

Personality predicts academic achievement in higher education: Differences by academic field of study?

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ABSTRACT

In the present study it is investigated whether students enrolled in different academic fields of study have differing personality traits (i.e., conscientiousness and openness) and whether the relationship between these traits and academic achievement differs by academic field. Using Structural Equation Modeling on data from a large sample of university students, this study examined to what extent students' levels of conscientiousness and openness differ by academic field and whether these personality traits have differential predictive value for academic achievement for students in different academic fields. We found that students who are more open to experience and less conscientious are more likely to enroll in a program in the academic field of arts/humanities than in another field. There were no differences in the predictive value of these personality traits for academic achievement by academic field when controlling for prior performance in high school. These findings emphasize the general effectiveness of conscientiousness in explaining academic achievement and also call for the consideration of academic fields or college majors in personality research. Besides having theoretical implications, these findings have practical implications for higher education.

Personality traits are one of the main non-intellectual variables predicting academic achievement in higher education (De la Iglesia & Solano, 2019). In particular, the Big Five personality traits conscientiousness and openness to experience have consistently been found to positively predict academic achievement (e.g., O'Connor & Pauonen, 2007; Poropat, 2009; Vedel, 2014). However, conclusions from existing research are often based on studies with psychology students as participants (Poropat, 2009; Vedel, 2014) so that "we know a lot about psychology students and little about the remaining population" (Vedel, 2014, p. 73).

Students seem to choose academic fields or majors that fit their personalities. In general, arts/humanities students tend to be more open to experience (e.g., De Fruyt & Mervielde, 1996; Lievens, Coetsier, de Fruyt, & de Maeseneer, 2002; Vedel, 2016) and science students tend to be more conscientious than students in other academic fields (e.g., Kline & Lapham, 1992; Van der Molen, Schmidt, & Kruisman, 2007). However, it is unclear whether these differences imply that certain personality traits are also more beneficial for academic achievement in some academic fields than in others (Vedel & Poropat, 2020). For example, college majors in the academic field of science often emphasize

independent problem solving which requires aspects of conscientiousness such as precision and persistence, while aspects of openness, such as creativity, aesthetic appreciation, philosophical depth, or inquisitiveness about the human world, are emphasized in arts/humanities studies (Pozzebon, Ashton, & Visser, 2014). The few studies done into this have found initial evidence of a differential predictive strength of conscientiousness and openness for academic achievement by academic field, although the evidence is far from unequivocal regarding which traits are most beneficial in which academic fields (Fonteyne, Duyck, & de Fruyt, 2017; Vedel, 2014; Vedel, Thomsen, & Larsen, 2015).

In the present study, we examine whether there are differences in students' levels of conscientiousness and openness to experience between students in the fields of arts/humanities, science, social science, and law/economics/governance. We also examine, using Structural Equation Modeling, whether there are differences in the predictive value of conscientiousness and openness for achievement by academic field of study. We did not include the other three Big Five personality traits, Agreeableness, Extraversion, and Neuroticism, as these traits are not consistently related to higher education achievement (e.g., Trapmann, Hell, Hirn, & Schuler, 2007). Besides having theoretical implications,

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this study might have implications for both for educational guidance and counseling and for university admission procedures. First, this study may have implications for practitioners involved in educational guidance and counseling. If sizable differences are found, this may help prospective students or students who consider switching from college major or academic field to become aware of the academic fields in which they have the best chances to succeed due to their personality (Fonteyne, Duyck, & de Fruyt, 2017; Vedel, Thomsen, & Larsen, 2015). Second, in the context of the increased interest in the United States and Europe in using noncognitive criteria such as students' scores on personality tests for admission (Niessen & Meijer, 2017), our study may inform decisions about which personality traits are most suitable to include in university admission and selection procedures within specific academic fields.

1. Personality predicts academic achievement

In this study, we focus on conscientiousness and openness to experience as predictors of higher education achievement, which are personality dimensions of the Five-Factor Model (FFM; also called Big Five). The FFM has received extensive support in terms of its generalization across cultures, theoretical frameworks, and assessment methods (Hogan & Ones, 1997). Conscientiousness is also referred to as will to achieve or dependability (Poropat, 2009). It entails traits such as being organized, achievement-oriented, ambitious, self-disciplined, hard-working, and persevering. Openness to experience, also named openness or intellect, includes being original, imaginative, daring, independent-minded, creative, curious, and having broad interests (John & Srivastava, 1999; McCrae & Costa Jr., 1987). Academic achievement is mostly operationalized as grades in studies investigating the relation between personality traits and achievement (Vedel & Poropat, 2020).

Conscientiousness is, as shown in meta-analytic investigations, the personality dimension that most strongly and consistently predicts academic achievement in higher education (O'Connor & Paunonen, 2007; Poropat, 2009; Richardson, Abraham, & Bond, 2012; Trapmann, Hell, Hirn, & Schuler, 2007; Vedel, 2014). It even predicts achievement with similar strength as but beyond intelligence (Poropat, 2009). Openness to experience has also been found to be associated with higher education achievement in meta-analytic research (Poropat, 2009; Vedel, 2014), although with a considerably smaller effect size ($\rho = 0.07$) compared to conscientiousness ($\rho = 0.23$; Poropat, 2009). On the contrary, the meta-analyses of Trapmann, Hell, Hirn, and Schuler (2007) and O'Connor and Paunonen (2007) did not show a substantial and generalizable effect of openness to experience on college grades. Thus, in the case of openness to experience, results are more ambiguous about its relation with academic achievement and several authors of meta-analytic investigations have pointed to the possible existence of moderator variables, such as college major and study period (e.g., bachelor vs. master), influencing the relation between openness to experience and academic achievement (O'Connor & Paunonen, 2007; Trapmann, Hell, Hirn, & Schuler, 2007; Vedel, 2014). Moreover, conclusions about the relation of personality with academic achievement are often based on samples with psychology students which are generalized to students in postsecondary education in general, even though these generalizations do not seem entirely valid (Poropat, 2009; Vedel, 2014). These findings point to the importance of investigating whether the effect of personality traits on academic achievement differs by academic field.

One explanation of why personality traits serve as predictors of academic performance is that personality traits are predictive of particular behavioral tendencies that can influence academic success (O'Connor & Paunonen, 2007). In the case of conscientiousness, the relation with academic achievement is commonly interpreted in terms of motivation (Chamorro-Premuzic & Furnham, 2005; O'Connor & Paunonen, 2007). Indeed, motivation (Hazrati-Viari, Rad, & Torabi, 2012; Richardson & Abraham, 2009) and its resulting proximal behaviors (e.g., more time spent on the task at hand; Biderman, Nguyen, & Sebren, 2008; increased class attendance; Conard, 2006) have been shown to mediate the

relation between conscientiousness and academic achievement. The positive relationship between openness to experience and academic achievement has, on the one hand, been interpreted in terms of cognitive ability (Chamorro-Premuzic & Furnham, 2005; O'Connor & Paunonen, 2007) due to its correlations with intelligence (e.g., McCrae & Costa Jr., 1985). On the other hand, aspects of openness such as being original, widely interested, and resourceful are regarded as having a direct effect on the relation with achievement (De Raad & Schouwenburg, 1996). If the importance of such behavioral tendencies differs by academic field, it is possible personality traits may have differential predictive value for achievement in different academic fields.

