From School to Work – Examining Conscientiousness, Intelligence, and Self-Esteem in Academic and Professional Settings

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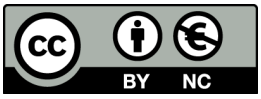

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Summary

Undoubtedly, intelligence is an important predictor of academic performance and, to a lesser extent, is also linked to professional success (e.g., Roth et al., 2015; Strenze, 2007). However, non-cognitive factors have gained increasing importance in explaining academic performance and other crucial life outcomes. For instance, meta-analytical studies have found positive correlations between academic performance and the Big Five personality traits of agreeableness, conscientiousness, and openness, with conscientiousness showing a particularly strong correlation (Poropat, 2009). Conscientiousness not only influences academic performance but is also related to various other outcomes, such as health, professional outcomes, and marital outcomes (Roberts et al., 2007). Nevertheless, conscientiousness is not the only personality trait with a positive impact on multiple life domains. Self-esteem, for example, affects educational and professional success, job satisfaction, health, and relationship satisfaction (Orth & Robins, 2014, 2022).

Building on this, the dissertation pursues two aims: First, to investigate the contribution of non-cognitive factors (specifically conscientiousness) to academic performance, particularly in interaction with intelligence. Can conscientiousness compensate for lower intelligence, or do these constructs reinforce each other's positive effect on performance?

Second, given the positive influence of non-cognitive factors on life outcomes, this dissertation examines the development of conscientiousness and self-esteem during the formative stages of adolescence and young adulthood, including factors that influence this development. Special focus is placed on intelligence and career entry: like conscientiousness, intelligence is a very important predictor of academic performance, and its interplay with conscientiousness presents substantial, unexplored potential for explaining individual differences in conscientiousness trajectories. Self-esteem responds to life transitions, such as starting a career in young adulthood. Successfully mastering this important developmental task could enhance self-

esteem trajectories. Therefore, career entry also holds considerable potential for personality change.

To achieve these aims, the dissertation comprises three papers. The first paper examines whether conscientiousness can compensate for intelligence in predicting school grades. Both intelligence and conscientiousness are known to be related to academic performance, yet the interplay between these two factors has been interpreted and explained differently across various papers, with some disagreement on whether conscientiousness can indeed compensate for lower intelligence.

To provide further insight, the first paper conducted latent moderation analyses using data from a sample of 3775 high school graduates from the LISA6 study (Kampa et al., 2020). The findings revealed positive main effects of both intelligence and conscientiousness on school grades in German, Math, Biology, and English (as a foreign language), as well as synergistic interactions for the first three subjects. The association between conscientiousness and grades in German, Math, and Biology was especially strong among more intelligent students, indicating that these students benefitted particularly from being conscientious. Interestingly, the effect of conscientiousness on Biology grades was especially pronounced in intelligent male students, whereas the relationship between conscientiousness and Biology grades did not differ across intelligence levels for female students.

This suggests that rather than compensating for lower intelligence, conscientiousness enhances the positive effect of intelligence on academic performance. Nevertheless, both intelligence and conscientiousness positively predicted academic performance, and the study only examined the cross-sectional relationship between these variables. According to the intelligence compensation hypotheses (ICH; Moutafi et al., 2003, 2004), individuals develop greater conscientiousness as a means of compensating for lower intelligence, which suggests that longitudinal analyses focused on conscientiousness change over time could provide further insight.

This methodological issue was addressed in the second paper, which analyses conscientiousness change during adolescence using longitudinal data. The current state of research indicates that conscientiousness, like other mature personality traits, increases during adolescence and young adulthood (e.g., Bleidorn, 2012; Van den Akker et al., 2014). However, less is known about the underlying reasons for this developmental trajectory, and intelligence has largely been overlooked in explaining individual differences in conscientiousness change. Does conscientiousness increase to compensate for lower intelligence or are these increases independent of intelligence?

To explore this question, the second paper examines adolescents' conscientiousness trajectories from ages 12/13 to 18/19 using data from the German National Educational Panel Study Starting Cohort 3 (NEPS SC3; NEPS Network, 2021). Latent Change Models revealed no clear pattern of change in early adolescence but showed an increase in conscientiousness during late adolescence. Reasoning negatively influenced conscientiousness change in early adolescence; that is, students with lower reasoning exhibited stronger increases in conscientiousness. Interestingly, this effect was again more pronounced in boys than in girls. In contrast to the findings of the first paper, the second paper provided evidence that conscientiousness can indeed partially compensate for intelligence – in this case, for reasoning.

However, conscientiousness is not the only non-cognitive factor that positively influences various important life outcomes. Individuals' self-perception also plays a significant role in many different aspects of life. As mentioned earlier, self-esteem impacts, among others, relationship satisfaction, physical and mental health, academic performance, and success and satisfaction in the workplace (Orth & Robins, 2014, 2022). As with conscientiousness, little research has focused on factors that account for individual differences in self-esteem trajectories. In general, life transitions are considered catalysts for personality changes (Reitz et al., 2020), with starting a career being a particularly important milestone in young adulthood.

Therefore, the third paper examines self-esteem change during career entry, with a specific focus on success at career entry and job investment. The analyses are based on nearly 2000 young adults from the Pairfam study (Brüderl et al., 2022; Huinik et al., 2011). The study revealed that career entry, as well as the age at which individuals entered their careers, influenced self-esteem trajectories. Self-esteem declined before career entry and increased thereafter – though this increase was only observed in individuals who entered their career at an average or late age. Success at career entry (measured by factors such as job satisfaction, high income, and a well-respected occupation) further boosted self-esteem change after career entry for those who began their career at a young or average age. In contrast, for late entrants, career entry itself was the primary factor driving changes in self-esteem.

The present dissertation aims to emphasize that intelligence alone is not decisive for academic and professional success; non-cognitive factors should also be considered in recruitment and other selection processes. In addition, the dissertation is intended to highlight that a successful career entry can positively influence young adults' self-esteem, which, in turn, impacts numerous life outcomes.

Preamble

The present cumulative dissertation comprises three self-contained papers. Each paper can be read independently and has been submitted to a different scientific journal. In all papers, I contributed substantially to the study conception, design and methodology, data analyses, visualization, and writing.

Paper 1:

Friedrich, T. S., & Schütz, A. (2023). Predicting school grades: Can conscientiousness compensate for intelligence? *Journal of Intelligence*, *11*(7), 146. https://doi.org/10.3390/jintelligence11070146

Paper 2:

Friedrich, T. S., & Schütz, A. (2025). Changes in conscientiousness during adolescence – the role of intelligence. *Personality Science*, *6*. https://doi.org/10.1177/27000710241309790

Paper 3[1]:

Friedrich, T. S., & Schütz, A. (under review). Self-esteem change during career entry. *Journal of Adult Development*.

Further Publications:

Friedrich, T. S., & Galkiewicz, A. D. (2024). Adult lifelong learning: Cross-country comparison with a focus on Germany. *IAB-Forum*. https://doi.org/10.48720/IAB.FOO.20240221.01

Friedrich, T. S., Janssen, S., & Laible, M.-C. (2022). Ungenutzte Chance: Digitale Weiterbildung im ersten Corona-Lockdown. *IAB-Forum*. https://doi.org/10.48720/IAB.FOO.20220816.01

[1] The paper is based on my master's thesis, which I completed at the University of Tübingen. For the dissertation, I fundamentally revised the statistical analysis and used different data.

Friedrich, T. S., Laible, M.-C., Müller, C., Pollak, R., Schongen, S., Schulz, B., & Vicari, B. (2022). Digitalisierung der Arbeitswelt – ein Messinstrument der NEPS-Erwachsenen-befragungen. *NEPS Survey Papers*. https://doi.org/10.5157/NEPS:SP92:1.0

Friedrich, T. S., Laible, M.-C., Pollak, R., Schongen, S., Schulz, B., & Vicari, B. (2021). Grasping digitalization in the working world. *Soziale Welt*, *72*(4), 415–452. https://doi.org/10.5771/0038-6073-2021-4-415

Friedrich, T. S., & Vicari, B. (2023). The digitalization boost of the Covid-19 pandemic and changes in job quality. *Social Inclusion*, *11*(4). https://doi.org/10.17645/si.v11i4.7082

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Chapter 1: Introduction

Intelligence is undoubtedly an important predictor of academic performance (see Roth et al. (2015) for a meta-analysis). As early as the beginning of the 20th century, Binet and Simon, commissioned by the French Ministry of Education, developed methods to identify students with special needs. They later published the resulting exercises as the first intelligence test. Thus, the original aim of the first intelligence test was to differentiate children according to their academic performance (Hagemann et al., 2023).

However, it is not only intelligence that influences (academic) performance and success – non-cognitive factors, such as the Big Five personality trait of conscientiousness (e.g., Poropat, 2009) and self-esteem (e.g., Orth & Robins, 2014, 2022), also affect academic performance and numerous other important life outcomes.

In general, "[p]ersonality traits are the relatively enduring patterns of thoughts, feelings, and behaviors that reflect the tendency to respond in certain ways under certain circumstances" (Roberts, 2009, p. 140). The present dissertation focuses on two personality traits – conscientiousness and self-esteem.

Alongside openness, extraversion, agreeableness, and neuroticism, conscientiousness is one of the Big Five personality traits. Conscientious individuals lead organized and disciplined lives; they plan tasks in detail and are persistent, orderly, diligent, reliable, dutiful, punctual, and hard-working (e.g., Hagemann et al., 2023).

In contrast, self-esteem is an attitude towards oneself based on subjective evaluations of one's worth. It reflects whether individuals perceive themselves as valuable and adequate (Donnellan et al., 2011; Rosenberg, 1965).

Conscientiousness and self-esteem are both dynamic constructs that change throughout life. For instance, conscientiousness tends to decrease in early adolescence and then increase from late adolescence onward (Roberts et al., 2006; Van den Akker et al., 2014). Self-esteem follows a quadratic trajectory, increasing from adolescence to middle adulthood, peaking around ages 50-60, before declining again in old age (Orth et al., 2015; Orth & Robins, 2014).

Personality change in adolescence and adulthood can be explained by several mechanisms. A prominent theory in this context is the social investment principle (Roberts et al., 2005), which attributes personality change to investment in age-specific social roles. According to this principle, individuals commit to social institutions such as work or family by adopting social roles. These roles entail behavioral expectations and corresponding reward structures: behavior that aligns with expectations is rewarded, while deviation is discouraged. To meet these expectations, individuals often adjust their personalities. Initially, this altered behavior influences the specific role identity and over time, becomes internalized and generalizes to other areas of life (Roberts et al., 2005; Roberts & Wood, 2006). The social investment principle posits that it is the degree of commitment to (new) social roles, rather than the mere presence of these roles, that drives personality change. Thus, personality changes according to the level of commitment to new roles, resulting in individual differences in personality development based on the degree of investment in social roles (Lodi-Smith & Roberts, 2007; Roberts et al., 2005).

Havighurst (1966) offers a different perspective on personality change, focusing on developmental tasks. Developmental tasks comprise age-specific challenges that individuals are expected to master to achieve satisfaction and success in subsequent tasks (Havighurst, 1966). Social and societal expectations are important in determining which tasks should be accomplished and at what age. Successful mastery of these tasks offers developmental success, satisfaction, and social rewards (Freund & Nikitin, 2018; Neugarten, 1972). Self-esteem reflects developmental success and thus depends on the successful completion of developmental tasks (Reitz et al., 2020).

In summary, personality change is driven by investment in new social roles and the successful mastery of developmental tasks. Personality adapts to meet social expectations, either through role investment or by fulfilling developmental tasks. This dissertation focuses on deviations from normative change trajectories to identify their origins and to better understand

individual differences in personality development. In line with the second paper, it could be argued that intelligent students may invest less in the social role of "student" because high achievement may not require such investment for these students. Reduced investment in school could result in a smaller increase in conscientiousness. The third paper examines career entry as both a new social role and a developmental task in young adulthood, highlighting its substantial potential for fostering personality change.

Outline

The present dissertation contains three papers that examine different cognitive and non-cognitive predictors of performance in varying educational and professional settings. The individual papers are self-contained and can be read independently of one another.

Whereas the relationship between intelligence and conscientiousness with performance is already well-researched, it remains unclear how personality and intelligence interact in predicting performance, and whether this relationship differs by domain or school subject and gender. These open questions were addressed in the first paper of the dissertation. The paper is based on the intelligence compensation hypothesis (ICH; Moutafi et al., 2003, 2004), which suggests that individuals become more conscientious to compensate for lower intelligence. More intelligent individuals can rely on their intelligence to handle daily challenges and specific tasks, reducing their need to be conscientious. The paper investigates 3775 13th-grade students from Germany using latent moderated regression analyses.

According to the ICH, intelligence influences changes in conscientiousness. Therefore, the second paper of this dissertation examines conscientiousness trajectories using longitudinal data, with intelligence as a predictor of change. More precisely, I analysed latent change models with data from the German National Educational Panel Study (NEPS, SC3; NEPS Network, 2021) that includes 7122 students who were repeatedly surveyed between the ages of 12/13 and 18/19.

By now, personality change – respectively that personality changes – in adolescence and (young) adulthood is relatively well-researched. In contrast, the reasons for personality change are less researched, making it particularly relevant that this dissertation explores potential causes of personality change in its second and third papers. As noted, the second paper examines intelligence as a predictor of conscientiousness change. The third paper takes a different perspective: Personality is particularly susceptible to change during life transitions, such as starting a career in young adulthood (Reitz et al., 2020). Consequently, the third paper examines self-esteem change at career entry, focusing on the role of career success and job investment – factors that have not been previously explored in this context. For this purpose, I selected nearly 2000 young adults from the Pairfam study (Brüderl et al., 2022; Huinik et al., 2011) and examined their self-esteem trajectories during career entry using latent growth curve models.

After presenting the three papers, I integrate their results in a general discussion, followed by a consideration of the implications, limitations, and directions for future research, before concluding the dissertation.

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Chapter 2: Predicting School Grades: Can Conscientiousness Compensate for Intelligence?

Journal of *Intelligence*

MDPI

Article

Predicting School Grades: Can Conscientiousness Compensate for Intelligence?

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Abstract: Intelligence and noncognitive factors such as conscientiousness are strongly related to academic performance. As theory and research differ with respect to their interplay in predicting performance, the present study examines whether conscientiousness compensates for intelligence or enhances the effect of intelligence on performance in 3775 13th grade students from Germany. Latent moderation analyses show positive main effects of intelligence and conscientiousness on grades. Further, analyses reveal synergistic interactions in predicting grades in biology, mathematics, and German, but no interaction in predicting grades in English. Intelligence and grades are more strongly linked if students are conscientious. Multigroup models detected gender differences in biology, but no differences with respect to SES. In biology, conscientiousness has especially strong effects in intelligent men. Conscientiousness thus enhances the effect of intelligence on performance in several subjects.

Keywords: intelligence; conscientiousness; school grades; LMS; gender

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1. Introduction

Good grades in high school and university are an important starting point for a successful life. Grades determine whether students receive their preferred study or training place, and thus whether they can pursue their desired profession. Furthermore, grades predict university dropout (Behr et al. 2020) and are related to salary (Roth and Clarke 1998), job performance (Roth et al. 1996), and life satisfaction (Ng et al. 2015). However, how do students achieve good grades?

Intelligence is an important positive predictor of academic performance (e.g., Roth et al. 2015). However, in addition to intelligence, various socioemotional skills, such as subject-specific interests (Schiefele et al. 1993), self-concept (Huang 2011), self-efficacy (Multon et al. 1991), grit (Lam and Zhou 2021), or the Big Five personality traits, have an impact on academic performance.

Conscientiousness is especially relevant, as it is the strongest predictor of academic performance among the Big Five (Poropat 2009). According to Lechner et al. (2017), conscientiousness accounts for approximately as much variance in grades as intelligence does. It facilitates learning, as conscientious individuals are particularly ambitious, organised, reliable, hard-working, persistent, and disciplined (Bergold and Steinmayr 2018; Dumfart and Neubauer 2016). To summarize, both intelligence and conscientiousness influence academic performance, but do the two constructs interact in their influence on performance?

1.1. The Interplay of Intelligence and Conscientiousness in Predicting Performance

The effects of intelligence and conscientiousness on performance could take various forms. First, it is possible that intelligence and conscientiousness have independent effects on performance. Second, intelligence and conscientiousness might reinforce each other as a synergistic interaction, such that intelligent individuals particularly benefit from being

conscientious. Third, the effect could be compensatory, such that less intelligent people benefit particularly from being conscientious.

The intelligence compensation hypothesis supports the idea of compensation, and suggests that less intelligent individuals become particularly conscientious, i.e., organised, thorough, persistent, and systematic, to compensate for a lack of intelligence. In contrast, intelligent individuals do not need to improve their conscientiousness because they can rely on their intelligence to master most tasks (Moutafi et al. 2003, 2004). Some studies found a negative correlation between intelligence and conscientiousness in line with the intelligence compensation hypothesis (e.g., Moutafi et al. 2003; Rammstedt et al. 2016), but most studies and meta-analytical results indicate no significant correlations (e.g., Ackerman and Heggestad 1997). For example, in a recent meta-analysis, Anglim et al. (2022) concluded that intelligence and conscientiousness are not correlated overall. However, they found negative correlations between intelligence and conscientiousness facets that focus on organization and order, and positive correlations with the competence facet.

Many studies that investigated the relationship between intelligence and conscientiousness did not test their relation to academic performance, and less attention has been given to possible interactions (Bergold and Steinmayr 2018). To our knowledge, seven studies thus far have investigated the interaction of intelligence and conscientiousness in predicting academic performance in twelve independent samples (Beaujean et al. 2011; Bergold and Steinmayr 2018; Brandt and Lechner 2022; Di Domenico and Fournier 2015; Meyer et al. 2022; Zhang and Ziegler 2015; Ziegler et al. 2009). These studies operationalized academic performance either with GPA/other grades or achievement tests. They included participants from fourth grade through university. The results showed a stronger interplay between intelligence and conscientiousness in predicting grades than in predicting achievement tests. All studies that operationalized performance via GPA/other grades showed evidence of synergy (Bergold and Steinmayr 2018; Di Domenico and Fournier 2015; Meyer et al. 2022; Ziegler et al. 2009): intelligent individuals in particular benefited from being conscientious. Most studies that operationalized performance via achievement tests showed no interaction (Beaujean et al. 2011; Brandt and Lechner 2022; Zhang and Ziegler 2015). However, Meyer et al. (2022) investigated four different performance indicators (grades, final exams, achievement tests, and GPA) and found synergistic interactions for all indicators. Furthermore, Ziegler et al. (2009) additionally found a compensatory interaction between intelligence and the conscientiousness facet achievement striving in predicting GPA in low performers.

The added value of the present paper is that we distinguish subjects and consider additional constructs: we calculate multigroup models for gender and SES. Our analyses thus provide new insights into whether the interplay of intelligence and conscientiousness in their effect on performance differs by gender or SES.

