in the study or did not. In the end 94 % of the students participating in the study received extra credit. Additionally, one $50 Amazon gift card was raffled between the participants. Every student had to provide active consent via the online questionnaire before participating.

Measures

The same scales and items were used as in the high school sample for conscientiousness, grit, task value, interest, utility value, and effort. Indicators for reliability are presented in Table 2.

Grades. Researchers collected final semester grades for the math or science course for which the students answered the domain-specific questions via school records. The grades were received in the form of letters (e.g., A+, C-, F). For the analyses they were recoded on a scale from 1 to 13 (1 = F and 13 = A+).

Statistical Analyses

We estimated all models in the structural equation modeling (SEM) framework, and we used full information maximum likelihood (FIML) estimation with robust standard errors (MLR; using Mplus 8.6; Muthén & Muthén, 1998-2017). This is identical to the approach that Trautwein et al. (2015) and Song et al. (2020) used to test the CONIC model (and its extension) in their studies.

To assess model fit, we used the common fit indices for latent variable models: the root mean square error of approximation (RMSEA), the standardized root mean square residual (SRMR; Hu & Bentler, 1998), the Tucker-Lewis index (TLI), and the comparative fit index (CFI). According to Hu and Bentler (1999) a good fit is provided by values equal to or less than .05 for RMSEA/SRMR and equal to or greater than .95 for the CFI/TLI (but see McNeish & Wolf, 2020). For models with latent interactions, we used the AIC and BIC for model evaluation as the common fit indices are not defined for these models.

We performed latent variable regression models to investigate the unique effects of conscientiousness or grit, as well as interest, utility value, or task value on effort and achievement.

Due to the study design, the participants answered the domain-specific items either for math or for science. However, 70 participants of the high school sample and 17 participants of the college sample did not specify for which domain they answered the questions and thus had to be excluded from the analyses. All models were estimated separately for each domain (math, science) using multi-group analyses (i.e., for the domains of math and science). The main advantage of multi-group analyses is that the domain-general constructs (conscientiousness, grit) can be kept constant across the two groups (i.e., math and science) in terms of measurement invariance. By contrast, no measurement invariance was imposed for the interest and effort measures as they are different constructs.

Previous studies have shown that negatively worded items usually show low item-total correlations (e.g., Eys et al., 2007; Roszkowski & Soven, 2010). One might therefore consider the direction of response in statistical analyses. In order to address the negatively worded items we included correlated residuals between all negatively worded items.

For model identification, we used two different identification methods (i.e., reference-group method and non-arbitrary identification method; see Little et al., 2006). On the one hand, we applied the reference-group method (i.e., fixed the means and the variances to 0 and 1 respectively) for the predictors (i.e., interest, utility value, task value, conscientiousness, grit). On the other hand, we used the non-arbitrary identification approach for the outcomes (i.e., effort, achievement). By fixing the average intercept to zero and the average loading to 1, the non-arbitrary identification approach uses an optimally weighted combination of all indicators and thus, provides a meaningful interpretation of the latent variable. To address the interaction research question, we added a latent interaction term to the model using the latent moderated structural (LMS) equations approach (Klein & Moosbrugger, 2000) as implemented in Mplus (identical to previous research of Trautwein et al., 2015, and Song et al., 2020). We report the standardized regression coefficients.

Additionally, the high school students' data has a multilevel structure in which students are nested within classes. Thus, students within a class may not be independent from each other (i.e., students in the same class are usually more similar than students from different classes; Raudenbush & Bryk, 2002). Failure to take this structure into account could lead to an underestimation of standard errors (see, e.g., Muthén & Satorra, 1995). However, as contextual effects or school-level predictions are not of substantive interest and the number of schools are too small to be treated as a random effect, we applied single-level analyses with cluster-robust standard errors (McNeish et al., 2017) as implemented in Mplus ("type = complex" option).

Statistical tests were one-tailed for the confirmatory analysis and two-tailed for the exploratory analyses. We used the 5 % level of significance.

We visually depicted the interaction effects using the plot.RSA() -function as implemented in the RSA-package (Schönbrodt & Humberg, 2021) in the statistical software R (R Core Team, 2019). The plots can be found in the online supplemental material (Figure B1 to Figure B16).

Transparency and Openness

The data used in the present study come from a longitudinal study of the development of grit, motivation, and self-regulation in U.S. high school students, and a cross-sectional study

of U.S. college students' grit, motivation, and self-regulation. Although a number of papers have been published from these data the present study addresses research questions not yet examined in these data. Therefore, the study's design, sample size and measures were already determined. We specified and preregistered (see https://osf.io/3qfa8/) the study's hypotheses and planned analyses in advance at the Center for Open Science (OSF). The codes behind the analyses and the data as variance-covariance matrices and mean vectors are also publicly available and accessible at the URL above. The results of all preregistered analyses are reported. Deviations from the preregistration are reported in the following section.

Preregistered Analyses: Modifications and Additions

In line with the goal of full transparency, we conducted all analyses as preregistered except for three deviations, which are documented in Table 1. Two are minor deviations from the preregistered analysis plan (i.e., we used a newer Mplus version and included an additional exploratory hypothesis). A third deviation is that we used additional criteria to evaluate replication success. In particular, while working on the statistical analyses, it became apparent that our preregistered analytic plan was characterized by one major limitation: The strategy for evaluating the results was not specified in more detail beyond setting a significance level. This is at odds with the most recent thinking on assessing replication success where a consensus has been established that statistical significance alone is not sufficient to judge whether a replication succeeded or not (e.g., Anderson & Maxwell, 2016; Brandt, 2014; Braver et al., 2014; National Academies of Sciences, Engineering, and Medicine, 2019; Open Science Collaboration, 2015; Schauer & Hedges, 2021). In fact, Schauer and Hedges (2021) proposed two approaches to define replication success. One definition of replication requires the effect parameters to be similar in size to the effect parameters of the original studies. The other definition requires the effect parameters to be qualitatively similar. According to the second definition, a replication needs to have the same sign, that is, either both negative or both positive. We considered both of these definitions in our approach. Accordingly, we made some additions to our analyses that balance the needs for being consistent with what was preregistered and what is the current state-of-the-art on how to conduct replication studies (see Brandt et al., 2014). To assess agreement in sign, we compared the result pattern in the respective test models with the unique CONIC pattern (i.e., positive main effects, negative interaction effect). To assess agreement in size, we used the significance criterion and the confidence interval overlap criterion. In terms of being consistent with the preregistration, we report all statistical significance tests using the significance criterion that was preregistered.

However, to assess the success of replication, we extended our preregistered analyses by applying the confidence interval overlap criterion. The confidence overlap criterion is met if the confidence interval of the replication covers the effect size of the original study (Schauer & Hedges, 2021).

Table 1

Deviations From the Preregistration

Preregistration	Manuscript	Explanation
"We will estimate all models in the structural equation modeling (SEM) framework, and we will use full information maximum likelihood (FIML) estimation with robust standard errors (MLR; using Mplus 7.31; Muthén & Muthén, 1998-2012)." (p. 5)	"We estimated all models in the structural equation modeling (SEM) framework, and we used full information maximum likelihood (FIML) estimation with robust standard errors (MLR; using Mplus 8.6; Muthén & Muthén, 1998-2017)."	We preregistered that we would use Mplus 7.31 (Muthén & Muthén, 1998-2012). However, as Mplus 8.6 (Muthén & Muthén, 1998-2017) implements a function for standardization, we decided to use this newer version.
"Statistical tests will be one-sided for the confirmatory analyses and two-sided for the exploratory analyses. We will use the 5 % level of significance." (p. 5)	"Accordingly, we made some additions to our analyses that balance the needs for being consistent with what was preregistered and what is the current state-of-the-art on how to conduct replication studies (see Brandt et al., 2014). […] In terms of being consistent with the preregistration, we report all statistical significance tests using the significance criterion that was preregistered. However, to assess the success of replication, we extended our preregistered analyses by applying the confidence interval overlap criterion."	"The strategy for evaluating the replication success was not specified in more detail beyond setting a significance level." Because statistical significance as a criterion to judge whether a replication succeeded or not does not meet the current state-of-the-art for determining the success of replications, we follow the approach and criteria for reporting a replication proposed by Brandt and colleagues (2014).
"As grit relates strongly to conscientiousness, especially in terms of the grit component “perseverance of effort” (Duckworth et al., 2007; Duckworth & Quinn, 2009; Eskreis-Winkler, Shulman, Beal, & Duckworth, 2014), we will also extend previous investigation of the CONIC model and add Grit as predictor into the set of exploratory analyses. Therefore, we will test the Grit × Interest model for predicting academic effort." (pp. 6-7)	"2. U.S. high school and U.S. college students' grit and domain-specific interest will significantly predict their effort and course grades in this domain. There will be a negative interaction effect for the Grit × Interest interaction term."	The research question of grit and interest predicting course grades is not preregistered. For the sake of content coherence and consistency, we added it as an additional exploratory hypothesis.

Results

Means, standard deviations, and internal consistency for the manifest variables in both samples are presented in Table 2. The intraclass coefficients for the high school sample are presented in Table A6 in online supplemental material. The absolute values of skewness ranged from .02 to .64 (average = .36) in the high school sample and from .09 to 1.28 (average = .77) in the college sample. The absolute values of kurtosis ranged from .05 to .71 (average = .38) in the high school sample and from .03 to 2.14 (average = .63) in the college sample. According to West and colleagues (1995) a skew value smaller than 2 or a kurtosis value smaller than 7 can be used as reference values for normality. Following this guideline all scales were found to be approximately normally distributed. Table 3 shows the correlations among the latent variables. The correlation pattern was comparable to the pattern of the science and math domain in the study of Song et al. (2020): conscientiousness correlated with interest r = .37 to .38 in Song et al. and r = .29 to .45 in the present study.

For each set of predictors (Conscientiousness × Interest, Conscientiousness × Utility value, Conscientiousness × Task value, Grit × Interest), we specified two structural equation models for each sample (i.e., high school and college) and each outcome (i.e., effort and achievement), including two group factors for the domains of mathematics and science in each model. In Model 1 we tested the main effects of the respective predictors, whereas in Model 2 the interaction term was included. Because the coefficients of the main effects did not change substantially when including the interaction terms (see comparison Model 1 vs. Model 2), the focus of reporting on the results is on the complete models (see Model 2).

Table 2

Descriptive Results of the Manifest Variables

Variables	High School									College								
	Domain-general personality			Math			Science			Domain-general personality			Math			Science		
	M	*SD*	α	*M*	*SD*	α	*M*	*SD*	α	*M*	*SD*	α	*M*	*SD*	α	*M*	*SD*	α
1. Conscientiousness	*N* = 1153									*N* = 564								
	3.55	.64	.81							3.68	.65	.84						
2. Grit	*N* = 1153									*N* = 564								
	3.44	.58	.68							3.34	.58	.78						
3. Interest				*N* = 526			*N* = 560						*N* = 277			*N* = 282		
				4.46	1.74	.81	4.95	1.63	.84				4.71	1.55	.88	5.72	1.45	.88
4. Utility value				*N* = 532			*N* = 569						*N* = 277			*N* = 282		
				4.98	1.49	.66	4.98	1.44	.64				5.43	1.39	.78	5.95	1.30	.83
5. Task value				*N* = 460			*N* = 533						*N* = 277			*N* = 282		
				4.94	1.33	.85	5.17	1.24	.86				5.29	1.14	.87	5.89	1.21	.93
6. Academic effort				*N* = 545			*N* = 577						*N* = 277			*N* = 282		
				5.08	1.24	.69	5.25	1.22	.73				5.39	1.12	.74	5.52	1.14	.73
7. Academic achievement				*N* = 513			*N* = 484						*N* = 274			*N* = 274		
				84.70	9.50		85.19	8.25					8.88	2.84		9.85	3.15	

Table 3

Correlations Between the Latent Variables

	1	2	3	4	5	6	7
High School							
Math (N = 579, above the diagonal) / Science (N = 597, below the diagonal)							
1. Conscientiousness	—	.91	.45	.52	.54	.69	.22
2. Grit	.81	—	.37	.48	.48	.65	.22
3. Interest	.31	.33	—	.82	NA [a]	.60	.25
4. Utility value	.43	.49	.86	—	NA [a]	.61	.28
5. Task value	.45	.50	NA [a]	NA [a]	—	.73	.29
6. Academic effort	.75	.79	.58	.62	.69	—	.37
7. Academic achievement	.25	.31	.28	.31	.33	.45	—
College							
Math (N = 282, above the diagonal) / Science (N = 282, below the diagonal)							
1. Conscientiousness	—	.93	.29	.16	.37	.72	.21
2. Grit	.91	—	.24	*.12*	.29	.71	.21
3. Interest	.33	.29	—	.66	NA [a]	.51	.19
4. Utility value	.28	.23	.85	—	NA [a]	.32	*.12*
5. Task value	.39	.32	NA [a]	NA [a]	—	.59	.19
6. Academic effort	.69	.65	.62	.64	.70	—	.26
7. Academic achievement	.17	.20	.24	.22	.25	.35	—

Notes. All coefficients are statistically significant at $p < .05$, except for results in italics.

[a] Task value consists (among others) of the items of interest and utility value. Therefore, no latent correlations were calculated.

Testing the CONIC Model in U.S. Samples

The first studies of the CONIC model included conscientiousness, interest, and the Conscientiousness × Interest interaction term as predictors of academic effort (Trautwein et al., 2015). We tested this same model in the U.S. samples (Table 4), and also extended it by replacing student's effort with their grades in STEM courses (see Table 5).

Conscientiousness ($.12 \leq \hat{\beta} \leq .63$) and interest ($.14 \leq \hat{\beta} \leq .44$) positively predicted effort and achievement in both samples and both domains. The interaction term for predicting effort was negative and statistically significant in both domains for the high school sample (math: $\hat{\beta} = -.09$, $SE = .04$, $p = .014$; science: $\hat{\beta} = -.08$, $SE = .03$, $p = .004$) and in the math domain for the college sample ($\hat{\beta} = -.15$, $SE = .06$, $p = .010$). The interaction term for the science domain in the college sample was negative ($\hat{\beta} = -.13$, $SE = .08$, $p = .091$), but not statistically significant. Using STEM grades as the outcome, three of the four tested interaction terms were negative, but only the interaction term for the science domain in the college sample was statistically significant ($\hat{\beta} = -.25$, $SE = .08$, $p = .001$).

Table 4

Predicting Academic Effort by Conscientiousness, Interest, and the Conscientiousness × Interest Interaction

Variable	High School						College					
	Model 1			Model 2			Model 1			Model 2		
	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p* [a]	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p*
Math			*n = 579*						*n = 282*			
Conscientiousness	.19	.08	.012	.20	.08	.011	.15	.06	.010	.12	.06	.049
Interest	.20	.06	.001	.20	.06	.002	.14	.07	.052	.14	.07	.047
Conscientiousness × Interest				.06	.05	.263				-.09	.06	.123
R^2	.11	.02	<.001	.11	.02	<.001	.05	.03	.047	.05	.03	.046
Science			*n = 597*						*n = 282*			
Conscientiousness	.58	.03	<.001	.59	.03	<.001	.54	.07	<.001	.58	.08	<.001
Interest	.41	.07	<.001	.41	.07	<.001	.46	.08	<.001	.44	.08	<.001
Conscientiousness × Interest				-.08	.03	.004 [a]				-.13	.08	.091
R^2	.65	.08	<.001	.66	.08	<.001	.66	.08	<.001	.70	.08	<.001

[a] For this model we used one-tailed testing of significance for the high school sample.

Table 5

Predicting Academic Achievement by Conscientiousness, Interest, and the Conscientiousness × Interest Interaction

Variable	High School						College					
	Model 1			Model 2			Model 1			Model 2		
	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p* [a]	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p*
Math			*n = 579*						*n = 282*			
Conscientiousness	.19	.08	.012	.20	.08	.011	.15	.06	.010	.12	.06	.049
Interest	.20	.06	.001	.20	.06	.002	.14	.07	.052	.14	.07	.047
Conscientiousness × Interest				.06	.05	.263				-.09	.06	.123
R^2	.11	.02	<.001	.11	.02	<.001	.05	.03	.047	.05	.03	.046
Science			*n = 597*						*n = 282*			
Conscientiousness	.17	.04	. <.001	.17	.04	<.001	.08	.08	.323	.17	.08	.024
Interest	.21	.05	<.001	.21	.05	<.001	.23	.07	.002	.19	.07	.004
Conscientiousness × Interest				-.02	.05	.695				-.25	.08	.001
R^2	.09	.02	<.001	.09	.02	<.001	.07	.04	.068	.16	.07	.016

Substituting Grit for Conscientiousness

We next tested a model where we substituted grit for conscientiousness, including the main effects of grit and interest and the Grit × Interest interaction as predictors of effort (Table 6) and achievement (Table 7).

All main effects were positive and for 15 out of 16 cases statistically significant (not significant for grit predicting math achievement in the high school sample). Six out of eight interactions were negative (not for high school achievement), two of which were statistically significant ($\hat{\beta}$ = -.09, *SE* = .04, *p* = .022 for science effort in the high school sample; $\hat{\beta}$ = -.14, *SE* = .06, *p* = .029 for math effort in the college sample).

Table 6

Predicting Academic Effort by Grit, Interest, and the Grit × Interest Interaction

Variable	High School						College					
	Model 1			Model 2			Model 1			Model 2		
	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p* [a]	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p*
Math			*n = 579*						*n = 282*			
Grit	.51	.04	<.001	.50	.04	<.001	.62	.07	<.001	.61	.08	<.001
Interest	.43	.05	<.001	.44	.04	<.001	.40	.07	<.001	.41	.07	<.001
Grit × Interest				-.09	.05	.087				-.14	.06	.029
R^2	.60	.04	<.001	.60	.04	<.001	.65	.08	<.001	.66	.09	<.001
Science			*n = 597*						*n = 282*			
Grit	.69	.07	<.001	.70	.06	<.001	.47	.07	<.001	.49	.09	<.001
Interest	.36	.08	<.001	.36	.07	<.001	.52	.07	<.001	.51	.08	<.001
Grit × Interest				-.09	.04	.022				-.05	.11	.691
R^2	.76	.08	<.001	.78	.08	<.001	.64	.08	<.001	.65	.09	<.001

Table 7

Predicting Academic Achievement by Grit, Interest, and the Grit × Interest Interaction

Variable	High School						College					
	Model 1			Model 2			Model 1			Model 2		
	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p* [a]	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p*
Math			*n = 579*						*n = 282*			
Grit	.18	.12	.126	.18	.12	.120	.15	.06	.007	.15	.06	.009
Interest	.21	.08	.008	.21	.08	.008	.15	.06	.024	.14	.06	.024
Grit × Interest				.02	.06	.774				-.01	.06	.829
R^2	.10	.02	<.001	.11	.03	<.001	.05	.03	.050	.05	.03	.049
Science			*n = 597*						*n = 282*			
Grit	.21	.04	<.001	.21	.04	<.001	.24	.08	.003	.29	.08	<.001
Interest	.19	.05	<.001	.19	.05	<.001	.20	.08	.013	.19	.07	.009
Grit × Interest				.01	.04	.860				-.14	.08	.088
R^2	.11	.02	<.001	.10	.02	<.001	.12	.05	.008	.18	.07	.012

Substituting Task Value for Interest

We next tested a model substituting overall task value for interest, with effort (Table 8) and achievement (Table 9) as the outcome variables. Again, all main effects of conscientiousness and task value were positive, but not significant for two out of 16 cases (i.e., conscientiousness predicting science achievement and task value predicting math achievement in the college sample). Six out of eight tested interactions were negative (not for high school achievement), two of which reached the level of statistical significance ($\hat{\beta}$ = -.09, *SE* = .04, *p* = .019 for math effort in the high school sample; $\hat{\beta}$ = -.24, *SE* = .07, *p* = .001 for science achievement in the college sample).

Substituting Utility Value for Interest

The next model tested utility value as the motivational variable. Results of the models using academic effort as the outcome are in Table 10 and those using achievement as the outcome are in Table 11. Conscientiousness (not significant for science achievement in the college sample) and utility value (not significant for math achievement in the college sample) positively predicted effort and achievement in both samples and both domains. The interaction terms for predicting effort and achievement were all negative and statistically significant when predicting math effort in the high school sample ($\hat{\beta}$ = -.09, *SE* = .04, *p* = .011) and predicting science achievement in the college sample ($\hat{\beta}$ = -.26, *SE* = .07, *p* < .001).

Table 8

Predicting Academic Effort by Conscientiousness, Task Value, and the Conscientiousness × Task Value Interaction

Variable	High School						College					
	Model 1			Model 2			Model 1			Model 2		
	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p* [a]	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p*
Math			*n = 579*						*n = 282*			
Conscientiousness	.36	.05	<.001	.35	.05	<.001	.65	.07	<.001	.63	.07	<.001
Task value	.57	.04	<.001	.57	.04	<.001	.33	.07	<.001	.35	.08	<.001
Conscientiousness × Task value				-.09	.04	.019				-.10	.09	.282
R^2	.66	.04	<.001	.66	.04	<.001	.67	.08	<.001	.68	.09	<.001
Science			*n = 597*						*n = 282*			
Conscientiousness	.48	.02	<.001	.48	.02	<.001	.49	.08	<.001	.52	.08	<.001
Task value	.51	.06	<.001	.50	.06	<.001	.54	.07	<.001	.52	.07	<.001
Conscientiousness × Task value				-.07	.04	.094				-.12	.08	.123
R^2	.69	.08	<.001	.70	.08	<.001	.73	.07	<.001	.75	.07	<.001

Table 9

Predicting Academic Achievement by Conscientiousness, Task Value, and the Conscientiousness × Task Value Interaction

Variable	High School						College					
	Model 1			Model 2			Model 1			Model 2		
	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p* [a]	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p*
Math			*n = 579*						*n = 282*			
Conscientiousness	.14	.06	.024	.15	.06	.022	.15	.06	.010	.13	.06	.035
Task value	.24	.04	<.001	.25	.04	<.001	.11	.07	.102	.12	.07	.101
Conscientiousness × Task value				.02	.03	.542				-.04	.06	.520
R^2	.12	.03	<.001	.12	.03	<.001	.05	.03	.063	.04	.02	.067
Science			*n = 597*						*n = 282*			
Conscientiousness	.13	.04	.002	.12	.04	.004	.06	.08	.465	.12	.08	.142
Task value	.25	.05	<.001	.25	.05	<.001	.23	.08	.002	.19	.06	.002
Conscientiousness × Task value				.01	.04	.791				-.24	.07	.001
R^2	.11	.02	<.001	.11	.02	<.001	.07	.04	.058	.13	.06	.018

Table 10

Predicting Academic Effort by Conscientiousness, Utility Value, and the Conscientiousness × Utility Value Interaction

Variable	High School						College					
	Model 1			Model 2			Model 1			Model 2		
	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p* [a]	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p*
Math			*n = 579*						*n = 282*			
Conscientiousness	.43	.05	<.001	.42	.06	<.001	.73	.06	<.001	.73	.06	<.001
Utility value	.43	.07	<.001	.44	.07	<.001	.19	.08	.015	.20	.09	.026
Conscientiousness × Utility value				-.09	.04	.011				-.02	.12	.899
R^2	.56	.07	<.001	.56	.08	<.001	.62	.09	<.001	.63	.09	<.001
Science			*n = 597*						*n = 282*			
Conscientiousness	.42	.06	<.001	.52	.04	<.001	.73	.06	<.001	.56	.07	<.001
Utility value	.44	.07	<.001	.45	.05	<.001	.19	.08	.015	.52	.07	<.001
Conscientiousness × Utility value	-.09	.04	.011	-.10	.05	.052				-.14	.08	.090
R^2	.56	.08	<.001	.67	.08	<.001	.62	.09	<.001	.77	.08	<.001

Table 11

Predicting Academic Achievement by Conscientiousness, Utility Value, and the Conscientiousness × Utility Value Interaction

Variable	High School						College					
	Model 1			Model 2			Model 1			Model 2		
	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p* [a]	$\hat{\beta}$	*SE*	*p*	$\hat{\beta}$	*SE*	*p*
Math			*n = 579*						*n = 282*			
Conscientiousness	.14	.04	.001	.14	.04	.001	.17	.06	.002	.17	.06	.002
Utility value	.25	.06	<.001	.25	.06	<.001	.08	.07	.264	.08	.07	.272
Conscientiousness × Utility value				-.02	.06	.681				-.02	.07	.796
R^2	.12	.05	.012	.12	.05	.016	.04	.02	.081	.04	.02	.083
Science			*n = 597*						*n = 282*			
Conscientiousness	.15	.04	<.001	.15	.04	<.001	.09	.08	.267	.14	.08	.076
Utility value	.22	.05	<.001	.22	.04	<.001	.21	.08	.007	.20	.06	.001
Conscientiousness × Utility value				-.02	.04	.707				-.26	.07	<.001
R^2	.10	.02	<.001	.10	.02	<.001	.06	.04	.087	.15	.06	.022

Joint Consideration of All Models

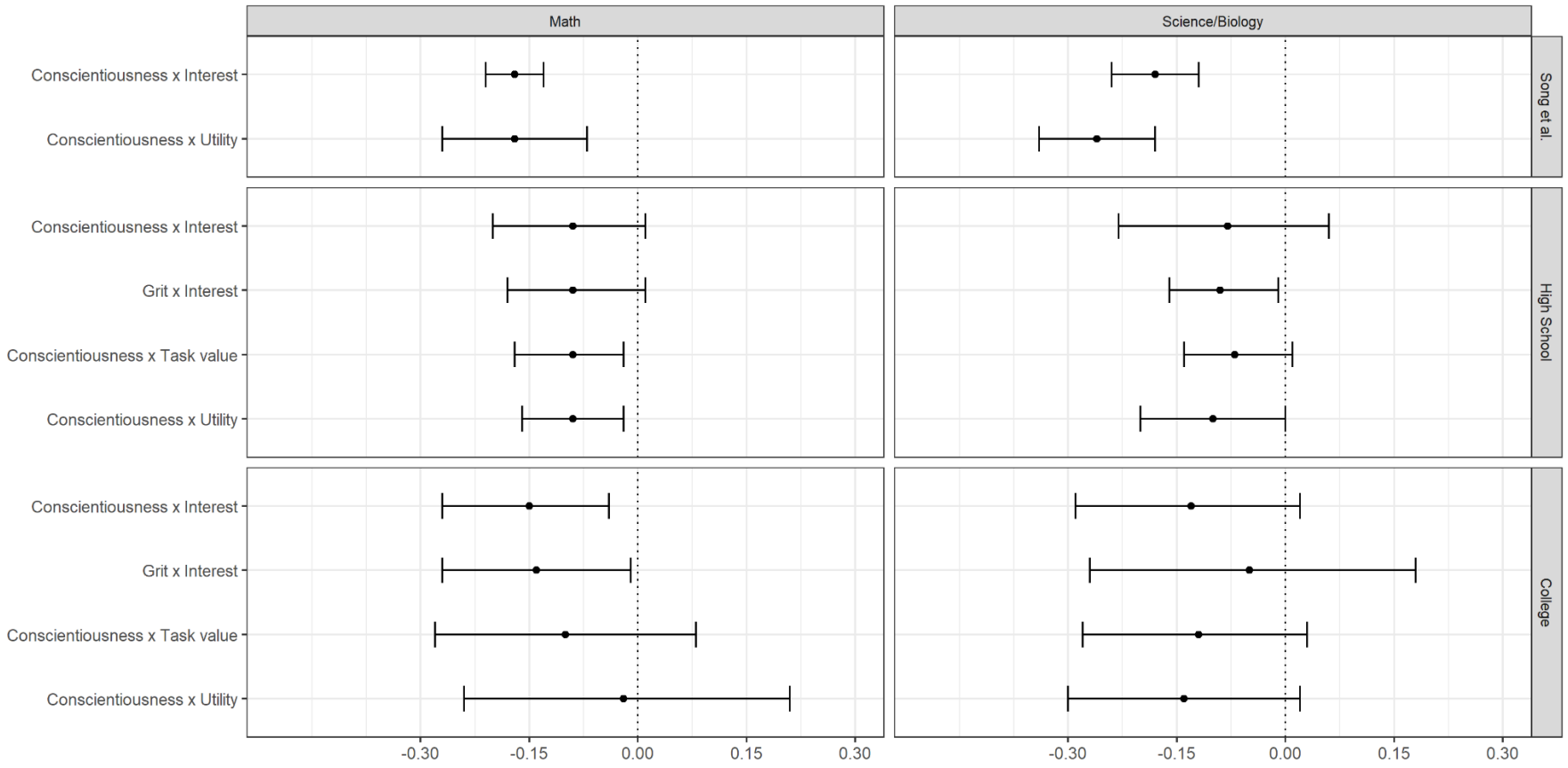
As stated earlier, the assessment of replication or generalization success should not be based solely on the correspondence of statistical significance, but additional criteria besides the *p* value threshold should be considered (e.g., Anderson & Maxwell, 2016; Braver et al., 2014; Open Science Collaboration, 2015; Schauer & Hedges, 2021). Thus, as an additional criterion for agreement in size (Schauer & Hedges, 2021) we used the measure of confidence interval overlap of the different models. This addresses the question of whether the current effect size was significantly different from the original effect size (i.e., if the effect size estimate of the original study lies within the confidence interval of the replication, they do not differ significantly). As it has been pointed out that the study to detect an effect in the first place may be subject to publication selection (e.g., Dickersin, 2005; Hedges & Schauer, 2019), we use the interaction effects for (a) the original CONIC model (where interest and conscientiousness are predictors, and effort is the outcome) as well as (b) the first extension test for utility value published by Song et al. (2020) as references. We took the interaction effect parameters for math and biology effort of the study by Song et al. and calculated a confidence interval for each model in the present study with effort as the outcome (see Figure 2). Furthermore, we compared the interaction effect parameters for math and biology achievement by Authors with the confidence intervals of the effect parameters for each model in the present study with math and science achievement as the outcome (see Figure 3).