2. Personality differences by academic field

A substantial amount of research has been done into differences in personality by academic field (Pozzebon, Ashton, & Visser, 2014) which has produced mixed findings. In most studies, it was found that science and engineering students report higher levels of conscientiousness than students in other academic fields (e.g., Kline & Lapham, 1992; Van der Molen, Schmidt, & Kruisman, 2007) while arts/humanities students report lower levels of conscientiousness (e.g., Kline & Lapham, 1992; Lievens, Coetsier, de Fruyt, & de Maeseneer, 2002; Vedel, 2016; Vedel, Thomsen, & Larsen, 2015). Regarding openness to experience, arts/humanities students generally report higher levels of this trait than students in other fields (e.g., De Fruyt & Mervielde, 1996; Kline & Lapham, 1992; Lievens, Coetsier, de Fruyt, & de Maeseneer, 2002; Pozzebon, Ashton, & Visser, 2014; Silvia & Nusbaum, 2012; Vedel, 2016; Vedel, Thomsen, & Larsen, 2015). Nevertheless, some studies had different results (e.g., Balsamo, Lauriola, & Saggino, 2012; Kaufman, Pumacahua, & Holt, 2013) or did not find a difference between academic fields in (one of) these personality traits (e.g., Marrs, Barb, & Ruggiero, 2007; Pozzebon, Ashton, & Visser, 2014; Pringle, DuBose, & Yankey, 2010; Rubinstein, 2005).

Instead of a true difference in personality between students in different academic fields, it is possible that there are alternative explanations for such personality differences. One might question whether personality differences between fields could be a result of uneven gender distributions in various academic fields. However, it appears that these differences in personality are not merely a result of unequal gender distributions (Vedel, 2016). Also, personality group differences across academic fields could be derived from socialization processes within those fields instead of being caused by pre-existing differences between students enrolling in different fields (Vedel, 2016). Although most research administered personality questionnaires to students well into their studies, some research found similar results among prospective college students (Balsamo, Lauriola, & Saggino, 2012) and students in the very beginning of their first academic year (Lievens, Coetsier, de Fruyt, & de Maeseneer, 2002; Vedel, Thomsen, & Larsen, 2015). Hence, the findings of these studies indicate that personality differences between different academic fields are pre-existing rather than following the choice for an academic field or major. In the present study, we control for gender and use a measure of personality that is administered to prospective students just before enrollment.

Findings of personality differences between students in different academic fields of study are often interpreted using Holland's typology of persons and environments which entails that people will flourish when there is a match between their personality and the environment in which they function (Holland, 1996). In contrast, a mismatch can lead to dissatisfaction and lower performance. For college students, this suggests that a match between their personality and college major or academic field is beneficial (Wen, Zhao, Yang, Wang, & Cao, 2021), implying that some academic majors are more suitable for some students than for others (Vedel, 2016). Therefore, one important factor in choosing for an academic field and a college major is the match of a major's corresponding college environment with students' personality traits (Balsamo, Lauriola, & Saggino, 2012). According to this theory,

this also implies that (potential) differences in personality by academic field result in differences in the predictive strength of conscientiousness and openness for achievement, although this has been scarcely investigated.

3. Differences in personality predicting academic achievement by academic field

As mentioned above, an explanation for personality traits serving as predictors of academic achievement is that these traits predict particular behavioral tendencies that influence academic success. The importance of the behavioral tendencies resulting from being conscientious or from being open to experience for achievement may differ by academic field of study. Different academic majors prepare students for different professions, and may therefore place different emphases (Barrick & Mount, 1991) and may require different personality traits from students (Wen, Zhao, Yang, Wang, & Cao, 2021). For example, programs in the field of arts/humanities may focus more on interpersonal contact or creativity, whereas other programs, for example in the academic field of science, may focus more on analytical and focused thinking. And, being open, which is consistent with the goal of helping people, may be more predominant among students in psychology and other majors in the academic field of social science (Kaufman, Pumacchua, & Holt, 2013). Such differences in focus may be reflected in teaching methods, curricula, examinations, and learning goals in different academic faculties or even majors (Vedel, Thomsen, & Larsen, 2015). Consequently, different personality traits may be more advantageous in different academic fields and majors. Conscientiousness, which involves being self-disciplined and persistent, may be more advantageous in the field of science. Instead, openness to experience, which has been shown to be consistently and positively correlated to creativity (King, Walker, & Broyles, 1996; Vartanian et al., 2018), may be more advantageous in the fields of arts/humanities and social science. However, few studies investigated moderation of the relation between personality traits and academic achievement by academic field (Vedel & Poropat, 2020) and these studies have yielded mixed results.

Regarding conscientiousness, there is some evidence of academic field serving as moderator of its relationship with achievement. It has been found in meta-analyses that the relation between conscientiousness and GPA was stronger for psychology students than for students who were enrolled in other academic fields than psychology (Poropat, 2009; Vedel, 2014). The finding that academic field moderates the conscientiousness-achievement relation was supported in a few other studies (De Fruyt & Mervielde, 1996; Fonteyne, Duyck, & de Fruyt, 2017; Vedel, Thomsen, & Larsen, 2015) but differences between academic fields were relatively small and based on small sample sizes, which impedes drawing substantial conclusions about the moderation of the relation between conscientiousness and achievement by academic field. In contrast to these studies, the meta-analysis of Trapmann, Hell, Hirn, and Schuler (2007) indicated that academic field did not moderate the relation between conscientiousness and college grades.

Regarding openness to experience, it was found in two meta-analyses that openness predicted college grades besides conscientiousness, but this relation did not differ among students in different college majors (Trapmann, Hell, Hirn, & Schuler, 2007; Vedel, 2014). In contrast, another study did find differences by academic field: openness correlated positively with GPA for political science students but negatively for law students (Vedel, Thomsen, & Larsen, 2015). The authors concluded that it is likely that different personality traits are advantageous in different academic environments. In sum, there is some initial evidence of academic field serving as moderator of the relationship between conscientiousness and openness with achievement, although results are mixed regarding for which academic fields this relationship is stronger and for which fields it is weaker. The current study aims to gain more insight into this.

4. Present study

Given the abundance of research on the relationship between personality and achievement, it is surprising that participants' academic field is rarely the subject of discussion (Fonteyne, Duyck, & de Fruyt, 2017). This while differences in this relation by academic field would have implications for the generalizability of results from previous research on the predictive value of personality traits for academic achievement (Fonteyne, Duyck, & de Fruyt, 2017; Vedel, 2014). Furthermore, the results of this study could have implications for educational guidance and counseling and for university admission procedures.

The first aim of the present study is to examine whether students' levels of conscientiousness and openness to experience differ by academic field of study. Second, we examine, using Structural Equation Modeling, whether the predictive value of the personality traits conscientiousness and openness for academic achievement differs by academic field. In this study, we distinguish between the academic fields of arts/humanities, science, social science, and law/economics/governance. First, we expect that arts/humanities students are lower in conscientiousness and higher in openness than other students. Second, we expect that conscientiousness predicts academic achievement most strongly for science students and openness predicts achievement most strongly for arts/humanities and social science students.

In examining personality differences by academic field, we control for gender to take unequal gender distributions across academic fields into account as previous research found personality differences by gender. That is, females reported higher levels of conscientiousness (e.g., Mac Giolla & Kajonius, 2018; Vianello, Schnabel, Sriram, & Nosek, 2013). In examining the effect of personality on achievement, we also control for gender, as females have higher academic achievement in higher education than males (e.g., Conger & Long, 2010), and for prior performance in high school. High school performance, which is likely to be the result of a combination of cognitive (including intelligence), social, and dispositional variables (Richardson & Abraham, 2009), has been found to consistently and strongly predict higher education achievement (Conger & Long, 2008; Sax & Harper, 2007). Hence, controlling for high school performance enables us to rule out the impact of such variables on academic achievement and to determine whether personality traits have predictive value for academic achievement over and above prior performance in high school.