1.2. The Role of School Subjects

The demands and learning required vary by subject. Furthermore, the impact of personality traits and cognitive abilities on performance is context specific (e.g., Brandt et al. 2020): Brandt et al. (2020) observed a stronger association of both intelligence and conscientiousness with performance in mathematics than in German. Thus, to investigate the effect of intelligence and conscientiousness on performance, it is important to distinguish subjects. Of the previously mentioned studies with moderation analysis, only Meyer et al. (2022) considered grades in multiple (school) subjects. They found no significantly different interactions for German, mathematics, and English. In our analyses, we additionally consider biology. In contrast to mathematics, German, and English, biology is a subject that requires particularly good preparation. For biology tests, students have to memorize facts and schemes. By contrast, in math tests, students calculate problems. In German and English tests in upper secondary school, students mostly write essays or interpret texts. Thus, biology requires more diligence and preparation—as a consequence, conscientiousness

should be important, which is why the subject is especially interesting when investigating possible compensation effects.

1.3. The Role of Gender

Conscientiousness (e.g., Donnellan and Lucas 2008; Schmitt et al. 2008), as well as school and university grades (e.g., Voyer and Voyer 2014), systematically differ between men and women. Boys dedicate less of their cognitive potential to school performance than girls (Spinath et al. 2010), and gender differences in grades can at least partially be explained by self-discipline and conscientiousness. Achievement tests underpredict the grades of girls and overpredict those of boys. Mediation analyses have shown that self-discipline explains at least partial grade differences between boys and girls (Duckworth and Seligman 2006). It is possible that the interplay of intelligence and conscientiousness also differs between boys and girls. Thus, we performed the analyses separately by gender. Some of the other studies included gender as a covariate in their models (e.g., Brandt and Lechner 2022; Meyer et al. 2022), and observed that women had better grades in languages/higher reading test scores, and men had better grades in mathematics/higher mathematic test scores. Brandt and Lechner (2022) further found higher reading competence gains for girls, and higher mathematics competence gains for boys. We extend that approach in our analyses by conducting multigroup models. Thus, we examine whether the interaction of intelligence and conscientiousness differs between women and men, rather than just controlling for gender.

1.4. The Role of SES

In addition to gender, SES is related to academic performance, but its interplay with intelligence and conscientiousness has not been analysed. We want to address this gap in the present study. High-SES students are more at risk of experiencing intergenerational downwards mobility than low-SES students, especially if their intelligence is low. Low-SES students already achieve upwards mobility when attending upper secondary school. In addition, if SES is very low, it cannot decline much more. Therefore, we expect students who are below average in intelligence, but high in SES, to try exceptionally hard and be especially conscientious. von Stumm (2017) found that high-SES students perform better in school than low-SES students, even when they are less intelligent. Furthermore, conscientiousness and measures of SES correlated positively (Bucciol et al. 2015). However, one can also argue the other way around: low-SES students, especially if they are of at least medium intelligence, make a special effort because they are highly motivated to improve their standard of living. As with gender, some of the studies controlled for SES (e.g., Brandt and Lechner 2022; Meyer et al. 2022). Meyer et al. (2022) did not report specific results on SES, but Brandt and Lechner (2022) found that high-SES students had higher baseline test scores in reading and mathematics, and higher competence gains, than low-SES students. Therefore, we consider multigroup analyses examining different interactions of intelligence and conscientiousness in high- and low-SES students to be of particular interest.

1.5. Present Study

Intelligence is an important predictor of academic performance, but noncognitive factors such as conscientiousness also have an effect on performance. Can conscientiousness compensate for intelligence, or do the two constructs support each other? In other words, do intelligent people benefit more from being conscientious than less intelligent people, or is it the other way round?

Theoretical reasoning, specifically the intelligence compensation hypothesis (Moutafi et al. 2003, 2004), proposes that compensation is possible. However, empirical evidence is ambiguous and partly contrary to this argument. Meta-analyses that investigated the correlation between intelligence and conscientiousness showed negative correlations for some conscientiousness facets, but not a clear overall positive or negative correlation. Interaction analyses indicate that there may be synergistic effects when performance was

operationalized with grades, but no interaction when performance was operationalized with achievement tests. In addition, previous research leaves some questions open: only one study has differentiated between grades across school subjects (Meyer et al. 2022), although the relationship of conscientiousness and intelligence with performance may vary with subject. Furthermore, no study has considered gender and SES via multigroup analyses, although there are gender differences in conscientiousness and grades, and SES is also related to grades.

The present study aims to close these research gaps by examining the interplay of intelligence and conscientiousness in predicting academic performance and considering gender, SES, and school subject. The aim is to shed light on the divergence between theory and research, and therefore to clarify whether conscientiousness can compensate for intelligence or enhance the effect of intelligence on performance.

Hypothesis 1. *Intelligence has a positive effect on academic performance (grades) in all subjects (German, mathematics, English, and biology); we assume the strongest effect for mathematics grades.*

This is in line with Brandt et al. (2020) and B. Roth et al. (2015). Mathematics performance strongly relies on basic cognitive abilities (Rohde and Thompson 2007).

Hypothesis 2. *Conscientiousness has a positive effect on grades in all subjects. We assume that the strongest effect will be found for biology and mathematics grades.*

Students need to study and memorize subject matter to receive excellent biology grades. For mathematics, continuous practice is necessary for performance (Meyer et al. 2019).

Hypothesis 3. *Intelligence is negatively correlated with conscientiousness.*

This is in line with the intelligence compensation hypothesis: people may compensate for a lack of intelligence by being conscientious (Moutafi et al. 2003, 2004). The present empirical evidence does not suggest an overall negative correlation between intelligence and conscientiousness, but a recent meta-analysis showed negative correlations between intelligence and the conscientiousness facets of order and self-discipline. The items used in the present study focus on self-discipline; therefore, a negative correlation is to be expected.

Hypothesis 4. *The intelligence compensation hypothesis (Moutafi et al. 2003, 2004) suggests a compensatory interaction between intelligence and conscientiousness in predicting grades. However, empirical evidence points to a synergistic interaction when performance is operationalized through grades. We therefore formulate competing hypotheses:*)

Hypothesis 4a. *There is a compensatory interaction between intelligence and conscientiousness in predicting grades in all subjects beyond the main effects of either variable.*

Hypothesis 4b. *There is a synergistic interaction between intelligence and conscientiousness in predicting grades in all subjects beyond the main effects of either variable.*[1] *We expect the strongest interaction effects for biology and mathematics.*

Students need to memorize subject matters and practice continuously to perform well in these subjects. Thus, biology and mathematics grades offer the most opportunities for improvement based on conscientiousness.

Hypothesis 5. *We assume stronger interactions for women than for men.*

In previous research, women achieved better grades than predicted based on their intelligence because of their higher conscientiousness scores (e.g., Kling et al. 2013).

Hypothesis 6a. *We assume stronger interaction terms for above-average SES students than for below-average SES students.*

Hypothesis 6b. *We assume stronger interaction terms for below-average SES students than for above-average SES students.*

On the one hand, high-SES students are at risk of downwards mobility; on the other hand, intelligent, but low-SES students may be highly motivated to improve their status.

2. Methods

2.1. Design and Sample

We analysed secondary data from the sixth wave of the study "Educational Outcomes of Students from Vocational and Academic Upper Secondary School" (LISA 6; Kampa et al. 2020b). This study examined 13th grade students in the 2012/2013 school year in the German federal state of Schleswig-Holstein. The sample covered all vocational upper secondary schools, as well as 17 out of the 99 academic upper secondary schools in Schleswig-Holstein (Leucht and Köller 2016).[2]

School coordinators completed student participation lists for all 13th grade students in their school with information on age, gender, and grades in selected subjects. Thus, complete data are available for these variables. Furthermore, the students participated in mandatory achievement tests and completed a voluntary student questionnaire. The study took place in the classroom and was supervised by trained test administrators (Leucht and Köller 2016). The codebook documents the exact wording and central item parameters (Kampa et al. 2020a). The data were made available by the Research Data Centre at the Institute for Educational Quality Improvement (FDZ at IQB).

The sample included 3775 students,[3] of whom 54.82% were women. The mean age was 19.90 years, 15.10% had a migration background, and the average SES was 55.75. SES was coded using the Highest International Socio-Economic Index of Occupational Status (HISEI; Ganzeboom et al. 1992), with scores ranging between 12 and 89. The students who answered items on conscientiousness differed from those who did not respond to these items regarding gender ($\chi^2(1) = 15.15$, $p < .001$, w = 0.06), school type ($\chi^2(1) = 4.12$, $p = .0423$, w = 0.03), intelligence ($t(3773) = -2.98$, $p = .0029$, d = 0.10), and German grade ($t(3769) = -2.66$, $p = .0079$, d = 0.09). Women, students at vocational track schools, students with better German grades, and more intelligent students were more likely to provide these data. However, the effects were rather small or negligible in size.

2.2. Measures

Intelligence: The study examined intelligence via two subscales (V3 word analogies and N2 figure analogies) of the KFT 4-12+ R (Heller and Perleth 2000). A total of 19.7% of the academic track students and 12.7% of the vocational track students were absent on the day of the test. Missing values were handled via multiple imputation, and the dataset contains estimates for all 3775 students. The reliability for the intelligence measure (both subscales combined) in the sample of all 3775 students is 0.80 (reliability estimate retrieved from Leucht and Köller 2016).

Conscientiousness: Students answered four items from the BFI-K (Rammstedt and John 2005) to measure the Big Five personality trait conscientiousness: (1) "I complete tasks thoroughly", (2) "I am comfortable; tend to be lazy", (3) "I am efficient and work fast", and (4) "I make plans and carry them out". Answers ranged from 1 "*very inappropriate*" to 5 "*very appropriate*". The student questionnaire was voluntary; only 1714 students responded to the conscientiousness items; Cronbach's alpha in the present sample is 0.67 ($N = 1620$).

Academic performance: We used German, mathematics, English, and biology report card grades from 13th grade students to measure academic performance. In Germany, upper school grades range between 0 "*insufficient*" and 15 "*excellent*" points. Tables 1 and 2 present descriptives of and correlations between the main variables.

Table 1. Descriptives of the Main Variables.

	M	SD	Min	Max	Skew	N
Intelligence	0	0.67	−3.02	2.22	−0.27	3775
Conscientiousness	3.65	0.69	1	5	−0.37	1714
German grade	8.47	2.35	2	15	0.24	3771
Mathematics grade	8.05	3.08	1	15	0.09	3771
English grade	8.65	2.64	1	15	0.1	3765
Biology grade	9.13	9.13	2	15	−0.04	2369

Table 2. Correlations Between all Variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Intelligence																			
2. Conscientiousness	−0.04																		
3. German grade	**0.20**	**0.20**																	
4. Mathematics grade	**0.33**	**0.26**	**0.42**																
5. English grade	**0.23**	**0.14**	**0.61**	**0.40**															
6. Biology grade	**0.21**	**0.27**	**0.53**	**0.54**	**0.47**														
7. Age	**−0.14**	**−0.05**	**−0.12**	**−0.19**	**−0.14**	**−0.13**													
8. Female	**−0.15**	**0.27**	**0.11**	0.01	**0.06**	**0.07**	**−0.11**												
9. Migration background	**−0.16**	−0.02	**−0.13**	**−0.10**	**−0.06**	**−0.08**	**0.16**	−0.03											
10. Academic track school	**−0.37**	**0.09**	**−0.15**	**−0.13**	**−0.16**	−0.02	**0.27**	**0.06**	**0.10**										
11. Study intention	**0.13**	**0.12**	**0.26**	**0.21**	**0.23**	**0.23**	−0.02	**−0.06**	**0.07**	**−0.13**									
12. Self-concept	**0.21**	**0.21**	**0.23**	**0.25**	**0.24**	**0.22**	−0.04	**−0.21**	**−0.09**	−0.02	**0.18**								
13. Motivation German	**−0.12**	**0.18**	**0.36**	**−0.14**	**0.10**	**0.05**	0.01	**0.21**	0.00	0.04	0.05	−0.03							
14. Motivation mathematics	**0.24**	**0.26**	**0.07**	**0.54**	**−0.06**	**0.25**	−0.02	**−0.15**	0.00	0.02	**0.16**	**0.15**	**−0.10**						
15. Motivation English	0.03	**0.16**	**0.25**	0.01	**0.57**	**0.12**	**−0.05**	**0.05**	0.03	**−0.06**	**0.15**	**0.06**	**0.30**	**−0.17**					
16. Motivation science	**0.14**	**0.19**	**0.12**	**0.15**	−0.00	**0.38**	**0.06**	**−0.09**	0.01	−0.03	**0.17**	**0.08**	0.04	**0.39**	−0.03				
17. Openness	0.01	**0.11**	**0.15**	**−0.09**	**0.11**	0.04	**0.07**	**0.21**	**0.09**	−0.02	**0.10**	−0.01	**0.31**	**−0.10**	**0.21**	0.05			
18. Extraversion	**−0.10**	**0.17**	**0.17**	−0.01	**0.13**	0.07	−0.03	**0.04**	0.01	−0.01	**0.09**	**0.24**	**0.15**	**−0.09**	**0.13**	**−0.08**	**0.11**		
19. Agreeableness	**−0.07**	0.06	0.04	**0.06**	−0.01	0.04	**−0.11**	**0.20**	−0.05	0.01	−0.02	0.02	**0.07**	**0.07**	0.01	0.04	0.06	0.08	
20. Neuroticisms	**−0.07**	−0.01	0.06	−0.04	0.04	0.00	0.00	**0.29**	0.06	0.04	−0.04	**−0.43**	**0.13**	**−0.08**	0.05	**0.05**	**0.19**	**−0.36**	**−0.14**

Note. Numbers in bold are significant at $p < .05$.

Control variables: We controlled for age, gender, migration background (first and second generation), type of school (vocational vs. academic upper secondary school), students' intentions to go to university, academic self-concept, and motivation for and interest in German, mathematics, English, and science.

Student's intention to attend university: Following Trautwein et al. (2007), students were asked if they wanted to attend university after school. Answers ranged from 1 "*certainly not*" to 4 "*for sure*".

Academic self-concept: Academic self-concept was assessed with four items from Schwanzer et al. (2005) on a four-point scale from 1 "*not at all true*" to 4 "*totally true*": (1) "I am sure in advance that I will not be able to solve many exercises, because I am not talented with this matter", (2) "I wish I was as intelligent as the others", (3) "I often think I'm not as smart as the others", (4) "Compared to others, I am not that talented". The reliability in the present sample is 0.83 (N = 2033).

Motivation/Interest: Four revised items from Baumert et al. (1997), Kunter et al. (2002), and Trautwein et al. (2007) measured motivation for or interest in German, mathematics, English, and science: (1) "I like to know a lot in the subject of xy", (2) "I would like to have more xy classes than I have now", (3) "I am looking forward to a lesson in xy", and (4) "xy is important to me personally". Scales ranged from 1 "*not at all true*" to 4 "*totally true*". The reliability is 0.88 for German (N = 2025), 0.91 for mathematics (N = 2045), 0.81 for English (N = 2041), and 0.90 for science (N = 2000).

2.3. Statistical Analyses

We analysed the research question by moderated regression analyses. As the presence of measurement error is especially problematic for measuring multiplicative and nonlinear effects such as interactions, SEM is particularly valuable for investigating these analyses (Little et al. 2006). The latent moderated structural equations (LMS) approach (Klein and Moosbrugger 2000) provides an unbiased and efficient method for implementing latent interactions in structural equation models.

We first estimated four regression models with German, mathematics, English, and biology grades as dependent variables, and intelligence and conscientiousness as independent variables. Next, we included the interaction terms as additional parameters in the models. Thus, we can investigate whether the interaction term accounts for a significant amount of variance beyond intelligence and conscientiousness. As the chi^2 difference test and the resulting fit statistics are not suitable for nonlinear latent variable models (Klein and Schermelleh-Engel 2010), we compared the two models via the log-likelihood ratio test, as described in Maslowsky, Jager, and Hemken (Maslowsky et al. 2015).

Next, we estimated multigroup models with men and women and below-average SES and above-average SES students.[4] To compare the relations of latent variables over groups, there must be weak measurement invariance (Christ and Schlüter 2012). For a more intuitive interpretation of the data, and because of collinearity, we standardized intelligence and conscientiousness before the analyses (Aiken et al. 1991).

We considered the multilevel structure of the data (TYPE = COMPLEX), as well as missing values (FIML), in all analyses. Furthermore, we controlled for gender, age, migration background, type of school, study intention, academic self-concept, and motivation in all final models, as these constructs (particularly the latter two) are strongly related to intelligence and conscientiousness. Analyses were performed in R (R Core Team 2020) and Mplus (Muthén and Muthén 1998).

3. Results

Both intelligence and conscientiousness had positive effects on grades in German, mathematics, English, and biology classes. To investigate differences in estimates between subjects, we examined whether the 95% confidence intervals overlapped. Intelligence had significantly stronger effects on grades in mathematics than on those in other subjects. Conscientiousness had further stronger effects on grades in mathematics than in English

and German, but not in biology. There was no significant correlation between intelligence and conscientiousness. The models explained 8.22% of the variance in German grades, 18.44% of the variance in mathematics grades, 7.89% of the variance in English grades, and 12.03% of variance in biology grades. All four models fit the data well (CFI $\geq$ 0.963, TLI $\geq$ 0.930, RMSEA $\leq$ 0.036, SRMR $\leq$ 0.026).

All models with the interaction term fit the data significantly better than the models without the interaction term (German $\chi^2_{diff, df=1}$ = 22.40, p < .001, mathematics $\chi^2_{diff, df=1}$ = 14.55, p < .001, English $\chi^2_{diff, df=1}$ = 5.14, p = .0234, biology $\chi^2_{diff, df=1}$ = 10.64, p = .0011). R^2 was 0.1037 for German grade, 0.1926 for mathematics, 0.0833 for English, and 0.1281 for biology grades. The interaction terms explained additional 2.15% of variance in German grades, additional 0.82% of variance in mathematics, additional 0.44% of variance in English, and additional 0.78% of variance in biology grades. The interaction terms provide important information beyond that provided by models that do not include interaction. For German, mathematics, and biology grades, we found a synergistic interaction; for English grades, we did not find a significant interaction. The interaction terms hardly differed between the subjects, and the 95% confidence intervals overlapped; nevertheless, the interaction was largest in mathematics, followed by German and biology. Figure 1 shows the simple slopes for the interaction analyses. To show the robustness of the results, we ran additional manifest regression analyses with the 1714 students who answered the conscientiousness items. The results did not differ between manifest and latent analyses; only the effect sizes were slightly smaller in the manifest analyses (see Table A3).