Figures 2 and 3 show that the effects reported in Song et al. (2020) were somewhat stronger than the effects we found in the present study. However, regarding the confidence interval overlap criterion it can be observed that for 30 of the 32 models in the present study, at least one of the interaction effects by Song et al. was covered with the confidence intervals of the interaction effects, indicating that there is no statistically significant difference between the effects found by Song et al. for German academic track high school students and most of the present study's effects. The confidence interval criterion was not met for only the Grit × Interest model as well as the Conscientiousness × Task value model for predicting science effort in high school students. Thus, according to the confidence interval overlap criterion, overall, there is support for replicating the CONIC model in the present study.

In addition, when evaluating the agreement in sign (positive or negative) across all models, we found that all main effects and 27 of 32 interactions met the expected research pattern in sign.

Figure 2

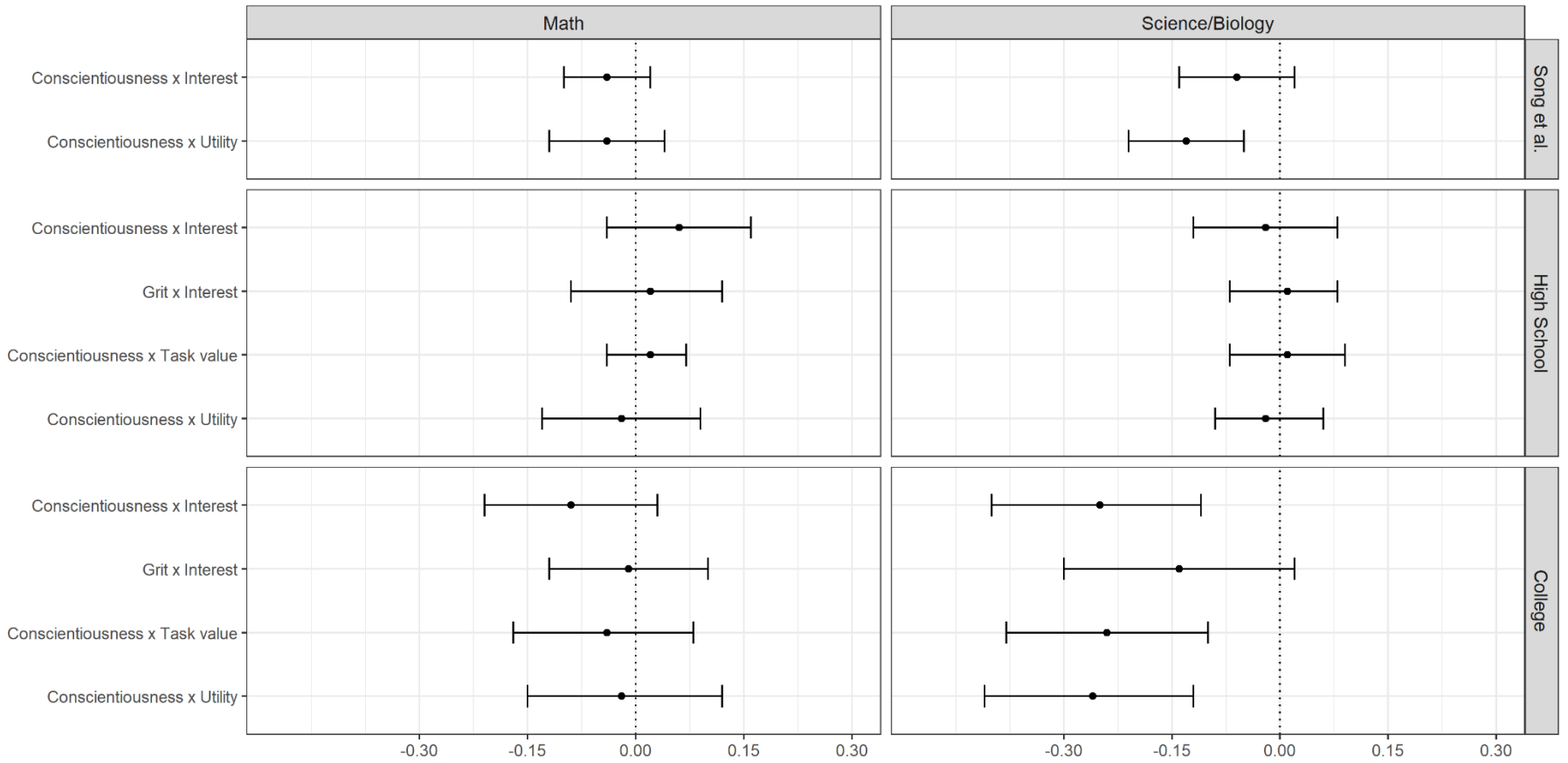
Confidence Interval Overlap for the Models Predicting Effort



Note. The figure shows the 95 % confidence intervals of the interaction effects when predicting academic effort in math and biology in the first replication study of the CONIC model by Song et al. (2020) as well as the 95 % confidence intervals of the interaction effects when predicting academic effort in math and science for the two samples (college and high school) used in the present study.

Figure 3

Confidence Interval Overlap for the Models Predicting Achievement



Note. The figure shows the 95 % confidence intervals of the interaction effects when predicting math and biology grades in the first replication study of the CONIC model by Song et al. (2020) as well as the 95 % confidence intervals of the interaction effects when predicting math and science grades for the two samples (college and high school) used in the present study.

Discussion

Results of this study provide support for the generalizability and extensivity of Trautwein et al. (2015, 2019) CONIC model of the relations of conscientiousness and interest to academic effort. The compensatory processes between conscientiousness and interest proposed in the model were found in different age groups, and in another Western country. We tested the relations separately for the two subjects of Math and Science, and found stronger support for the model in the Science domain. In addition, we found support for the model when a conceptually and empirically related personality variable (grit) and different aspects of task value were assessed, although the findings were somewhat weaker. It is noteworthy that, in general, trait-by-trait interactions tend to be smaller than main effects, as we also observed in our study (Vize et al., 2022). Nonetheless, such small interaction effects, when combined with theoretical justification and pre-registered hypotheses, should not be disregarded as they can contribute significantly to the development of a rigorous and cumulative scientific knowledge base (Funder & Ozer, 2019; Götz et al., 2022).We first discuss the major results, and then discuss their implications both for work on the relations of personality trait to motivational variables and for education.

Generalizability of the CONIC Model Across Age Groups and Countries

We examined whether the compensatory interaction effects proposed in the model and examined primarily in German middle and high school students would occur in both high school and college students in another Western country. Support for the original CONIC model was strongest for American high school students, the age group on which most of the previous work in Germany focused. Thus, despite the differences in the education systems in the two countries described in the introduction, our results show that the CONIC model is robust across the two countries.

For the college students we proposed that interest might be a stronger factor at that education level given that students attend college voluntarily and structure their course choices around their interests. Results did not fully support this prediction; more significant interaction terms occurred for the high school than college students, albeit the size of regression coefficients were rather similar. Thus, the processes or mechanisms proposed in the CONIC model may not as strong or pronounced among college students in the U.S. Perhaps college students have less of a need to "compensate" than high school students, given that they have chosen to be in college. However, the smaller number of statistically significant effects in the college students in this study may simply be due to its smaller sample size.

Extensivity of the CONIC Model to Grit and Overall Task Value

Turning to the generality of the model, when grit was substituted for conscientiousness in the model many of the relations were similar, albeit somewhat weaker. Our results provide another source of evidence that grit is not a personality construct distinct from conscientiousness as originally claimed by Duckworth and colleagues (2007). We therefore agree with Credé and colleagues (Credé, 2018; Credé et al., 2117), Muenks and colleagues (2017) and Morrell and colleagues (2021) that it is time to discontinue research on grit.

With respect to motivational variables, in the CONIC model we built on previous work in two ways: first, assessing whether Song et al.'s (2020) findings regarding utility value would replicate in the U. S samples, and second, by substituting overall task value into the model. Utility value can be thought of as a more extrinsic way to engage in an activity; there are things we have to do (like taking certain courses) even when we are not interested in them. Our findings regarding utility value show that when it was substituted for interest the interactions were not as strong and several effects were not significant. Thus, it appears that utility does not compensate as strongly as does interest when people are less conscientious, and vice versa.

Eccles and Wigfield (2020) have called for work to understand the processes by which individuals' overall valuing of a task take shape and how it impacts different outcomes. We therefore assessed how substituting overall task value for interest impacted the strength of the compensatory effects found in the earlier studies. Overall, findings were weaker than for the models that included interest. Because overall task value includes both more extrinsic (utility value) and intrinsic (interest value, attainment value) aspects when combined together, the compensatory effects observed when interest or utility value are in the model also are diluted to some extent.

Testing the Model with Achievement Rather than Effort as the Outcome

When achievement (as measured by grades) was the outcome measure, the main effects and interactions for both the original CONIC model and the other models were generally smaller. One explanation for this is that in most variable-centered studies individuals' task values are stronger predictors of their choices of which activity to work on, whereas their expectancies for success are the stronger predictor of achievement (Eccles et al., 1984; Meece et al., 1990; Trautwein et al., 2015). The results for effort perhaps reflect this overall tendency for task value to be associated with continuing to work on something when it is valued. Further the differences in the results for effort versus STEM grades may have occurred because grades are impacted by many factors, with personality variables and interest being important but

perhaps not as important as some other variables such as previous performance or abilities. One methodological explanation is the shared method variance in predictors and outcomes in the models including effort, as all variables were self-reported in those models.

Suggestions for Future Research

The results provide support for the generalizability of the CONIC model's findings to a similar age group in another country, as well as for generalizability in a different age group, and when other variables were substituted into the model. To build on our findings researchers should continue to assess the generalizability of the model by examining relations of other personality characteristics in the Big Five model to different motivation variables. Doing so would shed light not only on compensatory processes between such variables, but also provide information about the ways in which different and more stable characteristics like personality traits impact motivation, and vice versa. We suggest in particular to examine the roles of openness to experience and curiosity as potential pull factors. Similar to interest, both share a willingness to engage with new information and experiences. However, unlike interest, they are broader and not domain-specific.

We also need more work on the processes behind the relations observed in the CONIC model. Trautwein et al. (2015) described conscientiousness as a "push" factor and interest as a "pull" factor as a way to explain how the two constructs worked together. Work to date has not directly addressed how push and pull factors impact individuals' effort and achievement. Process-oriented work needs to be done to understand how each operates independently and in conjunction with each other. One approach could be to include subjective experience of exertion in future studies to compare interest-driven effort to conscientiousness-driven effort and gain additional insights into underlying processes of the CONIC model.

Additionally, future research on the CONIC model should employ experimental designs to investigate the interplay of interest and conscientiousness, which could allow causal inferences. A promising approach could be to conduct a lab study under controlled conditions, including an experimental manipulation of interest. Finally, it would be interesting to assess the CONIC model in younger age groups to see when the observed compensatory relations between conscientiousness and interest, and the related variables studied here, begin to emerge.

Implications for Enhancing Student Outcomes

The results of the present study have important implications for interventions designed to enhance students' academic effort and achievement. Intervention researchers focused on motivation have developed successful interventions that impact students' interest and task value (Renninger et al., 2014; Rosenzweig et al., 2021). There also are successful interventions to increase individuals' conscientiousness (Hudson et al., 2019; Steger et al., 2021). Results here suggest when it might be more promising to focus on interest and when to focus on conscientiousness. For example, for students who lack conscientiousness or otherwise have challenges organizing themselves to get their work done, interventions aimed at enhancing their interest in what they are studying may, at least in the short run, be more likely to increase their academic efforts. On the other hand, enhancing conscientiousness may be particularly useful for situations in which individuals need to perform tasks that are—and will likely—not lie within their area of interest. More generally, increasing conscientiousness rather than domain-specific interest may have some broader impact given its domain-generality. However, perhaps the best strategy is to think inclusively: Researchers increasingly are pointing to the need to consider more than one variable when designing interventions given that extant intervention work (at least in the motivation field) better for some students than others, and in some situations and not others (see Rosenzweig et al, 2020, and Yeager & Dweck, 2020). Looking across the two fields combining conscientiousness interventions with those combining interest and/or task value could be an interesting next step.

Limitations and How to Address Them

Some methodological limitations of the present research should be noted and addressed in future research. In our study as well as all previous studies on the CONIC model, the assessment of conscientiousness (or grit) and interest (or utility value or task value) was limited to self-report measures. This assessment approach is widely used and accepted for conscientiousness (see Noftle & Robins, 2007; Richardson et al., 2012) and is probably most appropriate for assessing students' value beliefs (Wigfield & Cambria, 2010). However, to strengthen the confidence in the robustness and generalizability of the CONIC model, there should be tests of it using different kinds of measures of the constructs (e.g., teacher ratings) or even using alternative research designs (e.g., various lab settings).

The design of this study did not include multiple time points, and so we were not able to control for previous performance. This means the interest, task value, and personality variables may be influenced by prior experiences and grades, leaving open the possibility that

the causal direction between those variables and outcomes could be reversed. To address this issue, future longitudinal studies testing the model across different time points should be conducted.

Another limitation was the limited sample size, especially regarding the college sample, which resulted in larger confidence intervals indicating less precise results for the college sample. Therefore, investigating the CONIC model in larger samples of older learners (e.g., college students), including from other cultural backgrounds and across additional subject domains, should be the subject of future research.

It would have been desirable to have done an a priori power analysis. However, we could not do so because the data from the U. S. samples had already been collected and were not originally intended to address our research question. As reporting post-hoc power analyses may not significantly contribute to the interpretation of results beyond what can be inferred from the p-value alone (Lakens, 2021), we conducted a simulation study to demonstrate the power of different data scenarios (https://osf.io/3qfa8/). For example, for an interaction effect of -.10 the power seems to be adequate across the different data scenarios.

In conclusion, the present study provides evidence that the effects observed in studies of the original CONIC model in Germany also occurred in two different samples in the U.S. Results also provide some support for the various extensions to other empirically related predictor constructs, but these effects generally were smaller.

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4 STUDY 2

THE INTERPLAY OF CONSCIENTIOUSNESS AND INTEREST IN PREDICTING ACHIEVEMENT OUTCOMES IN A LAB SETTING

Bareis, A., Spengler, M., Rieger, S., Appel, T., Tibus, M., Gerjets, P., Nagengast, B., & Trautwein, U. (to be submitted). The interplay of conscientiousness and interest in predicting achievement outcomes in a lab setting.

Abstract

The Conscientiousness × Interest Compensation (CONIC) model (Trautwein et al., 2019) proposes that conscientiousness and interest compensate for each other in predicting academic effort and school grades (Song et al., 2020). In this study, we investigated whether the CONIC model applies to task achievement assessed in a controlled lab setting. The study involved 317 university students (M = 23.23 years) who participated in a laboratory study comprising five learning tasks addressing different topics. Regression analyses were conducted for each task, revealing an overall pattern of task-specific interest predicting achievement positively and the Conscientiousness × Interest interaction term predicting achievement negatively. The main effect of conscientiousness was not statistically significant for achievement in any of the learning tasks. The findings support the assumptions of the CONIC model in a controlled lab setting but suggest that conscientiousness has limited predictive validity for achievement in laboratory tasks.

Keywords: CONIC, interest, conscientiousness, laboratory task achievement

The Interplay of Conscientiousness and Interest in Predicting Achievement Outcomes in a Lab Setting

To address the question of how academic achievements can be explained, two psychological constructs have gained substantial importance: conscientiousness and interest (e.g., Mammadov, 2022; Renninger et al., 2015). Both focus on interindividual differences and are important predictors of academic achievement. However, due to being rooted in different research traditions, they have typically been studied separately in different subareas of psychology (i.e., interest in educational psychology and conscientiousness in personality psychology). Investigating the interplay between the two constructs, Trautwein et al. (2019) developed the Conscientiousness × Interest Compensation (CONIC) model to account for the extent to which conscientiousness and interest predict academic outcomes separately and jointly. Previous research on the CONIC model has found that high conscientiousness can partly compensate for a lack of interest in certain domains when predicting academic effort and achievement (Bareis et al., 2024; Rieger et al., 2022; Song et al., 2020; Trautwein et al., 2015).

Extant studies are all conducted in regular classroom environments. The absence of variation in study design in researching the CONIC model represents a limitation, as the question remains open how different study conditions might alter the interplay between conscientiousness and interest (e.g., higher external control, without teaching person, shorter time period, standardized learning tasks). Enhancing more clarity on the contextual conditions under which the model applies and how they affect the interplay of conscientiousness and interest is the primary objective of the present study. A deeper understanding of these conditions can serve as source of insights for refining the model further and enables more robust inferences about the model's susceptibility to contextual factors. Moreover, a more precise specification of the model not only enhances theoretical insights but also increases the practical utility. Knowing the specific conditions under which a model can serve as a guiding principle improves its effectiveness in practical applications.

Specifically, we contribute with our study to the further specification of the CONIC model by investigating it for the first time in a laboratory setting and for low-stakes test scores as achievement measure. Here, we test to what extent conscientiousness, interest, and their interplay predict achievement across five different digital learning tasks that vary in the topics they address.

Conscientiousness and Interest as Predictors of Academic Achievement

On a theoretical level, both interest and conscientiousness lead to students' willingness to work hard and persevere until they achieve their goals. However, they operate through different pathways due to their distinct characteristics.

Individuals with high levels of conscientiousness are described as goal-directed, self-controlled, hardworking, rule-abiding, responsible to others, and planful (John et al., 2008; Roberts et al., 2009). Consequently, the pathway via conscientiousness to academic effort is driven by an orientation towards the outcome or goal rather than the learning process itself (Sansone et al., 2010). On the one hand, conscientious individuals set more goals to improve and challenge themselves. On the other hand, these individuals also have the ability to resist distractions and temptations by inhibiting behaviors. These behaviors are closely related to the construct of "self-control" and can either initiate and sustain effort or restrict impulsive behavior (McCrae & Löckenhoff, 2010). This enables individuals to work without hesitation and to stick to tasks, even when associated with negative emotions. Consequently, individuals with high levels of conscientiousness persist in studying and perform better.

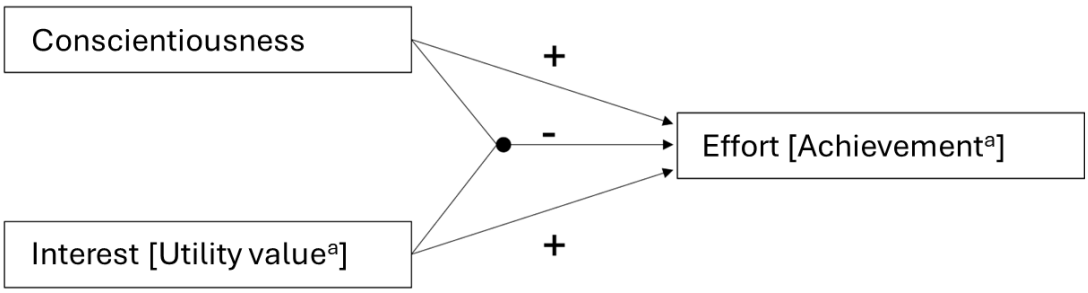
Interest, on the other hand, is a motivational construct that refers to the orientation to engage or the predisposition to reengage with specific matters (Hidi & Renninger, 2006). It is always related to a specific matter, which can be an object, a theme, or an activity (Renninger & Hidi, 2011). This makes it a relational construct and strongly domain-specific (in comparison to conscientiousness, which is domain-general). The driving force of interest results from the learning behavior and the learning process itself. Interest prompts positive affectivity and automatic attention, thereby enhancing goal-oriented behavior (Ainley et al., 2002; Hidi et al., 2004; Renninger & Wozniak, 1985). The accompanying positive affectivity leads to a self-reinforcing process and, thus, to persistence and academic effort (Ainley et al., 2002; Murayama et al., 2019; Sansone et al., 2010). Interest leads through enthusiasm and eagerness to perseverance and effortful behavior, which facilitates high performance.

The interplay between these two constructs in the process towards sustained effort is captured in a compensatory effects model, namely the CONIC (Conscientiousness × Interest Compensation) model (Trautwein et al., 2015; Trautwein et al., 2019). The CONIC model posits that high conscientiousness can partly compensate for a lack of interest in a domain, and vice versa, when predicting academic effort and achievement (Song et al., 2020; Trautwein et al., 2019). Statistically, this is tested using regression models with conscientiousness, interest, and their interaction (Conscientiousness × Interest) predicting academic effort or achievement, yielding two positive main effects and a negative interaction effect (see Figure 1). Such a pattern

of regression coefficients supports a compensatory effect (Cohen et al., 2003). At the practical level, this implies that conscientiousness plays a more crucial role for academic outcomes among students with low interest, whereas interest is more important among students who are low in conscientiousness. Somewhat simplified, this suggests that for academic effort, it is only necessary for one of the two constructs to be highly pronounced.

Figure 1

Summary of Previous Empirical Results for the CONIC Model (Trautwein et al., 2015) and its Extension by Song et al. (2020)



Note. [a] Extended by Song et al. (2020)

Empirical Support of the Conscientiousness × Interest Compensation (CONIC) Model

Initial empirical evidence for the CONIC model was found by Trautwein et al. (2015) in a series of four studies. These studies tested interaction effects in four different data sets. Within these four studies, they included (a) samples of academic-track-schools as well as non-academic-track schools from Germany and Switzerland, (b) measures of individual interest as well as situational interest, and (c) four different school domains (math, English, German, French). Rieger et al. (2022) demonstrated that conscientiousness, interest, and their interaction can also longitudinally predict changes in academic effort. As the next significant step in consolidating of the CONIC model, Song et al. (2020) expanded the model for predicting achievement, specifically focusing on school grades in their research. Their results demonstrated that the CONIC model holds across achievement as an additional outcome, broader than previously assumed, albeit with slightly weaker results compared to effort. Bareis et al. (2024) replicated Song et al.'s results and extended the model across another sample (U.S. as another culture/country) and for college students as another age group. In sum, evidence for the predictions of the CONIC model has accumulated over several studies.

Assessing Generalizability Across Another Outcome and Setting

The present study builds upon these findings and examines the CONIC model for achievement in several learning tasks. Originally proposed to predict effortful behavior, subsequent studies expanded the CONIC model also for predicting achievement (Bareis et al., 2024; Song et al., 2020). A critical advantage of investigating achievement measures rather than self-reported effort is that they represent more objective metrics and are not based on subjective assessments. This helps to avoid shared method variance. However, a challenge in using achievement measures is that they are influenced by numerous additional factors (e.g., intelligence, prior knowledge) that cannot be easily controlled. On the other hand, studying achievement provides a more comprehensive approach as it reflects the most frequently used outcome for evaluation and assessment, which enables comparability between individuals. Previous research has shown that the predictive power of determinants varies depending on the type of achievement measure employed (e.g., grades vs. test scores; Hübner et al., 2022; Meyer et al., 2023). In contrast to previous studies that utilized course grades as achievement measures, this study employs performance in lab-based achievement tests as the measure for assessing achievement. Lab-based achievement tests differ in several key characteristics from traditional school grades. According to the PASH hypothesis (Hübner et al., 2022) level of standardization, relevance for the student, curricular validity, instructional sensitivity, and cognitive ability saturation can be considered essential differentiating features between achievement measures. In comparison to school grades, lab-based test performance has lower relevance and higher standardization. Additionally, there is no instructional teaching practice or other means of long-term preparation for the tests, leading to the absence of instructional sensitivity and curricular validity. Regarding cognitive ability saturation, it is difficult to make a general statement, due to the substantial variations among the tests used in our study.

The current body of research suggests that conscientiousness manifests itself, especially in achievement measures that are less standardized and less saturated with cognitive ability but higher in relevance, curriculum validity, and instructional sensitivity (Hübner et al., 2022). Similarly, the relationship between interest and achievement measures varies depending on the features of the respective measure. A systematic review examining the relationship between interest and various performance measures following the PASH hypothesis is currently lacking. However, considering previous research on interest predicting different achievement outcomes (e.g., test scores, standardized learning assessments, school grades), it can be inferred that the relationships similarly are stronger when the outcomes are more relevant, have higher curriculum validity, are more instructionally sensitive, and less saturated with cognitive ability

(Jansen et al., 2016; Mao et al., 2021; Schiefele et al., 1992). Consequently, it can be assumed that the correlation between conscientiousness and achievement, as well as between interest and achievement, is lower for the outcome utilized in this study compared to previously examined school grades. On a broader level, these findings indicate that the associations between personality, interest, and achievement should not be readily generalized across various measures and underscore the significance of our study in examining the CONIC model for the prediction of lab-based test scores as an achievement measure distinct from school grades.

All previous research on the CONIC model to date has used data collected in classroom settings. Whether the assumptions of the CONIC model also apply to self-regulated behavior and effortfulness in controlled learning environments outside of the classroom remains an open question. This is another focal point of the current study, which aims to investigate the validity of the CONIC model under controlled conditions in a laboratory setting.

Laboratory studies offer high internal validity by controlling for possible confounding factors. In a lab setting, researchers can standardize procedures, ensuring that all participants experience the same conditions. This allows for greater control over potential undesirable factors that could impact the dependent variables under investigation. Achieving this degree of control is not possible in a real-world school setting, where numerous variables can exert influence. For example, in a real-world school setting, factors such as class composition (Tent & Birkel, 2010) or teachers' expectations (Jussim & Harber, 2005) are additional relevant factors influencing the individual learning behavior and achievements. Further, performing well in laboratory tasks has no personal relevance, and there is no opportunity to prepare in advance. Consequently, it can be assumed that long-term goals and study habits have less influence on learning behavior in laboratory tasks (e.g., Marsh et al., 2005). Examining the CONIC model in a laboratory setting allows us to isolate the interplay of conscientiousness and interest from the real-world context and observe how this impacts the proposed compensatory effect. This contributes to new insights into the model, which can then be utilized for further hypothesis generation and the design of future research projects. Overall, the aim is to enhance our understanding of the model by expanding upon existing field studies with laboratory research.

Present Study

In the current research, we investigate the CONIC model predicting achievement in lab-based learning tasks. To this end, we used data from a study that included five distinct learning tasks, each addressing a different domain of interest. All learning tasks were presented in digital form but varied somewhat in their design. For each of the five different learning tasks, we

examined the predictive power of task-specific interest, conscientiousness, and their interaction for learning outcomes. Domain-specific measures of interest were employed for every task. Prior research has shown that conscientiousness and interest are predictors of achievement, encompassing both test scores and school grades (Marsh et al., 2005; Meyer et al., 2023). However, recent research also emphasizes that the associations between conscientiousness or interest and student achievement vary depending on the measure used (Jansen et al., 2016; Meyer et al., 2023). The current body of research indicates that conscientiousness and interest show stronger associations with low standardized achievement measures compared to those with higher standardization (e.g., Hübner et al., 2022; Mao et al., 2021). Based on these findings, we hypothesize a positive predictive value of conscientiousness and interest, which may, however, be smaller than in previous studies on the CONIC model using grades as outcomes (Bareis et al., 2024; Song et al., 2020).

We posit that the CONIC mechanism constitutes a fundamental psychological phenomenon not limited to classroom settings but applies across other learning settings. Consequently, we predict that the hypothesized negative (i.e., compensatory) interaction effects between conscientiousness and respective interest will also manifest in predicting achievement across different learning tasks.