5. Method

5.1. Participants

Participants were 4719 students (55.7% female; $M_{age} = 19.18$ years, $SD = 2.69$) who enrolled in a non-selective bachelor program (i.e., without selection process prior to enrollment) at Utrecht University, the Netherlands, in 2015. Participants were enrolled in the following academic fields of study: 26.7% in arts/humanities, 27.8% in science, 21.7% in social science, and 23.9% in law/economics/governance. The academic field of arts/humanities includes language and language-related studies, communication and media (and culture) studies, philosophy, history, art history, artificial intelligence, music sciences, and religion sciences. The field of science includes biology, physics and astronomy, chemistry, (applied) mathematics, computing sciences, information sciences, and geoscience studies (e.g., earth sciences, environment and nature sciences). The field of social science includes psychology, sociology, educational sciences, pedagogical sciences, cultural anthropology, and interdisciplinary social sciences. The field of law/economics/governance includes law and economics and business economics.

5.2. Procedure

Data were collected during the spring of 2015 as part of a compulsory matching program, which included completing an online questionnaire on personality, that took place 2–3 months prior to enrollment (see Verbree et al., under review, for details about the matching program). After finishing the matching program, students were asked for passive consent for the additional use of the data for research ends, which gave students the opportunity to opt-out of the study. For students who gave consent, data about their demographic characteristics, high school performance, and academic achievement during the first year of enrollment were obtained from university registers, linked to students' answers on the matching questionnaire, and anonymized. Ethical approval for this study has been granted by the local Institutional Review Board.

5.3. Measures

5.3.1. Personality

Students' self-perceived conscientiousness was assessed with nine items and their openness to experience was assessed with five items (selected out of ten based on factor loadings in prior research) that came from the Dutch translation of the Big Five Inventory (BFI; Denissen, Geenen, van Aken, Gosling, & Potter, 2008). The items were answered on a 5-point Likert scale ranging from (1) *strongly disagree* to (5) *strongly agree*. For conscientiousness, four out of the nine items were negatively formulated. These items were recoded so that higher scores reflected higher conscientiousness. All openness items were positively formulated. Based on reliability analyses, one item from each of the item sets of conscientiousness and openness was deleted, resulting in Cronbach's alpha = 0.81 for conscientiousness and, Cronbach's alpha = 0.70 for openness to experience. This implies adequate internal consistency of both scales in this sample (Kline, 2011). The remaining eight and four items (see Appendix D) were used as indicators of the latent constructs conscientiousness and openness to experience, respectively.

5.3.2. Achievement and prior performance

While most studies employ a single indicator of academic achievement (often grades; Vedel & Poropat, 2020), we used two indicators of academic achievement to better represent its multidimensional nature (O'Connor & Paunonen, 2007). In addition to students' first-year average grade (on a scale from 1 to 10), we included the number of credits (which are awarded to students who pass a course of a specified time requirement) according to the European Credit Transfer System (ECTS; see e.g., Schippers, Scheepers, & Peterson, 2015, for more details) that students obtained during their first year of enrollment. Students' average high school performance was used as indicator of prior achievement. We excluded prior achievement for students older than 25 at enrollment ($n = 12$) due to a lack of comparability to the prior achievement of younger students and a potential lower predictive value of this variable for these students.

5.4. Data analysis

The hypothesized model was tested using Structural Equation Modeling (SEM) in Mplus, version 8.3 (Muthén & Muthén, 2019). SEM can be used to model relations between multiple variables, including both observed and latent variables that account for measurement error in the indicators that are used (Geiser, 2013). Full information maximum likelihood estimation (Geiser, 2013) was used to handle missing data. Missing data ranged from 7.5% to 16.1% for all variables, except for academic field of study and gender (both 0%).

First, a multinomial logistic regression analysis was performed to assess whether the latent variables conscientiousness and openness to experience predicted students' enrollment in different academic fields while controlling for gender. In this way, it could be determined whether

an increase in a predictor (i.e., conscientiousness or openness) was related to a higher probability of a participant being enrolled in a certain academic field rather than another. Next, measurement invariance by academic field of study for the latent variables conscientiousness, openness, and achievement was examined in a three-factor confirmatory factor analysis, using a stepwise approach in which equality constraints were added (equal factor loadings, both equal factor loadings and equal intercepts, respectively; cf. Wicherts & Dolan, 2010). Subsequently, a multigroup model with the latent variables conscientiousness and openness predicting the latent variable academic achievement was specified for the different fields of study separately, while controlling for gender and prior performance in high school. Then, it was examined whether the structural parameter estimates were equal for the different fields of study by constraining these parameters one by one and comparing the model fit of the consecutive, nested models.

To assess goodness-of-fit, we used the chi-square statistic ($p > 0.05$ indicating good fit). However, as this statistic is sensitive to sample size (Marsh, Balla, & McDonald, 1988), we primarily looked at other goodness-of-fit indices. It is important to note that the cutoff criteria for these indices are not hard standards and that a model may fit the data even when one or more fit measures suggest inadequate fit (Schermelleh-Engel, Moosbrugger, & Müller, 2003). The indices (and cutoffs) used (Schermelleh-Engel, Moosbrugger, & Müller, 2003) are: Root Mean Square Error of Approximation (RMSEA; 0.05–0.08 indicating adequate fit, ≤ 0.05 indicating good fit), Comparative Fit Index (CFI; ≥ 0.95 indicating acceptable fit, ≥ 0.97 indicating good fit), Tucker-Lewis Index (TLI; see CFI for cut-off values), and Standardized Root Mean Square Residual (SRMR; 0.05–0.08 indicating acceptable fit, < 0.05 indicating good fit). We also used these indices to compare nested models (i.e., to examine whether equality constraints lead to a decrease in model fit; $\Delta CFI > 0.02$, $\Delta RMSEA > 0.02$; Fan & Sivo, 2009). Modifications indices (MIs) were considered, if theoretically sensible (Kline, 2011), in case of poor model fit.

Before conducting these analyses, multivariate normality and independence of exogenous variables (i.e., gender and high school performance) were checked. Due to some violations of normality, maximum likelihood estimation with robust standard errors (MLR) was used. This estimator yields a chi-square statistic that is robust to nonnormality and is available with missing data (Muthén & Muthén, 2010). The assumption of the independence of exogenous variables was met.

6. Results

6.1. Descriptive statistics

Table 1 presents descriptive statistics for the mean of the eight conscientiousness and four openness items, the indicators of academic achievement (average grade and credits), and high school performance by academic field and in total. Table 2 presents correlations between the variables of the present study for each academic field separately as well as the overall correlations. For conscientiousness, openness, and academic achievement, these correlations are based on the latent variables, which are also used in subsequent analyses. For all four groups of students, conscientiousness had significant and positive associations with high school performance and academic achievement. This while openness to experience only had significant but small, negative correlations with high school performance and academic achievement for social science students and a small positive correlation with high school performance for law/economics/governance students. Also, high school performance was strongly correlated to higher education achievement in all academic fields.

6.2. The relation between personality and academic field

The results of the multinomial regression analyses to examine personality differences by academic field of study are displayed in Table 3.