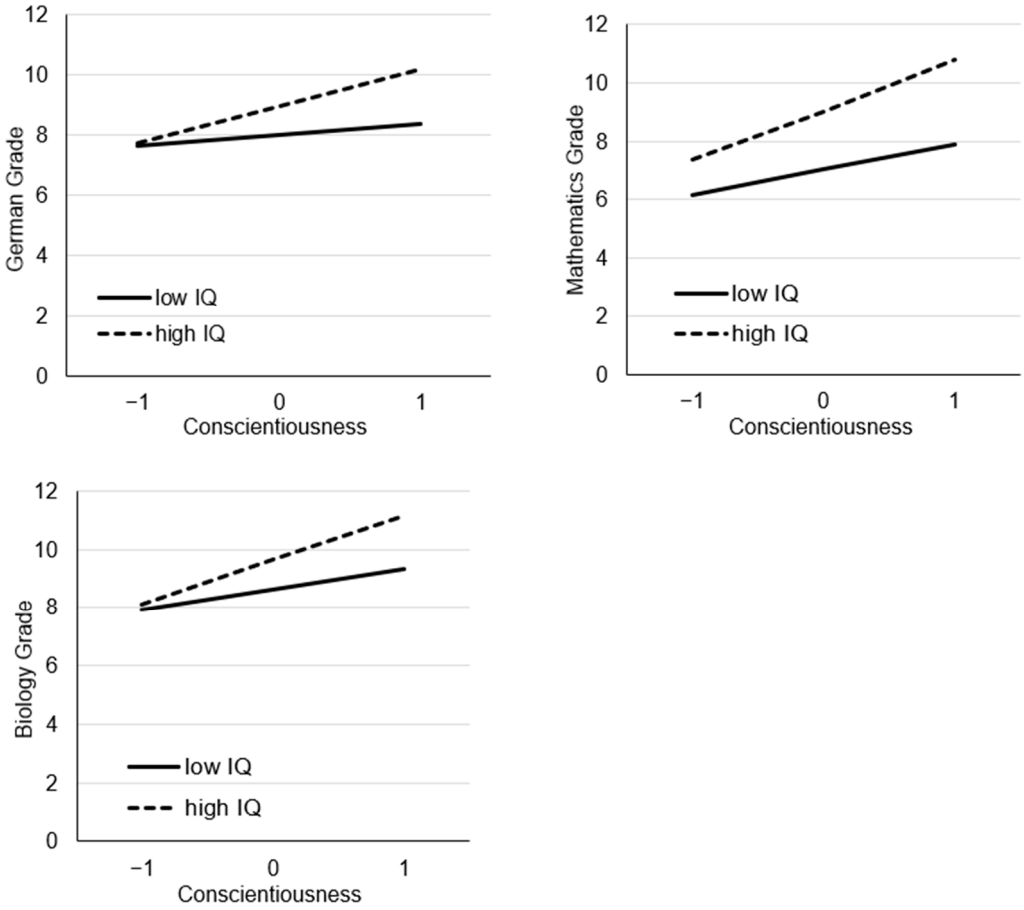

Figure 1. Simple slopes for high- and low-intelligence students.

Next, we analysed the multigroup models for gender and SES to investigate their effect on the interplay of intelligence and conscientiousness when predicting academic performance. We found partial weak measurement invariance across groups (gender

$\chi^2_{diff, df=2} = 1.14$, $p = .565$, SES $\chi^2_{diff, df=2} = 3.91$, $p = .142$).[5] In German, mathematics, and English, the interaction terms did not differ between men and women. In biology, men and women differed significantly in their interaction term: while we still found a synergistic interaction for men, the interaction term for women was no longer significant. Figure 2 shows simple slopes in biology for men and women.

Regarding SES, below-average and above-average SES students did not differ in their interaction of intelligence and conscientiousness while predicting grades. The models with control variables provide a comparable picture with smaller differences. Table A1 provides more detailed information.

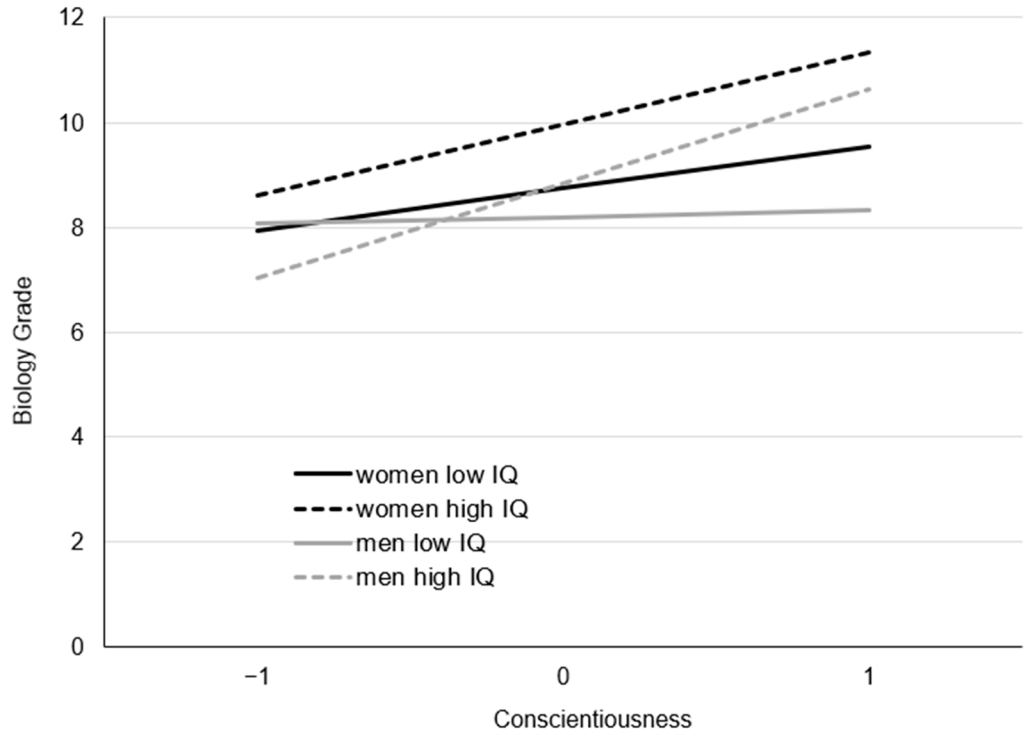

Figure 2. Simple slopes for high and low intelligent men and women in biology.

4. Discussion

As in previous studies, and in line with our hypotheses, we found larger positive effects of intelligence and conscientiousness on grades in science than on grades in languages (e.g., Brandt et al. 2020). One possible explanation is that students have to memorize subject matter in science classes, and therefore invest effort and learning time. Especially for mathematics, it is necessary to repeat and practice calculations for good grades. Furthermore, the word and figure analogies subscales of the KFT capture logical reasoning, which is also particularly helpful in science classes.

Contrary to our hypothesis, intelligence did not correlate significantly with conscientiousness. The state of research is ambiguous at this point. However, a recent meta-analysis (Anglim et al. 2022) showed no overall correlation between intelligence and conscientiousness, but only with specific conscientiousness facets. It is possible that the correlation between intelligence and conscientiousness is highly dependent on the sample, operationalization of conscientiousness, and situation.

Furthermore, we found significant synergistic interactions in German, mathematics, and biology. This is in contrast to the intelligence compensation hypothesis, but in line with the results of previous research on grades (e.g., Bergold and Steinmayr 2018; Di Domenico and Fournier 2015; Meyer et al. 2022; Ziegler et al. 2009). Intelligent students benefit particularly when they are conscientious, but a compensatory effect in less intelligent students is less pertinent. It is possible that students need to be conscientious to use their

full intelligence potential and that, in turn, at least some intelligence is needed to benefit from conscientiousness.

Meyer et al. (2022) converges with the present study. They examined the interaction of intelligence and conscientiousness in predicting various performance indicators in the school subjects German, mathematics, and English, and found the same results. In adding to these findings and other previous studies, we calculated multigroup models with gender and SES: we found no differences between groups with respect to SES, and only differences in biology interaction terms between men and women. For men with lower scores on the intelligence test, it made no difference whether they were conscientious or not. Intelligent men, on the other hand, performed significantly better if they were rather conscientious. In contrast, women, regardless of their intelligence level, performed better when they were rather conscientious. The results were contrary to our hypothesis, as we had expected stronger interaction effects in women. It is possible that conscientious women at all intelligence levels strive to optimise their performance, while in men it is the intelligent ones in particular who strive for performance. Furthermore, women are typically more interested in biology, which may be why women, unlike men, work hard at all levels of intelligence and do the best they can.

Why did we not find any compensatory interaction? On the one hand, intelligence did not correlate significantly with conscientiousness in our sample. It would be interesting for future studies to investigate whether a compensatory interaction can be found in samples with a negative correlation between intelligence and conscientiousness. On the other hand, the intelligence compensation hypothesis may be wrong. To date, only correlative studies support the intelligence compensation hypothesis; regression analyses with interaction terms between intelligence and conscientiousness tend to speak against compensation. However, these studies—as well as the present study—only cross-sectionally examined the extent to which the relationship between conscientiousness and performance varies with the level of intelligence. According to the intelligence compensation hypothesis, however, individuals become more conscientious to compensate for a lack of intelligence; change in conscientiousness is at the focus of the theory. The existing studies examined only the possible effects of an underlying process in which conscientiousness compensates for lack of intelligence, but did not look at the process itself, or at increases in conscientiousness. Thus, further analyses with longitudinal data are needed.

Limitations

After the present analysis was completed, a paper was published that converges with the present paper and relies on the same dataset (Meyer et al. 2022). This increases our confidence in the results, but reduces their novelty. Nevertheless, in the present paper, we additionally examine the school subject of biology, and analyse multigroup models with gender and SES—which goes beyond that paper.

In addition, our sample included only students who attended an upper secondary school in Schleswig-Holstein. Upper secondary schools are the highest school track in Germany, and successful completion leads to a university entrance qualification. On the one hand, it is questionable whether the results can be transferred to other German federal states or other countries. On the other hand, upper secondary schools place high demands on their students, so that only particularly high-achieving students can attend. It can be assumed that the mean and variance in intelligence and conscientiousness in our sample therefore differ from those in the general population.

Participation in the questionnaire was voluntary, which is why many students did not participate. The students who did not answer the items on conscientiousness differed significantly from others regarding gender, intelligence, type of school, and grade in German.

Furthermore, intelligence measurements in studies should generally be treated cautiously, as the results do not have any consequences for the participants. It is likely that conscientious participants will try harder and take the test more seriously, which would

lead to better results (Chamorro-Premuzic and Furnham 2004). It is possible that this effect offsets the negative correlation between intelligence and conscientiousness hypothesised by the intelligence compensation hypothesis. This may be the reason we did not find a significant relationship between intelligence and conscientiousness in the present study.

5. Conclusions

Our results support previous empirical findings on a synergy between intelligence and conscientiousness, rather than the intelligence compensation hypothesis: we found no correlation between intelligence and conscientiousness, but synergistic interactions between the two constructs in predicting German, mathematics, and biology grades. Gender differences were found for biology: Intelligent men particularly benefitted from being conscientious, whereas women benefit from conscientiousness regardless of their intelligence level. Thus, especially for men, conscientiousness is important to exploit the person's full cognitive potential. In any case, we found positive effects of both intelligence and conscientiousness on grades. Both traits help students to achieve good grades.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Moderated Regression Analyses Predicting School Grades.

	M1		M2		M3	
	β	95% CI	β	95% CI	β	95% CI
				German		
Intercept	8.48 ***	[8.30, 8.65]	8.48 ***	[8.30, 8.66]	8.59 ***	[8.21, 8.96]
Intelligence	0.47 ***	[0.38, 0.56]	0.47 ***	[0.38, 0.56]	0.37 ***	[0.26, 0.48]
Conscientiousness	0.73 ***	[0.53, 0.93]	0.79 ***	[0.61, 0.97]	0.25 **	[0.12, 0.38]
IQ × C			0.42 ***	[0.27, 0.57]	0.34 ***	[0.19, 0.50]
Female					0.48 ***	[0.28, 0.67]
Age					−0.05	[−0.19, 0.10]
Migration background					−0.52 ***	[−0.71, −0.32]
Academic track school					−0.33	[−0.79, 0.13]
Study intention					0.46 ***	[0.37, 0.55]
Self-concept					0.73 ***	[0.52, 0.94]
Motivation					1.01 ***	[0.90, 1.13]
	M1		**M2**		**M3**	
	β	95% CI	β	95% CI	β	95% CI
				Mathematics		
Intercept	8.05 ***	[7.89, 8.22]	8.05 ***	[7.89, 8.22]	8.00 ***	[7.64, 8.37]
Intelligence	1.04 ***	[0.91, 1.16]	1.02 ***	[0.90, 1.14]	0.53 ***	[0.39, 0.67]
Conscientiousness	1.27 ***	[1.05, 1.49]	1.28 ***	[1.07, 1.49]	0.44 ***	[0.28, 0.60]
IQ × C			0.42 ***	[0.22, 0.63]	0.23 *	[0.06, 0.41]
Female					0.59 ***	[0.34, 0.85]

Table A1. *Cont.*

Age					−0.38 ***	[−0.55, −0.21]
Migration background					−0.36	[−0.66, −0.05]
Academic track school					−0.19	[−0.60, 0.22]
Study intention					0.32 ***	[0.19, 0.45]
Self-concept					0.74 ***	[0.53, 0.94]
Motivation					1.64 ***	[1.50, 1.77]
	M1		**M2**		**M3**	
	β	**95% CI**	**β**	**95% CI**	**β**	**95% CI**
				English		
Intercept	8.65 ***	[8.47, 8.83]	8.65 ***	[8.47, 8.84]	8.54 ***	[8.18, 8.89]
Intelligence	0.61 ***	[0.52, 0.70]	0.61 ***	[0.52, 0.70]	0.45 ***	[0.34, 0.56]
Conscientiousness	0.65 ***	[0.43, 0.87]	0.66 ***	[0.45, 0.86]	0.03	[−0.17, 0.24]
IQ × C			0.25	[0.03, 0.46]	0.22 *	[0.05, 0.40]
Female					0.51 ***	[0.31, 0.70]
Age					−0.17	[−0.32, −0.02]
Migration background					−0.12	[−0.40, 0.16]
Academic track school					−0.17	[−0.59, 0.25]
Study intention					0.29 ***	[0.20, 0.39]
Self-concept					0.82 ***	[0.63, 1.02]
Motivation					1.59 ***	[1.46, 1.73]
	M1		**M2**		**M3**	
	β	**95% CI**	**β**	**95% CI**	**β**	**95% CI**
				Biology		
Intercept	9.12 ***	[8.90, 9.34]	9.13 ***	[8.90, 9.35]	8.33 ***	[7.93, 8.73]
Intelligence	0.51 ***	[0.36, 0.67]	0.50 ***	[0.35, 0.65]	0.46 ***	[0.28, 0.63]
Conscientiousness	1.13 ***	[0.87, 1.38]	1.10 ***	[0.85, 1.34]	0.53 ***	[0.30, 0.75]
IQ × C			0.41 *	[0.13, 0.69]	0.33 *	[0.09, 0.57]
Female					0.64 **	[0.31, 0.98]
Age					−0.26 *	[−0.45, −0.07]
Migration background					−0.13	[−0.49, 0.22]
Academic track school					0.62 *	[0.12, 1.12]
Study intention					0.42 ***	[0.30, 0.55]
Self-concept					0.58 ***	[0.34, 0.81]
Motivation					0.95 ***	[0.81, 1.09]

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table A2. Robustness Check—Moderated Regression Analyses Predicting School Grades With 1714 Students Who Completed Conscientiousness Items.

	M1		**M2**		**M3**	
	β	**95% CI**	**β**	**95% CI**	**β**	**95% CI**
				German		
Intercept	8.59 ***	[8.31, 8.82]	8.59 ***	[8.36, 8.82]	8.59 ***	[8.23, 8.95]
Intelligence	0.44 ***	[0.31, 0.57]	0.47 ***	[0.38, 0.56]	0.35 ***	[0.23, 0.47]
Conscientiousness	0.72 ***	[0.53, 0.91]	0.74 ***	[0.57, 0.91]	0.25 **	[0.12, 0.38]
IQ × C			0.32 **	[0.14, 0.50]	0.35 ***	[0.19, 0.51]
Female					0.49 ***	[0.27, 0.71]
Age					−0.04	[−0.18, 0.10]
Migration background					−0.51 ***	[−0.73, −0.28]
Academic track school					−0.32	[−0.78, 0.13]
Study intention					0.45 ***	[0.35, 0.55]
Self-concept					0.74 ***	[0.52, 0.96]
Motivation					1.01 ***	[0.87, 1.15]

Table A2. *Cont.*

	M1		M2		M3	
	β	95% CI	β	95% CI	β	95% CI
				Mathematics		
Intercept	8.15 ***	[7.93, 8.37]	8.15 ***	[7.93, 8.37]	7.96 ***	[7.57, 8.35]
Intelligence	1.11 ***	[0.94, 1.28]	1.11 ***	[0.94, 1.28]	0.53 ***	[0.38, 0.68]
Conscientiousness	1.28 ***	[1.06, 1.50]	1.30 ***	[1.09, 1.51]	0.45 ***	[0.29, 0.61]
IQ × C			0.39 **	[0.18, 0.60]	0.23 *	[0.05, 0.41]
Female					0.57 ***	[0.30, 0.84]
Age					−0.40 ***	[−0.58, −0.22]
Migration background					−0.37*	[−0.66, −0.07]
Academic track school					−0.16	[−0.58, 0.26]
Study intention					0.31 ***	[0.17, 0.45]
Self-concept					0.79 ***	[0.57, 1.01]
Motivation					1.61 ***	[1.48, 1.75]
	M1		**M2**		**M3**	
	β	95% CI	β	95% CI	β	95% CI
				English		
Intercept	8.73 ***	[8.51, 8.94]	8.73 ***	[8.51, 8.95]	8.52 ***	[8.17, 8.87]
Intelligence	0.68 ***	[0.57, 0.78]	0.68 ***	[0.57, 0.78]	0.44 ***	[0.32, 0.57]
Conscientiousness	0.62 ***	[0.41, 0.83]	0.64 ***	[0.43, 0.84]	0.03	[−0.18, 0.23]
IQ × C			0.21 *	[0.04, 0.38]	0.22 *	[0.05, 0.40]
Female					0.55 ***	[0.35, 0.75]
Age					−0.17	[−0.32, −0.02]
Migration background					−0.11	[−0.39, 0.17]
Academic track school					−0.18	[−0.59, 0.23]
Study intention					0.29 ***	[0.18, 0.39]
Self-concept					0.86 ***	[0.65, 1.07]
Motivation					1.58 ***	[1.43, 1.73]
	M1		**M2**		**M3**	
	β	95% CI	β	95% CI	β	95% CI
				Biology		
Intercept	9.16 ***	[8.89, 9.43]	9.17 ***	[8.90, 9.44]	8.31 ***	[7.90, 8.72]
Intelligence	0.56 ***	[0.38, 0.74]	0.55 ***	[0.38, 0.73]	0.47 ***	[0.29, 0.65]
Conscientiousness	1.16 ***	[0.90, 1.42]	1.15 ***	[0.89, 1.41]	0.54 ***	[0.32, 0.77]
IQ × C			0.39 *	[0.10, 0.68]	0.34 *	[0.08, 0.60]
Female					0.66 **	[0.31, 1.01]
Age					−0.26	[−0.49, −0.04]
Migration background					−0.19	[−0.55, 0.18]
Academic track school					0.64 *	[0.13, 1.16]
Study intention					0.42 ***	[0.29, 0.55]
Self-concept					0.56 ***	[0.32, 0.80]
Motivation					0.87 ***	[0.70, 1.03]

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table A3. Robustness Check—Regression Analyses with Observed Variables.