Method

This research was approved by the institutional review board at the university where the study was conducted.

Study Design and General Procedure of the Tasks

The subjects participated in a laboratory study that included completing five learning tasks on different topics: formation of the moon, extraordinary animals, characteristics of water, probability calculation, and art theory. The data collection encompassed three four-hour lab sessions. The participants also completed several measures that are not relevant to the current analyses, which is why they are not reported here. For economic reasons, the data collection was conducted in group settings from three to 13 individuals in parallel. The sessions for each group were scheduled on the same time slot and day for three consecutive weeks. In a few cases, participants deviated from this schedule (e.g., due to illness). The order of the surveys and tasks across all sessions was predefined across sessions. Within each session, there was a scheduled break halfway through.

Most of the variables under investigation—conscientiousness, sociodemographic information, and all measures of the learning tasks "Formation of the moon", "Characteristics of water", and "Extraordinary animals"— were collected via the survey platform SoSci Survey (Leiner, 2019). The remaining two learning tasks "Probability theory" and "Art Theory", were implemented as hypermedia digital learning environments.

The domain-specific measure of interest was consistently assessed prior to task engagement. The learning phase within the tasks exhibited some variations. The learning tasks "Formation of the moon", "Characteristics of water", and "Extraordinary animals" involved reading tasks in which the participants were presented with five texts on different topics. The learning tasks "Probability theory" and "Art Theory" included self-paced study phases in the provided digital learning environments. Upon task completion, participants responded to multiple-choice (MC) questions about the topic they had learned.

Sample

A total of 321 university students participated in the study. Only those students who participated in all three sessions of data collection were included, resulting in a sample size comprising 317 participants. The sample includes 218 females, 95 males, and four participants who preferred not to indicate their gender. Participants' age ranged from 18 to 30 years, with a mean of 23.25 years (SD = 3.03). The participants were recruited from the e-mail distribution

list of the university where the study was conducted. Participants had the opportunity to earn up to 111 € by participating in all three sessions. Students who were enrolled in a psychology program (N = 53) also had the opportunity to be rewarded with course credits.

Measures

Information about descriptives, number of missing values, and indicators for reliability can be found in Table 1. To get a more informative and reliable assessment of task achievement, we excluded items with difficulty levels below 5 % or above 95 %, resulting in a more balanced set of test questions in terms of difficulty.

Conscientiousness

Conscientiousness was assessed during the first lab session using the German version of the Revised NEO Personality Inventory (NEO PI-R) scale for Conscientiousness (Ostendorf & Angleitner, 2004). This scale comprises 48 items, rated on a 5-point response scale ranging from *strongly disagree* to *strongly agree*. An example item is: "I work hard to meet my goals."

Learning Task: "Formation of the Moon"

Material. Participants were presented with a text on the formation of the moon, sourced from OECD's Programme for International Student Assessment in 2000 (PISA; 557 words; Kunter et al., 2002). They were required to read the text on the screen for 5 minutes and were not permitted to proceed to the next part of the task before the allotted time had elapsed.

Interest. Interest in the topic was measured using two items from the PISA test 2000 ("How interesting do you find this topic?" and "Will you enjoy reading this text?") rated on a 5-point response scale ranging from *very* to *not at all*.

Achievement. The participants were presented with six MC questions. We excluded one item because the item difficulty exceeded 95 %. The number of correct answers was used as an achievement score.

Learning Task: "Characteristics of Water"

Material. Participants were provided with a text on the characteristics of water, also sourced from the Pisa survey 2000 (461 words; Kunter et al., 2002). Similar to the learning task regarding the formation of the moon, they were required to read the text on the screen for five minutes and were not allowed to proceed to the next part of the task before the designated time had elapsed.

Interest. Interest in the topic was assessed using the same measure from the PISA test 2000 as employed for the task regarding the formation of the moon.

Achievement. The participants were presented with 32 MC questions. We excluded four items because their item difficulty exceeded 95 %. The number of correct answers was used as the achievement score.

Learning Task: "Extraordinary Animals"

Material. For the learning task about extraordinary animals, we provided the participants with five different texts about exotic species: snow monkeys, saiga antelopes, ice sharks, mitten crabs, and giant squids. These texts were sourced from the GEO/GEOlino Corpus (Hancke et al., 2012) and have been used in previous empirical work (Andreessen et al., 2021). Each text varied in length, ranging from 431 to 448 words, and their presentation order was randomized.

Interest. Interest in the topic was assessed using the same measure from the PISA test 2000 as utilized for the task regarding the formation of the moon and the characteristics of water.

Achievement. After reading each text, participants were presented with 11 MC questions. The total number of correctly answered questions, including all 55 MC questions in total, was used as an achievement measure.

Learning Task: "Probability Calculation"

Material. Participants were presented with the hypertext-based learning environment "HYPERCOMB" (Gerjets et al., 2006), designed to facilitate knowledge acquisition in probability theory. The key instructional approach employed in HYPERCOMB involves using elaborated solution examples. In the beginning, students completed a brief introduction before they started an example-based learning phase. The entire task takes approximately 70 minutes.

Interest. Interest in the topic was assessed using the two items "I like to engage myself with mathematical topics" and "I enjoy dealing with mathematical topics". Participants rated their responses on a 4-point response scale, ranging from *is not true at all* to *is correct exactly*.

Achievement. The participants were presented with a math exam consisting of eleven mathematical problems and declarative knowledge questions. The number of correct answers was used as the achievement score.

Learning Task: "Art Theory"

Material. In the learning task about art history, we developed a multi-perspective hypermedia digital learning environment addressing five core topics of art history. In this environment, students are provided with learning materials about twenty artworks and sample tasks representing the topics of the subsequent knowledge test. The learning environment automatically closes after 60 minutes.

Interest. Interest in the topic was evaluated using a single-item measure "How would you rate your interest in art?". Participants rated their interest on a 5-point response scale, ranging from *very low* to *very high*.

Achievement. After the learning phase, participants were presented with 30 MC questions. We excluded four items because their item difficulty exceeded 95 %. The number correct answers was used as the achievement score.

Statistical Analyses

To test the relations between conscientiousness, interest, and achievement for each learning task, we specified a set of two multiple linear regression models (A, B). The achievement measure of each learning task served as the dependent variable. Conscientiousness, task-specific interest, and the interaction term of conscientiousness and interest were included as independent variables. Prior to analysis, all measures (except the control variable gender) were *z*-standardized. In model A, we tested for the main effects of the respective predictors, whereas in model B, the interaction term was included. All models were adjusted for gender and age. We employ two-tailed tests to assess statistical significance. Further, we used full information maximum likelihood (FIML) estimation to deal with missing data.

Table 1

Descriptive Statistics and Internal Consistency for the Variables

Measure	*N*	*M*	*SD*	α
Conscientiousness	271	3.47	0.47	.92
Interest				
Formation of the moon	314	3.43	0.89	.85
Characteristics of water	310	3.44	0.79	.83
Extraordinary animals	234	3.57	0.85	.84
Probability calculation	310	2.21	1.07	.93
Art theory	311	2.89	1.09	-
Achievement				
Formation of the moon	315	0.82	0.22	.49
Characteristics of water	283	0.86	0.11	.67
Extraordinary animals	315	0.55	0.13	.80
Probability calculation	278	0.79	0.18	.64
Art theory	282	0.60	0.11	.50

Table 2

Correlations between Task-Specific Interests, Conscientiousness, and Task Achievement

Measure	1	2	3	4	5	6	7	8	9	10
1. Conscientiousness			.	.						
2. Interest - Formation of the moon	-.05									
3. Interest - Characteristics of water	.03	.44								
4. Interest - Extraordinary animals	-.05	.50	.41							
5. Interest - Probability calculation	.11	.11	.10	-.03						
6. Interest - Art theory	-.20	.18	.10	.22	-.02					
7. Achievement - Formation of the moon	-.07	.17	.03	.01	.04	.10				
8. Achievement - Characteristics of water	-.07	.19	.03	.11	.13	.00	.44			
9. Achievement - Extraordinary animals	-.16	.21	.09	.36	-.01	.12	.41	.43		
10. Achievement - Probability calculation	.06	.13	.06	.03	.28	-.02	.39	.40	.41	
11. Achievement - Art theory	-.10	.11	.12	.06	.02	.26	.22	.20	.26	.13

Results

For a comprehensive analysis, first we have included an assessment of confidence interval overlap. This approach mitigates against the overinterpretation of the statistical significance of individual coefficients and facilitates a more balanced interpretation of the results by reducing the risk of placing undue emphasis on isolated effects. Hence, we gain insights into the robustness of the observed effects and can make a statement about the general pattern of the results. The confidence intervals for the regression coefficients of conscientiousness, interest, and their interaction when predicting task achievement are graphically depicted in Figure 1.

Assessing the overlap of the confidence intervals of the regression coefficients included in the CONIC model, it can be observed that the confidence intervals overlap across tasks, indicating a consistent pattern. For conscientiousness, four out of five confidence intervals include zero, with point estimates of regression coefficients ranging from β = -.13 to .06. Taken together, this suggests an effect close to zero. For interest, one out of five confidence intervals include zero, and the point estimates have all positive values ranging from β = .03 to .38. The tasks about the formation of the moon, probability calculation, and art theory cover a very similar confidence interval. The confidence intervals of the tasks about extraordinary animals and the characteristics of water cover slightly higher or lower ranges, so they no longer overlap with each other. However, there are overlaps between both intervals with the confidence intervals of the other tasks. Overall, the results for interest suggest a positive effect. For the interaction term, two out of five confidence intervals do not include zero with negative point estimates, two barely include zero with negative point estimates, and one include zero with a positive point estimate. The values of the point estimates range from β = -.17 to .02. Generally, the pattern for four tasks appears quite similar, yet the task about probability calculation shows some deviation, albeit with overlapping intervals in all cases. Overall, the results suggest a negative interaction effect.

The results of the regression models are reported in Table 3. Because the coefficients of the effects of conscientiousness and interest did not change substantially when including the interaction terms (see comparison model A vs. model B), the focus of reporting on the results is on the complete models (see model B).

Consistent with our hypotheses, we found task-specific interest predicting achievement positively (β = .03 to .38; water task not significant). Contrary to our hypotheses, the main effect of conscientiousness on achievement was statistically significant negative for the task about extraordinary animals. For the other tasks, there were no statistically significant effects

of conscientiousness. In accordance with our hypothesis, the interaction between conscientiousness and interest predicted achievement statistically significantly for two of the tasks (β = -.17 to -.14). Figure 3 displays the graphical representation of the interaction effects for each task. With respect to sex, we found a negative predictive effect for all tasks except the task about art theory, indicating that female students performed better than male students. With respect to age, there was a negative effect for the task about probability calculation, indicating that the younger participants performed better in this task. For the other tasks, there was no age effect. The proportion of explained overall variance ranged from 5 % to 19 %.

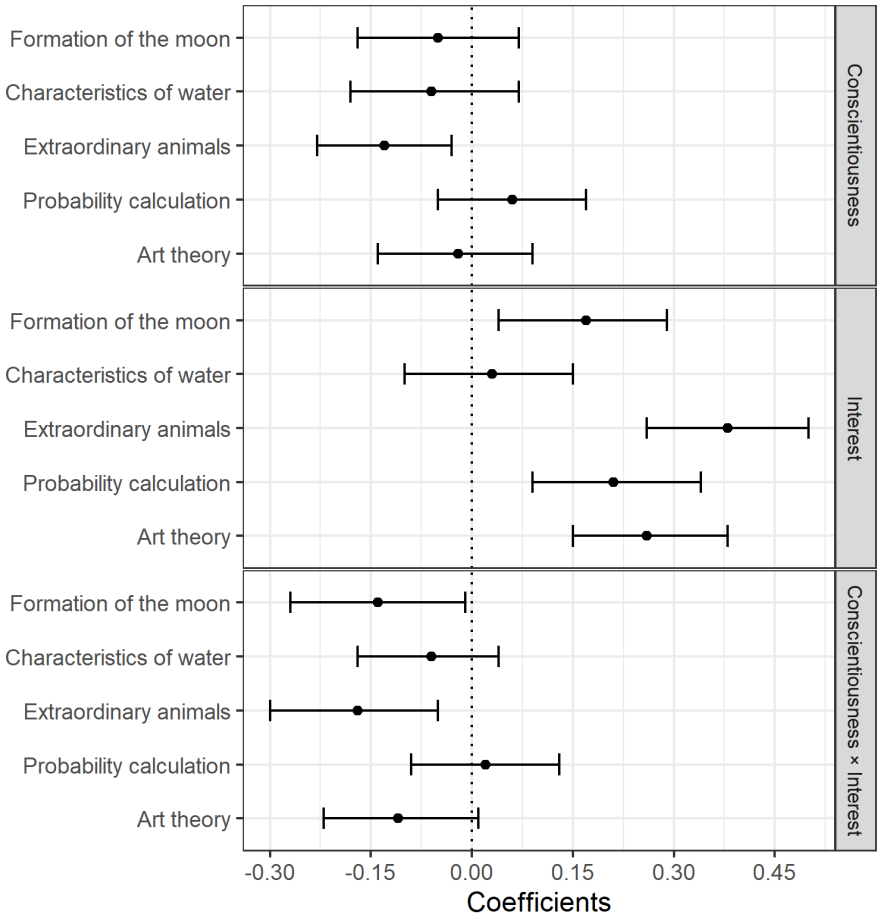
Table 3

Regression Results for the Learning Tasks Using Achievement as the Criterion

	Model A			*Model B*		
Variables	β	*95% CI*	*p*	β	*95% CI*	*p*
Formation of the moon						
Conscientiousness	-.05	[-.17, .07]	.412	-.05	[-.17, .07]	.431
Interest	.15	[.02, .28]	.023	.17	[.04, .29]	.009
Cons. × Interest				-.14	[-.27, -.01]	.030
Sex: Male	-.36	[-.58, -.15]	.001	-.35	[-.56, -.14]	.001
Age	-.08	[-.19, .03]	.134	-.10	[-.21, .01]	.069
R^2	.07			.09		
Characteristics of water						
Conscientiousness	-.06	[-.18, .07]	.355	-.06	[-.18, .07]	.373
Interest	.03	[-.10, .15]	.682	.03	[-.10, .15]	.699
Cons. × Interest				-.06	[-.17, .04]	.235
Sex: Male	-.44	[-.66, -.21]	<.001	-.42	[-.65, -.20]	<.001
Age	-.05	[-.18, .08]	.464	-.05	[-.18, .08]	.463
R^2	.05			.05		
Extraordinary animals						
Conscientiousness	-.13	[-.24, -.02]	.026	-.13	[-.23, -.03]	.011
Interest	.37	[.24, .50]	<.001	.38	[.26, .50]	<.001
Cons. × Interest			.	-.17	[-.30, -.05]	.006
Sex: Male	-.15	[-.39; .09]	.226	-.13	[-.37; .11]	.011
Age	.01	[-.10; .12]	.836	-.00	[-.11; .10]	.908
R^2	.16			.19		
Probability calculation						
Conscientiousness	.06	[-.05, .17]	.318	.06	[-.05; .17]	.296
Interest	.21	[.09, .34]	.001	.21	[.09, .34]	.001
Cons. × Interest				.02	[-.09, .13]	.720
Sex: Male	-.33	[-.57, -.10]	.005	-.33	[-.57, -.10]	.006
Age	-.16	[-.27, -.04]	.009	-.15	[-.27, -.04]	.010
R^2	.12			.12		
Art theory						
Conscientiousness	-.05	[-.17, .07]	.439	-.02	[-.14, .09]	.603
Interest	.26	[.14, .38]	<.001	.26	[.15, .38]	<.001
Cons. × Interest				-.11	[-.22, .01]	.063
Sex: Male	-.13	[-.40, .14]	.351	-.15	[-.42, .12]	.281
Age	-.01	[-.12, .10]	.829	-.02	[-.14, .09]	.667
R^2	.07			.09		

Figure 2

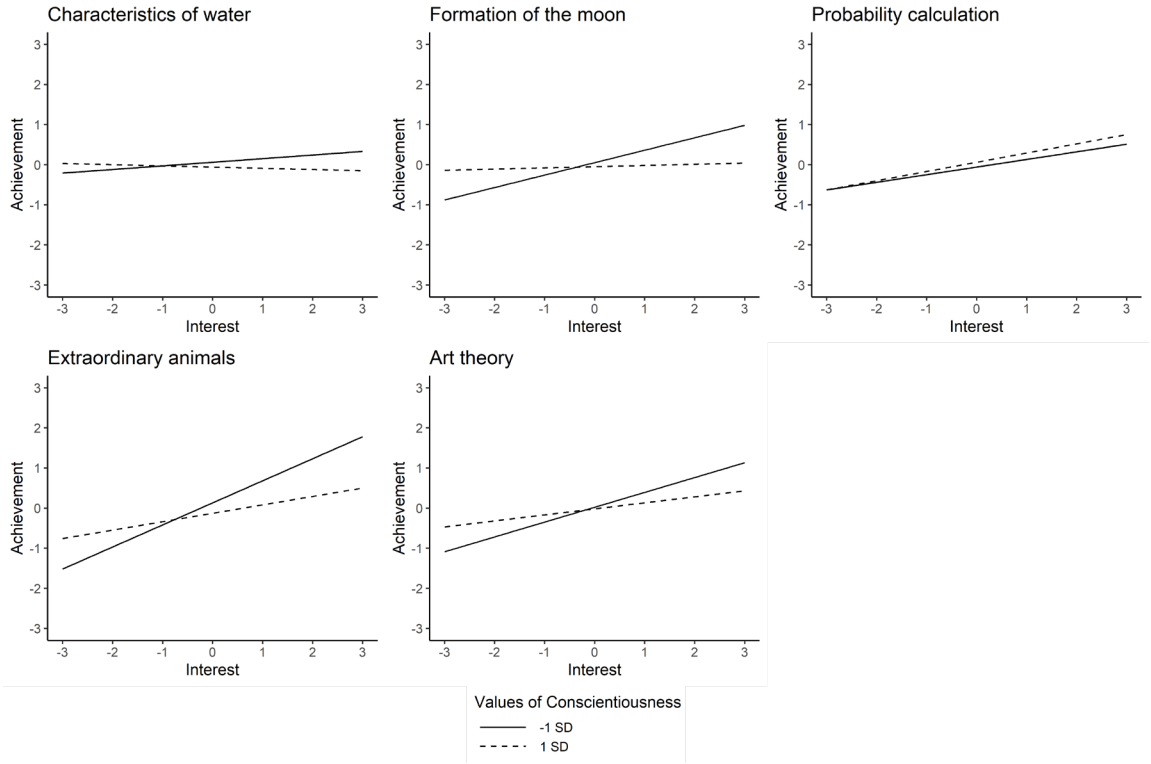
Confidence Interval Overlap for the Models Predicting Task Achievement



Note. The figure shows the 95 % confidence intervals of the regression coefficients when predicting task achievement.

Figure 3

Plots of the Conscientiousness × Interest Interaction Effects on Achievement in the Different Learning Tasks



Note. The independent variable is domain-specific interest. The dependent variable is achievement in the respective task. Solid line = 1 standard deviation (SD) below the mean of conscientiousness; dashed line = 1 SD above the mean of conscientiousness.

Discussion

The CONIC model proposes that the compensatory interplay between conscientiousness and interest represents a unique driving mechanism leading to sustained effort and achievement. In this study, we tested the CONIC model for the first time in a tightly controlled setting for achievement across five learning tasks. The overall findings support the CONIC model; however, they also point to limitations of the predictive validity of conscientiousness in the context of controlled laboratory settings.

The typical CONIC pattern is characterized by a negative interaction effect between conscientiousness and interest, alongside two positive main effects. The results of the present study did not show a positive main effect of conscientiousness; however, the pattern of a negative interaction effect could still be revealed. Further, a positive main effect for interest was observed. It is worth noting that interactions between traits typically tend to be smaller than main effects, which is observed in our study as well (Vize et al., 2022). These effects should not be undervalued based on their size (Funder & Ozer, 2019; Götz et al., 2022), as they are small yet consistent interactions and supported by theoretical justification.

The present study's key difference from prior studies is that they were conducted in a classroom setting, where achievement assessment always consisted of course grades. In contrast, the present study involved test scores for different learning tasks as an assessment of achievement and was conducted within a laboratory setting. First, we discuss the findings for the generalization of the CONIC model across test achievement as another outcome before addressing the implications related to the different research setting.

Generalizable Across Task Achievement?

Previous research suggests that different features of course grades and achievement scores influence the strength of the relationship between personality and achievement (e.g., Hübner et al., 2022). For example, course grades in the classroom setting are much less standardized but cover a longer time span and a broader range of topics, making them less specific than test scores in the lab setting. Grades are, therefore, also more influenced by other factors, such as the teacher's subjective assessment or the student's long-term preparation in class. On the other hand, test scores pertain to a much shorter time frame and are not dependent on long-term factors, providing a highly standardized snapshot of performance in a narrow and very specific range of topics. Another significant difference is the personal relevance of course grades, as they can impact student's future life. In contrast, performance in laboratory tasks serves exclusively for research purposes and holds no personal relevance for the participants.

Previous findings suggest that the main effects of conscientiousness and interest are likely weaker for task achievement compared to school grades. This is primarily attributed to the circumstance that task achievement is more standardized and holds lower relevance. Another important difference is the short-term nature of task achievement. Short-term performance outcomes measure whether an individual maintains a high level of effort and achievement in a specific evaluative situation, while long-term performance outcomes reflect how an individual consistently applies effort over an extended period and stays committed, thus measuring more the average performance across various situations over an extended period of time. Sackett et al. (1988) distinguishes between the concepts of *typical performance* and *maximum performance*. Typical performance represents how an individual performs on a regular basis, whereas maximum performance refers to the performance when effort is maximized. At least for conscientiousness, it is known that it is particularly relevant for typical performance and not necessarily for maximum performance (e.g., Ivcevic & Brackett, 2014).

The current results substantiate previous results regarding a weaker relationship with task achievement compared to course grades for conscientiousness, but not for interest. For interest similar-sized main effects can be observed compared to findings predicting school grades (for example, Bareis et al., 2024 or Song et al., 2020). Moreover, the use of a different outcome does not impact the interaction effects, which were observed in the overarching pattern as negative and of similar size. In the comparative consideration of the interaction effects between the tasks, one interaction effect seems to be somewhat different from the others (i.e. interaction effect in the task about probability calculation). Upon further examination, it becomes apparent that the interest measure in this task is broader operationalized compared to the others. In the other tasks, specific interest in the topic of each task is captured (e.g., for extraordinary animals), whereas for the task involving probability calculation, mathematical interest is measured (and not specifically interest in probability calculation). According to Ainley et al.'s (2002) taxonomy, which differentiates between situational interest, topic interest, and individual interest, topic interest is assessed for four of the tasks, while individual interest is assessed for the task about probability calculation. Related to the disparate hierarchical structure of the constructs these differences in the interaction effects can be clarified using Wittmann's Brunswik symmetry principle (Kretzschmar et al., 2018; Wittmann, 1988). According to this principle, the empirical correlation between two constructs at different levels of aggregation are underestimated if the hierarchical levels do not align. This implies that when the hierarchical level of operationalization between the predictors and the outcome match, existing effects can be best captured. If the operationalisations are at different hierarchical

levels, asymmetrical prediction occurs, attenuating the empirical relation. In the case of the present study, the broad construct conscientiousness at a higher level of aggregation predicts the narrow construct of task achievement at a lower level of aggregation. Similarly, the symmetry principle is violated for individual interest and task achievement, whereas topic interest and task achievement show hierarchical symmetry according to the Brunswik principle.

Taken together, it can be concluded that, the compensatory relationship between conscientiousness and interest also exists for task achievement as an outcome. Consequently, the current findings provide evidence for the generalization of the CONIC model to an additional class of outcomes. When focusing solely on statistical significances, however, capturing the interaction effect are found to be less effective compared to previous studies using school grades as the outcome variable. Potential explanations for this result include the absence of personal relevance and short-term nature of the outcome, as well as an asymmetrical relationship according to the Brunswik principle between predictors and outcomes (for conscientiousness and individual interest as predictors).

Implications for Testing the CONIC Model in the Lab Setting

This study tests whether the CONIC model operates similarly outside a real-world classroom scenario in a laboratory based artificial learning scenario. We chose this setting due to its ability to ensure high internal validity by controlling for confounding factors. The controlled environment enabled standardized procedures, providing a level of control that is not possible to attain in a real-world school setting where numerous variables can exert influence. However, the increased internal validity is accompanied by altered learning conditions and comes at the expense of the realism of the setting. We attribute the limited predictive validity of conscientiousness not only to the type of achievement measure but also to the high level of external control in the learning setting created in the laboratory. Previous research suggests conscientiousness has a stronger effect in situations with low external control (e.g., homework vs. learning in school; see Trautwein & Lüdtke, 2007). Further, researchers found that self-control and goal setting, in particular, mediate the relation between conscientiousness and academic achievement (e.g., Corker et al., 2012). In our learning tasks, where most of the conditions were externally fixed (e.g., fixed completion time, no possibility to engage otherwise, clearly defined goals), neither self-control nor setting challenging goals had the opportunity to cause an effect.

However, despite the limited predictive validity of conscientiousness, there is a negative interaction effect, indicating a compensatory relationship, which is the core of the CONIC

model. Thus, the present study provides evidence supporting the CONIC model for predicting achievement in lab-based learning tasks across different topics. The results demonstrate that the proposed compensatory mechanism may operate not only in school settings but also in controlled laboratory settings. This generalization to the laboratory setting is an important finding for the CONIC model, as it demonstrates that the CONIC effect is also detectable at a finer-grained task level in research settings with higher internal validity and fewer potential confounding factors. However, the findings also indicate that when examining the interplay of interest and conscientiousness in the lab setting and for task achievement as an outcome, the predictive validity of conscientiousness is limited.

Limitations and Future Research Directions

A limitation of the current study is that the employed laboratory setting incorporates an observational design like previous studies. The findings suggesting that the CONIC model can be generalized across a laboratory setting are promising for future research. However, this is constrained by the fact that the study is purely observational, lacking the manipulation of conditions to examine their effects. Future studies should adopt an experimental setting to enhance control over potential confounding variables and to get closer to the cause-and-effect mechanism within the CONIC model. As another next step in research, the hypotheses derived from the present study (i.e., influence of external control, personal relevance, short-term nature, and the Brunswik symmetry between predictor and outcome) should be tested in future field studies under more realistic conditions. The present study also emphasizes the need for further research on the relationship between interest and performance. It would be desirable to have this relationship systematically examined and compared between different types of interests (i.e., situational, topic interest, and individual interest) and various performance measures (e.g., according to the PASH hypothesis, Hübner et al., 2022).

Concluding, the present study provides further evidence for a compensatory relationship between conscientiousness and interest in performing well at learning tasks across a variety of topics. This means that, to a certain extent, a high-interest experience when working on a task can substitute for low conscientiousness, and high conscientiousness can substitute for a lack of interest experience. However, the results also indicate that, especially in highly structured learning environments, pedagogical efforts emphasizing the experience of interest are more promising than addressing conscientiousness because the latter cannot manifest its unique effects under controlled, highly standardized conditions.

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5 STUDY 3

THE CONSCIENTIOUSNESS × INTEREST COMPENSATION MODEL PREDICTING EFFORTFUL BEHAVIOR IN AN EXPERIMENTAL TASK

Bareis, A., Rieger, S., Spengler, M., Stoll, G., Nagengast, B., & Trautwein, U. (to be submitted). The Conscientiousness × Interest Compensation model predicting effortful behavior in an experimental task.

This study was preregistered with OSF (for more details see: https://osf.io/h6vcw/?view_only=a40467715ae849709c3fe18f0cb21bbc).

The version of the article displayed here may not exactly replicate the final version published in the journal. The manuscript has not yet been accepted or published.

Abstract

The present study examines the interplay of conscientiousness and interest in predicting different indicators of effortful behavior. It uses an online experiment (N = 1,250) with two conditions where the interestingness of the situation was manipulated resulting in an interesting and a boring task. The participants were randomly assigned to one of the two conditions (boring task first vs. interesting task first). For the between-person perspective, we use only the task presented first and compare the effortful behavior a group of individuals shows on one task with the effortful behavior the other group shows on the other task. For the within-person perspective, we use data from both tasks. Analyses were conducted on the between-and the within-person level. We found that the interestingness of a situation is a strong predictor of several indicators of effortful behavior. The predictive validity of conscientiousness was limited. According to the Conscientiousness × Interest Compensation (CONIC) model (Trautwein et al., 2019) conscientiousness is especially important for predicting effort when interest is low. The present study's results do not support this assumption. Possible inferences regarding boundary conditions of the CONIC model are discussed.