Table 1
Mean (SD) conscientiousness, openness to experience, academic achievement, and high school performance by academic field.

| | Arts/Humanities | Science | Social science | Law/economics/governance | Total |
|--------------------------------|-----------------|---------------|----------------|--------------------------|---------------|
| % female | 62.6% | 32.5% | 80.4% | 52.7% | 55.7% |
| Conscientiousness ^a | 3.66 (0.53) | 3.64 (0.56) | 3.84 (0.51) | 3.90 (0.56) | 3.75 (0.55) |
| Openness ^a | 4.16 (0.48) | 4.12 (0.48) | 4.07 (0.50) | 4.11 (0.47) | 4.12 (0.48) |
| Average grade | 6.87 (0.58) | 6.99 (0.67) | 6.94 (0.54) | 6.87 (0.63) | 6.92 (0.61) |
| Credits | 50.21 (19.30) | 50.86 (16.44) | 52.69 (14.71) | 50.45 (16.88) | 51.00 (17.04) |
| High school performance | 6.78 (0.54) | 6.83 (0.60) | 6.70 (0.52) | 6.68 (0.48) | 6.76 (0.55) |
| Range of <i>n</i> | 1127–1196 | 1110–1217 | 921–971 | 913–981 | 4071–4365 |

Note. Range of *n* indicates per column on which the means and standard deviations presented in the table are based, *n* varied due to missing data.

^a Mean of the respectively eight and four items of conscientiousness and openness, latent variables are used in the remainder of the analyses. See Appendix A for the means (SDs) separated by gender.

A negative coefficient indicates a lower likelihood of enrollment in a certain academic field compared to the reference group, and a positive coefficient indicates a greater likelihood of being enrolled in the comparison academic field. Different reference groups were used in order to test for differences between all combinations of academic fields. The odds ratios represent that the comparison academic major group is more likely as outcome as the predictor variable increases when the odds ratio is >1 and the reference academic major group is more likely when the odds ratio is <1 .

Gender was included in these analyses as a covariate. Results indicated that being male was associated with a higher probability of enrollment in the science and law/economics/governance field than in the arts/humanities and social science field, and in the science field than in the law/economics/governance field. The likelihood to be enrolled in the field of social science compared to in the field of arts/humanities was lower for male students than for female students. These results align with the percentage of female students in different fields presented in Table 1.

The main effects of conscientiousness, $\chi^2(3) = 138.36, p \leq 0.001$, and openness, $\chi^2(3) = 20.90, p \leq 0.001$, were both significant, so both traits significantly predicted enrollment in academic fields while controlling for gender. Students with higher levels of conscientiousness were more likely to be enrolled in the academic fields of science, social science, and law/economics/governance than in the arts/humanities field (OR varying between 1.53 and 5.27 for the different fields). Also, and contrary to our expectations, more conscientious students were less likely to be enrolled in the academic field of science than in the social science and law/economics/governance field (OR = 0.67 and OR = 0.29, respectively).

Finally, students high in conscientiousness were more likely to be enrolled in the law/economics/governance field than in the social science field (OR = 2.30). The odds ratios show, in line with the means in Table 1, that higher levels of conscientiousness most strongly predicted enrollment in the academic field of law/economics/governance. In sum, students who are higher in conscientiousness were most likely to be enrolled in the academic field of law/economics/governance, then in the field of social science and science, respectively, and the least likely to enroll in the field of arts/humanities.

While arts/humanities students were less conscientious than students in other academic fields, this was reversed for openness in which these students were higher than students in other fields: higher levels of openness were associated with a lower probability of enrollment in the three other academic fields rather than enrollment in the arts/humanities field (OR varying between 0.55 and 0.63 for the different fields). Students in the academic fields of science, social science, and law/economics/governance did not differ from each other in openness. Thus, in line with the expectations, students with lower levels of conscientiousness and higher levels of openness were more likely to be enrolled in arts/humanities than in other academic fields. Note that these results may seem not to align with the means presented in Table 1. This is largely due to controlling for gender in the multinomial regression analyses. The effect size of the analyses with conscientiousness and

openness predicting enrollment can be classified as small-to-medium (Cohen, 1988), Cox and Snell's $R^2_{CS} = 0.07$.

6.3. Differences by academic field in personality predicting academic achievement

Before examining whether academic field of study moderated the association between personality and academic achievement using multigroup analysis, (partial) strong measurement invariance of the measurement model (Kline, 2011; Putnick & Bornstein, 2016) with the (correlated) latent variables conscientiousness, openness to experience, and academic achievement was established across groups (see Appendix C). Then, we tested the structural equation model of conscientiousness and openness predicting academic achievement while controlling for gender and high school performance. The unconstrained model, without constraints on the relations between personality and achievement across groups, had an acceptable model fit, $\chi^2(443) = 1937.74, p \leq 0.001$, RMSEA = 0.05, CFI = 0.90, TLI = 0.89, SRMR = 0.06.

Next, to investigate whether the relations of conscientiousness and openness to experience with academic achievement differ by academic field, the structural relations of conscientiousness and openness with achievement were constrained one by one to be equal across groups. Constraining these relations did not lead to a significant decrease in model fit. The final model in which the relations between the two personality traits and achievement were constrained fitted the data equally well as the unconstrained model, $\chi^2(449) = 1948.39, p \leq 0.001$, RMSEA = 0.05, CFI = 0.90, TLI = 0.89, SRMR = 0.06. This indicates that the relations between conscientiousness and achievement and between openness and achievement are similar for students enrolled in different academic fields. Standardized parameter estimates for this final model are presented in Fig. 1 (see Appendix D for the standardized factor loadings). The results show that gender did not have a significant effect on achievement (except for the academic field of science) while high school performance positively predicted students' achievement with a medium-to-large effect size. After accounting for gender and high school performance, conscientiousness positively predicted academic achievement for students in all academic fields (Fig. 1). However, contrary to our expectations, openness negatively predicted academic achievement. This aligns with the correlations presented in Table 2. According to the guidelines of Cohen (1988), the corresponding effect sizes for conscientiousness and openness can be interpreted as small.

In the final model, 44.1% to 61.2% of the variance in academic achievement was explained by gender, high school performance, conscientiousness, and openness to experience. Especially high school performance was an important predictor of achievement and contributed largely to the explained variance. After removal of the control variables gender and high school performance, 10.4%–12.6% of the variance in achievement was explained by conscientiousness and openness.

Furthermore, in an exploratory way, we checked for the presence of an interaction between the personality traits conscientiousness and

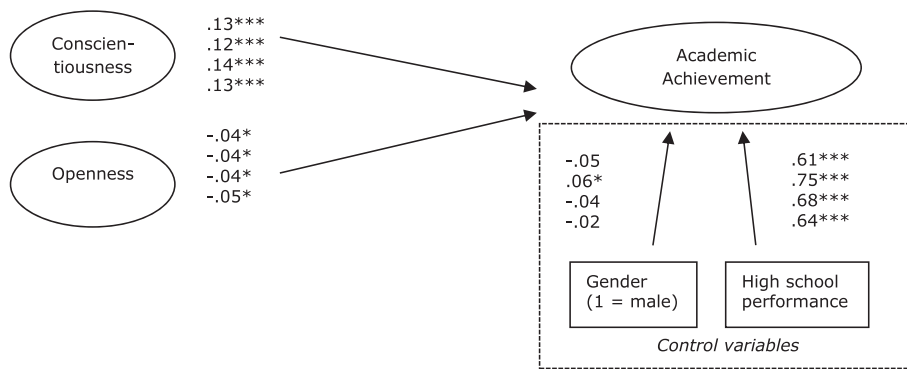


Fig. 1. Standardized parameter estimates of the structural equation model of gender, high school performance, and personality predicting academic achievement for, from first to last, arts/humanities ($R^2 = 0.44$), science ($R^2 = 0.61$), law/economics/governance ($R^2 = 0.55$), and social science students ($R^2 = 0.48$). SEs range from 0.02 to 0.03 for all estimates. Unstandardized estimates are constrained to be equal, standardized estimates presented here differ slightly due to differences in variances between the academic fields. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Mervielde (1996) and Lievens, Coetsier, de Fruyt, and de Maeseeneer (2002). Whether consciously or not, it is likely that students select academic environments that appear to match their personality when choosing a college major or academic field (Vedel, Thomsen, & Larsen, 2015). For example, programs in the academic field of law/economics/governance seem to mostly underscore perseverance, high performance, and ambition, whereas inventiveness, imagination, creativity, aesthetic appreciation, and reflection are valued more in the field of arts/humanities (Pozzebon, Ashton, & Visser, 2014), which may attract students with different personality traits.