	M1		M2	
	β	95% CI	β	95% CI
			German	
Intercept	8.59 ***	[8.50, 8.68]	8.59 ***	[8.50, 8.68]
Conscientiousness	0.46 ***	[0.36, 0.55]	0.45 ***	[0.36, 0.54]
Intelligence	0.45 ***	[0.35, 0.55]	0.45 ***	[0.36, 0.55]
IQ × C			0.17 **	[0.06, 0.27]

Table A3. *Cont.*

	M1		M2	
	β	95% CI	β	95% CI
		Mathematics		
Intercept	8.15 ***	[8.04, 8.36]	8.16 ***	[8.04, 8.27]
Conscientiousness	0.74 ***	[0.63, 0.86]	0.74 ***	[0.63, 0.86]
Intelligence	1.12 ***	[1.00, 1.24]	1.13 ***	[1.01, 1.25]
IQ × C			0.19 *	[0.07, 0.32]
	M1		**M2**	
	β	95% CI	β	95% CI
		English		
Intercept	8.73 ***	[8.63, 8.82]	8.73 ***	[8.63, 8.83]
Conscientiousness	0.37 ***	[0.29, 0.49]	0.39 ***	[0.29, 0.49]
Intelligence	0.68 ***	[0.58, 0.78]	0.68 ***	[0.58, 0.79]
IQ × C			0.10	[−0.02, 0.21]
	M1		**M2**	
	β	95% CI	β	95% CI
		Biology		
Intercept	9.18 ***	[9.06, 9.31]	9.19 ***	[9.07, 9.32]
Conscientiousness	0.67 ***	[0.54, 0.79]	0.66 ***	[0.53, 0.78]
Intelligence	0.58 ***	[0.44, 0.71]	0.57 ***	[0.43, 0.71]
IQ × C			0.25 *	[0.09, 0.41]

Note. Sample sizes are: N_D = 1713, N_M = 1713, N_E = 1707, N_B = 1039; R^2 for M1 and M2 are: R^2_{D0} = 0.073; R^2_{D1} = 0.078; R^2_{M0} = 0.179; R^2_{M1} = 0.183; R^2_{E0} = 0.088; R^2_{E1} = 0.089; R^2_{B0} = 0.107; R^2_{B1} = 0.116. * $p < .05$, ** $p < .01$, *** $p < .001$.

Notes

1 We added hypothesis 4b after preregistration. The hypotheses at preregistration were based solely on theory. As the state of research suggested different outcomes than theory, we added an additional hypothesis.

2 The academic upper secondary schools in the sample already participated in previous waves of the LISA survey. The sample was drawn as a multistage stratified cluster sample prior to the first survey. In wave six, the sample comprises 18.6% of all students at academic upper secondary schools in Schleswig-Holstein (Leucht and Köller 2016).

3 We ran robustness checks with the 1714 students who completed the conscientiousness items. We found no major differences as compared with the results in the full sample. See Table A2 for the results.

4 As the individuals with below-average and above-average SES did not differ in their interaction terms, we did not analyse differences between combined gender and SES groups, in deviation from the preregistered analyses.

5 For both gender and SES, the factor loading for one item was freed ("I am comfortable; tend to be lazy").

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3

Chapter 3: Changes in Conscientiousness During Adolescence – The Role of Intelligence

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Changes in conscientiousness during adolescence – the role of intelligence

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Abstract

Do adolescents become more conscientious to compensate for a lack of intelligence, or does conscientiousness change independent of intelligence? The reasons for personality changes in adolescence have rarely been studied thus far, and in particular, the possible role of intelligence in that process has been neglected. The present study aims to close this research gap. In a large nationwide longitudinal sample of German adolescents (NEPS SC3; *N* = 7122), changes in conscientiousness and the question of whether fluid intelligence influences these changes were investigated. Latent change models indicated that conscientiousness increased in late adolescence, while the trajectories were less clear in early adolescence. Reasoning had a negative effect on changes in conscientiousness in early adolescence, which was more pronounced in boys than in girls.

Keywords

conscientiousness change, fluid intelligence, intelligence compensation hypothesis, adolescence, latent change model, NEPS

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Several studies have observed a negative relationship between intelligence and conscientiousness (e.g., Moutafi et al., 2003; Rammstedt et al., 2016), although both constructs are positive predictors of important life outcomes such as academic performance (e.g., Poropat, 2009; Schneider & Preckel, 2017). According to Moutafi et al. (2003, 2004), intelligence may be negatively related to conscientiousness because less intelligent people may become particularly conscientious to compensate for their lack of intelligence. However, other researchers disagree with this assumption and argue that intelligence does not impact changes in conscientiousness (Murray et al., 2014). To our knowledge, no study has tested these two assumptions against each other.

Adolescence is an extremely important phase in personality development (Soto & Tackett, 2015). However, there is little research on the factors that influence changes in conscientiousness in adolescence, and in particular, the role of intelligence in this process has been neglected. The present study aims to close these research gaps with data from a large nationwide panel study (German National Educational Panel Study (NEPS); Blossfeld & Roßbach, 2019).

The intelligence compensation hypothesis

Several empirical investigations have shown that intelligence and conscientiousness are negatively correlated (e.g., Moutafi et al., 2003; Rammstedt et al., 2016). According to the intelligence compensation hypothesis (Moutafi et al., 2003, 2004), this negative relationship may be because conscientiousness is malleable, and changes can occur based on perceived necessities: less intelligent people may compensate for their lack of intelligence by

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becoming particularly organized, thorough, persistent, and systematic – in other words, particularly conscientious. In contrast, intelligent people may see less necessity to become particularly conscientious, as they can rely on their intelligence to master most (cognitive) tasks.

Fluid intelligence plays a special role in the intelligence compensation hypothesis. Above all, aspects such as reasoning, problem solving, or perceptual speed provide intelligent individuals with an advantage and must be compensated for by conscientiousness if they are not high. However, the empirical results on fluid intelligence are just as inconsistent as those on general intelligence: Some studies have found positive correlations between fluid intelligence and conscientiousness, some have found negative correlations, and some have found nonsignificant correlations (e.g., Ackerman & Heggestad, 1997; Kretzschmar et al., 2018; Moutafi et al., 2006; Soubelet & Salthouse, 2011).

To our knowledge, eight studies to date have approached questions related to the intelligence compensation hypothesis; however, most of these studies were cross-sectional and examined the interaction of intelligence and conscientiousness in predicting academic performance. Five of the eight studies found a significant synergistic interaction term (Bergold & Steinmayr, 2018; Di Domenico & Fournier, 2015; Friedrich & Schütz, 2023; Meyer et al., 2022; Ziegler et al., 2009). The relationship between intelligence and achievement was stronger for conscientious individuals – that is, intelligent individuals benefitted particularly if they were also conscientious. The interactions in the remaining studies were not significant (Beaujean et al., 2011; Brandt & Lechner, 2022; Zhang & Ziegler, 2015).

These results are not in line with the intelligence compensation hypothesis. However, Ziegler et al. (2009) found a significant compensatory interaction term for the facet of achievement striving in low performers: the association between intelligence and achievement was weaker for people high in achievement striving – less intelligent individuals particularly benefitted from being conscientious, and intelligence was a weaker predictor of achievement. Other studies also investigated which conscientiousness facets mainly compensate for intelligence; they found that characteristics such as working hard, being well organized and disciplined especially help one master tasks. Thus, the conscientiousness facets order, self-discipline, and deliberation are particularly relevant for compensating for low intelligence (Moutafi et al., 2006).

In contrast to the intelligence compensation hypothesis, Murray et al. (2014) argued that conscientiousness may be enhanced by intelligence or by a lack of intelligence and that conscientiousness development should therefore be independent of intelligence. Indeed, they argued that intelligence and conscientiousness have only negative relationships in selective samples such as university students or managers. In these cases, selection into the sample is likely to depend on a combination of intelligence and conscientiousness: people with low levels of intelligence can only reach the required performance level if they are particularly conscientious. Conversely, people low in conscientiousness can reach the required performance level only if they are intelligent. This selection bias may lead to a negative relationship between intelligence and conscientiousness in these samples even if there is no such relationship in the population (Murray et al., 2014).

To test their hypothesis, the authors analyzed two cross-sectional samples – an adolescent sample and an adult sample. They simulated compensatory selection by excluding all participants below a certain performance threshold and calculated the correlations between intelligence and conscientiousness in the unselected and selected samples. In all samples (unselected and selected adolescent and adult samples), most correlations were either not significant or positive. Only the correlation with one subscale (achievement striving) in one occupational category (major professionals) in the adult sample became negative in the selective sample (Murray et al., 2014). The results suggested that previously observed negative correlations between intelligence and conscientiousness were not due to selective sampling. Nevertheless, most correlations in that study were not negative. However, analyses of a representative sample of ninth-grade students revealed a negative relationship between intelligence and conscientiousness (Lechner et al., 2017).

In summary, individual theories and empirical studies suggest different relationships between intelligence and conscientiousness. In general, intelligence and conscientiousness can together predict performance in three different ways (following Cohen et al. (2014)). On the one hand, intelligence and conscientiousness can influence performance independently (1- additive effect). An additive effect is suggested in the selection argument (Murray et al., 2014). On the other hand, intelligence and conscientiousness can also influence each other in predicting performance, they can interact. They can either reinforce – high intelligence combined with high conscientiousness results in especially good performance (2- enhancing effect) – or compensate for each other – high scores on one construct can reduce the impact of low scores on the other construct (3- compensatory effect). A compensatory effect is suggested in the intelligence compensation hypothesis.

However, the state of research on the relationship between intelligence and conscientiousness is rather unclear. To determine whether conscientiousness actually compensates for intelligence, it is necessary to examine whether conscientiousness adjusts to intelligence over a longer period. For this purpose, it is necessary to first

investigate whether conscientiousness changes in general and whether intelligence is a predictor of this change. Currently, longitudinal analyses examining the joint development of intelligence and conscientiousness in adolescence are lacking.

However, changes in conscientiousness may be especially prominent in adolescence (Soto & Tackett, 2015). To shed further light on the associations over time and understand possible drivers of changes in conscientiousness, we used a large nationwide sample of adolescents and longitudinal data on fluid intelligence and conscientiousness.

Changes in conscientiousness in adolescence

Childhood and adolescence are crucial periods for personality change (Soto & Tackett, 2015); during that period of life, rank order stability is lowest (Roberts & DelVecchio, 2000). Thus, it is of particular interest to investigate changes in conscientiousness and the possible impact of intelligence in this age group.

Studies that have investigated change in conscientiousness in adolescence have identified different trajectories, and it has been difficult to reconcile these findings. In a meta-analysis, Roberts et al. (2006) examined personality changes in ten- to eighteen-year-old adolescents and found no significant changes in conscientiousness in this age group. However, the investigated age span was quite large, and it is possible that opposing trajectories occurred in young and late adolescence, which could have offset each other (Soto et al., 2011). Research seems to support the assumption that conscientiousness decreases in early adolescence and increases in late adolescence (e.g., Denissen et al., 2013; Van den Akker et al., 2014, 2021). To avoid obfuscation of results through such antagonistic processes, we examined students starting in early adolescence and observed changes over time.

In addition, some studies have found different conscientiousness trajectories for boys and girls. On average, girls showed more positive trajectories than boys, i.e., girls became more conscientious (Brandes et al., 2020) or remained stable (Klimstra et al., 2009) in adolescence, whereas boys remained stable or became less conscientious. According to Klimstra et al. (2009), however, the trajectories of change do not differ between boys and girls, but rather the timing of the trajectories differs. The biological and neurological development of girls occurs at an earlier age. Personality maturation is related to this development and occurs earlier in girls. If individuals compensate for intelligence by becoming more conscientious and girls become more conscientious at an earlier age than boys, then it should be the case that girls compensate for intelligence earlier. To account for gender differences in the timing of change in conscientiousness, we analyzed separate conscientiousness trajectories for boys and girls in a multigroup model.

Students and apprentices also differ in their conscientiousness trajectories. For example, Golle et al. (2019) compared personality trajectories between students who participated in academic track schools after grade ten and students who started an apprenticeship. Students in the vocational track became more conscientious than students in the academic track. Students who start working must adopt adult-like roles earlier and take responsibility; thus, these individuals must become more conscientious. Thus, we analyzed a second multigroup model that differentiates between students who continued schooling and students who left school after the ninth or tenth grade.

Most studies thus find a decrease in conscientiousness in early adolescence and increasing conscientiousness trajectories from middle adolescence onward. However, only a few studies to date have examined factors that influence personality changes in adolescence (Israel et al., 2019). A possible explanation for the decrease in conscientiousness in early adolescence and its increase in late adolescence are biological, neurological, and social changes and related challenges in adolescence (Klimstra et al., 2009; Soto et al., 2011). Furthermore, new social roles and associated role expectations require more mature behavior and thus also contribute to a change in personality (Roberts & Wood, 2006). Nevertheless, some of the variance in changes in conscientiousness in adolescence remains unexplained. Intelligence may account for some of the previously unexplained variance. However, intelligence is not the only driver of changes in conscientiousness in adolescence. Therefore, not only less intelligent adolescents do change in conscientiousness, but they might show greater increases than intelligent adolescents.

One of the few studies dealing with predictors of personality change in adolescence investigated the reciprocal relationship between conscientiousness and academic achievement (German and math grades and standardized achievement test results), as well as the influence of parenting styles, in a sample of adolescent students (Israel et al., 2019). The authors analyzed data from the NEPS from students in starting cohort three when they were approximately 13–15 years old. Analyses of cross-lagged panel models revealed a positive relationship between conscientiousness and German and math grades two years later. In addition, math achievement test results were negatively associated with conscientiousness scores two years later.[1] The researchers argued that math achievement increases self-efficacy, which in turn may reduce discipline and diligence. Furthermore, the researchers found correlated changes between

conscientiousness and grades in German and math. Students who improved in German and math grades also showed positive changes in conscientiousness. Thus, the results of Israel et al. (2019) are consistent with the intelligence compensation hypothesis; however, they analyzed German and math grades and achievement test results, not intelligence per se or reasoning and perceptual speed test performance, as in the present study.

Unlike in adolescence, there are already studies that have examined the influence of intelligence on change in conscientiousness in old age (see Curtis et al. (2015) for a review). Individuals with higher initial levels or smaller decreases in intelligence decreased less than others in conscientiousness or even increased slightly (e.g., Mõttus et al., 2012; Mueller et al., 2016), which runs contrary to the intelligence compensation hypothesis. However, health has a great influence on changes in cognitive abilities and personality in old age (Wettstein et al., 2017). Therefore, the results of studies involving older participants cannot be generalized to adolescents.

The present study

Adolescence is an important phase in personality development. According to previous studies, conscientiousness declines in early adolescence and increases in late adolescence. However, factors that influence this trajectory have rarely been investigated, and intelligence in particular has been neglected as a factor that may impact such changes. In the present study, we aimed to close this gap and test fluid intelligence as a possible predictor of changes in conscientiousness in adolescence.

Moutafi et al. (2003, 2004) and Murray et al. (2014) provide theoretical considerations on the possible relationship between intelligence and conscientiousness. Both argue that conscientiousness can compensate for intelligence; however, their arguments differ regarding the issue of compensation. The intelligence compensation hypothesis assumes that conscientiousness increases because of a lack of intelligence; in other words, intelligence impacts changes in conscientiousness. In contrast, Murray et al. (2014) did not assume causal effects and attributed the negative relationship between intelligence and conscientiousness in some studies to compensatory selection.

The questions to be answered are as follows: Do less intelligent individuals become more conscientious, or do the conscientiousness trajectories for more and less intelligent individuals not substantially differ? In other words, do our data support the intelligence compensation hypothesis or the selection argument (Murray et al., 2014)? To investigate this research question, longitudinal data are needed. However, to our knowledge, thus far, only cross-sectional studies have investigated the relationship between fluid intelligence and conscientiousness in adolescence.

In the present study, we analyzed longitudinal data from the NEPS (starting cohort 3 (SC3)) to close this gap. The NEPS SC3 data are particularly suitable for investigating whether the intelligence compensation hypothesis or the argument of selection (Murray et al., 2014) holds true, as they include students in all types of schools in Germany and at all ability levels; thus, the NEPS is not a selective sample. In addition, the NEPS has accompanied the participants for more than ten years, from childhood to young adulthood, and provides a wide range of information about this period. Personality and fluid intelligence are each recorded at least twice, which makes it possible to investigate longitudinal changes.

The aim of this study is to clarify the following research questions using latent change and multigroup latent change models: (1) How does conscientiousness change in adolescence? (2) Does fluid intelligence influence conscientiousness trajectories? (3) Are there gender differences in the levels and trajectories of conscientiousness? (4) Are there differences in the levels and trajectories of conscientiousness between students who left school after ninth or tenth grade and students who continued schooling? Regarding the research questions, the following hypotheses were tested:

Hypothesis 1. The conscientiousness of the students decreases between the first and second measurement points (aged 12/13-14/15) and increases between the second and third measurement points (aged 14/15-18/19). Although previous studies have shown differing results, studies with this trajectory pattern have slightly predominated (e.g., Denissen et al., 2013). The conscientiousness scale administered in the present study mainly captures the sub-facet self-discipline. However, the self-discipline and conscientiousness trajectories in adolescence are comparable (Soto et al., 2011). Therefore, we expect that the scale provides results that are comparable to those of studies with broader conscientiousness instruments. Israel et al. (2019) investigated the longitudinal relationship between conscientiousness and academic performance between seventh (age 12/13) and ninth (age 14/15) grades with the NEPS SC3. They found a rank order stability of .77 but did not report conscientiousness trajectories.

Hypothesis 2. In an exploratory fashion, we tested competing hypotheses regarding the intelligence compensation hypothesis. Israel et al. (2019) analyzed the NEPS SC3 and found that standardized mathematics test results in Grade 7 negatively predicted conscientiousness in Grade 9. This suggests that high fluid intelligence also negatively influences changes in conscientiousness. However, the study examined

standardized achievement tests instead of intelligence, and other studies came to different conclusions.

H2a: Our data support the intelligence compensation hypothesis – fluid intelligence and conscientiousness change are negatively associated.

H2b: Our data support the selection argument – fluid intelligence and conscientiousness change are not significantly associated.

Hypothesis 3. Consistent with the available research, we expect that girls have more positive trajectories, i.e., a greater increase or less decline in conscientiousness. Specifically, we expect that in girls, the conscientiousness decreases less between the first two measurement points than in boys but increases more between the second and third measurements.

Hypothesis 4. We expect that adolescents who left school after ninth or tenth grade show greater increases in conscientiousness scores between the second and third measurement points than do participants who continue their schooling, which is consistent with previous findings (e.g., Golle et al., 2019). We do not expect any differences between the first and second measurement points, as all participants were in school during this time. There is also a greater focus on cognitive tasks and skills at school than in apprenticeships. Thus, we also expect that the possible impact of fluid intelligence on conscientiousness would be stronger in adolescents who continued school than in those who did not.

Methods

Transparency, openness, and reproducibility

The theory, hypotheses, methods, and R code were preregistered prior to the analyses (https://osf.io/9ekny/?view_only=99e7cbfb08c64527850227563d190344).

This paper used data from the German National Educational Panel Study (NEPS; see Blossfeld & Roßbach, 2019). The NEPS is carried out by the Leibniz Institute for Educational Trajectories (LIfBi, Germany) in cooperation with a nationwide network.