Keywords: conscientiousness, interest, effort, online-experiment

The Conscientiousness × Interest Compensation Model Predicting Effortful Behavior in an Experimental Task

It is widely acknowledged that success does not happen overnight but results from hard work and perseverance. "*What drives people to continuous effort?"* is subsequently a question that we cannot give enough importance to. Reasonably, it has already been studied by a number of researchers. Psychologists identified two person characteristics as key predictors namely interest and conscientiousness. Interest is a key construct in educational psychology, whereas conscientiousness is a focal construct in personality psychology. The two constructs were examined rather separately and have rarely been brought together theoretically and empirically (Dweck, 2017; Norem, 2012; Trautwein et al., 2019). Trautwein et al. (2015) bridged this gap and investigated the interplay of domain-specific interests and conscientiousness. Based on this work, Trautwein et al. (2019) formulated the Conscientiousness × Interest Compensation (CONIC) model as a theoretical framework regarding the interactive relationship between interest and conscientiousness in predicting (academic) effort.

The CONIC model proposes a compensatory effect of conscientiousness and interest in predicting (academic) effort. More specifically, the CONIC model implies that high conscientiousness can partly compensate (i.e., in terms of an "either/or" pattern) for a lack of interest in a specific domain and vice versa (Song et al., 2020; Trautwein et al., 2019). This suggests that conscientiousness plays a particularly important role when interest is low, and that interest is especially important for individuals low in conscientiousness.

Since then, the CONIC model has been replicated and extended in three additional studies (Bareis et al., 2024; Rieger et al., 2022; Song et al., 2020). Although these attempts provided further evidence for the interactive relationship between interest and conscientiousness proposed by the CONIC model, it is still at the beginning of the theory testing process towards more maturity and consolidation. This theory testing process benefits most from accumulating results across various studies when the methods of these studies are diverse and complementary in their weaknesses and strengths (Diener et al., 2022; Reichardt, 2019; Rosenbaum, 2015). A limitation of existing replication studies on the CONIC model so far is that they all rely on survey data with self-report measures. Thus, one important generalization that remains to be tested is the examination of the CONIC model by experimental research, which is also sometimes considered the "gold standard" for examining causal relations (Rohrer, 2018; Shadish et al., 2002). The major strength of experimental studies is their high internal validity. In the present study, we address this research gap and conduct an experimental study

to test the CONIC model. Further, within our experimental design, we do not only include self-reported effort as in previous studies but included several other indicators of effortful behavior (e.g., time measures) to additionally test generalizability across measures.

Conscientiousness, Interest and Their Interplay On Predicting Academic Effort

Conscientiousness and interest both can be considered important predictors of academic effort. Conscientiousness is one of the five dimensions of the Five Factor model (FFM) of personality, the most common personality model (De Raad & Schouwenburg, 1996; Noftle & Robins, 2007). Personality dimensions are typically conceptualized as relatively enduring, habitual patterns of feelings, behaviors, and thoughts which arise in specific situations (John & Srivastava, 1999; Roberts, 2009). Conscientiousness describes the general tendency of individuals to be goal-directed, self-controlled, hardworking, well-organized, and responsible to others (John et al., 2008; Roberts et al., 2009)—or, in other words: the general tendency to show effortful and self-regulated behavior across different domains and areas of life. Previous results suggest that individuals high on conscientiousness set more challenging achievement-related goals, are more able to plan their goals and resist temptations in the pursuit of those goals, which in turn leads to persistent effortful behavior and to greater success in performance-related contexts (Bidjerano & Dai, 2007; Corker et al., 2012; Noftle & Robins, 2007).

Interest can be conceptualized as a positive evaluative orientation towards a certain domain that includes the predisposition to reengage with the content of that domain over time (Eccles & Wigfield, 2002; Renninger & Hidi, 2011). Most theoretical approaches and conceptualization can be broadly classified in terms of situational and individual interest (Brandstätter et al., 2018; Schiefele, 2009). Situational interest is an affective reaction aroused by specific contextual factors. It can be seen as a temporary state of being interested. In contrast, individual interest is due to its stability rather a dispositional characteristic and describes the enduring positive evaluative orientation towards a certain domain and the tendency to reengage with a particular topic or object. Previous studies of the CONIC model have focused mostly (but not exclusively) on individual interest because it is stable across situations and thus relevant to long-term school outcomes (e.g., grades at the end of the school year). In the present study, we use situational interest because of its strong situational dependency, which allows us to manipulate it in the experimental setting. However, both individual and situational interest energize behavior and lead to effortful engagement with a particular domain—just with different temporal stability (Schiefele, 2009). In attempting to uncover the underlying reason for this energizing process towards effort, particularly the involvement of positive feelings elicited

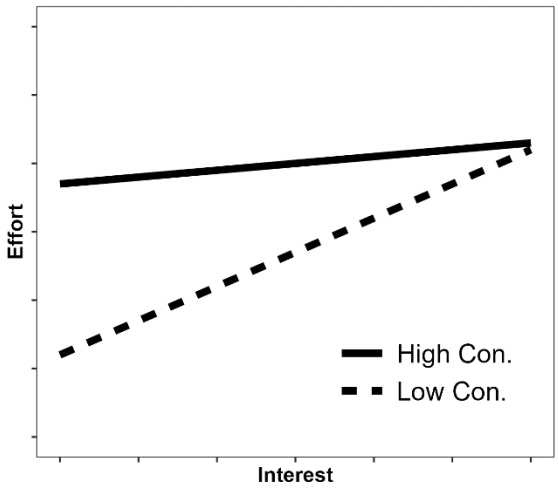
through interest seems to be a crucial factor (Krapp, 2002). It is postulated that the rewarding nature of positive feelings reinforces people's information-seeking behavior and, therefore, increases the likelihood of engaging (again) (Murayama et al., 2019). Further, the positive affect that accompanies interest also tends to replenish resources, which may, therefore, protect students from experiencing exhaustion while engaging in interest-driven activity (Thoman et al., 2011).

It can be summarized that interest and conscientiousness are both factors that lead to academic effort, but through their different characteristics on different ways. Because of the involvement of positive emotions, an interest-driven activity feels pleasant and effortless, so one is virtually pulled by the interest, which is why it can be conceptualized as a "pull factor" (Trautwein et al., 2019). Conscientiousness-driven activity lacks positive affectivity; it is more result-oriented and cognitive in nature. Therefore, it appears more like a built-in factor that pushes one forward, which is why it can rather be conceptualized as a "push-factor" (Trautwein et al., 2019).

Regarding the interplay of conscientiousness and interest in predicting effort, previous studies (Bareis et al., 2024; Rieger et al., 2022; Song et al., 2020; Trautwein et al., 2015) found negative interaction effects. These findings support a compensatory pattern, indicating that a high level on one of the predictors may compensate (partly) for a low level on the other predictor. As an explanatory principle, it is assumed that the compensatory effect is the result of the push-pull mechanism underlying the driving effects of conscientiousness and interest (i.e., interest acts as a "pull factor" and conscientiousness acts as a "push factor" toward effort). These assumptions about the interactive relation between interest and conscientiousness in predicting (academic) effort are theorized in the CONIC model (Trautwein et al., 2019; see also Figure 1).

Figure 1

Graphical Visualization of the CONIC Model



Current State of Research

Previous studies tested the CONIC model mostly by specifying regression models in which academic effort was regressed on conscientiousness, interest, and their interaction (i.e., implemented via the product of conscientiousness and interest). The predictions of the CONIC model are empirically supported when positive effects are found for conscientiousness and interest and a negative effect for the Conscientiousness × Interest interaction product term.

Initial evidence for the CONIC model comes from a multi-study paper by Trautwein et al. (2015). They revealed negative interaction effects between conscientiousness and interest in predicting academic effort for five domains and in four independent samples for eight out of ten tested interaction terms. Further, they investigated the generalization of the interaction effect for individual interest as well as situational interest and used between-student analyses as well as within-student analyses.

In subsequent studies, the CONIC model was generalized across different age groups and cultures (Bareis et al., 2024) and in a study that used a longitudinal design (Rieger et al., 2022) as well as extended across several independent (i.e., utility value, overall task value, grit) and dependent variables (i.e., school grades; e.g., Song et al., 2020). For an overview of studies that found (partial) support for the main assumptions of the CONIC model, see Table 1. In summary, the CONIC model could be shown for eight different data sets of high school and university students from German-speaking European countries and from the U.S. It was also found empirical support in a longitudinal study. Additionally, it was tested whether the model also holds when interest was replaced with utility value or overall task-value, when

conscientiousness was replaced with grit; and when predicting academic achievement instead of academic effort.

Results from some studies that did not directly examine the CONIC model are also relevant. Di Domenico and Fournier (2015) conducted another classroom study and investigated intelligence, conscientiousness, and autonomous motivation in predicting undergraduate students' academic achievement. Autonomous motivation is usually closely associated with high interest (e.g., Gillet et al., 2012). Di Domenico and Fournier (2015) found a positive Conscientiousness × Intelligence interaction term indicating that conscientiousness is a stronger predictor of academic achievement for those with higher levels of intelligence. Further, they found a negative Conscientiousness × Autonomous motivation interaction term indicating that conscientiousness is a stronger predictor for academic achievement when intrinsic motivation is low. The latter result aligns with the compensatory effect postulated in the CONIC model.

In an experimental study in a lab setting, Sansone et al. (1999) examined the role of conscientiousness in a boring activity when subjects were given the options of quitting, continuing, or using interest-enhancing strategies. Within their experimental study, all participants were given an open-ended boring task (i.e., copying matrices), and some of them also were given a reason to value the task (i.e., task is useful for developing jobs; in the following called benefit manipulation). They found that individuals high on conscientiousness copied more letters than individuals low on conscientiousness, independent of the experimental benefit manipulation. The finding that individuals with high levels of conscientiousness persisted longer in a boring situation than individuals with low levels of conscientiousness is in line with predictions/assumptions of the CONIC model. At the same time, assuming that the benefit manipulation increases task value (e.g., interest, utility), the finding that the conscientiousness effect was independent of the benefit manipulation is not in line with the assumptions of the CONIC model. However, as there was no direct comparison of the subjective interest rating between the conditions, no definite conclusions can be drawn. Further, Sansone et al. found that using interest-enhancing strategies promoted persistence, especially among those low in conscientiousness, which also supports the assumptions of the CONIC model.

Taken together, the interactive relationship between conscientiousness and interest received substantial empirical support in studies specifically investigating the CONIC model (Bareis et al., 2024; Rieger et al., 2022; Song et al., 2020; Trautwein et al., 2015) as well as related research (Di Domenico & Fournier, 2015; Sansone et al., 1999). All previous studies on

the CONIC model have in common that they exclusively used self-assessments for most of the variables of interest (i.e., interest, conscientiousness, and effort) in the context of observational survey studies. The study by Sansone et al. (1999) illustrated that the compensatory interactive relation proposed by the CONIC model may also manifest in measures of effortful behavior other than self-report (i.e., task persistence) in a lab setting. However, there was no controlled experimental manipulation of interest in this study, and therefore, the study's results do not allow for a broad evaluation of the CONIC model.

Table 1

Overview of Studies Supporting the CONIC Model

Study	Design	Data type	Sample size	Age	Participant pool	Predictors	Domains	Outcomes
Trautwein et al. (2015) – Study 1	Between-person	Cross-sectional survey data	N = 2,557	Grade 8 (M = 14.02 years)	133 classes in 99 non-gymnasium schools in two German states	Conscientiousness, Individual interest	Math, English, German	Domain-specific effort
Trautwein et al. (2015) – Study 2	Between-person	Cross-sectional survey data	N = 415	Grade 8 (M = 13.45 years)	20 classes in 11 gymnasium schools in Berlin, Germany	Conscientiousness, Individual interest	Math, English	Domain-specific effort
Trautwein et al. (2015) – Study 3	Between- and within-person	Cross-sectional survey data	N = 1,025	Grade 7 & 10 (M = 14.29 years)	51 classrooms in six high schools in Berlin, Germany	Conscientiousness, Individual interest	Math, English, German, Biology, second language	Domain-specific effort
Trautwein et al. (2015) – Study 4	Within-person	Cross-sectional survey and diary data	N = 1,530	Grade 8 *(M* = 13.79 years)	89 classrooms in three Swiss cantons	Conscientiousness, Interest Experience	French	Daily effort
Song et al. (2020)	Between-person	Cross-sectional survey data	N = 830	Grades 5 through 12 (M = 13.93 years)	51 classes in two gymnasium schools in Baden-Württemberg, Germany	Conscientiousness, Individual interest, Utility Value	Math, English, German, Biology	Domain-specific effort, Grades
Rieger et al. (2022)	Between-person	Longitudinal survey data	N = 3,880 (pooled data set)	Grade 5 at T1 (M = 11.1 years)	136 classes in 99 non-gymnasium schools in two German states	Conscientiousness, Individual interest	Math, English, German	Domain-specific effort
Bareis et al. (2024)	Between-person	Cross-sectional survey data	N_1 = 1,246; N_2 = 581	N_1: Grade 9 & 10 (M = 14.86); N_2: undergraduate students (M = 19.83)	N_1: one public and six private high schools in the mid-Atlantic region of the United States (U.S.); N_2: one mid-Atlantic university of the U.S.	Conscientiousness, Grit, Individual interests, Utility value, Overall task value	Math, Science	Domain-specific effort, Grades

Note. In addition, results from the studies by Sansone et al. (1999) and Di Domenico and Fournier (2015) are in line with main assumptions of the CONIC model. As these studies were not designed to test the CONIC model, they are not listed here.

Research Questions and Hypotheses

The present study was designed to test the Conscientiousness × Interest Compensation (CONIC) model (Trautwein et al., 2019) across different indicators of effortful behavior using an experimental online setting. Therefore, we created an experiment with two different treatment conditions in which participants were asked to work on an interesting and boring task (for a detailed description of the study design, see below). We then examined to what extent the interestingness of a task moderated the relation between conscientiousness and multiple indicators of effortful behavior.

We preregistered the study design, hypotheses, and the analysis strategy prior to data collection (see https://osf.io/h6vcw/?view_only=a40467715ae849709c3fe18f0cb21bbc).

Overall, the study encompasses three different research questions (RQ). The first set of analyses (i.e., RQ 1) examined whether the experimental treatment (i.e., creating a boring and interesting situation) did work as intended (i.e., higher self-reported interest collected after completing the task in the interesting task than in the boring task) and had the intended effect on the indicators of effortful behavior (i.e., higher in the interesting condition than in the boring condition). The second set of analyses (i.e., RQ 2) examines to what extent the relation between conscientiousness and several indicators of effortful behavior differs when working on an interesting or boring task. According to the CONIC model, we would assume a stronger relation between conscientiousness and effort when working on a boring task, arguing that the "boringness" of a situation makes conscientiousness (more) necessary. However, there are also reasons why the postulated effects might not occur in such an experimental setting. For example, previous studies also indicate that conscientiousness shows its effect, especially in situations with low external control (e.g., homework vs. learning in school, see Trautwein & Lüdtke, 2007). As the degree of external control in experimental settings is inherently high, it would also be plausible that there is no effect of conscientiousness under the study's conditions.

Third (i.e., RQ 3), we examine the data following the regression-based analysis procedure of previous CONIC studies, however, focusing on potential differences between the two experimental conditions. More specifically, we examine the interplay of conscientiousness and a self-reported interest measure (measured before the task was completed; pre-task interest measure) in predicting indicators of effortful behavior (i.e., using multiple regression models with main effects of conscientiousness and interest and the Conscientiousness × Interest interaction).

We assume that the CONIC pattern found in previous observational studies occurs the same way in the present experimental setup (i.e., positive simple slopes of conscientiousness

and interest and a negative coefficient of the Conscientiousness × Interest interaction term). Again, in line with the assumptions of the CONIC model, we hypothesize that conscientiousness has a stronger effect in the boring task (because interest is low and conscientiousness is needed), whereas interest has a stronger effect in the interesting condition (because when interest is high, conscientiousness is "not needed"). However, again due to high external control, it would also be plausible that there is no effect of conscientiousness (see above). Further, it is difficult to predict the effects of interest within two different interesting situations. By designing one task interesting and the other boring, it is plausible that this leads to a homogenization of interest within the situations (i.e., the interesting task is perceived as interesting by everyone, and the boring task is perceived as boring by everyone). This would limit the variance of interest within tasks and may diminish the positive effect of interest postulated in the CONIC model.

Finally, we apply the three analysis approaches (i.e., RQ 1, RQ 2, RQ 3) from a between-person perspective as well as from a within-person perspective. For the between-person perspective, we use only the task presented first. For the within-person perspective, we use data from both tasks (i.e., the interesting and the boring tasks) within the respective condition (i.e., interesting task first or boring task first). More specifically, at the between-person level, we compare the effortful behavior a group of individuals shows on one task with the effortful behavior the other group shows on the other task. At the within-person level, we compare the effortful behavior individuals show on one task with the effortful behavior the same individuals show on the other task (i.e., the task-related effort measures vary within-person). We then investigate to what extent this difference depends on conscientiousness and self-reported interest for the respective task (i.e., the rated interest varies within-person) or their combined effect (i.e., their interaction).

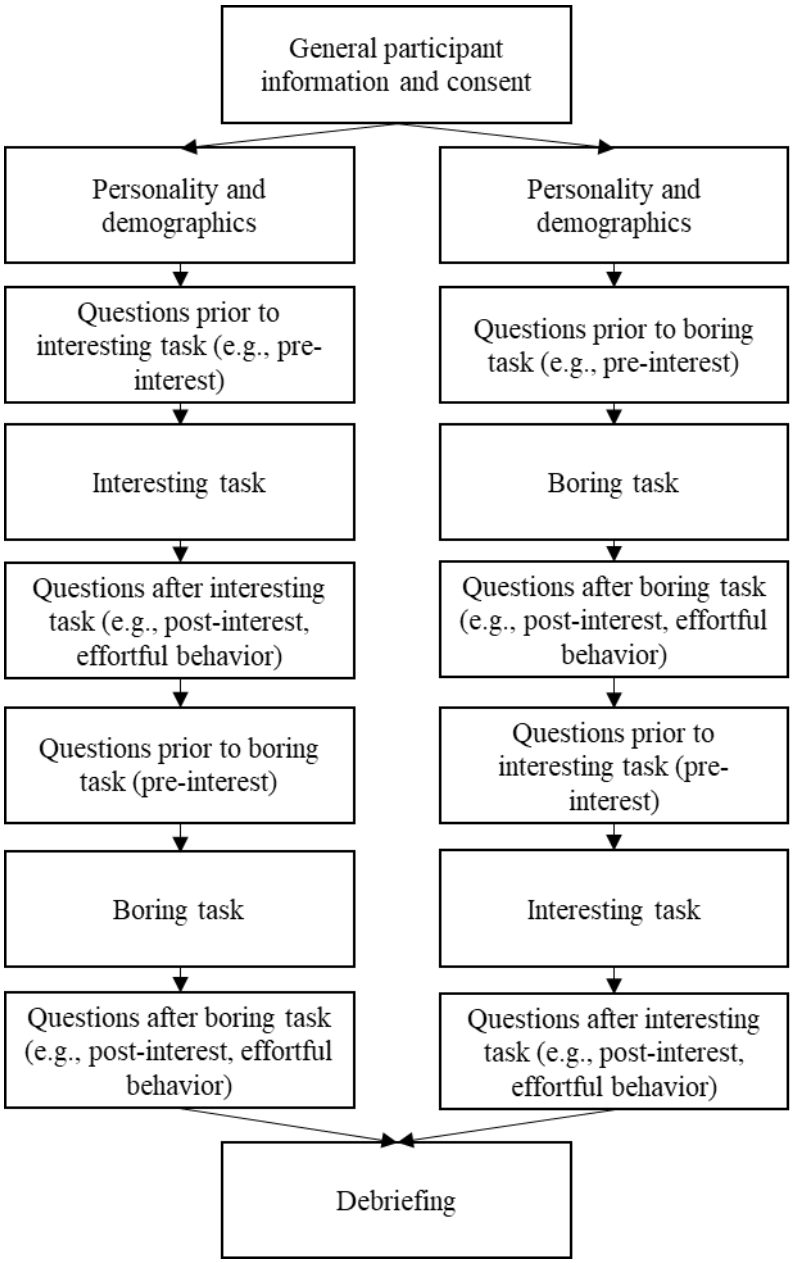
Method

Study Design

The participants were randomly assigned in a one-factor (order of conditions) design with two conditions (boring task first vs. interesting task first; see also Figure 2). We implemented the online experiment through the online platform prolific (https://www.prolific.co/).

Figure 2

General Procedure of the Experiment

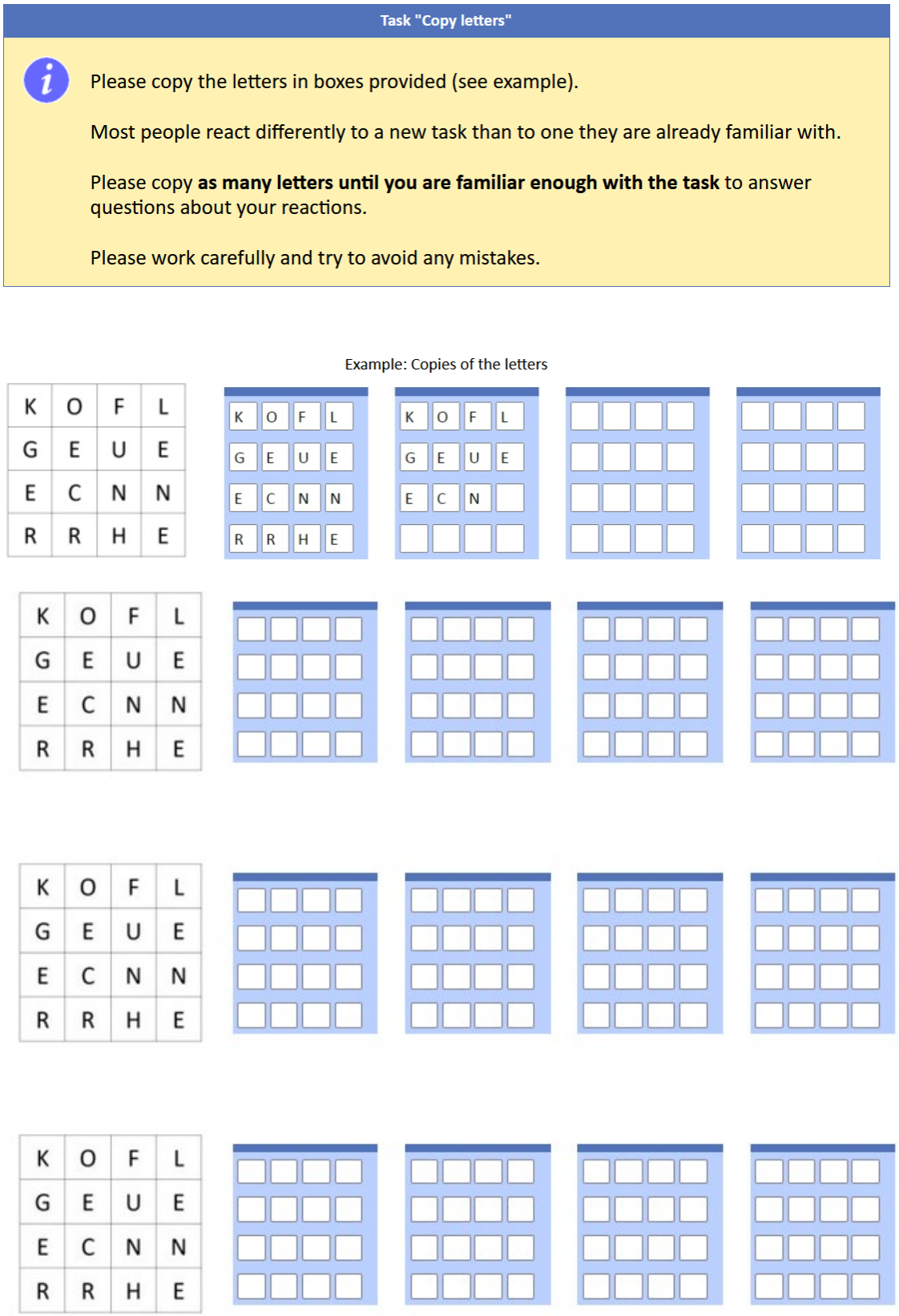


The general study procedure was as follows: First, the participants were asked to answer questions regarding demographic data and their personality (including conscientiousness). In the second step, the participants were presented with a matrix of letters. For the boring task, participants were instructed to type the letters displayed in the matrix in the empty spaces provided next to the matrix (see Figure 3).

For the interesting task, participants were asked to form words with the letters presented and list them in the spaces provided next to the matrix (see Figure 4). For both tasks, there was no set time frame, but the participants were asked to work on the task until they felt familiar enough with the task to answer questions about their reactions. Before and after completing each task, the participants were asked questions about the task (e.g., how interesting they found the task) and their processing (e.g., how much effort they put into it).

Figure 3

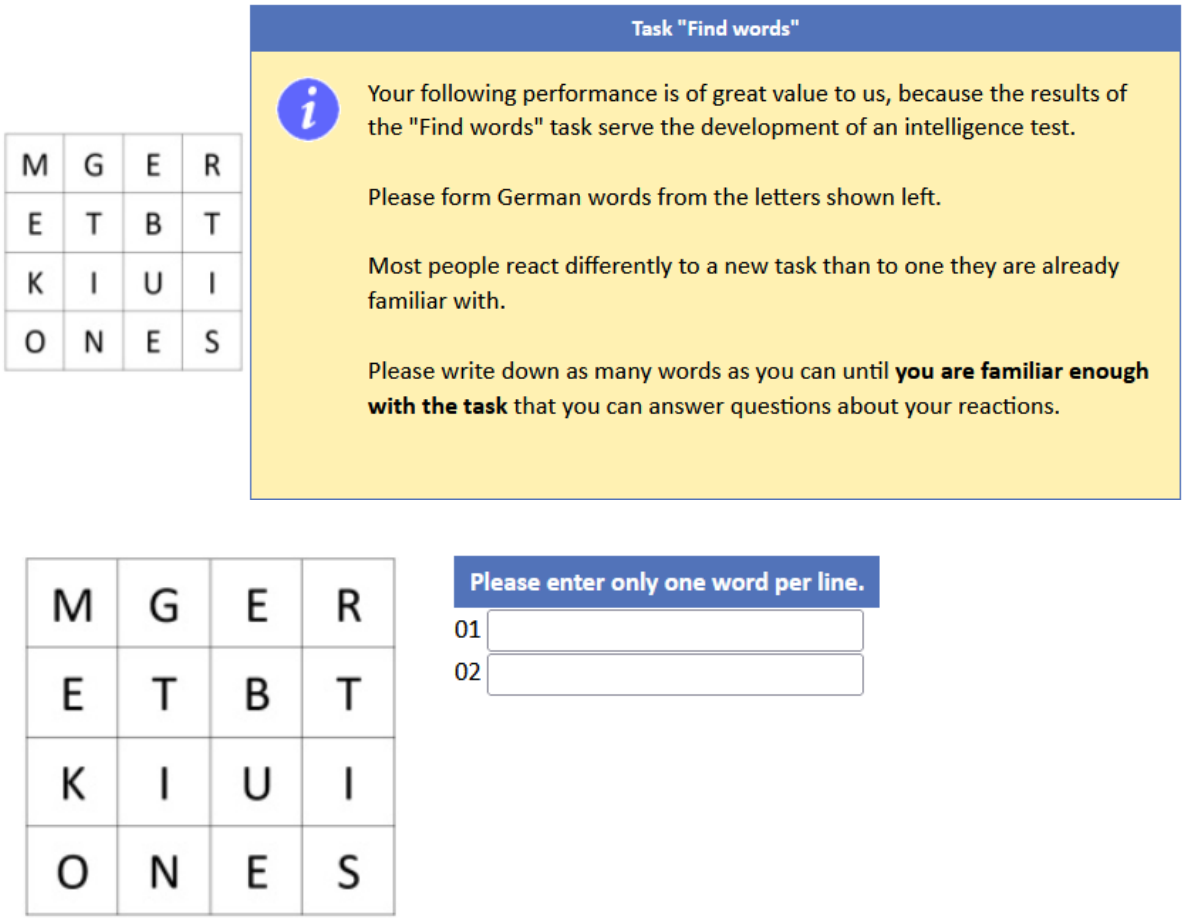
Boring Matrix Task



Note. The original task was presented in German language. This is a translated version.

Figure 4

Interesting Matrix Task



Note. The original task was presented in German language. This is a translated version. More lines (up to 25) appeared when typing in words.