Nevertheless, the results indicated that the associations between conscientiousness and openness and achievement were similar for students in different academic fields. More specifically, conscientiousness positively predicted academic achievement for students in all included academic fields, even after taking prior performance into account. This is in line with previous research that showed a consistent effect of conscientiousness on achievement (e.g., Poropat, 2009; Vedel, 2014), regardless of academic field (Trapmann, Hell, Hirn, & Schuler, 2007). Conscientiousness facets such as being organized, systematic, efficient, and having the drive to accomplish thus seem to be beneficial for student achievement across different academic fields. Nevertheless, the effect size was smaller than in previous research which was due to the inclusion of prior performance as a covariate¹ which means that part of the personality variance is left out in the relation between personality and achievement. Prior research also found a similar smaller effect size after controlling for secondary GPA (see meta-analysis by Poropat, 2009). The results of our study, and other studies including high school performance, do not represent the true effect of personality on achievement but rather the unique effect of personality on achievement controlling for prior performance. It could be argued that prior studies that did not include high school performance may overestimate the effect of personality on achievement as the effect may partly be explained by differences in prior performance, for example by differences due to ability. By any means, the unique effects of prior performance in high school and personality are difficult to determine as they interact in a complex way prior to enrolling in higher education.

In contrast, for students in all fields, students' levels of openness to experience had a slight negative impact on their academic achievement. In the meta-analysis of Poropat (2009), it was shown that openness had greater predictive value for students in primary education (medium effect) than for higher education students (small effect). Moreover, when secondary performance was controlled for in this meta-analysis, openness to experience only had a trivial effect on tertiary academic performance. It is also possible that openness to experience as a construct is too broad to predict academic achievement in higher education

(Trapmann, Hell, Hirn, & Schuler, 2007). The lower-level facets that make up the openness factor (e.g., curiosity, artistic interest) are all correlated with this factor but are largely independent of each other (McCrae, 1992) which implies that the facets may have unique predictive validity for achievement. Vedel, Thomsen, and Larsen (2015), for example, did find such variation in predictive validity among facets and, moreover, showed that lower-level personality facets had more predictive validity for achievement than the overall Big Five personality traits. Several other authors also suggest that consideration should be given to facets of personality traits as predictors of academic achievement (e.g., O'Connor & Paunonen, 2007; Trapmann, Hell, Hirn, & Schuler, 2007). An interesting avenue for research is to further examine the relation of these separate personality facets with higher education achievement for students in different academic fields.

However, in the current study, the relation of openness with achievement was even slightly negative. It is possible that an imaginative and creative thinking style and curiosity, which are associated with openness, may hinder performance on traditional university tests and assignments (Furnham, Chamorro-Premuzic, & McDougall, 2003) in which the reproduction of knowledge possibly plays a large role, while being conscientiousness is beneficial for this type of performance. Conversely, openness might have a positive effect on other forms of academic achievement in which creativity and problem-solving play a larger role, such as in portfolio assessments or complex situations during internships. Yet, the emphasis of exams on declarative knowledge (e.g., basic facts in multiple choice tests) may shift to other, more applied forms of knowledge (e.g., clinical practice, internships) during a study program and, hence, the predictive value of various personality traits may change during a study program (Lievens, Ones, & Dilchert, 2009).

Contrary to our expectations, we found no differences in the relation of conscientiousness and openness with academic achievement by academic field of study. Thus, the different personalities of students in different academic fields did not translate into certain personalities being more beneficial for academic performance in specific fields. A possible explanation is that the academic fields, rather than individual majors, included in our study are too broad to detect differences in the relation between personality and achievement. Our finding is in line with the meta-analysis of Trapmann, Hell, Hirn, and Schuler (2007) who did not find a moderating effect of academic field on the relation of openness and conscientiousness with achievement. On the contrary, our finding is inconsistent with the few empirical studies that aimed to examine the effect of academic field or major on the relation between personality and achievement (De Fruyt & Mervielde, 1996; Fonteyne, Duyck, & de Fruyt, 2017; Vedel, 2014; Vedel, Thomsen, & Larsen, 2015). These studies found that academic field impacted the relation between certain personality traits and achievement, although the specific results differ from study to study. Also, contrary to the current study, these studies did not control for prior performance in high school, limiting the generalizability of their results to this study. In sum, our study showed that – after controlling for high school performance – there

¹ Removal of high school performance from the model resulted in a higher effect size which could be interpreted as a small-to-medium effect size according to the guidelines of Cohen (1988).

is no difference in the predictive value of personality for achievement by academic field, corroborating the findings of [Trapmann, Hell, Hirn, and Schuler \(2007\)](#). It is still unclear, however, whether differences exist in this relation at the program level. Future research based on sufficiently large sample sizes per program is needed to address this unanswered question. This is important as we know very little about what characterizes academically successful students within specific academic fields and programs ([Vedel, 2016](#)).

The present study has some limitations. First, we used a shortened measure for openness to experience that did not fully capture all facets of this broad factor as it mainly measured imagination and openness to ideas, while other openness facets such as artistic interest and attentiveness to inner feelings were not covered. Given the high intercorrelations of items measuring different aspects of Openness in the longer scale ([Denissen, Geenen, van Aken, Gosling, & Potter, 2008](#)), it seems unlikely however that a broader measure would have led to different results. Second, academic fields rather than individual majors were used in our analyses due to an insufficient number of students in each major to distinguish between majors within academic fields. Yet, as mentioned, there could be differences between students in different majors belonging to the same academic field. For example, there could be a difference between natural-science students and applied-science students ([Balsamo, Lauriola, & Saggino, 2012](#)) and previous research showed differences between psychology students and other students ([Poropat, 2009](#); [Vedel, 2014](#); [Vedel, Thomsen, & Larsen, 2015](#)) which may have been masked in the present study. Ideally, future research would examine personality differences and differences in the relation of personality and achievement for students of different educational majors from different universities. This points to another limitation of our study which is that our data were collected from a single university. This may limit the generalizability of the findings. Future research is needed to replicate our results and generalize the findings to other universities both within and outside the Netherlands.

In our study, we looked at students' personality at the start of their enrollment in college. As students' personality traits may shift during their studies ([Rubinstein, 2005](#)) and as it has been shown that with age, people tend to become more conscientious (e.g., [Terracciano, McCrae, Brant, & Costa Jr., 2005](#)), it would be interesting for future research to measure students' personality both at enrollment and later in their studies in a longitudinal design. This can yield insight into whether developments in personality over time differ between academic fields. Also, many students switch from college major during their time in college ([Astorne-Figari & Speer, 2019](#)). A relevant focus for future studies could be to investigate whether such choices are related to personality traits and how they affect academic achievement ([Vedel, Thomsen, & Larsen, 2015](#)). For example, it is possible that students high in openness to experience are more likely to change their major more compared to students lower in openness ([Trapmann, Hell, Hirn, & Schuler, 2007](#)).