Design and sample

The present study investigated data from the NEPS (NEPS Network, 2021). The NEPS examines education as a lifelong process that includes competence development, educational decisions and returns to education. The NEPS frequently surveys six age cohorts. This provides information from infancy to old age (Blossfeld & Roßbach, 2019).

The present study was based on SC3. SC3 consisted of students who attended fifth grade in the 2010/2011 school year. Since then, students have completed repeated annual surveys. The surveys initially took place in the school context and later in individual personal or telephone interviews. At this time, data for a ten-year period are available. We analyzed data from the 2012/2013, 2014/2015 and 2018/2019 surveys, as personality was assessed in these waves. For the sake of simplicity, we refer to these survey waves as measurement points one, two and three. Students with missing values for all conscientiousness items were excluded from the analyses.

The final sample included 7122 students, of whom 51.7% were boys. In December 2010, when the first intelligence measurement took place, they were, on average, 10.5 years old. Not all participants from the first wave also participated in the survey in 2018/2019. We therefore investigated whether people who participated in both 2010 and 2018/2019 differed in their gender, age, fluid intelligence, and socioeconomic background from those who dropped out before 2018/2019. The results of the chi^2 test and t tests indicated significant differences in gender ($\chi^2(1) = 16.01$, $p < .001$), age ($t(4176.2) = -9.23$, $p < .001$), reasoning ($t(2184.1) = 9.95$, $p < .001$) and perceptual speed ($t(4586) = 3.03$, $p = .0024$) in fifth grade. Boys and older and less intelligent students were more likely to leave the study.

Measurements

Fluid intelligence. The NEPS measures perceptual speed and reasoning, which are both very good indicators of fluid intelligence (Brunner et al., 2014). The picture symbol test (NEPS-BZT) measures perceptual speed and consists of three sets of 31 items each, and the matrices test (NEPS-MAT) measures reasoning and consists of three sets of four items each. The Scientific Use File (SUF) includes sum scores for each perceptual speed subtest and all items of the reasoning test. A maximum of 93 points can be achieved in the picture symbol test, and twelve points can be achieved in the matrices test. The students completed the test in 2010 (fifth grade) and 2015 (ninth grade) (Haberkorn & Pohl, 2013). Brunner et al. (2014) and Lang et al. (2014) provided further information on the tests. Furthermore, reasoning and perceptual speed have practical relevance for investigating the intelligence compensation hypothesis, as they are positively related to grades (e.g., Brandt et al., 2020; Lechner et al., 2017).

Conscientiousness. To date, conscientiousness has been assessed in three waves: 2012/2013, 2014/2015 and 2018/2019. Conscientiousness was measured using a Big Five short scale (BFI-10; Rammstedt & John, 2007) with two items per dimension in 2012/2013 and 2014/2015 and four items in 2018/2019. The two items collected in each wave were 1) "I am thorough when completing my tasks/Ich

erledige Aufgaben gründlich" and 2) "I am easy-going and tend to be a bit lazy/Ich bin bequem, neige zur Faulheit". Thus, the items mainly represent self-discipline as a facet of conscientiousness (Rammstedt & Danner, 2017). However, the short version of the conscientiousness scale is strongly correlated (.82) with the long version (Rammstedt & John, 2007). Due to the overlap between the two scales, the short version nevertheless seems suitable for investigating the research question – especially as the conscientiousness facet self-discipline is a likely candidate in the compensation model (Moutafi et al., 2006). The correlations, reliabilities and descriptive statistics are presented in Tables 1 and 2.

Statistical analyses

In the first analysis step, we tested for measurement invariance over time and groups using latent state models. To do so, we specified one latent conscientiousness variable per measurement point, each of which was measured by two indicators. The covariances between the latent variables were estimated freely. To investigate changes in latent means, strong measurement invariance must be obtained. We compared the nested models via chi^2 difference tests and additionally considered goodness-of-fit indices to assess measurement invariance. Measurement invariance is violated if there is a change $\geq -.010$ in TLI, $\geq .015$ in RMSEA and $\geq .030$ (loadings) and .010 (intercepts) in SRMR (Chen, 2007).

We then analyzed a latent change model (Steyer et al., 2000) to examine conscientiousness trajectories in adolescence in general. Latent change models can be applied to investigate similar issues as latent growth curve models – to measure individual differences in intra-individual change over time without measurement errors. The main difference between the models is that latent change models do not specify the form of change (for example, linear or quadratic change) as latent growth curve models do. Therefore, they are less restrictive. Furthermore, latent change models measure the change between two explicit measurement points (for example, between waves 1-2 or 2-3), whereas latent growth curve models examine the change over an entire period (Steyer et al., 2000). In addition, certain parameters need to be fixed so that latent growth curve models with only three measurements can be identified. Because of these advantages, we selected latent change models.

In the latent change model, the latent difference between two variables is added to the model as an additional latent variable. This latent change variable is modeled by reformulating the latent variables in the structural equation model (SEM). The change variables can be both exogenous and endogenous variables in the model (Steyer et al., 1997, 2000). Intelligence can therefore predict the change variables in the model and thus the change in conscientiousness.

In the next step, we included a latent perceptual speed and reasoning variable as predictors of the change variables to investigate whether intelligence influences conscientiousness trajectories. Instead of specifying a higher-order factor, "fluid intelligence", we calculated separate models for perceptual speed and reasoning. On the one hand, the NEPS unit responsible for competence testing recommends this approach from a psychometric point of view because the underlying data and modeling differ between the two tests. Furthermore, that procedure seems reasonable for reasons of comparability: other papers with NEPS data also analyze reasoning and perceptual speed separately or only analyze reasoning (e.g., Brandt et al., 2020; Lechner et al., 2017). Since both reasoning and perceptual speed are indicators of fluid intelligence, we do not expect different results for the two scales.

Moreover, longer education is related to increases in intelligence. In other words, intelligence changes over a school career (Ritchie & Tucker-Drob, 2018). To address this issue, we used both fifth- and ninth-grade intelligence measures in the analyses. We predicted change in conscientiousness between 12/13 and 14/15 years of age with fifth-grade intelligence and change in conscientiousness between 14/15 and 18/19 years of age with ninth-grade intelligence. Figure 1 shows an example SEM.

Table 1. Descriptives.

	n	Mean	sd	Min	Max	α
Conscientiousness w1	6716	3.22	0.86	1	5	0.53
Conscientiousness w2	5599	3.05	0.84	1	5	0.5
Conscientiousness w3	3846	3.56	0.79	1	5	0.53
Reasoning grade 5	4203	7.15	2.5	0	12	0.65
Reasoning grade 9	4405	9.29	2.18	0	12	0.65
Perceptual speed grade 5	4588	44.45	13.21	0	93	0.79
Perceptual speed grade 9	4571	63.31	13.24	0	93	0.79

Note. Own calculations based on NEPS SC3: 12.1.0.

Table 2. Correlations.

	1	2	3	4	5	6	7	8	9	10
1 Conscientiousness w1	**1**									
2 Conscientiousness w2	**0.51**	**1**								
3 Conscientiousness w3	**0.38**	**0.47**	**1**							
4 Reasoning grade 5	**−0.03**	**−0.11**	**−0.05**	**1**						
5 Reasoning grade 9	0.00	**−0.06**	**−0.07**	**0.5**	**1**					
6 Perceptual Speed grade 5	0.00	−0.02	0.01	**0.12**	**0.09**	**1**				
7 Perceptual Speed grade 9	**0.07**	**0.04**	**0.04**	**0.14**	**0.20**	**0.31**	**1**			
8 Boy	**−0.18**	**−0.16**	**−0.21**	**0.05**	−0.01	**−0.10**	**−0.16**	**1**		
9 Age	−0.01	**0.04**	**0.04**	**−0.13**	**−0.17**	**−0.03**	**−0.08**	**0.08**	**1**	
10 Hisei	0.03	**−0.03**	−0.01	**0.19**	**0.19**	−0.01	**0.06**	**0.03**	**−0.18**	**1**
11 Continuing school	**0.08**	0.00	**−0.03**	**0.30**	**0.32**	**0.08**	**0.18**	**−0.08**	**−0.24**	**0.27**

Note. Own calculations based on NEPS SC3: 12.1.0; numbers in bold are significant with $p < .05$.

Next, we calculated a multigroup model for gender to investigate whether girls and boys differ in their conscientiousness trajectories. We then calculated another multigroup model separately for people who left school after Grade nine/ten and people who stayed in school. More precisely, students who left school between 2015 and 2017 are in one group, and students who left school after 2017 are in the other group. Students who dropped out of the study were assigned a missing value due to incomplete information on their school career. Since especially high-achieving students remain in school after the ninth/tenth grade, it is possible that the groups differ in intelligence and conscientiousness. Therefore, in the SEM, we additionally calculated whether the groups differed in intelligence and baseline conscientiousness. Similarly, we examined the differences between boys and girls.

As we found significant differences in gender and age between individuals who dropped out of the study and individuals who participated in the current wave, we ran additional models in which we controlled for these variables to test the robustness of the results.

The analyses were performed in the statistical software R (R Core Team, 2022). As students are nested in classes, we corrected the standard errors with the "cluster" argument of the SEM function in lavaan (Rosseel, 2012). The full information maximum likelihood (FIML) approach was used in all analyses to address missing values.

Furthermore, all the statistical tests were performed with a significance level of $\alpha = 5\%$. Since the chi^2 test statistic depends on sample size (Hu & Bentler, 1995), the model fit was assessed by alternative fit indices in this paper: the root-mean-square error of approximation (RMSEA) should be smaller than .06 for an acceptable model fit, the standardized root-mean-square residual (SRMR) should be smaller than .08, and the comparative fit index (CFI) and the Tucker–Lewis Index (TLI) should both be above .95 (Hu & Bentler, 1999).

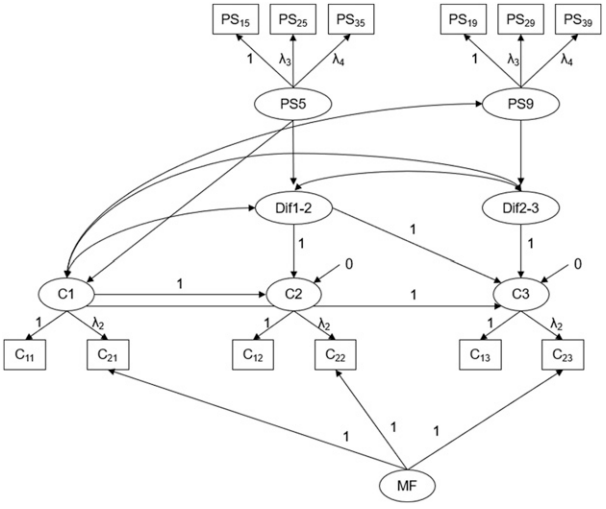

Figure 1. Latent change model with perceptual speed. Representation of the implemented latent change model with perceptual speed predicting conscientiousness change based on Geiser (2010). C1 = conscientiousness time 1, Dif1-2 = latent change variable time 1-2, MF = method factor, PS5 = perceptual speed Grade 5.

As conscientiousness was measured with the same items at each measurement point, the residuals are not random and uncorrelated. Thus, a method factor dealt with indicator-specific effects in all SEMs (Eid, 2000).

Results

First, we assessed measurement invariance over time and groups for conscientiousness, perceptual speed and reasoning. For some models, measurement invariance was not present, and we implemented partial measurement invariance. Table A1 reports further information and the results of the measurement invariance tests.

Next, we estimated a latent change model to investigate conscientiousness change in general. The model fit the data well (CFI = 0.997, TLI = 0.991, RMSEA = 0.026, SRMR = 0.010). Conscientiousness did not change significantly between 12/13 and 14/15 years of age but increased between 14/15 and 18/19 years of age (Δ = 0.625***). Baseline conscientiousness and the two change variables showed significant variance, indicating that students differed in conscientiousness at age 12/13 and in their individual changes in conscientiousness. Furthermore, we found significant covariances between baseline conscientiousness and the two change variables: higher baseline conscientiousness was associated with less increase over time.

To reveal the effect of fluid intelligence on conscientiousness development, we next included perceptual speed and reasoning in the models. The model with perceptual speed showed a good fit (CFI = 0.989, TLI = 0.985, RMSEA = 0.028, SRMR = 0.026), while the fit for reasoning was not good (CFI = 0.916, TLI = 0.912, RMSEA = 0.026, SRMR = 0.031). Therefore, we deviated from our preregistered analyses and built three parcels with 4 indicators each. This corresponds to the three sets of the reasoning test and parallels the perceptual speed analyses. The reasoning model with three parcels fit the data well (CFI = 0.981, TLI = 0.974, RMSEA = 0.030, SRMR = 0.026). We additionally ran the preregistered reasoning model with 12 indicators as a robustness check and found no meaningful differences between this model and the model with parcels.

Perceptual speed had no significant effect on conscientiousness development, while reasoning negatively predicted changes in conscientiousness between 12/13 and 14/15 years of age (b = −0.121***). Students with higher reasoning levels in Grade 5 increased less in conscientiousness between the ages of 12/13 and 14/15. Interestingly, the change in conscientiousness between 12/13 and 14/15 years of age was no longer non-significant in these models; instead, conscientiousness increased during this period.

To identify differences between boys and girls and between students who had left school after ninth/tenth grade and those who had continued schooling, we next analyzed multigroup models. For boys, conscientiousness increased over the entire period from 12/13 to 18/19 years of age. Both perceptual speed and reasoning were negatively associated with the increase in conscientiousness that occurred between 12/13 and 14/15 years of age. For girls, conscientiousness trajectories between 12/13 and 14/15 years of age were not clear; however, they increased between 14/15 and 18/19 years of age. For girls, only reasoning was significantly associated with changes in conscientiousness. Compared with boys, girls showed greater baseline conscientiousness and greater perceptual speed, whereas boys showed greater reasoning in fifth grade and greater changes in conscientiousness between 12/13 and 14/15 years of age.

For students who had left school after ninth/tenth grade as well as for students who had continued schooling, neither perceptual speed nor reasoning had any significant effects on conscientiousness change. However, reasoning negatively predicted change in conscientiousness between 12/13 and 14/15 years of age at the 10% level for students who stayed in school. In both groups, conscientiousness changed significantly between 14/15 and 18/19 only. Students who had left school and those who continued schooling differed in their reasoning and perceptual speed abilities.

To test the robustness of the results, we additionally calculated latent change models using a parametrization introduced by Steyer et al. (2000). These models showed exactly the same results as the parametrization used in the present study. Furthermore, we ran additional models in which we controlled for gender and age, as people who dropped out of the study differed in these two variables. In the models with control variables, we found more or less the same results as in the models without them.

Discussion

The present study aimed to answer four research questions. First, how does conscientiousness change in adolescence? The change in conscientiousness in early adolescence (aged 12/13 to 14/15) was not uniform. In late adolescence (aged 14/15 to 18/19), conscientiousness clearly increased. This finding is mostly in line with previous research and our hypothesis. New social roles in late adolescence and young adulthood result in normative increases in conscientiousness and other mature personality traits.

Notably, in the present study, conscientiousness increased significantly in early adolescence once intelligence was included in the models. Intelligence had a negative effect on conscientiousness change at this age (even if this effect was not always significant), more intelligent students experienced smaller increases. This could mean that in previous models without intelligence, conscientiousness change was underestimated.

This effect of intelligence was addressed in our second research question. Nevertheless, the results are not uniform but differ among subgroups and depend on the intelligence indicator. However, it is clear that the increase in conscientiousness in *late* adolescence was unrelated to intelligence. It appears that other reasons, such as new social roles, account for the trajectory. However, in *early* adolescence, there is evidence of compensation. Across most groups, reasoning was related to changes in conscientiousness in early adolescence: The conscientiousness of more intelligent students increased less strongly. This result is in line with Israel et al. (2019), who found a negative relationship between conscientiousness and math achievement test scores in early

adolescence. However, reasoning had a greater impact on changes in conscientiousness than did perceptual speed, possibly because it is a more general factor that could have a broader impact on success in school and work.

The impact of intelligence on changes in conscientiousness differed between boys and girls, which was the subject of the third research question. For boys with higher perceptual speed and reasoning, we observed smaller increases in conscientiousness in early adolescence. For girls, reasoning and, particularly, perceptual speed were less relevant; only reasoning influenced conscientiousness change – possibly due to gender roles and related differences in conscientiousness – and girls had higher baseline conscientiousness.

The fourth research question addressed those who had left school after ninth/tenth grade versus those who had continued schooling. Neither group experienced a significant change in conscientiousness in early adolescence. Nevertheless, overall, the direction of the effect of reasoning on change in conscientiousness in early adolescence was negative in both school subgroups.

Limitations

The present study has several limitations regarding the measurement of conscientiousness: conscientiousness was measured with only two of the original nine items of the BFI. Thus, the items do not reflect the full breadth of conscientiousness but rather focus mainly on self-discipline. However, the short scale correlates very highly with the long version (.82; Rammstedt & John, 2007). Obviously, the reliability of the short scale is reduced. Nevertheless, "given its brevity, the BFI-10 possesses acceptable psychometric properties"; the test-retest stability is .77, and the correlation between self- and peer ratings is .38 (Rammstedt & John, 2007, p. 210).

Furthermore, in previous studies, the conscientiousness facet 'striving for achievement' has proven to be relevant in compensating for lack of intelligence (Ziegler et al., 2009). Future studies should thus capture conscientiousness broader than in the present study and consider this aspect.

When specifying partial measurement invariance, it became clear that depending on the implementation of partial measurement invariance, the conscientiousness trajectories differed. We decided in favor of the current implementation, as the model showed a very good fit and the conscientiousness trajectories mostly reflect the current state of research.

In addition to measurement issues, we investigated multigroup models with students who left school after ninth/tenth grade and students who remained at school. In particular, high-achieving students continue schooling. The groups differed in terms of intelligence and conscientiousness. Restricted variance in the multigroup models could affect the results. Nevertheless, we would consider it more problematic for the present research to lump all participants together, as previous studies found different conscientiousness trajectories for students and apprentices (e.g., Golle et al., 2019).

Conclusion

Does fluid intelligence influence conscientiousness trajectories, or does conscientiousness change independent of intelligence? In students with lower reasoning ability, conscientiousness increased more strongly in early adolescence than it did in students with higher reasoning ability. This was also true for perceptual speed – in boys only, however. This result supports the hypothesis that intelligence influences conscientiousness trajectories: more intelligent students are likely less dependent on conscientiousness (compensation hypothesis). However, the effect was not found when students who had left school after ninth or tenth grade were analyzed separately.

The phenomenon of intelligence compensation has implications for assessment practices. As both intelligence and conscientiousness can predict achievement, both constructs should be administered and considered to adequately predict performance. Furthermore, both constructs should be accounted for when selecting applicants for universities, apprenticeships, or jobs, as conscientious individuals can compensate for a possible lack of intelligence and perform well.

Key insights

- Conscientiousness increased in late adolescence.
- Reasoning was negatively associated with conscientiousness trajectories.
- This association was more pronounced in boys than in girls.

Relevance statement

Using large nationwide panel data, the paper examines whether intelligence influences changes in conscientiousness and thus provides new insights into factors of personality changes in adolescence.

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Author contributions

Teresa Sophie Friedrich: Conceptualization; Formal analysis; Investigation; Methodology; Project administration; Software; Validation; Visualization; Writing - original draft, and Writing - review & editing.
Astrid Schütz: Conceptualization; Supervision; Writing - review & editing.