Sample Size Determination

To determine the sample size, we used a Monte Carlo simulation study (see Muthén & Muthén, 2002) as implemented in package SimDesign (Chalmers & Adkins, 2020) in the statistical software R (R Core Team, 2021) before the study was conducted. In short, we generated 840 different data scenarios (simulation conditions) from a population model with hypothesized varying parameter values and varying sample sizes (ranging from n = 250 to n = 2,500). To determine sample size, we used the analysis model to examine Research Question 2 (between-person). We assumed a treatment effect of .4, an effect of the covariate (i.e., conscientiousness) of .3 in the boring condition, and a considerably weaker effect in the interesting condition (i.e., a negative interaction effect of -.15). As a result, the power analysis identified a minimum sample of N = 1,250 participants with alpha at 0.05 and detection rate of .792. For more details on the procedure of the simulation study, see the preregistration.

Sample Characteristics

A total of 1285 participants were recruited from the online platform prolific (https://www.prolific.co/). Prolific is an online platform for recruiting participants that is explicitly aimed at researchers. Participants were paid a fixed amount of £ 2.27. This corresponds to an average hourly wage of £ 8.53 (individual hourly wage depends on the actual time spent on the task). We stopped data collection when prolific counted 1,250 participants who completed the study (i.e., only complete submissions that get paid for participation). As 35 participants dropped out and are therefore not accounted for in prolific's total number of participants, their incomplete data is additionally included. We exclusively recruited participants who stated that their first language is German. We implemented three attention checks in the questionnaires before and after working on the task and excluded all participants who failed any of these controls (n = 41). Therefore, we ended up with a sample of 1182 participants, including 45.35 % male, 52.88 % female, and 1.78 % non-binary participants or participants who preferred not to indicate their gender. They ranged in age from 18 to 72 years, with a mean of 31.02 (SD = 10.47) years. The majority of the participants reported having a university degree (46.53 %) or a high school degree (37.15 %) as the highest educational degree and being currently employed (48.48 %) or studying (36.89 %).

Measures

Item wordings and the number of items for all constructs are presented in Table 2.

Independent Variables

As independent variables, we measured conscientiousness and interest by self-reported measures before and after working on the task.

Conscientiousness. Conscientiousness was assessed by the respective 12 items of the NEO-FFI (Borkenau & Ostendorf, 2008). The internal consistency indicated by Cronbach's alpha (α) for the Conscientiousness scale was α = .86.

Situational interest. Situational interest before the task (i.e., pre-interest) was assessed by the two items: *How interesting do you find this task?* and *How much do you feel you like doing this task?* (slider scale from 1 to 100). Similarly, interest after task completion (i.e., post-interest) was surveyed with the two items: *How interesting did you find this task?* and *How much did you like the task?* (slider scale from 1 to 100). For the pre-interest measure, Cronbach's alpha was α = .77. For the post-interest measure, Cronbach's alpha was α = .78.

Dependent Variables

As dependent variables, we investigated different indicators of effortful behavior. This included a self-rate measure of effort as well as more indirect and behavioral measures of effort.

Self-reported measure. The self-rate measure of effort was assessed by seven items on a rating scale ranging from 1 (= strong disagreement) to 6 (= strong agreement). Cronbach's alpha (α) for the self-reported effort scale was α = .92.

Measures of intended effort. The participants were asked the following questions after completing the tasks: *How many more tasks are you willing to complete?* (response scale ranging from 0 to 4) and *Have you reviewed your solution again?* (response options: 0 = no, 1 = yes, partly and 2 = yes).

Processing time. Moreover, we used the time for processing the task and the time for reviewing the task. Both time measures were provided by the online environment and operationalized by the time spent on the respective pages where the task is performed, or the request to review is made.

Besides the variables presented above, we collected several additional measures irrelevant to the current analyses. More details about these are reported in the preregistration.

Table 2

Overview of the Study's Dependent and Independent Variables

Construct (Instrument)	Number of Items	α	Items (translated)
Independent Variables			
Conscientiousness (NEO-FFI; Borkenau & Ostendorf, 2008)	12	.86	e.g., In everything I do I strive for excellence.
Pre-Interest (own development)	2	.77	How interesting do you find this task? How much do you feel you like doing this task?
Post-Interest (own development)	2	.78	How interesting did you find this task? How much did you like the task?
Dependent Variables			
Self-Reported Effort (adapted version of the TRAIN study; Jonkmann et al. 2013)	7	.92	When working on the task, I was very diligent. When working on the task, I did my best. When working on the task, I wanted to complete the set task as good as possible. When working on the task, I put a lot of effort into it. When working on the task, I was very accurate in everything I did. When working on the task, I did as good a job as I could. When working on the task, I wanted to stay focused until the end.
Effort (own development)	1	-	How many more tasks are you willing to complete?
Effort (own development)	1	-	Did you double check your answer?
Time For Double Checking	-	-	Time in seconds the participants spent to double check the tasks
Time For Processing the Task	-	-	Time in seconds the participants worked on the task

Statistical Analyses

We applied the same three approaches from a between-person perspective as well as from a within-person perspective. For the between-person analyses, we used only the first task, which was presented to the participants. For the within-person analyses, we used both tasks. All models were estimated as path models with the lavaan package (Rosseel, 2012) in the statistical software R (R Core Team, 2021).

Between-Person Analyses

Research Question 1. To test if the indicators of effortful behavior and self-reported interest collected after task completion (post-interest) are higher in the interesting condition than in the boring condition, we estimated the mean and variance of the outcomes within a multiple-group model. We only used information from the task presented first. Hence, the group variable represents the experimental condition (g_0 = boring task [first] and g_1 = interesting task [first]).

The difference in the means was calculated in the model constraint options and tested using a *Z*-test. If the treatment implementation was successful (i.e., created an interesting task), the means of the indicators of effortful behavior measures and post-interest measures should be greater in the interesting than in the boring conditions. To account for the ordinal scaled indicators of effortful behavior (i.e., double-checking and more tasks) we used the WLSMV estimator (mean- and variance-adjusted weighted least squares estimation, Muthén et al., 1997). In WSLMV estimation, the ordinal response is interpreted as a result of an individual's categorization process. Each response category represents a range on a response continuum on the latent level. These ranges are defined by thresholds (Brauer et al., 2023).

Research Question 2. To examine whether the relation between conscientiousness and multiple indicators of effortful behavior differs between conditions, we estimated multiple-group linear regression models with the experimental condition as a grouping variable, conscientiousness as the predictor, and the indicators of effortful behavior as outcomes.

The difference of the regression weights was again calculated in the model constraint options and tested using the Z-test. According to the CONIC model, the associations of conscientiousness and the indicators of effortful behavior should be stronger in the boring task than in the interesting task. This should result in a negative difference in the regression coefficients.

Research Question 3. To examine the typical "CONIC pattern" within the two experimental conditions, we used conscientiousness, the self-reported pre-interest measure,

and their interaction term as predictor variables. Again, we used multiple-group modeling to investigate whether the relations between the variables differ between the two conditions.

To calculate and test the difference of the regression weights, we used the same approach as in RQ 1 and 2 (see above). According to the CONIC model, the associations of conscientiousness and the indicators of effortful behavior should be stronger in the boring task than in the interesting task. Regarding the associations of pre-interest and the interaction with the indicators of effortful behavior, we made no directional predictions and, hence, tested non-directional hypotheses.

Within-Person Analyses

To examine the interplay of conscientiousness and interest in predicting effort at the within-person level, we contrasted the domain generality of conscientiousness and the task specificity of interest (within a person) in predicting indicators of effortful behavior. Therefore, we used information about both tasks from each participant (i.e., the interesting and the boring task) and investigated to what extent conscientiousness and pre-interest for the respective task (i.e., interest varies within-person) or their combined effect explain variation in the different responses (to either the interesting or boring task) of the indicators of effortful behavior. To be more specific, we again used multiple group linear regression models, but this time, the grouping variable was the order of conditions (i.e., which task was presented first, either the interesting or the boring task). By controlling this variable, all analyses are on the within-person level.

Research Question 1. In the first step (to address RQ 1 from the within-person perspective), we introduced the indicator variable, which reflects the task type (interesting vs. boring). This variable contrasts the effort put into (or the post-interest for) the interesting or the boring task within persons. A positive regression coefficient implies that persons show/report higher effort (or post-interest) when working on the interesting than the boring task. If the difference in the regression weights between groups is statistically significant, this indicates that it also matters which task is presented first.

Research Question 2. The analysis steps for RQ 1 were followed by introducing conscientiousness as a predictor variable into the model to examine the extent to which a person's conscientiousness accounts for the effort they put in each task. According to the CONIC model, participants high on conscientiousness show more effortful behavior across both tasks. However, being conscientious is more important in the boring task (independent from the order of the presented task).

Research Question 3. As a next step, the self-reported pre-interest measure and their interaction term as additional predictor variables were included in the model (paralleling the procedure of the between-person analyses). Importantly, we also included all interaction terms with the task type variable in the model to examine whether the coefficients are different when working on the interesting or the boring task.

To what extent self-reported interest is relevant for putting effort into specific tasks is hard to predict as it is still an open question of how interest, as a personal characteristic, acts in an interest-manipulated situation. Therefore, again, we made no directional predictions and, hence, tested non-directional hypotheses.

For all analyses (i.e., RQ 1 to 3 for the between-person and the within-person perspective), we used $p < .05$ as the inference criterion. One-tailed tests were used when we formulated directed hypotheses (e.g., treatment effects). Two-tailed tests were used when we did not formulate directed hypotheses (i.e., the association of pre-interest and indicators of effortful behavior in RQ 2 at the between-person and at the within-person level). We applied the correction to each set of analyses (i.e., different indicators of effortful behavior) within the research questions (i.e., RQ 1 to 3 for the between-person as well as the within-person perspective). For more details on the technical implementation, see the codes on the corresponding OSF project.

Results

Table 2 shows the means, standard deviations, and correlation coefficients separated for the interesting task and the boring task.

We organize the presentation of the results by the underlying research question. For each research question, first, we present the results from the between-person perspective, and second, from the within-person perspective.

Within the two parts, we present all sets of outcomes in turn (i.e., RQ 1 for all indicators of effortful behavior, RQ 2 for all indicators of effortful behavior, then RQ 3 for all indicators of effortful behavior). For the between-person analyses, we use only the data from the task presented first, whereas for the within-person analyses, we use the data from both tasks. To account for the different order in which the tasks were presented, we used the condition (i.e., which task was presented first, either the interesting or the boring task) as the grouping variable and tested for order effects. We report the statistical significance of an effect only when it is present in both conditions.

Table 2

Means, Standard Deviations and Correlation Coefficients between the Variables of the Interesting Task (Above the Diagonal) and the Boring Task (Below the Diagonal)

	Interesting		Boring		Conscientiousness	Pre-Interest	Post-Interest	Self-reported Effort	Double-checking	Double-checking time	Task time	More tasks
	M	*SD*	*M*	*SD*								
Conscientiousness	3.55	0.62	3.57	0.60	-	.10	.08	.21	.03	-.03	.06	.00
Pre-Interest	65.89	23.36	42.89	24.96	.10	-	.75	.44	.11	.15	.14	.30
Post-Interest	63.76	26.71	21.65	21.83	.06	.62	-	.56	.14	.21	.22	.31
Self-reported Effort	4.49	0.89	3.88	1.18	.21	.34	.39	-	.20	.14	.27	.21
Double-checking	1.54	0.74	1.33	0.79	.05	.04	.02	.06	-	.02	.05	.08
Double-checking time	61.65	68.26	43.37	73.01	-.02	.16	.04	.15	-.04	-	.02	.08
Task time	156.81	142.06	161.82	164.58	.02	.11	.20	.41	-.09	.08	-	.05
More tasks	1.82	1.31	1.73	1.39	.02	.29	.32	.30	.04	.02	.11	-

Note. The correlations are calculated only for the task presented first. Interesting task: $N = 643$; boring task: $N = 642$.

Research Question 1

Our first goal was to investigate whether we succeeded in creating an interesting situation and a boring situation (i.e., manipulation check) and to what extent the situation affects the different indicators of effortful behavior (see Tables 3 and 4).

The participants reported statistically significant higher interest after completing the interesting task (between-person analyses: $M = 63.76$, $SD = 26.71$; within-person analyses: $\beta_{1g=1} = 48.75$, $SE = 1.33$, $p < .001$) than after completing the boring task (between-person analyses: $M = 21.65$, $SD = 21.83$; $\Delta_{\alpha} = 42.11$, $SE = 1.38$, $p < .001$; within-person analyses: $\beta_{1g=0} = 36.96$, $SE = 1.43$, $p < .001$). This indicates that the experiment's design worked as intended, as the interestingness of the tasks differs in the expected direction.

Further, from the between- as well as the within-person perspective, participants had statistically significant higher scores in the interesting task on self-reported effort (between: $\Delta_{\alpha} = .57$, $SE = .06$, $p < .001$; within: $\beta_{1g=0} = 0.57$, $SE = 0.05$, $p < .001$; $\beta_{1g=1} = 0.66$, $SE = 0.06$, $p < .001$) as well as double-checking (between: the threshold between not double-checked and partly double-checked: $\Delta_{\tau 01} = -0.17$, $SE = 0.09$, $p = .048$, the threshold between partly double-checked and double-checked: $\Delta_{\tau 12} = -0.41$, $SE = 0.08$, $p < .001$; within: $\beta_{1g=0} = 0.35$, $SE = 0.07$, $p < .001$; $\beta_{1g=1} = 0.31$, $SE = 0.07$, $p < .001$). From the between-person perspective, there were also higher scores for double-checking time ($\Delta_{\alpha} = 0.34$, $SE = 0.06$, $p < .001$) and for the willingness to complete more tasks (i.e., only threshold between 0 tasks and 1 task; $\Delta_{\tau 01} = -0.19$, $SE = 0.09$, $p = .027$). Taken together, these results indicate robust evidence that the higher interestingness of the task caused the participants to report higher effort and to more frequently double-check the task.

Table 3

Comparison of Interest and the Indicators of Effortful Behavior Between the Interesting and the Boring Task From the Between-Person Perspective (Research Question 1)

		Interesting			Boring			Difference		
Variables	Parameter	Est.	*SE*	*p*	Est.	*SE*	*p*	Est.	*SE*	*p*
Self-reported effort	Intercept α	0.28	0.03	<.001	-0.29	0.05	<.001	0.57	.06	<.001
	Residual Variance	0.68	0.04	<.001	1.17	0.06	<.001	-0.55	.08	<.001
Double-checking time	Intercept α	0.17	0.04	<.001	-0.17	0.04	<.001	0.34	0.06	<.001
	Residual Variance	1.14	0.18	<.001	0.79	0.14	<.001	0.37	0.24	.121
Double-checking	Threshold1	-1.02	0.06	<.001	-0.85	0.06	<.001	-0.17	0.09	.048
	Threshold2	-0.49	0.05	<.001	-0.08	0.05	.135	-0.41	0.08	<.001
Task time	Intercept α	-0.04	0.03	.282	0.04	0.05	.452	-0.07	0.06	.220
	Residual Variance	0.64	0.07	<.001	1.37	0.19	<.001	-0.75	0.18	<.001
More tasks	Threshold 1	-1.04	0.06	<.001	-0.85	0.06	<.001	-0.19	0.09	.027
	Threshold 2	-0.03	0.05	.569	0.02	0.05	.678	-0.05	0.07	.487
	Threshold 3	0.67	0.06	<.001	0.68	0.06	<.001	-0.01	0.08	.919
	Threshold 4	0.89	0.06	<.001	0.82	0.06	<.001	0.08	0.08	.367

Note. Est. = Estimate; Residual Variance = Unexplained Variable.

Table 4

Comparison of Interest and the Indicators of Effortful Behavior Between the Interesting and the Boring Task From the Within-Person Perspective (Research Question 1)

		Interesting first			Boring first			Difference		
Variables	Parameter	Est.	*SE*	*p*	Est.	*SE*	*p*	Est.	*SE*	*p*
Self-reported effort	Treatment	0.66	0.06	<.001	0.57	0.05	<.001	0.09	0.08	.254
	Intercept α	-0.37	0.05	<.001	-0.24	0.04	<.001	-0.12	0.06	.054
	Residual variance	0.96	0.04	<.001	0.85	0.04	<.001	0.13	0.06	.023
Double-checking time	Treatment	0.80	0.06	<.001	-0.26	0.05	<.001	1.05	0.08	<.001
	Intercept α	-0.33	0.02	<.001	0.06	0.05	.217	-0.38	0.05	<.001
	Residual variance	0.99	0.14	<.001	0.82	0.11	<.001	0.19	0.19	.323
Double-checking	Treatment	0.31	0.07	<.001	0.35	0.07	<.001	-0.04	0.10	.699
	Threshold 1	-0.67	0.05	<.001	-0.76	0.06	<.001	0.09	0.08	.270
	Threshold 2	-0.19	0.05	<.001	-0.13	0.05	.012	-0.06	0.07	.421
Task time	Treatment	-0.28	0.06	<.001	0.06	0.05	.313	-0.33	0.08	<.001
	Intercept α	0.16	0.05	.003	-0.05	0.04	.229	0.21	0.07	.002
	Residual variance	1.12	0.16	<.001	0.85	0.08	<.001	0.28	0.17	.102
More tasks	Treatment	1.37	0.07	<.001	-0.30	0.06	<.001	1.68	0.09	<.001
	Threshold 1	0.48	0.05	<.001	-0.86	0.05	<.001	1.34	0.07	<.001
	Threshold 2	1.34	0.06	<.001	0.06	0.05	.185	1.28	0.07	<.001
	Threshold 3	1.95	0.06	<.001	0.64	0.05	<.001	1.30	0.08	<.001
	Threshold 4	2.15	0.06	<.001	0.79	0.05	<.001	1.36	0.08	<.001

Note. Est. = Estimate; Residual Variance = Unexplained Variable.

Research Question 2

For RQ 2, our assumption was that conscientiousness is a significant predictor of the indicators of effortful behavior across both tasks but that the relation is stronger when working on the boring task (see Tables 5 and 6). First, conscientiousness was revealed to be a statistically significant predictor of self-reported effort on the interesting task (between: β1g=1 = .18, *SE* = .03, $p < .001$; within: β1g=1= .16, *SE* = .05, $p = .001$) and on the boring task (between: β1g=0 = .25, *SE* = .05, $p < .001$; within: β1g=0 = .24, *SE* = .04, $p < .001$) as well as from the between-person perspective whether participants double-checked the boring task (β1g=0 = .08, *SE* = .05, $p = .090$). The other indicators of effortful behavior did not show a statistically significant positive relation with conscientiousness. The examination of whether the relation between conscientiousness and multiple indicators of effortful behavior differed

between conditions revealed no statistically significant differences for any of the indicators (see Table 4). This suggests that conscientiousness does not have a stronger effect on the boring condition, as postulated by our hypothesis.

Table 5

Comparison of the Predictive Value of Conscientiousness Between the Interesting and the Boring Task From the Between-Person Perspective (Research Question 2)

		Interesting			Boring			Difference		
Variables	Parameter	Est.	*SE*	*p*	Est.	*SE*	*p*	Est.	*SE*	*p*
Self-reported effort	Consc.	.18	.03	<.001	.25	.05	<.001	-.08	.06	.165
	Intercept α	.28	.03	<.001	-.29	.04	<.001	.57	.06	<.001
	Residual Variance	0.65	0.04	<.001	1.11	0.06	<.001	-0.54	0.09	<.001
Double-checking time	Consc.	-.03	.04	.368	-.04	.04	.301	.01	.06	.881
	Intercept α	0.17	0.04	<.001	-0.17	0.04	<.001	0.34	0.06	<.001
	Residual Variance	1.14	0.18	<.001	0.79	0.14	<.001	0.37	0.24	.118
Double-checking	Consc.	0.03	0.05	.554	0.08	0.05	.090	-0.05	0.07	.474
	Threshold 1	-1.02	0.06	<.001	-0.85	0.06	<.001	-0.17	0.09	.047
	Threshold 2	-0.49	0.05	<.001	-0.08	0.05	.140	-0.41	0.07	<.001
Task time	Consc.	.03	.03	.350	.03	.05	.507	-.01	.06	.938
	Intercept α	-0.04	0.03	.288	0.04	0.05	.457	-0.07	0.06	.226
	Residual Variance	0.64	0.07	<.001	1.36	0.19	<.001	-0.75	0.18	<.001
More tasks	Consc.	-.01	.04	.776	.03	.04	.511	-.04	.06	.500
	Threshold 1	-1.04	0.06	<.001	-0.85	0.06	<.001	-0.19	0.09	.027
	Threshold 2	-0.03	0.05	.570	0.02	0.05	.673	-0.05	0.07	.485
	Threshold 3	0.67	0.06	<.001	0.68	0.06	<.001	-0.01	0.08	.917
	Threshold 4	0.89	0.06	<.001	0.82	0.06	<.001	0.08	0.08	.369

Note. Consc. = Conscientiousness.

Table 6

Comparison of the Predictive Value of Conscientiousness Between the Interesting and the Boring Task From the Within-Person Perspective (Research Question 2)

		Interesting first			Boring first			Difference		
Variables	Parameter	Est.	*SE*	*p*	Est.	*SE*	*p*	Est.	*SE*	*p*
Self-reported effort	Treatment	0.66	0.06	<.001	0.57	.05	<.001	0.09	0.08	.251
	Consc.	.16	.05	.001	.24	.04	<.001	-.08	.06	.209
	Treatment × Consc.	.01	.06	.887	-.09	.05	.114	.09	.08	.235
	Intercept β	-.36	.05	<.001	-.25	.04	<.001	-.12	.06	.061
	Residual variance	0.94	0.04	<.001	0.81	0.04	<.001	0.15	0.06	.012
Double-checking time	Treatment	0.80	0.06	<.001	-0.26	0.05	<.001	1.05	.08	<.001
	Consc.	.03	.02	.091	-.05	.05	.301	.08	.05	.132
	Treatment × Consc.	-.07	.05	.158	.05	.06	.353	-.12	.08	.105
	Intercept β	-0.33	0.02	<.001	0.06	0.05	.212	-0.38	0.05	<.001
	Residual variance	0.99	0.14	<.001	0.82	0.11	<.001	0.19	0.19	.321
Double-checking	Treatment	0.31	0.07	<.001	0.35	0.07	<.001	-0.04	0.10	.671
	Consc.	.14	.05	.003	.08	.05	.122	.06	.07	.371
	Treatment × Consc.	-.11	.07	.124	-.10	.07	.178	-.01	.10	.920
	Threshold1	-0.68	0.05	<.001	-0.76	0.06	<.001	0.08	0.08	.305
	Threshold2	-0.19	0.05	<.001	-0.13	0.05	.013	-0.06	0.07	.389
Task time	Treatment	-0.28	0.06	<.001	0.06	0.05	.302	-0.33	.08	<.001
	Consc.	.04	.05	.435	.03	.05	.507	.01	.07	.898
	Treatment × Consc.	-.01	.06	.822	-.09	.06	.097	.08	.08	.317
	Intercept β	.16	.05	.003	-.05	.04	.225	.21	.07	.002
	Residual variance	1.12	0.16	<.001	0.85	0.08	<.001	0.28	0.17	0.101
More tasks	Treatment	1.38	0.07	<.001	-0.30	0.06	<.001	1.68	0.09	<.001
	Consc.	.05	.04	.253	.03	.05	.510	.02	.06	.749
	Treatment × Consc.	-.06	.06	.345	-.01	.06	.940	-.05	.09	.541
	Threshold 1	0.48	.05	<.001	-.86	.05	<.001	1.34	.07	<.001
	Threshold 2	1.34	.06	<.001	0.07	.05	.180	1.28	.07	<.001
	Threshold 3	1.95	.06	<.001	0.64	.05	<.001	1.30	.08	<.001
	Threshold 4	2.15	.06	<.001	0.79	.05	<.001	1.36	.08	<.001

Note. Consc. = Conscientiousness.

Research Question 3

For RQ 3, the "CONIC pattern" (i.e., positive main effects of conscientiousness and interest and negative interaction effects) was investigated by including conscientiousness, interest, and their interaction term as predictors for the different indicators of effortful behavior (see Table 7 and 8). Conscientiousness was a statistically significant predictor only for self-reported effort in both tasks (between: $\beta_{1g=0} = .21$, $SE = .05$, $p < .001$; $\beta_{1g=1} = .15$, $SE = .04$, $p < .001$; within: $\beta_{1g=0} = .20$, $SE = 0.04$, $p < .001$; $\beta_{1g=1} = .14$, $SE = 0.05$, $p = .004$), but not for the other indicators of effortful behavior. Interest revealed to be a statistically significant predictor for all indicators of effortful behavior except for double-checking (the boring task) [between: self-reported effort ($\beta_{2g=0} = .39$, $SE = .05$, $p < .001$; $\beta_{2g=1} = .41$, $SE = .04$, $p < .001$), time to double-check the task ($\beta_{2g=0} = .19$, $SE = .05$, $p < .001$; $\beta_{2g=1} = .19$, $SE = .05$, $p < .001$), task time ($\beta_{2g=0} = .18$, $SE = .06$, $p = .003$; $\beta_{2g=1} = .13$, $SE = .03$, $p < .001$), willingness to complete more tasks ($\beta_{2g=0} = .36$, $SE = .04$, $p < .001$; $\beta_{2g=1} = .39$, $SE = .04$, $p < .001$), double-checking the interesting task ($\beta_{2g=1} = .16$, $SE = .06$, $p = .006$); within: self-reported effort ($\beta_{2g=0} = .37$, $SE = .04$, $p < .001$; $\beta_{2g=1} = .42$, $SE = .05$, $p < .001$), time for double-checking ($\beta_{2g=0} = .23$, $SE = .06$, $p < .001$; $\beta_{1g=1} = .10$, $SE = .03$, $p = .003$), processing time ($\beta_{2g=0} = .16$, $SE = .06$, $p = .003$; $\beta_{2g=1} = .31$, $SE = .07$, $p < .001$), willingness to complete more tasks ($\beta_{2g=0} = .39$, $SE = .05$, $p < .001$; $\beta_{2g=1} = .40$, $SE = .05$, $p < .001$)]. There was one statistically significant negative effect of the Conscientiousness × Interest interaction term ($\beta_{3g=1} = -.09$, $SE = .04$, $p = .034$) for predicting the willingness to complete more interesting tasks from the between-person perspective. The other interaction terms were not statistically significant. In summary, the results do not show the typical CONIC pattern.

Table 7

Investigation of the CONIC Pattern in an Interesting and a Boring Task From the Between-Person Perspective (Research Question 3)

		Interesting			Boring			Difference		
Variables	Parameter	Est.	*SE*	*p*	Est.	*SE*	*p*	Est.	*SE*	*p*
Self-reported effort	Consc.	.15	.04	<.001	.21	.05	<.001	-.06	.06	.281
	Interest	.41	.04	<.001	.39	.05	<.001	.01	.06	.827
	Consc. × Interest	-.03	.04	.469	.01	.04	.909	-.03	.06	.571
	Intercept β	.11	.04	.005	-.10	.04	.017	.21	.06	<.001
	Residual Variance	0.53	0.04	<.001	0.96	0.06	<.001	-0.61	0.09	<.001
Double-checking time	Consc.	-.03	.04	.391	-.06	.06	.281	.03	.07	.691
	Interest	.19	.05	<.001	.19	.05	<.001	.00	.07	.963
	Consc. × Interest	-.04	.05	.377	.00	.06	.966	-.04	.07	.567
	Intercept β	0.09	0.04	.027	-0.08	0.05	.105	0.18	0.07	.008
	Residual Variance	1.11	0.17	<.001	0.77	0.13	<.001	0.37	0.23	.107
Double-checking	Consc.	.03	.06	.667	.05	.05	.342	-.02	.08	.774
	Interest	.16	.06	.006	.04	.05	.435	.12	.08	.120
	Consc. × Interest	-.02	.06	.717	-.07	.05	.125	.05	.08	.535
	Threshold 1	-0.96	0.07	<.001	-0.87	0.06	<.001	-0.09	0.09	.363
	Threshold 2	-0.42	0.06	<.001	-0.10	0.06	.078	-0.32	0.08	<.001
Task time	Consc.	.03	.03	.371	-.02	.07	.804	.05	.08	.559
	Interest	.13	.03	<.001	.18	.06	.003	-.05	.07	.451
	Consc. × Interest	-.03	.03	.422	-.07	.07	.272	.05	.07	.504
	Intercept β	-0.09	0.03	.007	0.13	0.06	.031	-0.22	0.07	.002
	Residual Variance	0.63	0.07	<.001	1.34	0.18	<.001	-0.75	0.18	<.001
More tasks	Consc.	-.01	.04	.896	-.03	.05	.487	.03	.06	.686
	Interest	.39	.04	<.001	.36	.04	<.001	.02	.06	.679
	Consc. × Interest	-.09	.04	.034	-.04	.04	.256	-.05	.06	.429
	Threshold 1	-0.89	0.07	<.001	-1.04	.06	<.001	0.15	.09	.096
	Threshold 2	0.12	0.05	.021	-0.16	.05	.003	0.28	.08	<.001
	Threshold 3	0.83	0.06	<.001	0.51	.06	<.001	0.32	.08	<.001
	Threshold 4	1.05	.06	<.001	0.64	.06	<.001	0.41	.09	<.001

Note. Consc. = Conscientiousness.