The results of our study indicated that students in different academic fields differ in their personality traits. Particularly law/economics/governance students were found to be more conscientious than arts/humanities students. The other differences were generally rather small. In addition, when controlling for prior performance in high school, the personality traits conscientiousness and openness to experience do not have differential predictive value for achievement in different academic fields. This means that students with higher or lower levels of these traits do not have an increased chance of success in a particular field. Therefore, at this moment, we advocate that students' personality traits should not be the main focus of study orientation for prospective students and educational guidance and counseling for students considering switching their college major or academic field. Presumably, other factors, such as domain-specific abilities or interests, are more important for students'

educational success in a particular field and are therefore more important to consider in giving guidance and advice to students ([Kline & Lapham, 1992](#)).

Furthermore, regarding the increased interest in the United States and Europe in using noncognitive criteria including personality tests for admission ([Niessen & Meijer, 2017](#)), our findings show that conscientiousness consistently predicts academic achievement of students in different academic fields. Thus, conscientiousness can be used uniformly across academic fields as part of admission procedures. However, it should be taken into account that considering conscientiousness as an admission criterium may disadvantage male students as female students are generally higher in conscientiousness ([Verbree et al., under review](#)) and may therefore contribute to unequal gender distributions in college, with the majority being female. Also, it has been shown that non-cognitive predictors of achievement are inflated due to self-presentation behavior when obtained in an admission context, attenuating predictive and incremental validity ([Niessen, Meijer, & Tendeiro, 2017](#)). The authors of this study conclude that due to faking, there are currently no undisputed valid ways to measure personality traits validly in high-stakes contexts. In addition, it is important to note that there is considerable evidence that personality traits, including conscientiousness, are dynamic and change along developmental trajectories (e.g., [Roberts, Walton, & Viechtbauer, 2006](#)). Therefore, based on the results of this study, we argue that rather than selecting students based on their level of conscientiousness, higher education institutions may consider fostering conscientiousness in students who are low on this trait and may need improvements in their achievement, for example, through student support services ([Verbree et al., under review](#)) or an intervention provided via a smartphone application ([Stieger et al., 2021](#)). Teaching students to be more organized, careful, and to think about the consequences of their actions can result in students becoming more conscientious ([Roberts, Hill, & Davis, 2017](#)), although more research is needed into the most effective interventions to stimulate students' conscientiousness levels.

Surprisingly, students' academic field is seldom referred to in research into personality and its relation with achievement ([Fonteyne, Duyck, & de Fruyt, 2017](#)). The current study led to a better understanding of the intersection of personality with academic field by showing differences in conscientiousness and openness between students from different academic fields. We want to call for the consideration of academic field or college major in personality research, which should include mentioning the fields or majors their participants were taken from and limiting conclusions to these fields or majors ([Fonteyne, Duyck, & de Fruyt, 2017](#)). This can help to further build a knowledge base about the personalities of students in different majors and the relation of the personality traits with academic achievement.

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Declaration of competing interest

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Appendix A

Mean (SD) conscientiousness, openness to experience, academic achievement, and high school performance by academic field and gender.

| | Arts/humanities | | Science | | Social science | |
|--------------------------------|-----------------|-------------------|-----------------|-------------------|-----------------|-------------------|
| | Male (37.4%) | Female (62.6%) | Male (67.5%) | Female (32.5%) | Male (19.6%) | Female (80.4%) |
| Conscientiousness ^a | 3.50 (0.53) | 3.76 (0.51) | 3.55 (0.55) | 3.83 (0.52) | 3.59 (0.53) | 3.90 (0.49) |
| Openness ^a | 4.21 (0.47) | 4.13 (0.48) | 4.15 (0.48) | 4.06 (0.49) | 4.21 (0.49) | 4.03 (0.50) |
| Average grade | 6.76 (0.55) | 6.93 (0.59) | 6.96 (0.68) | 7.06 (0.67) | 6.79 (0.49) | 6.98 (0.55) |
| Credits | 47.52 (21.03) | 51.71 (18.11) | 50.19 (16.84) | 52.21 (15.54) | 48.85 (16.86) | 53.57 (14.04) |
| High school performance | 6.68 (0.54) | 6.84 (0.53) | 6.76 (0.59) | 6.96 (0.60) | 6.72 (0.49) | 6.51 (0.41) |
| Range of <i>n</i> | 372–442 | 630–754 | 743–848 | 367–401 | 153–186 | 685–785 |

| | Law/economics/governance | | Total | |
|--------------------------------|--------------------------|-------------------|-----------------|-------------------|
| | Male (47.3%) | Female (52.7%) | Male (44.3%) | Female (55.7%) |
| Conscientiousness ^a | 3.70 (0.54) | 4.06 (0.51) | 3.58 (0.55) | 3.88 (0.52) |
| Openness ^a | 4.14 (0.46) | 4.09 (0.47) | 4.17 (0.47) | 4.08 (0.49) |
| Average grade | 6.76 (0.60) | 6.95 (0.64) | 6.85 (0.62) | 6.97 (0.60) |
| Credits | 47.46 (17.79) | 52.81 (15.74) | 48.79 (18.16) | 52.62 (15.99) |
| High school performance | 6.61 (0.49) | 6.79 (0.54) | 6.68 (0.55) | 6.81 (0.54) |
| Range of <i>n</i> | 403–448 | 457–533 | 1720–1898 | 2173–2467 |

Note. Range of *n* indicates per column on which the means and standard deviations presented in the table are based, *n* varied due to missing data.

^a Mean of the respectively eight and four items of conscientiousness and openness, latent variables are used in the remainder of the analyses.

Appendix B

Correlations based on simple scale scores between conscientiousness, openness to experience, academic achievement (average grade and credits), and high school performance by academic field.

| | Arts/humanities | | | | | Science | | | | | Social science | | | | |
|----------------------------------|-----------------|--------|---------|---------|---|---------|-------|---------|---------|---|----------------|-------|---------|---------|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 1 Conscientiousness | – | | | | | – | | | | | – | | | | |
| 2 Openness to experience | –0.03 | – | | | | 0.06* | – | | | | 0.03 | – | | | |
| 3 Academic achievement – grade | 0.19*** | –0.01 | – | | | 0.22*** | 0.05 | – | | | 0.22*** | –0.03 | – | | |
| 4 Academic achievement - credits | 0.15*** | –0.07* | 0.43*** | – | | 0.18*** | 0.00 | 0.48*** | – | | 0.11** | –0.06 | 0.50*** | – | |
| 5 High school performance | 0.23*** | –0.01 | 0.60*** | 0.34*** | – | 0.23*** | 0.06* | 0.70*** | 0.41*** | – | 0.20*** | –0.03 | 0.64*** | 0.33*** | – |

| | Law/economics/governance | | | | | Total | | | | |
|----------------------------------|--------------------------|--------|---------|---------|---|---------|---------|---------|---------|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 1 Conscientiousness | – | | | | | – | | | | |
| 2 Openness to experience | 0.17*** | – | | | | 0.04** | – | | | |
| 3 Academic achievement – grade | 0.31*** | 0.01 | – | | | 0.22*** | 0.00 | – | | |
| 4 Academic achievement - credits | 0.23*** | –0.03 | 0.46*** | – | | 0.17*** | –0.05** | 0.46*** | – | |
| 5 High school performance | 0.30*** | 0.11** | 0.64*** | 0.37*** | – | 0.21*** | 0.04* | 0.65*** | 0.36*** | – |

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

Appendix C. Measurement invariance of personality and achievement by academic field

Before examining whether the predictive validity of conscientiousness and openness for achievement varied by academic field of study, invariance across students in different academic fields of the measurement model was established. This was done using a three-factor confirmatory factor analysis model with the latent variables conscientiousness, openness, and achievement. Respectively, the models of configural invariance, weak invariance (equal factor loadings), and strong invariance (both equal factor loadings and intercepts) were specified. In this process, correlated residuals between three pairs of items for various groups were added to the model based on MIs and theoretical grounds.