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Data accessibility statement

Researchers can request the data via the research data center (FDZ) of the Leibniz-Institut für Bildungsverläufe (LIfBi; https://www.neps-data.de/Data-Center/Data-and-Documentation/Start-Cohort-Grade-5/Data-and-Citation).

Supplemental material

Supplemental material for this article is available online. Depending on the article type, these usually include a Transparency Checklist, a Transparent Peer Review File, and optional materials from the authors.

Note

1. Grades were recoded such that high values indicated good performance.

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Appendix

Table A1. Measurement Invariance Analyses.

Model	Fit indices	Δ fit indices	X^2-test	Evaluation measurement invariance
		Conscientiousness		
Conscientiousness baseline model	CFI = 0.998, TLI = 0.988, RMSEA = 0.030, SRMR = 0.009	—	—	—
Conscientiousness weak MI time	CFI = 0.986, TLI = 0.969, RMSEA = 0.048, SRMR = 0.018	Δ CFI = 0.012, Δ TLI = 0.019, Δ RMSEA = 0.018, Δ SRMR = 0.009	$X^2(4)$ = 51.01, p < .001	Weak MI does not apply

(continued)

Table A1. (continued)

Model	Fit indices	Δ fit indices	X^2-test	Evaluation measurement invariance
Conscientiousness partial weak MI time	CFI = 0.997, TLI = 0.991, RMSEA = 0.026, SRMR = 0.010	Δ CFI = 0.001, Δ TLI = 0.003, Δ RMSEA = 0.004, Δ SRMR = 0.001	$X^2(2) = 3.73$, $p = .1551$	We implemented partial weak MI and freed the lazy-indicator for the third wave
Conscientiousness strong MI time	CFI = 0.923, TLI = 0.835, RMSEA = 0.110, SRMR = 0.047	Δ CFI = 0.074, Δ TLI = 0.156, Δ RMSEA = 0.084, Δ SRMR = 0.037	$X^2(2) = 602.27$, $p < .001$	Strong MI does not apply
Conscientiousness partial strong MI time	CFI = 0.997, TLI = 0.991, RMSEA = 0.026, SRMR = 0.010	Δ CFI = 0, Δ TLI = 0, Δ RMSEA = 0, Δ SRMR = 0	Not possible, 0 df	We implemented partial strong MI and freed the lazy-indicator. It was not possible to calculate a chi^2-test, but the fit indices look good
Conscientiousness baseline group model – gender	CFI = 0.998, TLI = 0.989, RMSEA = 0.028, SRMR = 0.010	—	—	—
Conscientiousness weak MI gender	CFI = 0.998, TLI = 0.994, RMSEA = 0.020, SRMR = 0.013	Δ CFI = 0, Δ TLI = 0.005, Δ RMSEA = 0.008, Δ SRMR = 0.003	$X^2(5) = 4.72$, $p = .4507$	Weak MI does apply and fit indices look good
Conscientiousness strong MI gender	CFI = 0.998, TLI = 0.996, RMSEA = 0.017, SRMR = 0.013	Δ CFI = 0, Δ TLI = 0.002, Δ RMSEA = 0.003, Δ SRMR = 0	$X^2(2) = 1.12$, $p = .5726$	Strong MI does apply and fit indices look good
Conscientiousness baseline group model – continuing school	CFI = 0.998, TLI = 0.991, RMSEA = 0.027, SRMR = 0.009	—	—	—
Conscientiousness weak MI continuing school	CFI = 0.998, TLI = 0.994, RMSEA = 0.022, SRMR = 0.014	Δ CFI = 0, Δ TLI = 0.003, Δ RMSEA = 0.005, Δ SRMR = 0.005	$X^2(5) = 6.60$, $p = .2522$	Weak MI does apply and fit indices look good
Conscientiousness strong MI continuing school	CFI = 0.994, TLI = 0.987, RMSEA = 0.032, SRMR = 0.016	Δ CFI = 0.004, Δ TLI = 0.007, Δ RMSEA = 0.010, Δ SRMR = 0.002	$X^2(2) = 13.80$, $p = .0010$	The chi^2-test was significant, but the differences between fit indices are smaller than defined by Chen (2007) and model fit is good. Therefore, MI holds
		Perceptual speed		
Perceptual speed baseline model	CFI = 0.994, TLI = 0.989, RMSEA = 0.040, SRMR = 0.017	—	—	—
Perceptual speed weak MI time	CFI = 0.989, TLI = 0.983, RMSEA = 0.050, SRMR = 0.033	Δ CFI = 0.005, Δ TLI = 0.006, Δ RMSEA = 0.010, Δ SRMR = 0.016	$X^2(2) = 18.37$, $p < .001$	The chi^2-test was significant, but the differences between fit indices are smaller than defined by Chen (2007) and model fit is good. Therefore, MI holds
Perceptual speed strong MI time	CFI = 0.922, TLI = 0.902, RMSEA = 0.119, SRMR = 0.089	Δ CFI = 0.067, Δ TLI = 0.081, Δ RMSEA = 0.069, Δ SRMR = 0.056	$X^2(2) = 153.84$, $p < .001$	Strong MI does not apply

(continued)

Table A1. (continued)

Model	Fit indices	Δ fit indices	X^2-test	Evaluation measurement invariance
Perceptual speed partial strong MI time	CFI = 0.988, TLI = 0.983, RMSEA = 0.049, SRMR = 0.034	Δ CFI = 0.001, Δ TLI = 0, Δ RMSEA = 0.001, Δ SRMR = 0.001	$X^2(1) = 1.79$, $p = .1806$	We implemented partial strong MI and freed the first perceptual speed indicator
Perceptual speed baseline group model – gender	CFI = 0.992, TLI = 0.986, RMSEA = 0.044, SRMR = 0.017		—	—
Perceptual speed weak MI gender	CFI = 0.992, TLI = 0.988, RMSEA = 0.040, SRMR = 0.020	Δ CFI = 0, Δ TLI = 0.002, Δ RMSEA = 0.004, Δ SRMR = 0.003	$X^2(4) = 7.07$, $p = .1322$	Weak MI does apply and fit indices look good
Perceptual speed strong MI gender	CFI = 0.989, TLI = 0.986, RMSEA = 0.043, SRMR = 0.024	Δ CFI = 0.003, Δ TLI = 0.002, Δ RMSEA = 0.003, Δ SRMR = 0.004	$X^2(4) = 21.64$, $p < .001$	The chi^2-test was significant, but the differences between fit indices are smaller than defined by Chen (2007) and model fit is good. Therefore, MI holds
Perceptual speed baseline group model – continuing school	CFI = 0.991, TLI = 0.982, RMSEA = 0.048, SRMR = 0.021		—	—
Perceptual speed weak MI continuing school	CFI = 0.991, TLI = 0.987, RMSEA = 0.042, SRMR = 0.022	Δ CFI = 0, Δ TLI = 0.005, Δ RMSEA = 0.006, Δ SRMR = 0.001	$X^2(4) = 1.04$, $p = .9031$	Weak MI does apply and fit indices look good
Perceptual speed strong MI continuing school	CFI = 0.992, TLI = 0.990, RMSEA = 0.036, SRMR = 0.022	Δ CFI = 0.001, Δ TLI = 0.003, Δ RMSEA = 0.006, Δ SRMR = 0	$X^2(4) = 1.03$, $p = .9056$	Strong MI does apply and fit indices look good
		Reasoning		
Reasoning baseline model	CFI = 0.989, TLI = 0.979, RMSEA = 0.040, SRMR = 0.019		—	—
Reasoning weak MI time	CFI = 0.987, TLI = 0.981, RMSEA = 0.039, SRMR = 0.022	Δ CFI = 0.002, Δ TLI = 0.002, Δ RMSEA = 0.001, Δ SRMR = 0.003	$X^2(2) = 9.58$, $p = .0083$	The chi^2-test was significant, but the differences between fit indices are smaller than defined by Chen (2007) and model fit is good. Therefore, MI holds
Reasoning strong MI time	CFI = 0.966, TLI = 0.958, RMSEA = 0.058, SRMR = 0.035	Δ CFI = 0.021, Δ TLI = 0.023, Δ RMSEA = 0.019, Δ SRMR = 0.013	$X^2(2) = 92.15$, $p < .001$	Strong MI does not apply
Reasoning partial strong MI time	CFI = 0.985, TLI = 0.979, RMSEA = 0.041, SRMR = 0.023	Δ CFI = 0.002, Δ TLI = 0.002, Δ RMSEA = 0.002, Δ SRMR = 0.001	$X^2(1) = 11.11$, $p < .001$	The chi^2-test was significant, but the differences between fit indices are smaller than defined by Chen (2007) and model fit is good. Therefore, partial MI holds
Reasoning baseline group model – gender	CFI = 0.989, TLI = 0.980, RMSEA = 0.039, SRMR = 0.019		—	—

(continued)

Table A1. (continued)

Model	Fit indices	Δ fit indices	X^2-test	Evaluation measurement invariance
Reasoning weak MI gender	CFI = 0.986, TLI = 0.979, RMSEA = 0.040, SRMR = 0.027	Δ CFI = 0.003, Δ TLI = 0.001, Δ RMSEA = 0.001, Δ SRMR = 0.008	$X^2(4)$ = 14.90, p = .0049	The chi^2-test was significant, but the differences between fit indices are smaller than defined by Chen (2007) and model fit is good. Therefore, MI holds
Reasoning strong MI gender	CFI = 0.972, TLI = 0.965, RMSEA = 0.051, SRMR = 0.034	Δ CFI = 0.017, Δ TLI = 0.015, Δ RMSEA = 0.012, Δ SRMR = 0.015	$X^2(4)$ = 44.33, p < .001	Strong MI does not apply
Reasoning partial strong MI gender	CFI = 0.979, TLI = 0.972, RMSEA = 0.045, SRMR = 0.031	Δ CFI = 0.07, Δ TLI = 0.005, Δ RMSEA = 0.005, Δ SRMR = 0.04	$X^2(3)$ = 23.02, p < .001	The chi^2-test was significant, but the differences between fit indices are smaller than defined by Chen (2007) and model fit is good. Therefore, partial MI partial
Reasoning baseline group model – continuing school	CFI = 0.986, TLI = 0.974, RMSEA = 0.037, SRMR = 0.021		—	—
Reasoning weak MI continuing school	CFI = 0.987, TLI = 0.980, RMSEA = 0.033, SRMR = 0.023	Δ CFI = 0.001, Δ TLI = 0.006, Δ RMSEA = 0.004, Δ SRMR = 0.002	$X^2(4)$ = 3.19, p = .5273	Weak MI applies
Reasoning strong MI continuing school	CFI = 0.984, TLI = 0.981, RMSEA = 0.032, SRMR = 0.025	Δ CFI = 0.003, Δ TLI = 0.001, Δ RMSEA = 0.001, Δ SRMR = 0.002	$X^2(4)$ = 7.02, p = .1348	Strong MI applies

Note. Own calculations based on NEPS SC3: 12.1.0.

4

Chapter 4: Self-Esteem Change During Career Entry

Abstract

Self-esteem is linked to several positive outcomes. Thus, it is important to improve our understanding of how self-esteem develops and why people exhibit different self-esteem trajectories. Important events pertaining to self-esteem are life transitions, such as starting a career in young adulthood. By reference to a sample of nearly 2000 participants in the pairfam study and latent growth curve models, we examined the extent to which career entry influences self-esteem trajectories in young adulthood, particularly with respect to success at career entry and investments in the individual's career. In line with the notion of mastering developmental tasks, self-esteem decreased prior to career entry but increased thereafter; however, this pattern was observed only among individuals who entered the workforce at an average or late age. For early entrants, self-esteem remained stable. However, successful career entry enhanced the self-esteem trajectories of young and average-aged career entrants; namely, they exhibited greater increases in self-esteem after career entry if they were satisfied with their jobs, if their jobs paid well, and if those jobs were well respected. All of the final analyses controlled for education, job status, and gender. Overall, the results of this research indicate that self-esteem increases alongside (successful) career entry.

Keywords: Self-esteem change, career entry, success at career entry, work investment

Self-esteem influences success and well-being in various important life domains. For example, high levels of self-esteem are associated with satisfaction in marriage and close relationships, physical and mental health, educational and academic success, success and satisfaction at work, and reduced criminal and anti-social behavior (Orth & Robins, 2014, 2022). Self-esteem refers to a "positive or negative attitude toward […] the self" (Rosenberg, 1965, p. 30). It does not reflect a person's talents or abilities objectively (Orth & Robins, 2014) but rather indicates whether they feel "good enough" (Rosenberg, 1965, p. 31) and valuable. Self-esteem therefore involves "an individual's subjective evaluation of her or his worth as a person" (Donnellan et al., 2011, p. 718) and is relevant to various life outcomes.

Self-esteem is dynamic and changes throughout life (James, 1890; Orth & Robins, 2014). Particularly in young adulthood, self-esteem can change dramatically because of the many opportunities, challenges, and changes that individuals encounter during this period of life (Arnett, 2000). Whereas the mean-level change trajectories of self-esteem have been well researched, our understanding of the reasons for and the conditions under which self-esteem changes occur remains limited. Further research is needed to explore individual differences in the changes in self-esteem that occur during young adulthood (Reitz, 2022; Reitz et al., 2020). How are such changes in self-esteem related to important life events?

Life transitions have been identified as a key driver of self-esteem changes; that is, self-esteem remains relatively stable as long as no major life transitions occur (Reitz et al., 2020). Career entry is a crucial transition and turning point in young adulthood. It is related to many opportunities and changes that are relevant to the self. However, research on the changes in self-esteem that occur during career entry is limited. To our knowledge, only Reitz et al. (2020) and Filosa et al. (2022) have investigated this topic. The present study builds on these studies. The effects of entering a career on self-esteem should be highly relevant because self-esteem subsequently has positive effects on various aspects of individuals' professional lives, including their job satisfaction, success, and work resources (Orth & Robins, 2022). The following study

aims to bridge this research gap by examining the changes in self-esteem that occur during career entry.

Self-Esteem Change in Young Adulthood

Self-esteem is a dynamic construct that, like other personality traits, is moderately stable over time and across different contexts (Baldwin & Hoffmann, 2002; Rentzsch et al., 2016; Trzesniewski et al., 2003). It changes throughout individuals' entire lifespan and follows a quadratic trajectory. Empirical studies have revealed a relatively high level of self-esteem in childhood, which decreases during adolescence before increasing once again in young and middle adulthood. Self-esteem peaks at approximately the age of 60 years before then decreasing in old age (Orth et al., 2010, 2015; Orth & Robins, 2014; Robins & Trzesniewski, 2005). Hitherto, no theory that explicitly explains the increase in self-esteem that occurs in young adulthood has been developed. However, from a personality psychology perspective, this increase may be explained by an investment in new social roles, whereas from a developmental psychology perspective, it may be explained in light of the successful mastery of normative developmental tasks in young adulthood.

Social Investment Principle

The social investment principle (Roberts et al., 2005) is an approach rooted in personality psychology that explains the changes in self-esteem that occur during young adulthood. According to that theory, investing in social institutions, such as age-specific social roles, is a major driver of personality change during this period. This theory is based on three assumptions: (1) People form their identities by making psychological commitments to social institutions (such as work, marriage, family, or community) through the social roles that they play. Social expectations determine which role they should fulfill at each age. (2) Social roles encompass specific (behavioral) expectations and are characterized by their own reward structure, thus promoting the development of mature personality traits. (3) Investing in these social roles

is a quasiuniversal task pertaining to social life and explains the changes in normative personality that occur during young adulthood (Roberts et al., 2005).

Social roles involve forms of behavior that are expected and appropriate. Appropriate behavior is rewarded, whereas inappropriate behavior is punished (Roberts et al., 2005). To meet the social expectations associated with a new role and exhibit appropriate behavior, people must change their behaviors. These new behaviors initially affect people's specific role identities before being internalized and transferred to other areas. In this way, new social roles and the corresponding expectations influence people's behaviors and personalities in the long term (Roberts & Wood, 2006). Young adulthood introduces important new roles, such as work force entry (Hutteman et al., 2014). People invest heavily in these roles and develop mature personality traits, such as emotional stability, conscientiousness, and agreeableness, with the goal of fulfilling them (Roberts & Wood, 2006).

The social investment principle suggests that investment in one's role is essential with respect to personality change. The questions of whether people work, are married, and so on are not essential; rather, *how* they engage in these activities is the crucial factor. Such engagement results in individual differences in personality change: not every person changes in the same way due to the varying degrees to which they are committed to their social roles, which are in fact rather universal (Lodi-Smith & Roberts, 2007; Roberts et al., 2005). Hudson and Roberts (2016) identified associations between social investment in work and all Big Five personality traits with the exception of openness. Furthermore, changes in social investment at work are related to changes in conscientiousness and agreeableness.

The social investment principle may also affect people's self-esteem because many of the mature personality traits included in this approach are also positively related to self-esteem. For example, Robins et al. (2001) investigated the correlations between the Big Five personality traits and self-esteem. Overall, 34% of the variance in self-esteem could be attributed to the Big Five personality traits. Individuals who exhibit high levels of self-esteem are more emotionally

stable (r = .50), extraverted (r = .38), conscientious (r = .24), open to experiences (r = .17), and agreeable (r = .13).

In summary, the social investment principle posits that engagement in new social roles and the corresponding behavioral expectations support mature personality development and should thus also increase people's self-esteem. Another approach to self-esteem changes in young adulthood is rooted in developmental psychology and based on developmental tasks (Havighurst, 1966).

Developmental Tasks

Developmental tasks are tasks that arise during certain stages of life. Successful mastery of these tasks can lead to happiness and success in the face of future tasks. Failure to accomplish a developmental task can result in unhappiness, societal disapproval, and difficulties with future tasks. Therefore, developmental tasks are particularly important topics for specific age groups and are essential with regard to individual development (Havighurst, 1966; Pinquart, 2019).

Societal expectations determine when individuals should pursue and achieve specific developmental tasks. People typically compare their own development to societal norms. If the individual's development matches the expected development, the individual can receive social support and reinforcement, whereas sanctions such as disapproval are implemented in cases of mismatch (Freund & Nikitin, 2018; Neugarten, 1972). Overall, society expects individuals to complete certain developmental tasks at specific ages, such as starting a career during young adulthood. Successful mastery of developmental tasks at the intended time determines individuals' developmental success and ensures satisfaction and social rewards.

Self-esteem is an indicator of developmental success and influenced by the successful mastery of developmental tasks (Reitz et al., 2020). Thus, the developmental task of career entry represents a milestone in self-esteem development.

Self-Esteem Changes During Career Entry

Starting a career is a major task during young adulthood. This task is crucial, as it determines individuals' social status, allows them to obtain financial independence, and influences their self-perceptions. An adult's identity is strongly formed through work. In addition, work provides individuals with a regular daily routine, and the income it offers enables them to participate in the adult world (Faltermaier et al., 2014).