Table 8

Investigation of the CONIC Pattern in an Interesting and a Boring Task From the Within-Person Perspective (Research Question 3)

		Interesting first			Boring first			Difference		
Variables	Parameter	Est.	*SE*	*p*	Est.	*SE*	*p*	Est.	*SE*	*p*
Self-reported effort	Treatment	.19	.07	.004	.39	.05	<.001	-.20	.08	.018
	Consc.	.14	.05	.004	.20	.04	<.001	-.06	.06	.373
	Interest	.42	.05	<.001	.37	.04	<.001	.05	.07	.458
	Consc. × Interest	-.01	.05	.823	.00	.04	.909	-.02	.06	.807
	Treatment × Consc.	.00	.06	.961	-.08	.05	.153	.08	.08	.337
	Treatment × Interest	-.04	.06	.568	-.06	.06	.325	.02	.09	.818
	Treatment × Consc. × Interest	-.02	.06	.796	-.03	.05	.557	.02	.08	.838
	Intercept	-.13	.05	.017	-.13	.04	.001	.00	.07	.970
	Residual variance	0.81	0.03	<.001	0.69	0.03	<.001	0.16	0.06	.008
Double-checking time	Treatment	.62	.06	<.001	-.34	.06	<.001	.96	.09	<.001
	Consc.	.03	.02	.194	-.07	.06	.217	.10	.06	.107
	Interest	.10	.03	.003	.23	.06	<.001	-.14	.07	.050
	Consc. × Interest	.02	.02	.454	.00	.07	.966	.01	.07	.863
	Treatment × Consc.	-.06	.06	.263	.08	.07	.246	-.14	.09	.108
	Treatment × Interest	.14	.07	.041	-.13	.07	.058	.27	.10	.005
	Treatment × Consc. × Interest	-.06	.06	.274	-.06	.08	.440	-.00	.10	.975
	Intercept	-.28	.04	<.001	.13	.06	.022	-.41	.07	<.001
	Residual variance	0.95	0.13	<.001	0.80	0.10	<.001	0.17	0.19	.357
Double-checking	Treatment	0.16	0.09	.057	0.32	0.08	<.001	-0.16	0.11	.155
	Consc.	.15	.06	.013	.07	.05	.221	.09	.08	.289
	Interest	.11	.05	.041	.04	.05	.517	.08	.08	.323
	Consc. × Interest	.02	.05	.713	-.05	.05	.359	.07	.08	.368
	Treatment × Consc.	-.13	.09	.151	-.09	.08	.224	-.03	.12	.776
	Treatment × Interest	.05	.08	.547	.07	.08	.404	-.02	.11	.892

Table 8

Investigation of the CONIC Pattern in an Interesting and a Boring Task From the Within-Person Perspective (Research Question 3)

		Interesting first			Boring first			Difference		
Variables	Parameter	Est.	*SE*	*p*	Est.	*SE*	*p*	Est.	*SE*	*p*
	Treatment × Consc. × Interest	-.03	.08	.681	.05	.08	.528	-.08	.11	.464
	Threshold 1	-0.75	0.06	<.001	-0.78	0.06	<.001	0.03	0.09	.743
	Threshold 2	-0.25	0.06	<.001	-0.14	0.06	.009	-0.11	0.08	.187
Task time	Treatment	-.53	.08	<.001	-.04	.06	.553	-.49	.10	<.001
	Consc.	.00	.07	.999	-.01	.06	.935	.01	.09	.960
	Interest	.31	.07	<.001	.16	.06	.003	.15	.09	.096
	Consc. × Interest	-.05	.07	.445	-.07	.06	.272	.01	.09	.889
	Treatment × Consc.	.03	.08	.721	-.07	.06	.277	.01	.10	.335
	Treatment × Interest	-.20	.08	.011	-.00	.07	.974	-.20	.10	.052
	Treatment × Consc. × Interest	.03	.08	.676	.04	.07	.558	-.01	.10	.931
	Intercept	0.34	0.08	<.001	0.01	0.05	.869	0.34	0.09	<.001
	Residual variance	1.08	0.15	<.001	0.83	.08	<.001	0.26	.17	.116
More tasks	Treatment	1.02	.08	<.001	-0.55	.07	<.001	1.57	.10	<.001
	Consc.	.06	.05	.250	-.03	.05	.574	.08	.07	.227
	Interest	.40	.05	<.001	.39	.05	<.001	.01	.07	.866
	Consc. × Interest	.05	.05	.342	-.05	.05	.266	.10	.07	.144
	Treatment × Consc.	-.04	.07	.549	.04	.07	.537	-.09	.10	.390
	Treatment × Interest	-.02	.07	.774	.09	.07	.220	-.11	.10	.294
	Treatment × Consc. × Interest	-.14	.07	.059	-.09	.07	.183	-.05	.10	.653
	Threshold 1	0.27	.06	<.001	-1.07	.06	<.001	1.34	.08	<.001
	Threshold 2	1.20	.06	<.001	-0.05	.05	.348	1.25	.08	<.001
	Threshold 3	1.84	.06	<.001	0.57	.06	<.001	1.26	.08	<.001
	Threshold 4	2.06	.06	<.001	0.72	.06	<.001	1.33	.09	<.001

Note. Consc. = Conscientiousness.

Discussion

In the present study, we investigated the CONIC model in an experimental setting using different indicators of effortful behavior. It can be concluded that the experimental treatment to manipulate the interestingness of a task was effective. Further, the variation of the situation created by this experimental treatment had significant effects on the effort assessed by different indicators using self-report as well as behavioral measures. In short words, task interestingness predicts different measures of effort. This also applies to conscientiousness for the self-reported effort measure (as well as partly for double-checking and double-checking time). However, this is not true for the other indicators of effortful behavior. Moreover, there is no statistically significant difference in terms of a stronger relationship between the various effort measures and conscientiousness for the boring task, which would be consistent with the assumptions of the CONIC model. Further, the "CONIC pattern" could not be revealed for any of the indicators of effortful behavior: again, conscientiousness only showed a positive main effect for self-reported effort, and there was only one negative interaction effect for the willingness to complete more tasks (only between-perspective). A clear conclusion can be drawn regarding the question, open to us in advance, of how self-reported interest behaves in an experimentally manipulated situation of varying interest. It can be stated that self-reported interest showed a robust predictor for all outcomes in nearly all tasks. These were independent of the interestingness of the task, except for the time measures from the within-person perspective. Subsuming the results cannot confirm the assumptions of the CONIC model, the predictive value of conscientiousness in the present setting is very limited, and there is a strong divergence between self-reported effort and more behavioral indicators of effortful behavior. Each of these findings is discussed in detail below.

Implications for the CONIC Model

The principal aim of the present study was to test the CONIC model in an experimental setting and thus contribute to the empirical validation process of the young model. We chose the experimental design as it is often considered the "gold standard" for examining causal relations and includes high internal validity. In contrast, previous observational studies have held high external validity. However, the experiment's results do not confirm the assumptions of the CONIC model. With respect to the inferences that can be drawn from the results, two essentially different approaches can be distinguished. One would be to prioritize the experiment's results and to state that only experiments allow meaningful causal inferences, and therefore, the present study's results should be preferred. As a consequence, the CONIC model

would be discarded because replication failed in the experimental setting. Contradicting to this, some methodologists urge against overestimating experiments and underestimating their shortcomings. They argue that experiments can also be unable to capture the mechanisms responsible for an effect or to reproduce the strength of an effect in everyday natural settings (e.g., Diener et al., 2022). This reasoning favors the second approach, which is not about automatically inferring the invalidity of theoretical assumptions from results that do not meet expectations, but about defining boundary conditions. However, what boundary conditions do the present results point to? A simple answer to this would be to state that the CONIC model does not hold in the experimental setting, and therefore, this is a boundary. To answer the question of boundary conditions systematically, one can refer to Cook and Campbell's (1979) and Cronbach's (1982) division of different *sampling particulars* to describe the variation of studies in relation to different elements. They distinguish between treatments (i.e., different study designs), settings (i.e., different contexts), units (i.e., different samples), and outcomes (i.e., different measures). The most prominent dissimilarity between the present study and previous studies is the treatment (i.e., experimental design vs. observational classroom studies). Associated with this, the main differences are the high degree of external control in the experimental design, the low-stakes outcomes, and the significantly shorter time span covered. These factors, in turn, limit the predictive value of conscientiousness. Previous studies have shown that autonomy moderates the relationship between conscientiousness and performance indicators (e.g., Barrick & Mount, 1993; Trautwein & Lüdtke, 2007). In the present study, this was addressed by not specifying the processing time in advance. However, it is, of course, in the nature of an experiment that most of the elements (instructions, environment, etc.) are predetermined and therefore controlled. Further, in contrast to the natural school setting, which may have a great impact on the future of a student, spending effort in an online experiment has no personal relevance, which also may diminish the conscientiousness effect. In addition, the experiment is also much shorter in time and may, therefore instead, test the maximum performance in the sense of "I'm going to try hard now". In contrast, the outcomes at school rather refer to the typical performance in the sense of "I'm basically trying hard", whereby conscientiousness shows its full effect, especially in the latter case. These reasons for the findings relate in particular to conscientiousness but, of course, also apply to the CONIC-specific results, given that conscientiousness is a key determinant here. However, the other *sampling particulars* may also contribute explaining the findings. As for the setting, the online setting is both very anonymous and involves many other (more personally meaningful) distractions, which could also contribute to the diminishment of the conscientiousness effect.

In addition, there is a fixed payment as an external source of drive, which could also influence the internal driving pattern. Regarding units, the CONIC model has never been tested for adults. In adulthood, conscientiousness is generally higher and more mature, in the sense that one may be more aware of when an effort is worthwhile, which could also amplify the reducing effects on conscientiousness mentioned above. Further, the educational status of most of the participants is high, which implies also that the majority exhibit some degree of conscientiousness, so that limited variance may be another reason limiting the conscientiousness effect. As for the outcomes, the results for self-reported effort and the other measures diverge very strongly. Here, the question arises whether this represents a boundary condition of the CONIC model. The correlation pattern with (almost) exclusively low correlations makes it doubtful that the same construct is underlying. What is the "true" effort and which measures are more relevant? It can be stated that the data do not suggest a preference for non-self-reported measures, as these are also uncorrelated. Instead, there are only significant correlations between self-reported effort and some other (more behavioral) measures. This might suggest that how each person shows effort on a behavioral level is highly individualized and depends on, for example, different individual strategies and approaches. However, further research is needed to determine the relationship between the various measures and to investigate shared method variance between the different self-report measures. Moreover, further research is also required to determine the exact implications of the overall results on the CONIC model. Depending on the perspective on the results, the next steps on the future research agenda will vary. If experimental results are preferred, the present study's results should be replicated to confirm them. If the goal is to determine the exact boundary conditions, further studies should be conducted to generalize across a) a different experimental treatment (e.g., quasi-experimental), b) a different setting (e.g., no online recruitment platform, but conducting the experiment in a classroom), and c) the adult age group by conducting observational studies.

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6 STUDY 4

INTEREST IS A STRONGER PREDICTOR THAN CONSCIENTIOUSNESS FOR TEACHERS' INTENSITY IN ENGAGING IN PROFESSIONAL DEVELOPMENT

Bareis, A., Fütterer, T., Spengler, M., Trautwein, M., Nagengast, B., Krammer, G., Boxhofer, E., Nausner, E., Pflanzl, B., & Mayr, J. (2024). *Interest is a stronger predictor than conscientiousness for teachers' intensity in engaging in professional development.* Manuscript submitted for publication.

This study's analysis plan was preregistered with OSF (for more details see https://osf.io/yn54q/?view_only=e1fc6cd748cc462abd00a33032835947).

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Abstract

The constantly changing demands teachers face in their professional life increase the importance of continuous in-service professional development (PD) activities. To create tailored calls to action and conditions that facilitate participation in PD, it is important to understand how teacher characteristics (e.g., personality, motivation) and teachers' PD activities are related. The present study is the first that jointly examines conscientiousness (as a personality trait), interest (as a motivational construct), and their interaction in predicting teachers' PD intensity. According to the Conscientiousness × Interest Compensation (CONIC) model (Trautwein et al., 2019), both conscientiousness and interest are factors that drive effort-related activities and represent different self-regulatory pathways. Data from the TEDCA study (Teachers' Education, Development and Career in Austria) were analyzed both cross-sectionally ($N_1 = 869$) and longitudinally ($N_2 = 143$) using latent variable modelling. Cross-sectional results revealed that interest was a statistically significant predictor of teachers' PD intensity, whereas conscientiousness was not. Longitudinal results also indicated mostly positive relations between interest and PD intensity, but only statistically significant for one interest measure, whereas no or negative relations were revealed between conscientiousness and PD intensity. Conscientiousness and interest had no compensatory effect in predicting PD intensity. These results extend the previous evidence base by suggesting that teachers' PD intensity is more interest-driven rather than conscientiousness-driven.

Keywords: CONIC, interest, conscientiousness, teacher professional development

Interest is a Stronger Predictor Than Conscientiousness for Teachers' Intensity in Engaging in Professional Development

Teachers need to be well prepared to adequately meet the complex and constantly changing demands they face in their classrooms. Therefore, continuous in-service teacher professional development (PD) has become internationally and increasingly recognized as an important topic of scientific and educational policy interest (Wei et al., 2009, 2017; OECD, 2019). Various stakeholders argue that not enough teachers engage in PD on a regular basis across their professional career (OECD, 2009), and policies seem to have a limited potential to stimulate PD (Kuschel et al., 2020). Thus, it is important to understand teachers' individual PD behavior as well as related drivers of and barriers to participation (Fütterer, Hübner, et al., 2023).

Studies examining psychological constructs that contribute to interindividual differences in teachers' PD behavior are scarce. The few studies taking psychological constructs into account in the context of teachers' PD behavior were often related to motivational psychology, for example, personal interest or self-efficacy (Kao et al., 2011; Richter et al., 2019; Zhang et al., 2021). Other teacher characteristics such as personality traits (e.g., conscientiousness) have largely been neglected in research regarding teachers' PD behavior. This is surprising given the fact that personality traits and especially conscientiousness as one of the Five-Factor model's personality traits (e.g., McCrae & Costa, 1985) predict many important work and effort-related outcomes such as occupational success, academic achievement, or effort (De Raad & Schouwenburg, 1996; Mammadov, 2022).

The present study addresses this gap by examining the relationship between conscientiousness and PD intensity as well as between interest and PD intensity, both cross-sectionally and longitudinally. Further, we investigate the interplay of conscientiousness and interest in the prediction of teachers' PD intensity. Specifically, we apply the integrative Conscientiousness × Interest Compensation (CONIC) model (Trautwein et al., 2019) as a theoretical framework, which has successfully been applied to predict effortful behavior in students. We will introduce the constructs as well as the CONIC model followed by a description of the teacher education system in Austria.

Teachers' Interest and Their Professional Development Activity

Interest refers to positive evaluative orientations towards specific activities or activity domains which can become relatively stable over time (see Hidi & Renninger, 2006) and lead

individuals to engage in certain activities (Ainley et al., 2002). When individuals engage in activities they are interested in, they show positive affect and persistence. Thus, interest usually results in increased effort for such activities (Trautwein et al., 2015). Interest has similarities to the construct of intrinsic value as described in expectancy-value theory and is conceptualized as a motivational construct (e.g., Eccles & Wigfield, 2020). A distinctive characteristic of interest is that it always refers to a specific domain (e.g., a topic or an activity).

Interest has a positive relation with many work-related outcomes such as job performance (Nye et al., 2017), job persistence (Van Iddekinge et al., 2011), and job satisfaction (Hoff et al., 2020).

Most of the previous studies on interest and teacher PD focused on interest as a single construct whereas a systematic distinction between the specific domains to which interest refers is lacking. However, studies on the relation between different interests and success or well-being in the teaching profession indicate a stronger positive relation with more specific interests than broader interests (Mayr, 2014). In the following presentation of previous findings on the relation of interest and teachers' PD, we have differentiated and specified the different interests according to their object of reference.

Teachers' interest in their subject is positively associated with their PD behavior (Peschel & Koch, 2014). The findings of Gorozidis and Papaioannou (2014) suggest that teachers with interest in a specific PD have higher intentions to participate in a similar future PD. McMillan and colleagues (2016) revealed interest in the topic of PD as one of the most important reasons for participation in PD. Richter et al. (2019) investigated if a high personal interest in PD is associated with the uptake of at least one PD course in the last year. The authors focused on PD in general as well as PD in the domains of subject matter knowledge, pedagogical competencies, and school management. Results indicated a positive association between interest in PD and the uptake of courses to improve subject matter knowledge, but not for participation in the other domains or general participation in PD. Karabenick and Conley (2011) reported that teachers with more positive emotions about teaching (which can be considered an indicator of interest in teaching) were more motivated to participate in PD. Finally, Fütterer et al. (2023) found that teachers who considered technology more useful for teaching showed a higher intention to participate in technology-related PD.

Taken together, these empirical findings indicate that interest in the subject taught, interest in the PD topic, interest in PD, and interest in teaching are positively related to participation in PD.

Teachers' Conscientiousness and Their Professional Development Activity

Personality traits are typically conceptualized as relatively enduring, habitual patterns of feelings, behaviors, and thoughts that are relatively consistent across relevant situations (John & Srivastava, 1999). The Five-Factor model (FFM), the most widely used model of personality (Noftle & Robins, 2007), posits five personality traits: Conscientiousness, Openness to experience, Extraversion, Neuroticism, and Agreeableness. Conscientiousness describes the tendency of people to be highly responsible, goal-directed, self-controlled, and hardworking as well as to follow rules (Roberts et al., 2014). Thus, it is not surprising that conscientiousness is associated with many positive outcomes—especially in areas that require self-discipline and persistent effort. Among the personality traits of the FFM, conscientiousness is most important for academic and work-related contexts. For instance, meta-analyses have shown that conscientiousness predicts overall job performance as well as work engagement (e.g., Dudley et al., 2006).

Regarding the associations between teachers' personality and teaching profession-related outcomes, studies in general are scarce. Some initial evidence exists that conscientiousness is related to teachers' PD behavior: Mayr (2007) found a positive relation between teachers' conscientiousness and how helpful they rated specific types of PD behaviors (i.e., reading or attending courses). We do not know of results regarding the relation of conscientiousness and PD intensity. However, because of the empirical support for the positive association of conscientiousness with effort-related job outcomes and the positive association of teachers' work engagement with the uptake of PD (Richter et al., 2011), we assume that conscientiousness is positively related to teachers' PD intensity.

The Conscientiousness × Interest Compensation (CONIC) Model

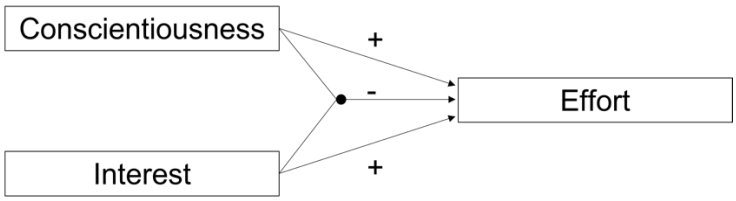
Prior studies that examined both interest and conscientiousness together as predictors of effort and academic achievement in a specific domain revealed a compensatory interaction effect between the two constructs (e.g., Trautwein et al., 2015). The interaction effect implies that a lack of interest can be (partly) compensated by a high degree of conscientiousness (and vice versa). An integrative theoretical model derived from these empirical findings is the Conscientiousness × Interest Compensation (CONIC) model (Trautwein et al., 2019). The CONIC model postulates that both conscientiousness and interest are driving forces that cause individuals to exert effort (see Figure 1). However, due to their conceptual differences, they are assumed to lead to effort along different self-regulatory paths. Conscientiousness acts like a strenuous built-in *push* factor, causing individuals to persist on a task with no intrinsic value.

Interest acts like an energizing *pull* factor, making effort happen with positive emotions and without strain.

According to the CONIC model, both constructs uniquely contribute to explaining effort when both constructs are simultaneously considered, but additionally can (partly) compensate for one another. The compensatory relation of interest and conscientiousness is supposed to be a basic psychological mechanism that applies across age groups, which makes it plausible that the effect is valid for all people in demanding situations (Bareis et al., 2024). Thus, as participation in PD activities requires teachers' effort (Fütterer et al., 2023), we started with the assumption that such a compensatory relation might also exist at the teacher level when predicting teachers' PD intensity.

Figure 1

Description of the Conception of the CONIC Model



Note. Figure adapted from Trautwein et al. (2019).

Teacher Education in Austria

The present study utilizes data collected from teachers in Austria. Therefore, in the following, we present an overview of the teacher education system in Austria. Pre-service teacher education in Austria takes place at University Colleges of Teacher Education as well as universities. All teachers in our sample completed a 3-year training program at a university college, earning a teaching degree for primary, lower secondary, or special education. This training includes a high amount of practical training, so on average the graduates in Austria feel significantly better prepared for the profession than new entrants to the teaching profession elsewhere in the EU (Schmich et al., 2019). Austrian teachers are required to complete at least 15 hours of PD per school year. PD programs are mainly provided by the university colleges, which are strongly directed by ministerial preferences but also by needs reported by the schools when compiling the offers. However, PD courses from other providers can also satisfy the PD requirement (Müller et al., 2019). Austrian teachers—more often than is the case on average in EU countries (Andreitz, 2018)—predominantly attend short PD courses, usually lasting only

half a day (Müller et al., 2019), and rarely attend courses lasting several days or several semesters (Schmich et al., 2019). PD is predominantly seen as an individual endeavor; the needs of the schools or the education system play a subordinate role (Müller et al., 2019). The lack of suitable offers and the lack of incentives are identified as obstacles to PD activities in Austria—much more frequently than in the EU comparison (Schmich et al., 2019). A high level of PD activities does not lead to salary benefits; at best, it can facilitate entry into a career as a school principal or teacher educator (Andreitz, 2018).

Research Questions and Hypotheses

In the present study, we contribute to the question of what drives teachers to participate in PD activities from the perspective of individual differences research. Specifically, we examine interest (research question 1 [RQ1]) and conscientiousness (RQ2) as well as their interaction (RQ3) as predictors of teachers' PD intensity. PD intensity can be understood as the subjective rating of the amount of PD a teacher completed. Thus, it also captures the individual involvement and commitment (what would not be the case when asking for the formal amount of PD, e.g., hours of PD).

Interest arouses enthusiasm and is accompanied by positive emotions, which leads to commitment to a subject with perseverance and effort. We therefore propose that interest is a predictor of teachers' PD intensity. Previous studies support this assumption. However, the construct of interest has never been examined separately for different domains relevant to teacher PD for its impact on PD behavior. Thus, in the present study, we account for the domain-specificity of interest and examined not only if teachers' general interest in teacher activities, but also if teachers' interest in different areas of teacher activities and teachers' interest in PD predict PD intensity. We propose that interest at all levels is positively related with the intensity of PD (hypotheses H1.1, H1.2, and H1.3). Conscientiousness leads to enduring performance in various areas of life. It is widely recognized that PD is important for effective teaching practice. However, participation is hampered, for example, by limited availability of suitable offers and lack of incentives. It is conceivable that conscientious people are more likely to fulfill this responsibility, despite all obstacles. Therefore, we assume that teachers' conscientiousness is positively related with intensity of PD (hypothesis 2 [H2]).

Following the CONIC model, we examine the interaction between conscientiousness and interest in predicting teachers' PD intensity. We hypothesize a weaker relation of conscientiousness when interest is high and a weaker relation of the respective interest measures when conscientiousness is high (i.e., a negative interaction effect; hypotheses H3.1, H3.2, H3.3)

when predicting teachers' PD intensity. With the concerns of the open science movement in mind (e.g., van Dijk et al., 2021), we preregistered the study (see https://osf.io/yn54q/?view_only=e1fc6cd748cc462abd00a33032835947). All deviations from our preregistered plan can be found at OSF as well.

Method

This study used data from the project *Teachers' Education, Development and Career in Austria* (TEDCA; Mayr et al., 2022). TEDCA combines data of four longitudinal studies with different starting points. The four TEDCA studies cover cohorts of teachers that began their teacher training between 1985 and 2014 at one of the university colleges of teacher education in Austria. All participants of the respective cohorts who had completed their teacher training and for whom at least a postal address from their teacher training period was available were invited to participate in the studies on a voluntary basis. In all studies the participants were surveyed with questionnaires (paper-and-pencil or online format). Participants did not indicate their name at any point of the study but chose a pseudonym. The results were made available upon request, and 20 book vouchers were raffled.

Sample

All teachers who participated in TEDCA hold a teaching degree for primary, lower secondary, or special education. We used data of participants surveyed in 2018, 2007 and 2005. We followed the preregistered procedure and excluded all participants from our analyses who were not working in schools as teachers at any of the measurement points or had missing values on all variables of interest, resulting in $N = 683$ for 2018, $N = 203$ for 2007, and $N = 295$ for 2005.

We examined the research questions based on both a cross-sectional and a longitudinal data structure. For the cross-sectional data, we included all observations of active teachers at the measurement points 2007 and 2018 as all relevant variables were assessed at these measurement points. The cross-sectional data consisted of $N_1 = 869$ (86 % female) teachers. On average, the participants were $M = 37.67$ years old ($SD = 8.12$) and had $M = 11.7$ years ($SD = 7.57$) of experience as a teacher.

For the longitudinal data, we used data from 2005 and 2007 as the first measurement point (t_1) and 2018 as the second measurement point (t_2). We included all participants who participated in 2005 or 2007 and worked as teachers at least at one of the measurement points ($N = 538$). At least strong measurement invariance (i.e., equal factor loadings and equal intercepts) of all latent constructs of interest between the two measurement points (t_1, t_2) was evident (see OSF Supplement A). As preregistered, we tested if the participants who participated only at the first measurement point differed from participants who did not drop out of the study (non-drop-out group) by using *t* tests. We found that the groups did not differ and therefore applied a listwise deletion approach and included only those participants from

the non-drop-out group in the longitudinal analyses. The longitudinal data consisted of N_2 = 143 teachers (82 % female). On average, the participants were M = 44.38 years old at the second measurement point (SD = 4.08) and had M = 16.90 years (SD = 5.58) of experience as a teacher. For further explanation on sampling see the preregistration and the document about deviations from preregistration at https://osf.io/yn54q/?view_only=e1fc6cd748cc462abd00a33032835947.

Measures

Independent Variables: Teachers' Interest

In the present study, we account for the domain-specificity of interest and examine the relationship with PD intensity separately for interest in different domains relevant to teacher PD. All interest measures used in this study were assessed via a questionnaire about teachers' interest in professional activities (LIS; Mayr, 1998). The LIS encompasses six different areas of professional activities: *prepare and conduct lessons*, *foster social relations*, *address specific needs*, *control and assess behavior*, *collaborate with parents and colleagues*, and *professional development.* Based on teachers' ratings on these six areas of activities, three different measures of teachers' interest were generated. The first interest measure referred to teachers' general interest in teacher activities (GIT). Second, five interest measures for the specific areas of teacher activities (IAT) were generated. Third, teachers' interest in PD (IPD) was calculated based on the ratings for the area of *professional development*. The following is a more detailed description of the operationalizations.

Teachers' General Interest in Teacher Activities (GIT). To measure teachers' general interest in teacher activities (GIT), we summed the ratings of five different areas of teaching activities asked within the LIS questionnaire (i.e., prepare and conduct lessons, foster social relations, address specific needs, control and assess behaviour, and collaborate with parents and colleagues). The internal consistency indicated by Cronbach's alpha (α) in our data was good (α = .81; see Taber, 2018). To calculate internal consistency, we used the cross-sectional data because it represents our largest data set.