While weak invariance held, strong invariance did not as indicated by a decrease in model fit as well as MIs indicating to free the intercept of openness item 1. After freeing this term, the final model of (partial) strong measurement invariance showed adequate fit to the data, $\chi^2(353) = 1641.17, p \leq 0.001, RMSEA = 0.06, CFI = 0.90, TLI = 0.89, SRMR = 0.06$. The factor loading of each indicator to its latent factor was high and significant at $p < 0.001$ (standardized factor loadings ranged from 0.38 to 0.85 for arts/humanities students, 0.40 to 0.77 for science students, 0.40 to 0.84 for social science students, and 0.36 to 0.79 for law/economics/governance students).

Appendix D

Standardized factor loadings of the indicators of conscientiousness, openness and achievement by academic field of study

| | Arts/humanities | | Science | | Social science | | Law/economics/governance | |
|---|------------------------------|----------------|------------------------------|----------------|------------------------------|----------------|------------------------------|----------------|
| | Standardized factor loadings | R ² | Standardized factor loadings | R ² | Standardized factor loadings | R ² | Standardized factor loadings | R ² |
| Conscientiousness | | | | | | | | |
| 1. Does a thorough job | 0.52 | 0.28 | 0.53 | 0.28 | 0.53 | 0.28 | 0.59 | 0.35 |
| 2 Perseveres until the task is finished | 0.48 | 0.23 | 0.50 | 0.25 | 0.52 | 0.27 | 0.54 | 0.29 |
| 3 Tends to be disorganized ^f | 0.60 | 0.36 | 0.64 | 0.41 | 0.61 | 0.38 | 0.67 | 0.45 |
| 4 Tends to be lazy ^f | 0.70 | 0.49 | 0.73 | 0.53 | 0.69 | 0.47 | 0.76 | 0.57 |
| 5 Is a reliable worker | 0.49 | 0.24 | 0.52 | 0.27 | 0.49 | 0.24 | 0.51 | 0.26 |
| 7 Makes plans and follows through with them | 0.54 | 0.30 | 0.59 | 0.35 | 0.56 | 0.31 | 0.61 | 0.37 |
| 8 Is easily distracted ^f | 0.55 | 0.30 | 0.56 | 0.32 | 0.56 | 0.31 | 0.63 | 0.39 |
| 9 Can be somewhat careless ^f | 0.58 | 0.34 | 0.61 | 0.38 | 0.57 | 0.33 | 0.61 | 0.37 |
| 2 with 5 | 0.22 | | | | | | 0.21 | |
| Openness | | | | | | | | |
| 1 Likes to reflect, play with ideas | 0.47 | 0.23 | 0.48 | 0.23 | 0.51 | 0.26 | 0.41 | 0.16 |
| 2 Is inventive | 0.75 | 0.57 | 0.78 | 0.60 | 0.80 | 0.64 | 0.72 | 0.52 |
| 4 Is original, comes up with new ideas | 0.68 | 0.46 | 0.71 | 0.51 | 0.72 | 0.52 | 0.66 | 0.44 |
| 5 Is ingenious, a deep thinker | 0.38 | 0.14 | 0.41 | 0.17 | 0.40 | 0.16 | 0.35 | 0.13 |
| 1 with 5 | 0.38 | | 0.28 | | 0.33 | | 0.27 | |
| Achievement | | | | | | | | |
| Average grade | 0.92 | 0.85 | 0.89 | 0.80 | 0.95 | 0.90 | 0.88 | 0.78 |
| Credits | 0.44 | 0.19 | 0.55 | 0.30 | 0.53 | 0.28 | 0.51 | 0.26 |

Note. Conscientiousness item 6 “Does things efficiently” and openness item 3 “Values artistic, aesthetic experiences” were removed due to a low corrected item-total correlation and a higher Cronbach's alpha after removal. One out of three pairs of correlated residuals (added while measurement invariance was established) was removed as this pair was no longer significant when the structural model was specified. Items marked with ^f are recoded. All estimates are significant at $p < 0.001$.

Appendix E. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.lindif.2021.102081>.

References

- Astorne-Figari, C., & Speer, J. D. (2019). Are changes of major major changes? The roles of grades, gender, and preferences in college major switching. *Economics of Education Review*, 70, 75–93. <https://doi.org/10.1016/j.econedurev.2019.03.005>.
- Balsamo, M., Lauriola, M., & Saggino, A. (2012). Personality and college major choice: Which comes first? *Psychology*, 3, 399–405. <https://doi.org/10.4236/psych.2012.35056>.
- Barrick, M. R., & Mount, M. K. (1991). The Big Five personality dimensions and job performance: A meta-analysis. *Personnel Psychology*, 44, 1–26. <https://doi.org/10.1111/j.1744-6570.1991.tb00688.x>.
- Biderman, M. D., Nguyen, N. T., & Sebrun, J. (2008). Time-on-task mediates the conscientiousness-performance relationship. *Personality and Individual Differences*, 44, 887–897. <https://doi.org/10.1016/j.paid.2007.10.022>.
- Chamorro-Premuzic, T., & Furnham, A. (2005). *Personality and intellectual competence*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Conard, M. A. (2006). Aptitude is not enough: How personality and behavior predict academic performance. *Journal of Research in Personality*, 40, 339–346. <https://doi.org/10.1016/j.jrp.2004.10.003>.
- Conger, D., & Long, M. C. (2008). Why are men falling behind? Explanations for the gender gap in college outcomes. In *Paper presented at the Texas higher education opportunity project conference*, Princeton, NJ, August.
- Conger, D., & Long, M. C. (2010). Why are men falling behind? Gender gaps in college performance and persistence. *The Annals of the American Academy of Political and Social Science*, 627, 184–214. <https://doi.org/10.1177/0002716209348751>.
- De Fruyt, F., & Mervielde, I. (1996). Personality and interests as predictors of educational streaming and achievement. *European Journal of Personality*, 10, 405–425. [https://doi.org/10.1002/\(sici\)1099-0984\(199612\)10:5<405::aid-per255>3.0.co;2-m](https://doi.org/10.1002/(sici)1099-0984(199612)10:5<405::aid-per255>3.0.co;2-m).
- De la Iglesia, G., & Solano, A. C. (2019). Academic achievement of college students: The role of the positive personality model. *Problems of Education in the 21st Century*, 77, 572–583. <https://doi.org/10.33225/pec/19.77.572>.
- De Raad, B., & Schouwenburg, H. C. (1996). Personality in learning and education: A review. *European Journal of Personality*, 10, 303–336. [https://doi.org/10.1002/\(sici\)1099-0984\(199612\)10:5<303::aid-per262>3.0.co;2-2](https://doi.org/10.1002/(sici)1099-0984(199612)10:5<303::aid-per262>3.0.co;2-2).
- Denissen, J. J. A., Geenen, R., van Aken, M. A. G., Gosling, S. D., & Potter, J. (2008). Development and validation of a Dutch translation of the Big Five Inventory (BFI). *Journal of Personality Assessment*, 90, 152–157. <https://doi.org/10.1080/00223890701845229>.
- Fan, X., & Sivo, S. A. (2009). Using Goodness-of-fit indexes in assessing mean structure invariance. *Structural Equation Modeling: A Multidisciplinary Journal*, 16, 54–69. <https://doi.org/10.1080/10705510802561311>.
- Fonteyne, L., Duyck, W., & de Fruyt, F. (2017). Program-specific prediction of academic achievement on the basis of cognitive and non-cognitive factors. *Learning and Individual Differences*, 56, 34–48. <https://doi.org/10.1016/j.lindif.2017.05.003>.
- Furnham, A., Chamorro-Premuzic, T., & McDougall, F. (2003). Personality, cognitive ability, and beliefs about intelligence as predictors of academic performance. *Learning and Individual Differences*, 14, 47–64. <https://doi.org/10.1016/j.lindif.2003.08.002>.
- Geiser, C. (2013). *Data analysis with Mplus*. New York, NY: The Guilford Press.
- Hazrati-Viari, A., Rad, A. T., & Torabi, S. S. (2012). The effect of personality traits on academic performance: The mediating role of academic motivation. *Procedia – Social and Behavioral Sciences*, 32, 367–371. <https://doi.org/10.1016/j.sbspro.2012.01.055>.
- Hogan, J., & Ones, D. S. (1997). Conscientiousness and integrity at work. In R. Hogan, & J. A. Johnson (Eds.), *Handbook of personality psychology* (pp. 849–870). San Diego, CA: Academic Press. <https://doi.org/10.1016/b978-012134645-4/50033-0>.
- Holland, J. L. (1996). Exploring careers with a typology: What we have learned and some new directions. *American Psychologist*, 51, 397–406. <https://doi.org/10.1037/0003-066x.51.4.397>.
- John, O. P., & Srivastava, S. (1999). The Big Five trait taxonomy: History, measurement and theoretical perspectives. In L. A. Pervin, & O. P. John (Eds.), *Handbook of personality: Theory and research* (pp. 102–138). New York, NY: Guilford.
- Kaufman, J. C., Pumacahua, T. T., & Holt, R. E. (2013). Personality and creativity in realistic, investigative, artistic, social, and enterprising college majors. *Personality and Individual Differences*, 54, 913–917. <https://doi.org/10.1016/j.paid.2013.01.013>.
- King, L. A., Walker, L. M., & Broyles, S. J. (1996). Creativity and the five-factor model. *Journal of Research in Personality*, 30, 189–203. <https://doi.org/10.1006/jrpe.1996.0013>.
- Kline, P., & Lapham, S. L. (1992). Personality and faculty in British universities. *Personality and Individual Differences*, 7, 855–857. [https://doi.org/10.1016/0191-8869\(92\)90061-s](https://doi.org/10.1016/0191-8869(92)90061-s).
- Kline, R. B. (2011). *Principles and practice of structural equation modeling* (3rd ed.). New York, NY: The Guilford Press.
- Lievens, F., Coetsier, P., de Fruyt, F., & de Maesseneer, J. (2002). Medical students' personality characteristics and academic performance: A five-factor model