However, the timing of career entry may be decisive with respect to self-esteem trajectories, as social expectations shape the appropriate age of career entry. Entering the labor market at an early or late age may have a stronger influence on self-esteem, as off-time events may have more influence on people's personalities (Luhmann et al., 2014; Neugarten, 1976). However, circumstances may differ between early and late career entrants: individuals who start their careers late often have higher levels of education and can thus enter more prestigious jobs than can people who enter the labor market at a very early age. Furthermore, early career entrants may have financial reasons for doing so, such as the need to earn a living, whereas late career entrants may face societal disapproval for not making their own money for a long time.

Young adults differ in terms of when they enter a job as well as in terms of how successfully they start their careers. Self-esteem reflects successful mastery. If people enter a career successfully, their self-esteem should increase; otherwise, it should decrease. Consequently, self-esteem might be rather diverse at career entry, as some people have great starts, whereas others face difficulties. Various aspects can thus indicate success at career entry. In addition to objective criteria such as salary, subjective criteria such as job satisfaction or various job characteristics indicate success, and some jobs may be more satisfying than others (Limmer & Schütz, 2021).

We are not aware of any studies that have explicitly analysed the influence of *successful* career entry on changes in self-esteem. We aim to bridge this research gap by conducting the present study. Reitz et al. (2022) examined the reciprocal effects between self-esteem and

transitions between unemployment and employment and revealed that job satisfaction had a moderating effect on changes in self-esteem: the self-esteem of people with satisfying jobs increased when they started such a job but decreased slightly thereafter, although it did not return to the initial level. For individuals with less satisfying jobs, this increase in self-esteem was less pronounced. In addition, Krauss and Orth (2022) conducted a meta-analysis on the longitudinal relationships between self-esteem and indicators of job success, such as different work experiences, including job satisfaction, job success, income, job resources, job stressors, and employment status. This study revealed reciprocal effects between work experiences and self-esteem. However, neither study considered the association between self-esteem change and success at career entry, despite the fact that career entry is an important turning point in young adulthood.

Personality in adulthood develops largely through interactions with work. Skills, attitudes, behaviors and competencies change in and through work, both in terms of the activity itself and in terms of its social context (Hoff & Schraps, 2007). Starting a career significantly influences the lives of young adults, as this transition fundamentally changes their daily routines and imposes new tasks and responsibilities; however, it also provides increased autonomy and leads to the emergence of many new relationships (Filosa et al., 2022).

Starting a career is also linked to several expectations regarding young adults' behavior and actions. For example, people with careers are expected to organize their lives in a more structured way, wake up early, interact professionally with colleagues, and take responsibility at work. Job entrants who are more psychologically committed to their jobs invest more in their new social roles and are therefore more likely to fulfill the behavioral requirements of their jobs (Roberts et al., 2005). The new behavior they exhibit during this process is then internalized and subsequently transferred to other life domains. This process, in turn, should lead to the development of mature personality traits and higher self-esteem. However, people vary in terms of their level of commitment to their jobs. Therefore, according to the social investment principle, we should observe large variance in self-esteem at career entry (Roberts et al., 2005).

Reitz et al. (2020) examined changes in self-esteem during the transition from university to work by reference to 163 students who had almost finished their master's degrees. Self-esteem was measured before and after graduation. Half of the participants were working full-time at the second measurement point, whereas the other half were not (i.e., these participants worked part-time jobs or internships or were unemployed). The study considered 14 diary entries through which these participants documented their daily achievement-related experiences, which could be used as indicators of investment. However, the participants' experiences were rather broad and not directly related to work. Participants' self-esteem increased slightly during the study period, but this change was significant only for career entrants. Although the two groups did not differ significantly, the rank order stability exhibited by the group of nonjob entrants was higher than that exhibited by the job entrant group. This finding highlights self-esteem change during career entry and the diverse self-esteem trajectories that are observed during that phase. In addition, a significant positive correlation was observed between changes in achievement-related experiences and self-esteem among the job entrant group. The present study also examines whether *success* at career entry influences self-esteem trajectories. Moreover, this study focuses on more measurement points and a more heterogeneous sample, and it distinguishes among individuals with different ages at career entry.

Other studies have examined the changes in self-esteem that occur during career entry without considering success or investment. Filosa et al. (2022) investigated the impact of career entry on self-esteem changes among 368 adolescents who were interviewed multiple times over a 14-year period. Piecewise growth curve models revealed that self-esteem increased throughout the study period; however, this increase was slightly faster before career entry than after career entry. However, the two slopes differed only slightly, and the model featuring equal slopes exhibited a better fit with the data. Moreover, the slope after the transition exhibited greater variance than did the slope before the transition, thus suggesting the presence of different trajectories. In addition, the intercept was positively correlated with the slope before career

entry but negatively correlated with the slope after career entry: the self-esteem of participants who exhibited high levels of self-esteem at career entry increased more strongly before the transition and less strongly after the transition. The present study uses the same method but focuses on a larger sample consisting of nearly 2000 adolescents and young adults; furthermore, this study also includes success and investment at career entry.

Finally, Wagner et al. (2013) investigated self-esteem during the transition from school to adult life. Self-esteem exhibited a quadratic trajectory; i.e., it increased throughout the study period with a steadily increasing trend. That study examined specific life events, such as living with one's parents, relationship status, and educational path; however, it did not consider career entry as a factor that could increase individuals' self-esteem.

The Present Study

Self-esteem changes throughout individuals' lifespan (Robins & Trzesniewski, 2005), particularly during young adulthood and life transitions (Arnett, 2000; Reitz et al., 2020). Investment in new social roles and the successful mastery of developmental tasks can explain changes in individuals' self-esteem during young adulthood.

Although starting a career represents a significant turning point in the lives of young adults, which entails many opportunities and challenges that are relevant to the self, only a few empirical studies have addressed the changes in self-esteem that occur during this transition (e.g., Filosa et al., 2022; Reitz et al., 2020; Wagner et al., 2013). However, these studies have not analysed role investments or the successful mastery of developmental tasks in detail. Only Reitz et al. (2020) included achievement-related daily experiences; however, the experiences on which these authors focused were rather general and not directly related to work. Thus, little is known regarding the *conditions* under which self-esteem changes. The present study aims to bridge this research gap by investigating the impact of successful career entry and investment in a new job on self-esteem change. For this purpose, we propose four hypotheses:

H1: In young adulthood, new social roles emerge, which offer great potential for mature personality changes. Therefore, we expect self-esteem to increase throughout this period. Furthermore, we anticipate that people who start a career at an early or late age experience greater changes, as off-time events have stronger impacts on the development of personality and self-esteem (Luhmann et al., 2014; Neugarten, 1976).

H2: We anticipate greater increases in self-esteem to occur after people enter a career than before they do so, as self-esteem is expected to respond to new social roles or the mastery of developmental tasks. Reitz et al. (2020) reported that job entrants exhibit increases in self-esteem, whereas the self-esteem of nonentrants does not exhibit any significant changes. Golle et al. (2019) compared the conscientiousness of adolescents in school with that of working adolescents at several time points and reported that working adolescents exhibit higher levels of conscientiousness. However, a study conducted in Italy reported greater changes in self-esteem prior to career entry (Filosa et al., 2022). This difference might be explained by different expectations of society and family in Italy and Germany, where the other samples stem from. In addition, we expect people who exhibit late career entry to be characterized by particularly large increases, as these people might have experienced social pressure to master this important developmental task at long last.

H3: We expect individuals who have successfully entered their careers to experience greater increases in self-esteem than other individuals. Additionally, we anticipate correlations between changes in success and changes in self-esteem.

H4: We also anticipate greater increases in self-esteem among individuals who invest more in their jobs. According to the social investment principle, investment in new social roles, such as entering a career in young adulthood, is crucial with regard to personality change.

Method

Design and Sample

We use data drawn from the Panel Analysis of Intimate Relationships and Family Dynamics (pairfam), release 13.0 (Brüderl et al., 2022; Huinik et al., 2011). Since 2008, this longitudinal study has surveyed three cohorts annually (1971-73, 1981-83, and 1991-93). We focus on the youngest cohort, as these individuals were between the ages of 15 and 19 (on average, 17 years) during the first wave featuring usable self-esteem data.

As not all participants continued to participate in this research until the most recent study wave, it was impossible to determine which participants never entered the labor market and which participants dropped out of the study before career entry. Therefore, we excluded all participants who dropped out of the study and who did not report career entry from the analyses. The final sample thus includes $N = 1994$ participants, of whom 50% are men. Participants who remained in the sample until the thirteenth wave are younger ($t(3553) = -2.65$, $p = .0082$) and more likely to be women ($\chi^2(1) = 7.63$, $p = .0057$). However, these participants exhibit no differences with respect to self-esteem ($t(3509) = -1.06$, $p = .2909$) or satisfaction with school/apprenticeship/work ($t(2454.7) = 0.80$, $p = .4236$).

For the multigroup models, we divided the sample into three groups according to participants' age at career entry. This sorting resulted in the emergence of early, average, and late career entry groups, each of which includes approximately one third of the participants ($N_1 = 623$, $N_2 = 664$, $N_3 = 582$). These three groups differ systematically in terms of their levels of education and the occupations they pursue (Years of education: $F(2, 1205.6) = 428.66$, $p < .001$; kldb: $X^2(16) = 149.18$, $p < .001$; ISEI: $F(2, 1111.8) = 211.4$, $p < .001$). Early career entrants exhibit the lowest levels of education and are more likely to work in low-status occupations. Late career entrants exhibit the highest levels of education and tend to work in high-status occupations; average-aged career entrants are moderate in both respects. Early career entrants are mainly blue-collar workers, whereas average and late career entrants are mainly

white-collar workers. Therefore, we controlled for years of education, the International Socio-Economic Index of Occupational Status (ISEI) of participants' first jobs, and gender in all the final models consulted in this research[2].

Measures

Career Entry: We used the participants' current labor force status (education, vocational training, military, full-time work, part-time work, marginal employment, self-employment, unemployment, parental leave, homemaker, and retirement) in each wave to determine career entry. We coded the wave in which participants first indicated that they worked full-time, part-time or in self-employment as career entry. Marginal employment was not considered to indicate career entry.

Self-Esteem: Pairfam measured self-esteem in 13 consecutive years via a simplified, short version of the Rosenberg self-esteem scale in German. This scale featured 3 items: 1) "Sometimes I believe that I'm worthless"; 2) "I like myself just the way I am"; and 3) "All in all, I am pleased with myself". Answers ranged from 1 = "*not at all*" to 5 = "*absolutely*". In wave 1, the participants responded to the self-esteem items during a personal interview, whereas beginning in wave 2, they did so through written or online interviews. The means and standard deviations of self-esteem differed significantly across these survey modes (Sonntag et al., 2014). Therefore, we excluded the first wave from our analyses.

Successful Career Entry: As a proxy for successful career entry, we used the following variables: 1) satisfaction with work (participants rated their satisfaction from wave 1 to wave 13 on a scale ranging from 0 = "*very dissatisfied*" to 10 = "*very satisfied*"); 2) good payment ("I am paid well for my job"); and 3) accepted and respected occupation ("My occupation is

[2] It would also be interesting to divide the groups according to participants' status or education at career entry. In fact, we tested this alternative approach and obtained very similar results. Ultimately, we chose to divide the groups according to age, as this division was well justified theoretically: developmental tasks must be mastered at a certain point in time, i.e., at a specific age.

accepted and respected"). Participants also responded to these two items from waves 1 to 13 on a scale ranging from 1 "*disagree completely*" to 5 "*agree completely*".

Investment in Job: Regarding job investment, various indicators capture the importance of work. In the analyses, we combined three items into a scale that exhibited a reliability of $\alpha = .79$. The participants responded to these items in wave 12 on a scale ranging from 1 "*disagree completely*" to 5 "*agree completely*". The items were as follows: 1) "Most of the important things that happen in my life are related to my job"; 2) "Most of my interests revolve around my job"; and 3) "Others see me as a career person."

Analyses

First, we conducted a general confirmatory factor analysis (CFA) that included all self-esteem measurement points and freely estimated covariances between latent self-esteem constructs. This model serves as a foundation for latent growth curve models and is therefore useful with regard to testing basic assumptions such as indicator-specific method effects and measurement invariance.

Self-esteem was measured via the same three items in all waves; thus, we first developed a model that featured indicator-specific factors (Eid, 2000) and compared it with a model that lacked such indicator-specific factors via a chi^2 test. The model that included the method factor fit the data significantly better than did the model without it.

We further tested for measurement invariance over time and across groups. First, we established a model that featured weak measurement invariance and tested it against the baseline model via a chi^2 test. We then developed a model that featured strong measurement invariance and tested it against the model that featured weak measurement invariance. Another method used to assess measurement invariance is to compare the fit indices of the models. Measurement invariance is present for changes in the comparative fit index (CFI) that are less than .010, for changes in the root mean square error of approximation (RMSEA) that are less than .015 and for changes in the standardized root mean squared residual (SRMR) that are less than .030 for

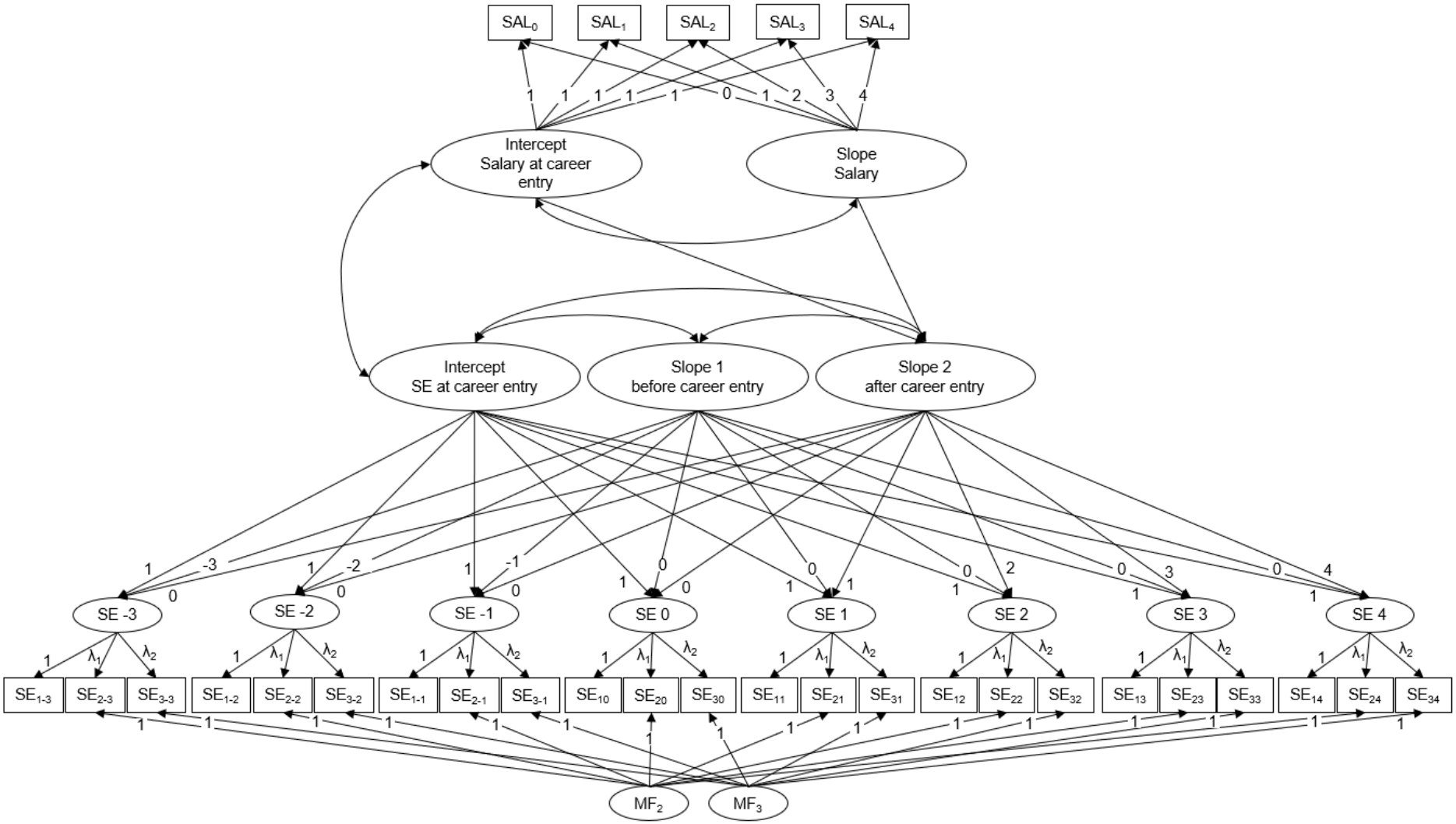
weak measurement invariance and less than .010 for strong measurement invariance (Chen, 2007).

Subsequently, we calculated several latent growth curve models (LGCMs). In the first step, we analysed a 2nd-order linear LGCM that was used to capture changes in self-esteem from waves 2 to 13. We also calculated the multigroup version of this model separately for people with and without career entry during the period under observation as well as separately for people with early, average, and late career entry.

We then centered the time at career entry and calculated multigroup two-piece LGCMs (Flora, 2008). These models are LGCMs that feature two separate linear slopes – one slope that measures changes in self-esteem before career entry and one that measures changes in self-esteem after career entry – as well as an intercept that captures self-esteem at career entry. Once again, we formed the groups in terms of early, average, and late career entry.

Finally, we included different indicators for success at career entry and investment in the job in the models with the aim of testing the influence of these factors on changes in self-esteem. As recent research has suggested the existence of differences in self-esteem (trajectories) between men and women as well as education-related differences (e.g., Orth et al., 2010), we controlled for years of education, ISEI, and gender in all final models (i.e., in all the two-piece LGCMs). This approach also allowed us to address the issue that individuals with early, average and late career entry differ in terms of their levels of education and occupational status. Figure 1 illustrates the final model. We performed all analyses with the assistance of R software (R Core Team, 2022) and accounted for missing values via the full information maximum likelihood method.

Figure 1
Two-Piece Latent Growth Curve Model with Good Salary as a Predictor



Results

First, we analysed the general CFA models with the goal of testing for measurement invariance and indicator-specific method effects. The model that included the method factor exhibited a good model fit (CFI = 0.979, TLI = 0.974, RMSEA = 0.031, SRMR = 0.060) and fit the data significantly better than did the model that lacked the method factor ($X^2(24) = 2958.5$, $p < .001$). However, the chi^2 tests indicated that measurement invariance across time and weak measurement invariance across groups (age at career entry) were not present. Nevertheless, the models that featured weak and strong measurement invariance exhibited an acceptable model fit, and the differences in CFI, RMSEA, and SRMR were rather small. In light of the differences in the fit indices and by reference to the suggestions of Chen (2007), we can nevertheless analyse and interpret the models with strong measurement invariance. See Table A1 for further details regarding the analyses of measurement invariance.

Subsequently, we estimated linear LGCMs for both the full sample and the group models, by age at career entry and career entry during the study period. The model fit exhibited by all three models was acceptable (CFI = 0.947–0.959, TLI = 0.947–0.960, RMSEA = 0.039–0.045, SRMR = 0.076–0.086). When all the participants were analysed together, self-esteem decreased slightly over the entire study period; this change was still significant. However, when the different groups were analysed separately, a different picture was obtained. Namely, for people who did not enter the workforce during the study period, self-esteem decreased slightly, whereas self-esteem increased for people who did enter the workforce. When people were considered separately according to their age at career entry, the self-esteem of early career entrants decreased slightly, whereas individuals with medium or late career entry experienced an increase in self-esteem over the study period.