Teachers' Interest in Specific Areas of Teacher Activities (IAT). To measure teachers' interest in different areas of teacher activities, we included the average ratings of the activities separately for five different areas of professional activities in the LIS questionnaire. These areas of activities represent core areas of PD (based on data from Austria, Germany, and Switzerland). The area *prepare and conduct lessons* was assessed with 5 items (items represent different activities; e.g., create exercises). The areas *foster social relations* (e.g., conduct games

and exercises for social learning), *address specific needs* (e.g., carry out special exercises with students with learning difficulties), *control and assess behavior* (e.g., assess the students' performance), and *collaborate with parents and colleagues* (e.g., discuss educational issues with parents) were assessed with 4 items each. Teachers rated how much they like doing these activities on a 5-point scale ranging from 1 (*not at all*) to 5 (*very much*). The internal consistency of the constructs in our data ranged from α = .62 (moderate) to α = .75 (good; see Taber, 2018). We modeled the different IAT measures as latent variables.

Teachers' Interest in PD (IPD). Teachers' interest in PD (IPD) was assessed with three items addressing the area of professional development within the LIS questionnaire (i.e., attend advanced pedagogical training courses, learning new teaching methods, reading professional literature about my subjects). Teachers rated how much they like doing those activities on a 5-point rating scale ranging from 1 (*not at all*) to 5 (*very much*). The internal consistency in our data was moderate (α = .64; see criteria of Taber, 2018). To estimate IPD without measurement error, we modeled IPD latently.

Independent Variables: Conscientiousness

The *Teacher Personality Adjective Scales* (LPA; H. Brandstätter & Mayr, 1994) were used to assess teachers' personality. Four items (i.e., contrasting pairs of adjectives) comprised the conscientiousness scale. We excluded one item based on methodological and content considerations. Teachers were asked how they perceive themselves and rated the pairs of adjectives on a 9-point scale ranging from 1 (e.g., *careless*) to 9 (e.g., *conscientious*). The internal consistency in our data was moderate (α = .64; see criteria of Taber, 2018). We modeled conscientiousness as a latent variable.

Dependent Variables: PD Intensity

Intended PD Intensity. Teachers rated how intensively they intended to continue their education in the different areas of activities in the future from 1 (*no further PD activity intended*) to 5 (*very intensive PD intended*).

For the analyses including GIT or IPD as measure of interest, the dependent variable was a sum score of the five items asking about intended PD intensity in the five areas of activities. For the analyses including the specific interest measures of IAT, we used the intended PD intensity in the specific area.

Completed PD Intensity. Teachers were asked to rate how intensively they had continued their education in the different areas of professional activities over the past 7 years from 1 (*no PD completed*) to 5 (*very intensive PD completed*).

For the analyses including GIT or IPD as measure of interest, we used a sum score of the five items on completed PD intensity in the five different areas of teacher activities as the dependent variable. For the analyses including the specific interest measures of IAT, we used the completed PD intensity in the specific area.

Covariates

We included teachers' *time in profession* (continuous; in years), *gender* (dichotomous; 0 = *male*, 1 = *female*), and *method of data collection* (dichotomous; 0 = online, 1 = *paper-pencil*) in both cross-sectional and longitudinal analyses as control variables. Additionally, we included *year of data collection* (0 = 2007 and 1 = 2005) as a covariate in the longitudinal analyses.

Statistical Analyses

We followed the preregistered procedure for item selection (see https://osf.io/yn54q/). The model fit indices for the final models can be found in OSF Supplement R.

To test if interest at different levels (H1.1, H1.2, H1.3), conscientiousness (H2), and their interaction predict PD intensity, we specified different sets of latent regression models.

The first set of models contained conscientiousness and either GIT, IAT, or IPD as predictors and PD intensity as outcome. In the second set of models, we included the interaction term of the respective two predictors for each model to test if the interaction effect proposed in the CONIC model is also apparent for PD intensity (H3.1, H3.2, H3.3). Because the coefficients of the effects did not change substantially when including the interaction terms, we only report the results of the second set of models. For the results including the first set of models see OSF Supplement S.

For the cross-sectional analyses we used the measure of intended PD intensity whereas for the longitudinal analyses we used the measure of completed PD intensity as dependent variable. We considered this to be the most appropriate approach due to the chronological sequence. In the cross-sectional scenario it is plausible to investigate intentions in the future. In the longitudinal scenario there is either 11 or 13 years between the first and second measurement points, so that retrospectively reporting PD intensity for a portion (i.e., 7 years) of this time period is more reasonable than predicting intentions.

Further, we preregistered a series of robustness checks which can also be found in the OSF Supplement. We estimated all models in a structural equation modeling (SEM) framework using the latent moderated structural (LMS) equations approach (Klein & Moosbrugger, 2000) as implemented in Mplus 8 (Muthén & Muthén, 1998-2017). We treated missing values with full information maximum likelihood (FIML) estimation for both independent and dependent variables. We report the standardized regression coefficients.

Results

We organize the results by predictors and present both models (i.e., model of the cross-sectional and model of the longitudinal scenario) of a set of predictors in turn. Consequently, each section presents both the cross-sectional and longitudinal results for each hypothesis. The hypotheses are confirmed when there is a positive main effect for both conscientiousness and interest, as well as a negative interaction effect.

Conscientiousness and Teachers' General Interest in Teacher Activities (GIT)

The relation of GIT (as a summary measure of teachers' general interest in teacher activities) and PD intensity was positive and statistically significant with a moderate effect size (Cohen, 1988) in the cross-sectional scenario (Table 1). This finding indicates that teachers showing higher general interest in teacher activities have also higher intended PD intensity across the five activity areas. The relation of conscientiousness and PD intensity was not statistically significant for the cross-sectional scenario. Furthermore, the Conscientiousness × GIT interaction term was not statistically significant in the cross-sectional. For the longitudinal scenario, there were no statistically significant effects of GIT, conscientiousness, or their interaction term predicting PD intensity. The results of the multiple robustness checks confirm the robustness of these findings (see OSF Supplement A and OSF Supplement H).

Table 1

Results for Teachers' General Interest in Teacher Activities as Predictor

	Cross-Sectional (n = 869)			Longitudinal (n = 143)		
	β	*SE*	*p*	β	*SE*	*p*
Predictor						
Time in profession	-.08	.03	.016	.29	.10	.004
Data collection mode	.13	.03	<.001	.20	.08	.009
Data collection year				-.07	.10	.517
Gender	.11	.04	.002	.37	.10	<.001
Conscientiousness	-.02	.05	.363	-.11	.13	.192
GIT	.29	.04	<.001	.03	.11	.396
CON × GIT	.07	.06	.139	.09	.07	.091
R^2	.15	.03	<.001	.21	.07	.002

Note. The dependent variable is teachers' intended PD intensity (cross-sectional) or completed PD intensity (longitudinal) across five different areas. Before regression analysis, all predictors were *z*-standardized. GIT = General interest in teacher activities; CON = Conscientiousness.

Conscientiousness and Teachers' Interest in Specific Areas of Teacher Activities (IAT)

Next, we tested if interest in the different areas of teacher activities *prepare lessons* (IAT lessons, Table 2), *foster social relations* (IAT social, Table 3), *address specific needs* (IAT needs, Table 4), *control and assess behavior* (IAT control, Table 5), and *collaborate with parents* (IAT collaborate, Table 6) predicted PD intensity in the respective areas.

In the cross-sectional scenario, all of the different areas of interest were positive and statistically significant predictors of PD intensity, ranging in effect size from small to moderate (Cohen, 1988). This indicates that the more teachers were interested in a specific area of activity the more intensively they intended to participate in PD in that area.

Further in the cross-sectional scenario, there was a statistically significant relation between conscientiousness and intended PD intensity in the area of *foster social relations*, indicating that the teachers low in conscientiousness have higher intentions to participate in PD in this area. There were two statistically significant positive interaction terms in the cross-sectional scenario.

In the longitudinal scenario, only IAT lessons showed a statistically significant, large positive relation with PD intensity. This indicates that the more teachers were interested in the area of *prepare lessons* at the first measurement point the more intensively the teachers participated in PD in this area between the first and the second measurement point. Further, conscientiousness was a statistically significant negative predictor in the models addressing IAT lessons and IAT social in the longitudinal scenario, indicating that the less conscientious teachers were at the first measurement point the more intensively they participated in PD in these areas between the first and the second measurement point.

There was found one statistically significant positive interaction effect in the longitudinal scenario.

The robustness checks confirm the findings for the different interests predicting PD intensity (see OSF Supplement B to OSF Supplement F for the cross-sectional analyses, and OSF Supplement I to OSF Supplement M for the longitudinal analyses). Similarly, the results on the relation of conscientiousness and PD intensity as remain largely robust across the various robustness checks. The findings on the interaction effects could be confirmed in the robustness analyses for the longitudinal scenario, but not for the cross-sectional scenario.

Table 2

Results for Teachers' Interest in the PD Topic of Prepare Lessons as Predictor

	Cross-Sectional (n = 869)			Longitudinal (n = 143)		
	β	*SE*	*p*	β	*SE*	*p*
Predictor						
Time in profession	-.05	.04	.155	.14	.13	.265
Data collection mode	.06	.04	.109	.24	.09	.012
Data collection year				.05	.11	.613
Gender	.05	.04	.147	.06	.11	.588
Conscientiousness	.06	.05	.107	-.34	.15	.011
IAT lessons	19	.05	<.001	.52	.15	.001
CON × IAT lessons	.15	.06	.008	-.07	.10	.234
R^2	.09	.03	.002	.25	.09	.005

Note. The dependent variable is teachers' intended PD intensity (cross-sectional) or completed PD intensity (longitudinal) in the area of prepare lessons (IAT lessons). Before regression analysis, all predictors were *z*-standardized. IAT = Interest in area of teacher activities; CON = Conscientiousness.

Table 3

Results for Teachers' Interest in the PD Topic of Foster Social Relations as Predictor

	Cross-Sectional (n = 869)			Longitudinal (n = 143)		
	β	*SE*	*p*	β	*SE*	*p*
Predictor						
Time in profession	-.01	.04	.893	.38	.09	<.001
Data collection mode	.04	.04	.322	.21	.09	.025
Data collection year				.07	.10	.485
Gender	.08	.04	.033	.34	.10	.001
Conscientiousness	-.10	.05	.016	-.30	.11	.004
IAT social	.27	.05	<.001	.20	.20	.161
CON × IAT social	.12	.06	.019	-.06	.12	.311
R^2	.11	.03	.001	.23	.08	.004

Note. The dependent variable is teachers' intended PD intensity (cross-sectional) or completed PD intensity (longitudinal) in the area of address specific needs (IAT needs). Before regression analysis, all predictors were *z*-standardized. IAT = Interest in area of teacher activities; CON = Conscientiousness.

Table 4

Results for Teachers' Interest in the PD Topic of Address Specific Needs as Predictor

	Cross-Sectional (n = 869)			Longitudinal (n = 143)		
	β	*SE*	*p*	β	*SE*	*p*
Predictor						
Time in profession	-.01	.04	.726	.19	.11	.090
Data collection mode	.03	.04	.406	-.03	.09	.735
Data collection year				-.01	.11	.901
Gender	.11	.04	.002	.18	.10	.074
Conscientiousness	-.04	.04	.198	.02	.11	.416
IAT needs	.33	.05	<.001	.14	.12	.111
CON × IAT needs	.09	.06	.075	.08	.18	.326
R2	.14	.03	<.001	.09	.05	.088

Note. The dependent variable is teachers' intended PD intensity (cross-sectional) or completed PD intensity (longitudinal) in the area of address specific needs (IAT needs). Before regression analysis, all predictors were *z*-standardized. IAT = Interest in area of teacher activities; CON = Conscientiousness.

Table 5

Results for Teachers' Interest in the PD Topic of Control and Assess Behavior as Predictor

	Cross-Sectional (n = 869)			Longitudinal (n = 143)		
	β	*SE*	*p*	β	*SE*	*p*
Predictor						
Time in profession	-.09	.04	.009	.15	.10	.148
Data collection mode	.13	.04	<.001	.11	.09	.211
Data collection year				-.04	.10	.679
Gender	.10	.04	.004	.25	.10	.015
Conscientiousness	.01	.05	.447	-.01	.15	.481
IAT control	.15	.04	.001	-.03	.13	.408
CON × IAT control	-.02	.05	.330	.16	.08	.027
R^2	.07	.02	<.001	.10	.05	.051

Note. The dependent variable is teachers' intended PD intensity (cross-sectional) or completed PD intensity (longitudinal) in the area of control and assess behavior (IAT control). Before regression analysis, all predictors were *z*-standardized. IAT = Interest in area of teacher activities; CON = Conscientiousness.

Table 6

Results for Teachers' Interest in the PD Topic of Collaborate With Parents as Predictor

	Cross-Sectional (n = 869)			Longitudinal (n = 143)		
	β	*SE*	*p*	β	*SE*	*p*
Predictor						
Time in profession	-.09	.04	.009	.09	.11	.403
Data collection mode	.09	.04	.009	.15	.09	.104
Data collection year				-.19	.10	.054
Gender	.05	.04	.154	.15	.11	.170
Conscientiousness	.01	.05	.389	-.12	.11	.139
IAT collaborate	.17	.05	<.001	.07	.14	.303
CON × IAT col.	.01	.06	.447	.01	.12	.472
R^2	.06	.02	.003	.10	.05	.036

Note. The dependent variable is teachers' intended PD intensity (cross-sectional) or completed PD intensity (longitudinal) in the area of collaborate with parents (IAT collaborate = IAT col.). Before regression analysis, all predictors were *z*-standardized. IAT = Interest in area of teacher activities; CON = Conscientiousness.

Conscientiousness and Teachers' Interest in PD (IPD)

Last, we tested if IPD and conscientiousness predicted PD intensity (see Table 7).

IPD positively predicted PD intensity in the cross-sectional scenario with a moderate effect size (Cohen, 1988). That is, the more interest teachers had in PD the more intensively the teachers intended to participate in PD. Conscientiousness was not a statistically significant predictor of PD intensity in the cross-sectional. The interaction term was statistically significant positive in the cross-sectional scenario.

In the longitudinal scenario IPD and conscientiousness both were not statistically significant predictors of PD intensity. The interaction term also was not statistically significant in the longitudinal scenario.

The robustness checks confirm the findings for IPD and conscientiousness predicting PD intensity (see OSF Supplement G for the cross-sectional analyses, and OSF Supplement N for the longitudinal analyses). The findings for the interaction effects could only partially be confirmed in the robustness analyses.

Table 7

Results for Teachers' Interest in PD as Predictor

	Cross-Sectional (n = 869)			Longitudinal (n = 143)		
	β	*SE*	*p*	β	*SE*	*p*
Predictor						
Time in profession	-.06	.03	.095	.25	.10	.010
Data collection mode	.04	.04	.260	.17	.09	.062
Data collection year				-.09	.10	.355
Gender	.07	.03	.026	.29	.13	.020
Conscientiousness	-.01	.05	.396	-.19	.12	.065
IPD	.39	.05	<.001	.21	.17	.105
CON × IPD	.12	.07	.039	.01	.09	.463
R^2	.20	.04	<.001	.23	.08	.006

Note. The dependent variable is teachers' intended PD intensity (cross-sectional) or completed PD intensity (longitudinal) across five different areas. Before regression analysis, all predictors were *z*-standardized. IPD = Interest in professional development; CON = Conscientiousness.

Discussion

The major aim of our study was to contribute to an improved understanding of how teacher characteristics and teachers' PD intensity are related. To this end, the present study is the first that jointly examines conscientiousness (as a personality trait), interest (as a motivational construct), and their interaction in predicting teachers' PD intensity. According to the Conscientiousness × Interest Compensation (CONIC) model (Trautwein et al., 2019) both conscientiousness and interest are factors that drive effort-related activities and represent different self-regulatory pathways. Results revealed interest measured at different levels as a robust predictor of intended PD intensity in the cross-sectional scenario: seven out of seven tested interest measures showed a statistically significant positive relation. In the longitudinal scenario, one out of seven tested interest measures showed a statistically significant positive relation with PD intensity. For conscientiousness, the results overall were weaker (i.e., smaller effect sizes and less often statistically significant). Conscientiousness and PD intensity showed statistically significant relations for two areas of teacher activities (in the cross-sectional scenario only for one). However, contrary to our expectations, they were negative. We did not find expected negative interaction effects (i.e., predicting PD intensity) as suggested by the CONIC model. Overall, the results suggest that teachers' PD intensity is more interest-driven rather than conscientiousness-driven. These findings provide important guidance for creating tailored calls to action and conditions that facilitate participation in PD.

Conscientiousness is a key predictor for many important occupational outcomes such as job dedication or overall job performance (Dudley et al., 2006). However, our results suggest that conscientiousness plays a subordinate role when it comes to PD. This finding is in line with recent findings by Fütterer et al. (2023) for technology-related PD. Thus, the psychological mechanisms that underlie the relation of conscientiousness and PD intensity may differ from those that underlie the relation of conscientiousness and other work-related outcomes. Based on the notion that the relationship between conscientiousness and performance-related life outcomes is mediated by effort (De Raad & Schouwenburg, 1996), one difference may be that PD behavior does not necessarily represent strenuous performance-related occupational behavior. Combined with the results on the positive relationship between interest and PD intensity, it can be argued that PD is more likely to be an interest-guided behavior that is aligned with one's personal affinities. Or in the words of the mechanism postulated by the CONIC model, individuals are more *pulled* into PD via the energizing interest-driven pathway than they are *pushed* into PD via the purposeful conscientiousness-driven pathway. This assumption is also supported by the results of Andreitz and colleagues (2018), Gorozidis and colleagues

(2014), as well as Zhang and colleagues (2021) who showed that controlled motivation—which has similarities with the proposed driving force of conscientiousness—has no effect on their (intended) PD, whereas autonomous motivation—which is similar to interest—is relevant to PD (intention). It may be that PD is not seen primarily as a necessary duty to obtain the most current knowledge, but rather as an opportunity for self-fulfillment. That is, conscientious individuals may set their priorities on other teaching duties. Against this backdrop, it appears plausible that conscientiousness had at least partly a negative relationship with completed PD intensity. Perhaps when confronted with daily work routines and limited resources (e.g., time), the conscientious individuals put their priority on other things than PD.

Additional relevant aspects associated with conscientiousness are grounded in the specific organizational context of PD in Austria: Austrian teachers are obliged to 15 PD hours per school year (Andreitz, 2018). Conscientiousness as a personality trait is not required to complete these mandated PD hours as the legal obligation ensures that everyone participates in these hours of PD. Moreover, previous research shows that conscientiousness is less relevant in settings with high external control (Trautwein & Lüdtke, 2007). Furthermore, most of the offered PD is not designed to be particularly performance-related (i.e., with high performance requirements and a certificate of achievement); instead, attendance is sufficient to receive credit for the courses. Most work or academic environments in which conscientiousness matters are likely to be more competitive.

Limitations

In discussing the differences between the cross-sectional and longitudinal scenarios, methodological limitations must be considered. The longitudinal sample is significantly smaller than the cross-sectional sample, which leads to diminished statistical power and thus makes it harder to detect statistically significant effects. Furthermore, there are 11 or 13 years between the first and second measurement points of the longitudinal scenario. Although the outcome is surveyed retrospectively for the 7 years prior to the second measurement point, this does not fully cover the period between the two measurement points. Besides methodological issues, it stands to reason that the differences may be due to the different outcomes used in the cross-sectional and longitudinal scenario. Intended PD intensity (used in the cross-sectional scenario) is less dependent on external factors, such as PD programs offered, than completed PD intensity (used in the longitudinal scenario). Knowing that one of the major obstacles to PD in Austria is that appropriate PD courses are not offered (Schmich et al., 2019), it can be assumed that the

lack of predictive value may be due in part to the lack of opportunities to implement PD intentions.

Furthermore, in the present study self-reported measures were used to assess PD intensity as the dependent variable. On the one hand, this can be seen as a strength, as the measures are not restricted to the number of hours, but also reflect the personal resources and effort involved. On the other hand, because the assessment requires a high degree of individual inference by the reporting person, this could lead to reduced validity and limit the informative value of the measure. Moreover, the instruments used are mostly short scales, sometimes single-item measures (e.g., specific PD intensity). These methodological limitations of the present study should be considered when interpreting the results and be addressed in future research.

Implications for Education Policy and Practice

The knowledge that teachers' interest measured at different levels is related to their PD intensity can be used by stakeholders responsible for designing PD courses. For instance, they could attract interested persons and promote interest by arousing situational interest utilizing advertisement (e.g., according to the Munich interest theory; Schiefele, 1991) or by fostering competence, relatedness, and autonomy (e.g., according to self-determination theory; Deci & Ryan, 1985). The findings of this study also point to the importance of providing customised PD offers that meet the interests of the target group (*differentiated PD*). Furthermore, from another perspective, the results indicate that the necessity and purpose of PD should be emphasised repeatedly by all involved parties, so that possibly conscientiousness also becomes a driving force for PD participation. This would be desirable so that teachers participate in not only personally interesting PD programs, but also necessary ones that may lie outside of one's own area(s) of interest.

In conclusion, the present study provides evidence that interest positively predicts teachers' intensity in engaging in professional development, whereas conscientiousness does not. Moreover, the compensatory effect captured in the CONIC model does not extend to predicting PD intensity. These results provide practical guidance, indicating that stimulating interest holds more promise than fostering conscientiousness in motivating teachers to engage in PD.

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7 GENERAL DISCUSSION

The CONIC model brings together two central determinants of academic effort: conscientiousness and interest. Based on previous empirical evidence, the model posits that conscientiousness and interest partially compensate for each other when predicting academic effort and achievement. However, all studies in previous research on the CONIC model are considerably similar in their research characteristics, which limits the implications for consolidating the model across other samples, study designs, measures, and contexts.

The present dissertation aims to specify the scope of the model by identifying its generality, extensivity, and boundary conditions. Therefore, I conducted four studies investigating the CONIC model using varying research characteristics. In this chapter, I will first summarize the findings of the four empirical studies. Following this, I will discuss the findings regarding their implications for the CONIC model. This part is structured according to the research characteristics: samples, study designs, measures, and contexts. Finally, I will integrate the different lines of discussion and reflect on the extent to which this dissertation specifies the scope of the CONIC model and which general implications for the validity of the CONIC model can be derived. This section also considers the strengths and limitations of the included studies and points to directions for future research. The general discussion closes with a conclusion.

7.1 Summary of the Four Empirical Studies

In this chapter, I will summarize the main findings from the four empirical studies included in this dissertation. Each study empirically tests the CONIC model but differs in terms of its research characteristics. To emphasize the added value of each study, I will relate them to previous research on the CONIC model and distinguish between investigations of its replicability, generalization, and extensivity.

7.1.1 Testing the CONIC Model With Similar Constructs in Two U.S. Samples

The first study consisted of a replicability part, a generalization part, and an extension part related to the CONIC model. Specifically, we assessed the replicability of the CONIC model's extension proposed by Song and colleagues (2020) by substituting utility value for interest as a predictor variable and school grades for effort as another outcome variable. Additionally, we assessed the replicability of the CONIC model by examining it for the first time using a non-German-speaking high school sample (i.e., a U.S. high school sample) and using different measures for interest and effort, as well as school grades. We also tested the generalization of the CONIC model using an older sample (i.e., a college sample) and its extensivity using grit and overall task value as additional predictor variables.

The results of Song et al. (2020) were successfully replicated. However, the interaction effects with utility value were less strong than when interest was included, and some were not statistically significant. Thus, in our study, utility value did not compensate as strongly as interest when students were less conscientious, and vice versa. Similarly, when grades were the outcome measure, the main effects and interactions for the original CONIC model and the other models were generally smaller than those for predicting academic effort.

The testing of the CONIC model in another Western country (i.e., the United States) and with college students revealed stronger support for the U.S. high school students. Accordingly, the replication of earlier results for German-speaking high school students was successful. The differences in the U.S. school system (e.g., self-selected courses vs. prescribed curriculum) did not appear to impact how students' conscientiousness and interest can compensate for each other in affecting both academic effort and achievement. The CONIC model was also confirmed for college students, suggesting that it is not restricted to high school-aged students. Turning to the extension tests for the model, when grit was substituted for conscientiousness or when overall task value was substituted for interest, many of the effects were similar to those of the original model, albeit somewhat weaker.

Taken together, the results of the first study provide strong support for the replicability of the CONIC model for high school students from the U.S. and for the extensions proposed by Song et al. (2020), independent of the use of different operationalizations for interest, effort, and achievement. Furthermore, the results support the generalization of the CONIC model across older U.S. students and its extensivity across grit and overall task value as additional predictor variables. However, the findings also suggest that the push-pull mechanism is most strongly mapped within the two constructs of interest and conscientiousness.

7.1.2 Testing the CONIC Model in a Lab Setting

The second study generalizes the model across an older sample and a laboratory design. It used a sample of German university students to investigate the CONIC model for predicting task achievement in a lab setting. Specifically, the study examined the CONIC model's ability to predict task achievement in five highly structured digital lab-based learning tasks addressing different domains. Therefore, conscientiousness and task-specific measures of interest, as well as their interaction term, were used to predict students' performance (i.e., mastery of the topic assessed with a knowledge test) for each task.

Overall, task-specific interest was found to have a positive effect on task performance, though statistically significant for only four out of the five tasks. There was a negative interaction effect on task performance for four of the tasks, with statistical significance in three of the tasks. However, we did not find any positive main effects of conscientiousness on task performance but instead found either no effect or a negative effect.

Taken together, the overall pattern of results from the second study supports the generalization of the compensatory mechanism across learning tasks in controlled laboratory settings, with task-specific interest playing a positive role in predicting task performance and negative interaction effects observed. However, the results also point to the limitations of the predictive power of conscientiousness for this setting, as there were no positive main effects of conscientiousness on task performance.

7.1.3 Testing the CONIC Model in an Experimental Setting

The third study tests the CONIC mechanism in an experimentally manipulated research setting. In addition to self-rated effort, several other indicators of effortful behavior (such as time measures) were included to test generalization across measures other than self-report. The

study was conducted online, and the sample was recruited from the online platform Prolific, consisting of adults. The experimental treatment to manipulate task interestingness had significant effects on effort assessed by different indicators, including self-report and behavioral measures, indicating that task interestingness predicts different measures of effort. Conscientiousness also showed a positive relationship with some of the effort measures, although not for all effort measures. However, the results do not confirm the compensatory effect in the tested experimental setting.

7.1.4 Application of the CONIC Model to Teachers' Professional Development

The fourth study aims to extend the scope of the CONIC model by focusing on an occupational context rather than examining students in classroom settings, by investigating another outcome (i.e., professional development [PD] intensity), and by using other operationalizations to measure conscientiousness and different interests. The study applied the CONIC model to predict teachers' PD intensity using different interests (i.e., teachers' general interest in teacher activities, teachers' interest in specific areas of teacher activities, teachers' interest in PD) as predictors and conducting the analyses in a cross-sectional as well as a longitudinal scenario. The overall pattern of results revealed the different interests as robust predictors of PD intensity in both the cross-sectional and longitudinal scenarios. There were no positive relationships between conscientiousness and PD intensity, either cross-sectionally or longitudinally. Further, there were no negative interaction effects predicting PD intensity as suggested by the CONIC model. Taken together, the results suggest that the CONIC model does not hold for predicting teachers' PD intensity.

7.2 Generalization and Extension of the CONIC Model

In the following chapter, I will discuss the results of the four studies on the CONIC model, focusing on their implications for generalizing the model. To do so, I will aggregate the findings following the research characteristics proposed by Shadish et al. (2002), which are also called *domains of generalizability* (Matt et al., 2010): samples, study designs, measures, and contexts. I will begin each section by briefly summarizing the state of research on each characteristic in relation to previous studies. I will then examine the new insights gained from the studies in this dissertation. An overview of the research characteristics of each study is provided in Table 2.

Table 2

Research Characteristics of the Studies Included in This Dissertation

Study	Sample	Study design	**Measures** Predictors	**Measures** Outcomes	Context
1	U.S. high school (M_{age} = 14.86) and college students (M_{age} = 19.83)	Observational field study	Conscientiousness, Grit, Individual interest, Utility value, Overall task value	Science and math effort, Grades	Natural context (i.e., U.S. school system)
2	German university students (M_{age} = 23.23)	Observational laboratory study	Conscientiousness, Task-specific interest	Performance in five different learning tasks	Laboratory context
3	German-speaking adults from the online platform Prolific (M_{age} = 31.02)	Experimental study	Conscientiousness, Task-specific interest	Different indicators of effortful behavior	Online experimental context
4	Austrian teachers (M_{age} = 37.67)	Observational field study	Conscientiousness, Individual interest at different levels	Professional development intensity	Natural context (i.e., teachers' occupational context in Austria)

7.2.1 Samples

Previous research on the CONIC model investigated high school students from German-speaking countries, including Germany and Switzerland. It covered students aged 11 to 18 (i.e., fifth to 12th grade) and various school types. The samples in the dissertation studies vary in age, country, or language compared to the prior samples. Each study included a different

sample. Study 1 used a sample of high school students but from the U.S., as well as an older sample of college students, also from the U.S. In Study 2, the sample consisted of German university students. In Study 3, a sample of adults was recruited through the online platform Prolific. Finally, Study 4 examined a sample of Austrian teachers.

The results of the studies support the CONIC model for high school (Study 1) and college students (Study 1). In addition, partial support for the CONIC model was found for university students—however, the positive effect of conscientiousness was not observed (Study 2). There was no support for the CONIC model in the studies investigating adult samples (Study 3 and Study 4).

In summarizing the dissertation studies concerning samples, the results suggest that the CONIC model is not limited to language area or origin from Western European, German-speaking countries (compared to the U.S.). Furthermore, the findings indicate that the model can be generalized across older students, including college and university students, to some extent. However, the CONIC model could not be demonstrated for the two adult samples, regardless of whether they were teachers (Study 4) or had diverse academic and occupational backgrounds (Study 3). Therefore, present results suggest adulthood as a boundary condition for the CONIC model. Potential reasons for this are elaborated below.

Considering the process of development, it must be stated that during adolescence and the transition to adulthood, individuals face a variety of developmental tasks and processes related to orientation and maturation. This is also reflected in the development of interest and conscientiousness over the lifespan. As individuals progress from adolescence to adulthood, their individual interest profile increasingly manifests itself (Krapp, 2002). Empirical research indicates that interest development peaks during the college years and then stabilizes (Low et al., 2005). This may be because adults have more autonomy in selecting environments that align with their interests and are more likely to elicit responses from others that promote stability (Low et al., 2005). Similarly, previous studies have found the mean-level of conscientiousness to increase during young adulthood (age 20 to 40), as well as the consistency of conscientiousness to increase over the lifespan (Roberts et al., 2006; Roberts & Wood, 2006). This can be explained by the fact that young adulthood is a phase during which individuals assume many new social roles, such as entry into professional life or parenthood, among others. This leads to a confrontation with new demands and challenges and can lead to identity development and contribute to the formation and growth of personality traits such as conscientiousness. It is conceivable that after a certain age, most individuals have passed a

certain threshold of conscientiousness and interest, leading to the compensatory effect no longer occurring. The underlying reason may be that adults have more agency and freedom of choice in selecting behaviors and environments that it no longer appears that someone has so little interest (or at least utility value) or so little conscientiousness that one construct needs to compensate for the other.

Another argument for adopting a developmental perspective within the CONIC model results from the different developmental trajectories of self-control competencies and reward sensitivity. The interest-driven path primarily operates through reward from positive emotions, whereas the conscientiousness-driven path primarily operates through self-control. Self-control tends to increase linearly throughout adolescence, and reward sensitivity peaks in mid-adolescence before declining over late adolescence and adulthood (Duckworth & Steinberg, 2015). This leads to a maturational imbalance in mid-adolescence, when self-control competencies are not yet fully developed and reward sensitivity is high (Casey et al., 2011). It is plausible that the CONIC model holds validity during this phase, with its compensatory mechanism potentially diminishing by adulthood.

Additionally, metamotivational strategies are more developed among adults, resulting in adults' higher ability to increase the interestingness or usefulness (e.g., considering its monetary benefits) of boring tasks by themselves. This may alter the interplay of conscientiousness and interest. For more theoretical considerations, see also the Model of Domain Learning by Alexander (1997), which suggests that different constructs are relevant at different stages of experience.

However, on the other hand, it may be unrealistic to assume that all situations in adulthood are self-selected and aligned with an individual's interests or utility. There may still be situations where adults are exposed to tasks that are outside of their interest or utility, challenging the notion that the compensatory effect disappears after a certain age.

To clarify this issue further, the next step should be to conduct a study with an adult sample but using research characteristics that have already been demonstrated for the CONIC model (e.g., concerning the measures, using conscientiousness, interest, and self-reported effort; concerning the context, choosing a classroom setting). Following the considerations mentioned above, this future study should also control for possible selection effects of environments in adulthood (as in Study 3) that may have an influence. Therefore, a good first step would be to investigate the CONIC model in adults in a situation that was not chosen based on interest. Promising contexts for a sample of adults in a future study are, for example, adult

education aimed at obtaining a high school diploma or language courses for immigrants. Additionally, it could be beneficial to control for interest-enhancing strategies and to explore the variance of interest and conscientiousness compared to the high school samples.

7.2.2 Study Designs

Regarding study designs, all previous studies on the CONIC model were observational studies of naturally occurring events in natural environments, whereas the studies in this dissertation differ in terms of whether they are observational or experimental and whether they are conducted in the field (i.e., in a natural environment), online, or in a laboratory. Three of the included studies used an observational design and one an experimental design (i.e., Study 3). Of the observational studies, two were conducted in the field and one in the laboratory. In the observational field studies, data were collected from naturally occurring events, whereas in the laboratory observational study, participants were presented with a set of laboratory learning tasks. The experiment included an experimental manipulation regarding the interestingness of the situation and involved an online environment.

Of the two observational field studies, one supports the CONIC model while the other does not. However, in the latter study (i.e., Study 4), all other research characteristics were also modified, leading to a broad scope of possible boundary conditions derived from this study. Given the robust previous findings on the CONIC model in observational field studies, it is more probable that the deviating results are attributed not to the study design but to the other research characteristics (i.e., sample, measures, and context).

The observational lab study partially supports the CONIC model (negative interaction effects, but no main effects of conscientiousness), while the experiment does not (no interaction effects and no main effects of conscientiousness). This may be due to differences in study designs. However, it should be noted that the studies also used different samples, measures, and contexts, again leading to a broad scope of possible reasons underlying the results.

Assuming that the varying results originate from differences in study design, this may particularly relate to the level of control and external validity. An increased level of control over variables that may impact the study's outcomes within a research design tends to diminish external validity. This means that the results may generalize poorly to real-world behavior and are more applicable to behavior under controlled study conditions. Linked to these considerations are the concepts of *typical performance* and *maximum performance,* which were

first proposed by Sackett et al. (1988). Typical performance represents how an individual performs on a regular basis, whereas maximum performance refers to the performance when effort is maximized. Maximum performance is typically shown in evaluative situations of short enough duration that one could maintain a high level of effort (Sackett, 2007). Sackett et al. (1988) suggest that maximum performance measures depend highly on ability, whereas longer-term typical performance measures depend on both ability and motivation. Thus, individuals with high and low conscientiousness mainly differ in their typical performance (or typically exerted effort). In contrast, there may not necessarily be a conscientiousness effect on maximum performance (or maximum effort).

Taken together, the strongest support for the CONIC model exists for observational field studies. Using the other study designs (i.e., observational lab study and experiment), no positive main effect of conscientiousness was found. To more accurately determine the boundary conditions related to study designs, it would be useful to vary the study design while holding the other research characteristics constant. For example, researchers could use a sample (i.e., high school students) and a context (i.e., German schools) that have been successfully tested several times and then conduct an experimental classroom study or a classroom study with learning tasks. This would allow for a more direct comparison of the different study designs.

7.2.3 Measures

The domain of "measures" refers to the different measurements used to collect data on a particular construct. The studies included in this work tested for generalization not only within constructs, but also across constructs (i.e., extension studies). Thus, they not only encompassed different measures for the constructs of the original CONIC model (i.e., conscientiousness, interest, effort), but also tested other constructs as extensions (i.e., utility value, overall task value, grit, task achievement, grades, PD intensity). I will structure the following section in such a way that for each of the constructs that are part of the original CONIC model, I will first discuss generalization across measurements and then across constructs.

Conscientiousness

To measure conscientiousness in the previous studies on the CONIC model, different self-report measures from different questionnaires were used. Specifically, three of the previous studies used the NEO-FFI (Studies 2, 3, and 4 of the multi-study paper by Trautwein et al., 2015), whereas the other three studies used the BFI (Study 1 by Trautwein et al., 2015; Rieger et al., 2022; Song et al., 2020) to assess conscientiousness.

The BFI was also used in Study 1 of this dissertation, which found support for the CONIC model. In Study 3, we used the NEO-FFI, where no effect of conscientiousness was found. In Study 2, we used the longer version of the NEO-FFI, the NEO-PI-R. We found a negative interaction effect between conscientiousness and interest but no main effect of conscientiousness. However, because the NEO-FFI has been shown to be applicable to the CONIC model, and both the NEO-PI and NEO-FFI have been extensively validated (e.g., Costa & McCrae, 2008; Hull et al., 2010; Spence et al., 2012; Young & Schinka, 2001), it is not plausible that the results are due to insufficient construct validity. Instead, it is more likely that they are due to other research characteristics that differ across studies.

In Study 4, we employed the *Teacher Personality Adjective Scales* (LPA; H. Brandstätter & Mayr, 1994), a personality questionnaire specifically designed for teachers. Unlike the other measures, the LPA does not rely on typical statements and Likert scales but instead uses contrasting pairs of adjectives to assess personality. The LPA has been shown to have moderate correlations of $r = .45$ with the NEO-FFI and $r = .64$ with the NEO-PI-R (Mayr, 2003). For conscientiousness, the LPA includes three items, which was shortened to two for the analyses in Study 4 due to poor model fit. Study 4 found no effect of conscientiousness, which could be attributed to the fact that the LPA focuses on the facet of self-control and does not capture other facets of conscientiousness, such as achievement striving (like the NEO questionnaires or the BFI does). However, the lack of a conscientiousness effect could also be due to factors like a different sample (i.e., adults) or a different context (i.e., occupational). Future research is needed to empirically test which facets are most relevant to the CONIC model. It should use a comprehensive questionnaire, such as the NEO-PI-R, combined with other research characteristics already confirmed for the CONIC model. Then, the predictive power of each conscientiousness subfacet should be assessed separately to gain deeper insights into the predictive role of the subfacets within the CONIC model.

Study 1 extended the CONIC model to include grit as a construct instead of conscientiousness. Grit was measured using the Grit-S scale (Duckworth & Quinn, 2009). The study's results showed that the compensatory relation also occurs when grit is substituted for conscientiousness. Previous studies on grit have indicated that there is a nearly complete overlap between the two constructs (e.g., Ponnock et al., 2020), raising questions about the usefulness of the grit construct itself. Nevertheless, it can be stated that the CONIC model can be extended to include grit as a predictor instead of conscientiousness.

Interest

In the previous studies on the CONIC model, interest was investigated across different school domains. In five of the six previous studies, individual interest was examined, while situational interest was examined in the other study (i.e., Study 4 in Trautwein et al., 2015). Most of the measures used were self-developed and comprised one to seven items regarding each of the assessed interest domains. The items primarily focused on the intrinsic value derived from engaging in the different subjects. For example, a sample item is *I enjoy dealing with the topics in [subject]* (developed by Gaspard et al., 2015 and used in the study of Song et al., 2020). Each of the studies in this dissertation used different measures of interest.

In Study 1 of this dissertation, interest in mathematics or science was assessed by the two items referring to interest from the task value subscale of the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991). A sample item is *I am very interested in the content area of this course.*

In Study 2, interest was assessed four times with respect to the topic of the respective learning task, as well as once with respect to the subject area of the learning task. In each case, one or two items were used. A sample item is *How interesting do you find this topic*?

In Study 3, the interestingness of the task was manipulated. One statistical approach used the treatment condition to which the person was assigned (boring task vs. interesting task) as an indicator of interest. Another statistical approach used a pre-task measure of interest consisting of two items (e.g., *How interesting do you find this task?*).

In Study 4, interest was operationalized in relation to the teaching profession, but at different levels: teachers' general interest in teacher activities (GIT), interest measures for specific areas of teacher activities (IAT), and teachers' interest in professional development (IPD). The different interest measures were all operationalized by items of the teachers' interest questionnaire (LIS; Mayr, 1998), which contained items referring to five different areas of teacher activities. GIT was calculated as the sum score of ratings across the five different areas of activities. The different IAT measures were generated based on the respective interest ratings for the different areas of teacher activities. IPD was calculated based on the ratings for the area of teacher activities *professional development*.

In conclusion, regardless of the various operationalizations and conceptualizations used (i.e., situational, topic, individual), interest has consistently been shown as a robust positive predictor of the various effort-related measures used. According to the theoretical framework

of the CONIC model, measures should work if the part responsible for the assumed "pull" factor within interest is represented in the operationalization. For the present measures, it can be assumed that this is true for all of them, as they are very specific to the core of interest (i.e., interest/enjoyment related to a specific domain). Furthermore, Study 2 indicates that the effects of interest within the CONIC model can be most effectively captured when the level of aggregation of the interest measure aligns with the aggregation level of the outcomes. This can be explained by the general principle of Brunswik symmetry, which suggests that the empirical correlation between two constructs underestimates the true correlation when the constructs' aggregation levels do not match (Kretzschmar et al., 2018). In the present studies, this is taken into account with the exception of one of the interest measures in Study 3. Apart from that, all are at a similar level of aggregation and relate to the same specific domain as the outcome to be predicted.

With respect to alternative constructs related to interest, Study 1 replicated a finding on utility as a substitute for interest and extended the CONIC model to include overall total task value as another substitute for interest. However, despite confirmed replication and extension, the predictive connections were not as strong as those for interest. This supports the theoretical assumption that it is the pull component that matters most, which is highest for interest compared to the other constructs. Overall, these results support the tested value components with respect to the robustness of the CONIC model for predicting effort and school grades.

Effort

Previous studies assessed effort by self-report with four to eight items regarding each domain. The items used were adapted from Trautwein and Köller's (2003) scale designed to measure homework effort. A sample item is *I do my best when it comes to [subject]*. One study (i.e., Study 4 of Trautwein et al., 2015) specifically addressed homework effort (*I did my best to answer all of the questions*), and another study operationalized academic effort through homework compliance (i.e., Study 2 of Trautwein et al., 2015; e.g., *I do my best when it comes to [subject] homework*).

In Study 1 of this dissertation, effort was measured using the four items from the effort regulation subscale of the MSLQ (Pintrich et al., 1991). A sample item is *I often feel so lazy or bored when I study for this class that I quit before I finish what I planned to do.* The results of this study replicated the predictive pattern of the CONIC model.

In Study 3, the self-reported effort measure consisted of seven adapted items similar to those used in previous studies on the CONIC model (e.g., *When working on the task, I put a lot*

of effort into it). In addition, more indirect and behavioral indicators of effort were included. Participants were asked how many more tasks they were willing to complete, as well as whether they reviewed their solution again. Additionally, the time they spent working on the task and the time they took to review the task were recorded. However, in this study, the CONIC pattern did not appear in the prediction of any of the outcomes.

In addition to examining effort as an outcome, Song et al. (2020) extended the CONIC model to include academic achievement (i.e., school grades). We were able to replicate this finding in Study 1. In Study 2, we used performance scores on different learning tasks as an outcome. We found a negative interaction effect as well as a positive main effect of interest in predicting lab-based performance but no main effect of conscientiousness. Study 4 examined teachers' intensity of professional development as an outcome. As participation in professional development activities requires teachers' effort, we had the assumption that the compensatory relation between interest and conscientiousness also exists at the teacher level when predicting teachers' intensity of professional development. However, this assumption could not be confirmed: Although there were positive main effects of interest, there were no positive main effects of conscientiousness and no interactive relationships found.

The range of effort and performance measures examined in previous and present studies on the CONIC model differ primarily in terms of the stakes involved and the time period over which they are aggregated. High-stakes outcomes (i.e., those with significant consequences for the individual, such as academic effort assessed in real classrooms) on a high aggregation level (e.g., effort in a respective subject in general) or across a relatively long period of time (e.g., grades at the end of the school year) were used in five out of the six previous studies on the model. This is also true for this dissertation's Study 1, which fully supports the CONIC model. Study 4 by Trautwein et al. (2015) also used a high-stakes outcome but covered a shorter time period (i.e., diary study after homework completion). The learning tasks in Study 2 of this dissertation are comparable in time to a homework assignment but can be seen as a more low-stakes assessment. The effort assessments in Study 3 of this dissertation are even more low-stakes and shorter in time. Study 4 of this dissertation covers a large time span but uses a low-stakes outcome, as there are no consequences for teachers with low PD intensity. Overall, the pattern of results suggests that conscientiousness is positively related to high-stakes outcomes but not necessarily to low-stakes outcomes.

Moreover, Study 2 revealed differences between self-reported effort and other measures of effort, such as behavioral and indirect measures, which raises concerns about potential

common method variance. However, as the CONIC model has also been found to hold for externally assessed school grades, it is plausible that the effect is not solely driven by shared method variance.

Taken together, the best evidence for the CONIC model comes from studies using high-stakes outcomes over a longer time period or a higher level of aggregation. The longer time period and the higher level of aggregation may also be related to the concepts of maximum and typical performance (Sackett et al., 1988; see also 7.2.1).

7.2.4 Contexts

All previous studies on the CONIC model were conducted in Western European and German-speaking school settings, meaning they were conducted in natural contexts. These societies are more individualistic (as opposed to collectivistic) and place high value on academic achievement for future success (e.g., Hofstede, 2001). Furthermore, all previous studies focused on observing naturally occurring events, indicating low external control of the situations studied. The school context is clearly performance-oriented and offers hardly any alternative choices.

Study 1 of this dissertation used the same setting but transferred it to the U.S. and found support for the CONIC model. The U.S. is also an individualistic society that values school achievement for future opportunities, but there is more choice in the selection of courses. These results suggest that the CONIC model is not limited to German-speaking and Western European school systems.

For the other contexts examined in this dissertation, there is either no or weaker support for the CONIC model, as the conscientiousness effect could not be found. Previous research suggests that factors of the context play a central role in this regard. More specifically, the external control or autonomy of the context is discussed as a major factor influencing the predictive validity of conscientiousness (see also 1.1.1). Specifically, previous empirical evidence indicates that conscientiousness may be more relevant in situations characterized by low external supervision or control, but high autonomy (Barrick & Mount, 1993; Trautwein et al., 2006; Trautwein & Lüdtke, 2007).

In the laboratory setting (Study 2), participants had no option but to work on the learning tasks; the only alternative was to wait out the time. Therefore, we can assume that the highly controlled external situation supported all participants to behave conscientiously. In the online

experimental setting (Study 3), an attempt was made to reduce external control by not specifying the processing time. However, it is inherent in experimental study designs that conditions are predetermined and controlled. As a result, the task objectives were predefined, and the procedures were clearly structured, which nevertheless led to a relatively high degree of external control and low autonomy in Study 3.

Study 4 was conducted in Austria, a Western European, German-speaking context, and took place in a natural setting. However, neither a positive conscientiousness effect nor a negative interaction effect, as predicted by the CONIC model, was found. Considering the differences between the context in Study 4 and the school context in previous studies, it becomes apparent that, whereas the school context is only partially chosen out of interest and is clearly performance-oriented, teacher professional development activities are self-selected and not primarily performance-oriented. This difference in the context may have contributed to the lack of a conscientiousness effect and to an altered interplay of conscientiousness and interest in Study 4.

Taken together, the results of all four studies suggest that the CONIC model works best in a natural achievement context that involves high autonomy and low external control and where participation is not entirely voluntary or driven by interest.

7.3 Implications for the CONIC Model

In this dissertation, results from previous studies for utility value replacing interest and school grades replacing effort were replicated, adding credibility to these findings. Additionally, the scope of the CONIC model was extended to include grit as a substitute for conscientiousness and overall task value as a substitute for interest, as well as to include older students and the U.S. as another culture. The dissertation also provides partial support for the compensatory relation in predicting lab-based task performance. Moreover, when exploring generalization across different research characteristics, some findings were inconsistent with the assumptions of the CONIC model. These inconsistent results indicate that the model is not perfectly robust, for example, across different study designs and provide insights into potential boundary conditions (Nosek & Errington, 2020). These will be further explained as they relate to samples, study designs, measures, and contexts in the following paragraphs.

The results suggest that adulthood may be a potential boundary condition for generalizing across samples. From a theoretical perspective, this may not be the most reasonable explanation (for more details, see also 7.2.1), but there are also some good arguments suggesting that the compensatory interaction between interest and conscientiousness is not a fixed general phenomenon, but evolves over the trajectory of development. Consequently, it would be imperative to incorporate a developmental perspective within the CONIC model. However, the specific question of whether the CONIC model also holds for adults is most straightforward to test, so future studies are expected to provide an answer.

In terms of generalizing the CONIC model across study designs, current evidence suggests that it has only been fully supported in observational studies. However, this may be due to the concurrent variation of measures and contexts in these studies, which provides plausible explanations for the observed inconsistencies.

Regarding generalization across measures, the CONIC model is robust across the quite heterogenous interest measures. Partially non-significant effects of conscientiousness are more likely due to variations in other study characteristics rather than to the measures used. To gain further insights, the sub-facets of conscientiousness should be considered in future investigations of the CONIC model. The critical aspect seems to be the operationalization of effortful behavior. It may be that only outcomes that capture "typical effort or performance" (as opposed to maximum effort or performance) work for the CONIC model. In technical terms, it may be that only high-stakes outcomes covering a longer time period and at a higher level of aggregation work for the CONIC model. A methodological explanation could involve the

violation of the Brunswik symmetry principle (Kretzschmar et al., 2018). Study 2 suggests that the main effect of interest depends on the same level of operationalization for both interest and the outcome. Likewise, in two of the dissertation's studies there is a mismatch in the hierarchical level between conscientiousness and the respective outcomes, which may result in underestimation of the true effects.

Regarding generalization across contexts, the results may indicate the need for an achievement setting as a boundary, which is also theoretically supported (i.e., conscientiousness promotes effort by setting achievement-related goals). The CONIC model may not be applicable to settings that are entirely voluntary or chosen solely out of interest. A rather evident boundary condition, which is also theoretically and empirically supported by previous studies, is the validity of the CONIC model exclusively for situations with high autonomy and low external control, which implies a need for self-regulating behavior.

A more general implication, derived from the results of this dissertation, concerns the predictive power of interest for effortful behavior. Across all generalization and extension studies included in this dissertation, one result was consistent: no matter the conscientiousness effect, interest is a powerful predictor of various effort-related outcomes, such as self-reported effort, school grades, task achievement, PD intensity, and indicators of effortful behavior, regardless of its operationalization. This finding holds across various samples, study designs, measures, and contexts. The evidence on boundary conditions derived from this dissertation relates specifically to the predictive validity of conscientiousness and the negative interaction effect proposed by the CONIC model.

In the following, these empirical findings are integrated into the theoretical rationale of the CONIC model to expand and refine it with more nuanced insights into the conditions under which the mechanisms operate.

The interest-driven path acts as a pull factor that prompts positive affectivity, which then leads to a self-reinforcing process. This pull factor is fuelled by the learning process itself and the associated positive emotions, rather than by an orientation towards the outcome. This makes the activation of this path dependent on the domain, but not on the outcome. The domain can be addressed in any area, so this path works independently of outcome and context. Thus, the key insight lies in recognizing that while the interest-driven process is more specific (as it relates to a domain), it also boasts broader functionality and increased robustness.

In comparison, the conscientiousness-driven path demonstrates a greater reliance on contextual factors, yielding insights into its operational mechanisms. The path via conscientiousness toward academic effort is driven by an orientation toward the outcome rather than the learning process itself (Sansone et al., 2010). As a result, this path is heavily dependent on the nature of the outcome. Emotions do not play a significant role; instead, cognitive appraisal processes are more relevant. Consequently, the activation of the conscientiousness-driven path is strongly influenced by the individual's self-set goals and the context. The conscientiousness effect operates by individuals setting higher goals and challenges for themselves, making it specific to achievement contexts where goals can be freely set and appear worthwhile. Given that the conscientiousness effect is demanding and particularly evident in longer-term outcomes at a higher aggregation level, it suggests that it operates not through increased activity intensity but through sustained persistence over time. Furthermore, conscientiousness proves particularly advantageous when it comes to resisting distractions and temptations. This means the level of conscientiousness makes a difference when distractions and temptations are present in the setting, creating a conflict between what would be enjoyable and what would be functional for achieving a long-term goal.

On a broader level, it is conceivable that the CONIC model does not represent a universal framework for understanding the relationship between constructs, but rather functions as a developmental model that describes the interaction within a specific developmental phase. This suggests that the applicability of the CONIC model may be constrained to a particular developmental stage, evolving and resulting in a different interplay over time. This developmental stage could be adolescence because during this phase significant development in conscientiousness and interest takes place, along with related constructs that underlie their driving forces (for more details see 7.2.1). These specific trajectories lead to a specific level of capabilities and maturational imbalance between the constructs which may represent an especially critical phase for the processes underlying the CONIC model.

7.4 Strengths and Limitations

A major strength of the present work lies in its general objective: the generalization and extension of a model. The studies do not focus on novelty or new discoveries but rather on replicating, generalizing, and extending previous findings to advance scientific knowledge and improve the quality of research. This approach helps to build confidence in earlier findings by the fact that the same results can be obtained using similar as well as varied methods. Moreover, these findings help to identify boundary conditions and determine the extent to which the model can be generalized across other research characteristics. This approach is further strengthened by the use of open science practices, such as pre-registration and open materials, which enhance transparency and rigor and build even greater confidence in the validity of the findings. Furthermore, open science also makes it easier for other researchers to replicate the studies, which can contribute to even more and better evidence for the CONIC model in the future.

In all studies conducted on the CONIC model, the primary focus has been on assessing the presence of the compensatory relationship proposed within it, aiming to depict and generalize the phenomenon (see Figure 5). Existing findings enable hypothetical inferences regarding the model's theoretical rationale, but empirical investigation has not yet directly addressed the underlying explanatory mechanism. This represents a limitation in the consolidation of the CONIC model.

However, the main limitation of this dissertation's significance is that the research characteristics vary unsystematically between the included studies. As the conditions were not constant in each case, no clear statements about specific boundary conditions can be derived from the studies. Instead, only hypotheses and assumptions about the influencing factors that depend on the varied research characteristics can be generated, providing direction for future research. Thus, it is important to note that the dissertation's results are an important part of the scientific process, but further investigations are necessary to fully understand their significance and implications.

7.5 Implications for Future Research

Thus far, the results suggest that in further research on the CONIC model, it would be particularly worth focusing on the role of external control, the sample of adults, the time dimension and relevance of the outcome as well as treatment, and whether the setting is self-selected or not. For this purpose, future studies should systematically vary the research characteristics under investigation while keeping the others constant.

To directly explore the assumed theoretical mechanisms of the CONIC model, conducting studies that specifically target the underlying processes is necessary. For example, incorporating measures of exertion would help to investigate the assumption that the interest-driven path does not feel effortful, while the conscientiousness-driven path feels strenuous. In this regard, research could also include qualitative methods for data collection, such as interviews following a task, exploring the question of "why?" regarding a completed task (i.e., "why did you exert effort or not?"). Furthermore, methods like "think-aloud" protocols could be employed to gain insights into the different cognitive appraisal processes involved. Employing within-subject designs in these kinds of studies could provide insights into the processes involved in an interesting task compared to a less interesting one.

In general, the evidence on boundary conditions derived from this dissertation relates specifically to the predictive validity of conscientiousness and the negative interaction effect proposed by the CONIC model, whereas interest was found to be a robust predictor for the effort-related outcomes used in the studies. Hence, it seems most beneficial to focus in future research on the underlying mechanisms and conditions for conscientiousness as well as the interplay of the two constructs. This will also contribute to the theoretical foundation of the CONIC model and help provide a better understanding of the CONIC mechanism and its boundaries.

7.6 Conclusion

The current dissertation provided further evidence and directions for refining the CONIC model. Four empirical studies examined the replication, generalization, and extension of the CONIC model across different samples, study designs, measures, and contexts. The findings from these four empirical studies on the CONIC model were evaluated in terms of their implications for further consolidation or identification of boundary conditions of the CONIC model.

On a broader level, the dissertation demonstrates that replication, generalization, and extension studies applying open science practices are theoretically and empirically valuable as well as necessary approaches for gaining deeper insights into the robustness of proposed assumptions and relevant influencing factors. The four studies included in this dissertation provide additional knowledge on the CONIC model and its proposed mechanisms. They add various perspectives on potential influencing factors and boundary conditions. Therefore, they offer directions for further empirical research and theoretical considerations.

In conclusion, the contributions of this dissertation lead to an expanded and more reliable empirical foundation on the interplay of interest and conscientiousness in predicting effort-related outcomes. The additional empirical findings provide theoretical refinement, particularly regarding the presence of boundary conditions, which contributes to a better theoretical foundation. Together, these are the foundations of sound science to inform practice based on reliable scientific evidence.

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