To explore the changes in self-esteem at career entry in further detail, we estimated a two-piece LGCM. CFI (0.970), TLI (0.968), RMSEA, (0.037) and SRMR (0.074) indicated good model fit, and these values exhibited improvements compared with the model that featured

only one linear slope. The Akaike information criterion (AIC) (66284.318 vs. 103105.707) and Bayesian information criterion (BIC) (67263.861 vs. 104275.717) were also lower than those observed in the previous model. Self-esteem at career entry was considerably higher for people with early career entry than for people with average or late career entry.

Unlike the previous model, which featured only one slope, we did not observe any significant changes in self-esteem before or after career entry for early career entrants, which could be the result of a ceiling effect. For people with either average or late career entry, self-esteem decreased before career entry and increased once again after career entry.

We did not observe any correlation between the level of self-esteem at career entry and the changes in self-esteem exhibited by people with early career entry. For people with average or late career entry, self-esteem at career entry was positively related to changes in self-esteem before career entry; furthermore, for people with average career entry, it was also negatively related to changes in self-esteem after career entry.

In addition, we observed significant individual differences in self-esteem at career entry in all three groups; small individual differences in self-esteem change after career entry were observed among people with early career entry; small individual differences in self-esteem change before and after career entry were observed among people with average career entry; and small individual differences in self-esteem change before career entry were observed among people with late career entry.

Finally, we examined whether the various indicators of successful career entry or career investment influenced changes in self-esteem. All the conditional models fit the data well. Among average-aged career entrants in particular (but also among early career entrants), successful career entry was relevant to self-esteem change. Job satisfaction trajectories positively predicted the changes in self-esteem that occurred after career entry among all three entrant groups, as did job satisfaction at career entry for both early and late entrants. Furthermore, the trajectory of and good pay at career entry positively predicted the self-esteem trajectories of

early and average career entrants. Additionally, working in a well-respected occupation positively affected the self-esteem trajectories of people who exhibited early or average career entry. Interestingly, only the indicator "job satisfaction" predicted self-esteem change among late career entrants. Investment in the job had no effect on self-esteem for either group.

Discussion

Life transitions, such as starting a career during young adulthood, have the potential to change individuals' self-esteem. However, little is known concerning the conditions under which self-esteem changes. To explore these conditions in further detail, the present study investigated self-esteem trajectories at career entry in light of individuals' success and investment in the job.

We first analysed individuals' general self-esteem trajectories as young adults over time. Contrary to previous research on this topic (e.g., Orth et al., 2015; Orth & Robins, 2014), among the participants in our sample, self-esteem decreased between the ages of 17 and 28. However, this finding can be attributed primarily to individuals who did not start a career and those who started a career at an early age. The decrease in self-esteem observed among early career entrants might be explained in part by the relatively low status of the occupations in which these individuals worked as well as by a need to start earning money at a relatively young age. In contrast, self-esteem increased among individuals who exhibited average or late career entry. These findings provide initial support for the hypothesis that starting a career may influence individuals' self-esteem; furthermore, they are in line with Reitz et al. (2020), who also reported that the self-esteem of young adults increased only for individuals who entered the workforce.

To investigate this issue in further detail, we next considered solely people who had started a career during the study period. We analysed the participants' self-esteem trajectories before and after career entry via separate slopes and differentiated among various groups according to their age at career entry, as the timing of the mastery of developmental tasks, such as starting a career, is relevant in this context.

Unlike the results of previous models featuring only one slope, the self-esteem of early career entrants did not change before or after they entered the labor market. However, their self-esteem at the time of career entry was higher than that of participants in the other groups. Their higher self-esteem at career entry might be the result of the fact that these individuals began earning their own money at a young age. In contrast, the self-esteem of average and late career entrants decreased before they entered the labor market and increased thereafter. Individuals may experience some degree of anticipation and anxiety before they begin a job and then experience a feeling of success thereafter. This finding is also generally in line with the underlying theory and the hypotheses proposed in this research: self-esteem depends on starting a career – a central developmental task that occurs during young adulthood and involves new social roles and corresponding behaviors (expectations).

Nevertheless, we expected normative self-esteem increase over the entire study period because other aspects, such as social relationships, also influence self-esteem during young adulthood (e.g., Harris & Orth, 2020). Instead, self-esteem decreased before career entry and increased once again thereafter. It appears that starting a career is an important aspect of identity determination for many young adults and that failing to enter a career may negatively impact individuals' self-esteem. However, Filosa et al. (2022) reported that self-esteem increases both before and after career entry, including a particularly large increase before career entry. These authors did not find any significant relationship between individuals' age at their first jobs and their self-esteem trajectories after controlling for other covariates, whereas the present study revealed different self-esteem trajectories by age at career entry. Although the data reported by Filosa et al. (2022) are comparable to those examined in the present study with respect to age, their sample size was smaller, and their data collection process took place in Italy. Germany and Italy may exhibit relevant differences in this context, e.g., in terms of societal and family expectations.

As partnerships also influence individuals' self-esteem trajectories, it would be interesting for future research to investigate how (the timing of) a partner's career entry affects the focal individual's self-esteem change at career entry. However, the sample referenced in the present study is too small to examine this question.

One aim of the present study was to investigate the conditions under which self-esteem changes during career entry. According to theory, success at career entry and investment in one's career are the primary factors that determine changes in self-esteem, rather than career entry per se. Our analyses confirmed this assumption only partially: job investment (as measured by the self-rated importance of one's job/career) did not influence self-esteem change. However, self-rated career importance is not necessarily identical to actual investment in work. Reitz et al. (2020) measured job investment in terms of achievement-related experiences and reported correlated change with self-esteem, although the experiences on which those authors focused were rather general. Further analyses on the basis of an indicator that asks participants directly about their job investment would be interesting and could yield further insights.

However, successful career entry, as measured by job satisfaction, self-rated good income and possession of a well-respected job, influenced self-esteem trajectories in the present study, which was primarily the case among individuals with young and average ages at career entry. For late career entrants, success was much less important. Instead, for late entrants, it may be more important that they have finally mastered this important developmental task and no longer depend on their parents; thus, their success and investment are of only secondary importance. In addition, late entrants were mainly university graduates, who tend to have better paying and more prestigious jobs. If success at career entry is higher overall among this group, success may consequently be less important with respect to their self-esteem trajectories.

Strikingly, in contrast to the results of other studies (Filosa et al., 2022; Reitz et al., 2020), we observed only small individual differences in self-esteem trajectories after career entry. The more differentiated analyses conducted for the present study, which took into account

age and success at career entry, may explain part of the unexplained variance observed in those other studies. Career entry may not have beneficial effects for everyone – the situation seems to be more complex.

This study has several limitations. First, the high dropout rate in the pairfam data led to uncertainty regarding whether these individuals never entered the labor market or whether they dropped out of the study before career entry. As a result, the sample did not contain a sufficient number of participants who did not enter the labor market during the study period to provide meaningful comparisons between their self-esteem changes and those of career entrants. Instead, we compared groups by age at career entry. However, this comparison was also not optimal, as the groups differed in terms of their levels of education, occupations and occupational status, which is why we controlled for these variables.

Furthermore, we use secondary data in our analyses. These data extensively captured participants' success at career entry, but they were less effective with regard to capturing their investment in work. The investment indicator tends to reflect the importance that an individual attributes to a career rather than that individual's investment in work specifically.

Conclusion

The present study aimed to reveal the conditions under which self-esteem changes during young adulthood by investigating self-esteem trajectories at career entry, particularly in light of success and investment in the job. Self-esteem decreased prior to career entry and increased thereafter, but only among individuals with average or late career entry. For people without career entry, self-esteem tended to decrease throughout the entire study period.

Success at career entry had a positive effect on the self-esteem trajectories of young and average-aged career entrants, whereas career entry itself appeared to be the relevant factor with respect to the self-esteem trajectories of late career entrants. Overall, starting a career apparently has considerable influence on self-esteem trajectories during young adulthood. Young adults

should therefore be provided with a range of counseling and support services that can help them start their careers successfully and cope with potential difficulties.

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Table A1
Results of the Measurement Invariance Analyses

Model	Fit indices	Δ Fit indices	X^2 test	Evaluation
Baseline model	CFI = 0.979, TLI = 0.974, RMSEA = 0.031, SRMR = 0.060			
Weak MI time	CFI = 0.978, TLI = 0.975, RMSEA = 0.031, SRMR = 0.063	Δ CFI = 0.001, Δ TLI = 0.001, Δ RMSEA = 0, Δ SRMR = 0.003	$X^2(44) = 82.86$, $p < .001$	The results of the chi^2 test are significant, but the differences among the fit indices are very small. Therefore, according to Chen (2007), measurement invariance is present.
Strong MI time	CFI = 0.972, TLI = 0.970, RMSEA = 0.034, SRMR = 0.065	Δ CFI = 0.006, Δ TLI = 0.005, Δ RMSEA = 0.003, Δ SRMR = 0.002	$X^2(22) = 221.65$, $p < .001$	The results of the chi^2 test are significant, but the differences among the fit indices are very small. Therefore, according to Chen (2007), measurement invariance is present.
Baseline group model – age at career entry	CFI = 0.948, TLI = 0.943, RMSEA = 0.049, SRMR = 0.083			
Weak MI group – age at career entry	CFI = 0.947, TLI = 0.942, RMSEA = 0.049, SRMR = 0.085	Δ CFI = 0.001, Δ TLI = 0.001, Δ RMSEA = 0, Δ SRMR = 0.002	$X^2(4) = 16.27$, $p = .0027$	The results of the chi^2 test are significant, but the differences among the fit indices are very small. Therefore, according to Chen (2007), measurement invariance is present.

Model	Fit indices	Δ Fit indices	X^2 test	Evaluation
Strong MI group – age at career entry	CFI = 0.947, TLI = 0.942, RMSEA = 0.049, SRMR = 0.085	Δ CFI = 0, Δ TLI = 0, Δ RMSEA = 0, Δ SRMR =0	$X^2(4) = 2.29$, $p = .6830$	Measurement invariance is present.
Baseline group model – no career entry	CFI = 0.950, TLI = 0.944, RMSEA = 0.048, SRMR = 0.077			
Weak MI group – no career entry	CFI = 0.950, TLI = 0.944, RMSEA = 0.048, SRMR = 0.076	Δ CFI = 0, Δ TLI = 0, Δ RMSEA = 0, Δ SRMR = 0.001	$X^2(2) = 2.19$, $p = .3339$	Measurement invariance is present.
Strong MI group – no career entry	CFI = 0.950, TLI = 0.945, RMSEA = 0.048, SRMR = 0.076	Δ CFI = 0, Δ TLI = 0.001, Δ RMSEA = 0, Δ SRMR = 0	$X^2(2) = 0.45$, $p = .7973$	Measurement invariance is present.

5

Chapter 5: Discussion

Overall Summary and Integration of the Study Results

Besides intelligence, non-cognitive factors significantly influence many important life outcomes. The present dissertation aimed, on the one hand, to examine the interplay between cognitive factors (specifically intelligence) and non-cognitive factors (specifically conscientiousness) in predicting performance. As non-cognitive factors such as conscientiousness or self-esteem change throughout life, the second objective of this dissertation was to explore the reasons behind these changes. Here, too, the focus was on the influence of cognitive factors (in this case, intelligence) and career entry – a crucial turning point in the lives of young adults.

In line with Paper 1, both intelligence and conscientiousness positively influenced grades across a broad range of subjects. The effect was stronger in natural sciences than in language subjects. Moderation analyses revealed synergistic interaction effects in German, mathematics, and biology – but not in English. This means that conscientiousness, contrary to the hypothesis, does not compensate for intelligence but instead amplifies its effect on grades. However, Paper 1 captures only the current state based on cross-sectional data. According to theory, individuals become more conscientious to compensate for lower intelligence. This implies that changes in conscientiousness are central to the theory, which I investigated in Paper 2.

First, Paper 2 found that conscientiousness increased during late adolescence (ages 14/15 to 18/19), whereas changes during early adolescence (ages 12/13 to 14/15) were less clear. However, intelligence negatively influenced self-esteem trajectories in early adolescence, meaning that more intelligent adolescents increased to a lesser extent in conscientiousness. Paper 2 thus suggests a compensation mechanism, as less intelligent adolescents exhibited a stronger increase in conscientiousness. In late adolescence, intelligence no longer affects changes in conscientiousness; at this stage, other factors, such as new social roles, appear to be decisive for normative conscientiousness trajectories.

Interestingly, I found significant gender differences in both Paper 1 and Paper 2. In Paper 1, intelligent men achieved better grades in biology the more conscientious they were, whereas

men with lower intelligence showed no performance differences based on their conscientiousness. Women, on the other hand, performed better in biology as their conscientiousness increased, regardless of their intelligence.

In Paper 2, the interplay between intelligence and conscientiousness also played a greater role for boys than for girls, though from a different perspective. Boys with higher perceptual speed and higher reasoning ability exhibited smaller increases in conscientiousness. For girls, both measures of intelligence were less relevant for conscientiousness trajectories, with only reasoning ability influencing change.

Paper 2 thus focused solely on the interplay between intelligence and conscientiousness and found that boys compensated for their intelligence more strongly through conscientiousness compared to girls. However, once this compensation has occurred, cross-sectional data revealed that intelligent men benefited most from being conscientious when it comes to predicting biology grades, which suggests synergistic effects. For girls, intelligence seems to play a smaller role because they 1) tend to become conscientious anyway, and 2) leverage this conscientiousness to achieve good performance – independent of their intelligence.

In Paper 3, I also investigated reasons for personality change, though the focus here was on self-esteem and career entry as sources of change. Many studies have shown that self-esteem, like conscientiousness, typically increases during young adulthood (e.g., Orth & Robins, 2014). However, when considering career entry, Paper 3 revealed a more nuanced picture: self-esteem declined before career entry and then increased afterward – but only for individuals entering at an average or older age.

A successful workforce entry (measured by job satisfaction, good payment, and a well-respected occupation) amplified self-esteem increases for young and average-aged entrants. For older entrants, entering the workforce itself was the most crucial predictor for their self-esteem trajectory. Interestingly, investment in one's career did not influence self-esteem trajectories.

In summary, from a longitudinal perspective, conscientiousness compensated for intelligence, as more intelligent individuals increased less in conscientiousness compared to less intelligent individuals, relying instead on their cognitive abilities. In contrast, no such compensation was observed when predicting performance in cross-sectional data. Indeed, intelligent individuals benefited in particular when they were also conscientious.

Secondly, self-esteem changed during young adulthood, with a successful career entry playing a crucial role in this development.

Theoretical and Practical Implications

The present dissertation offers various theoretical and practical implications. First, the dissertation examines multiple theories within a single study, which provides insights into what theories prove more robust empirically. In the first and second paper, I investigated whether conscientiousness could compensate for intelligence. According to the intelligence compensation hypothesis, individuals become more conscientious to compensate for lower intelligence. However, Murray et al. (2014) criticized this idea, suggesting that conscientiousness changes independently of intelligence.

The findings of the dissertation reveal that no compensation occurs when examining cross-sectional data and considering performance. Instead, synergistic effects were observed: for intelligent individuals, conscientiousness was more strongly related to performance. Nevertheless, the second paper shows that less intelligent adolescents exhibit a greater increase in conscientiousness, which indicates that these individuals develop strategies to cope with challenges successfully. However, intelligence influenced conscientiousness changes only during early adolescence. In late adolescence, new social roles, as proposed by Roberts and Wood (2006), seem to play an important role in shaping normative conscientiousness trajectories.

The third paper of the dissertation also provides new theoretical insights. It examines the reasons for self-esteem changes during young adulthood. Theoretically, these changes can

be explained either by investment in new social roles (in this case, career entry) or by the successful mastery of developmental tasks (such as career entry). The findings of the dissertation suggest that a successful career entry provides a better explanation for self-esteem changes. It is possible that investing in new social roles primarily influences other personality traits, such as conscientiousness, rather than self-esteem.

In addition to these theoretical implications, the dissertation also offers practical implications. Conscientiousness, alongside intelligence, was a key predictor of school grades and could partially compensate for a lack of intelligence. Therefore, individuals should be assessed comprehensively in educational settings, career counseling, or further training institutions, also considering their non-cognitive traits. The same applies to personnel selection processes, as well as decisions regarding apprenticeships or university admissions.

Moreover, the findings that less intelligent individuals exhibit greater increases in conscientiousness and that conscientiousness influences performance can be used to optimize support for all individuals in school, vocational training, and professional contexts. The performance of (less intelligent) individuals could be enhanced by specifically fostering their conscientiousness.

The second practical implication relates to self-esteem. The dissertation finds that self-esteem can be influenced by external factors and circumstances, such as entering the workforce. Therefore, it is important to support young adults during this transition with counseling services or similar initiatives to ensure a successful career start and foster the optimal development of self-esteem.

Limitations and Future Research

Several limitations arise regarding the measurement of the constructs studied. In the dissertation, I analysed secondary data, which means that the constructs of interest were not always measured optimally – either in terms of content or the number of items observed.

However, using secondary data is resource-efficient and reduces the burden on participants, who are often contacted repeatedly for various studies. Nevertheless, it would be interesting for future research to investigate the research questions using datasets in which the constructs are measured optimally content-wise and with a sufficient number of items.

In Papers 1 and 2, intelligence is a central construct. However, the data were collected in school context, and the results of the intelligence tests had no consequences for the students or their school careers. As a result, it is possible that students completed the intelligence tests with varying levels of diligence – potentially influenced by their conscientiousness. This could lead to biased results, and the results should be interpreted with caution.

The second limitation concerns the generalizability of the findings. All three papers focus on a narrow age group, making it unclear to what extent the results can be generalized and applied to other age groups. This concern is supported by findings in Paper 2, where intelligence influenced changes in conscientiousness during early adolescence but not in late adolescence. Therefore, the results should be replicated in future studies with different sociodemographic compositions.

In general, the findings of the dissertation often varied across subgroups and depended on factors such as age, gender, or the indicators used. As a next step, it would be beneficial to verify the findings through a meta-analysis.

Furthermore, the analyses in all three papers consider only a limited number of constructs. For instance, in addition to conscientiousness, other non-cognitive factors such as self-efficacy (Multon et al., 1991) or interests (Krapp et al., 1993) also influence grades. It remains unclear whether conscientiousness still predicts grades significantly when these constructs are controlled for, and how these constructs interact with each other as well as with intelligence.

Similarly, in Paper 2, factors other than intelligence – such as positive or negative life events, successfully mastered developmental tasks, and new social roles – could also influence individual conscientiousness trajectories. This needs to be investigated in future research.

Conclusion

Overall, this dissertation highlights the significance of non-cognitive factors in academic and professional contexts and provides novel insights into their longitudinal development. The findings demonstrate that both intelligence and conscientiousness are important predictors of academic performance. Cross-sectionally, the two constructs reinforce each other in their positive impact on performance; that is, particularly intelligent students benefit from being conscientious. Longitudinally, however, intelligence negatively influences changes in conscientiousness, with less intelligent students exhibiting a greater increase in conscientiousness over time. Regarding self-esteem, the dissertation shows that self-esteem in early adulthood is driven by a (successful) career entry.

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