- perspective. *Medical Education*, 36, 1050–1056. <https://doi.org/10.1046/j.1365-2923.2002.01328.x>.
- Lievens, F., Ones, D. S., & Dilchert, S. (2009). Personality scale validities increase throughout medical school. *Journal of Applied Psychology*, 94, 1514–1535. <https://doi.org/10.1037/a0016137>.
- Mac Giolla, E. M., & Kajonius, P. J. (2018). Sex differences in personality are larger in gender equal countries: Replicating and extending a surprising finding. *International Journal of Psychology*, 1–7. <https://doi.org/10.1002/ijop.12529>.
- Marrs, H., Barb, M. R., & Ruggiero, J. C. (2007). Self-reported influences on psychology major choice and personality. *Individual Differences Research*, 5, 289–299. Retrieved from <http://www.idr-journal.com/>.
- Marsh, H. W., Balla, J. R., & McDonald, R. P. (1988). Goodness-of-fit indices in confirmatory factor analysis: The effect of sample size. *Psychological Bulletin*, 103, 391–410. <https://doi.org/10.1037/0033-2909.103.3.391>.
- McCrae, R. R. (1992). Openness to experience as a basic dimension of personality. In *Paper presented at the annual convention of the American Psychological Association, Washington, DC, August*.
- McCrae, R. R., & Costa, P. T., Jr. (1985). Updating Norman's "adequate taxonomy": Intelligence and personality dimensions in natural language and in questionnaires. *Journal of Personality and Social Psychology*, 49, 710–721. <https://doi.org/10.1037/0022-3514.49.3.710>.
- McCrae, R. R., & Costa, P. T., Jr. (1987). Validation of the five-factor model of personality across instruments and observers. *Journal of Personality and Social Psychology*, 52, 81–90. <https://doi.org/10.1037//0022-3514.52.1.81>.
- Muthén, L. K., & Muthén, B. O. (2010). *Mplus user's guide* (6th ed.). Los Angeles, CA: Muthén & Muthén.
- Muthén, L. K., & Muthén, B. O. (2019). *Mplus, version 8.3 [computer software]*. Los Angeles, CA: Muthén & Muthén.
- Niessen, A. S. M., & Meijer, R. R. (2017). On the use of broadened admission criteria in higher education. *Perspectives on Psychological Science*, 12, 436–448. <https://doi.org/10.1177/1745691616683050>.
- Niessen, A. S. M., Meijer, R. R., & Tendeiro, J. N. (2017). Measuring non-cognitive predictors in high-stakes contexts: The effect of self-presentation on self-report instruments used in admission to higher education. *Personality and Individual Differences*, 106, 183–189. <https://doi.org/10.1016/j.paid.2016.11.014>.
- O'Connor, M. C., & Paunonen, S. V. (2007). Big Five personality predictors of post-secondary academic performance. *Personality and Individual Differences*, 43, 971–990. <https://doi.org/10.1016/j.paid.2007.03.017>.
- Poropat, A. E. (2009). A meta-analysis of the five-factor model of personality and academic performance. *Psychological Bulletin*, 135, 322–338. <https://doi.org/10.1037/a0014996>.
- Pozzebon, J. A., Ashton, M. C., & Visser, B. A. (2014). Major changes: Personality, ability, and congruence in the prediction of academic outcomes. *Journal of Career Assessment*, 22, 75–88. <https://doi.org/10.1177/1069072713487858>.
- Pringle, C. D., DuBose, P. B., & Yankey, M. D. (2010). Personality characteristics and choice of academic major: Are traditional stereotypes obsolete? *College Student Journal*, 33, 131–142. Retrieved from <https://www.ingentaconnect.com/content/prin/csj/>.
- Putnick, D. L., & Bornstein, M. H. (2016). Measurement invariance conventions and reporting: The state of the art and future directions for psychological research. *Developmental Review*, 41, 71–90. <https://doi.org/10.1016/j.dr.2016.06.004>.
- Richardson, M., & Abraham, C. (2009). Conscientiousness and achievement motivation predict performance. *European Journal of Personality*, 23, 589–605. <https://doi.org/10.1002/per.732>.
- Richardson, M., Abraham, C., & Bond, R. (2012). Psychological correlates of university students' academic performance: A systematic review and meta-analysis. *Psychological Bulletin*, 138, 353–387. <https://doi.org/10.1037/a0026838>.
- Roberts, B. W., Hill, P. L., & Davis, J. P. (2017). How to change conscientiousness: The sociogenomic trait intervention model. *Personality Disorders: Theory, Research, and Treatment*, 8, 199–205. <https://doi.org/10.1037/per0000242>.
- Roberts, B. W., Walton, K. E., & Viechtbauer, W. (2006). Patterns of mean-level change in personality traits across the life course: A meta-analysis of longitudinal studies. *Psychological Bulletin*, 132, 1–25. <https://doi.org/10.1037/0033-2909.132.1.1>.
- Rubinstein, G. (2005). The Big Five among male and female students of different faculties. *Personality and Individual Differences*, 38, 1495–1503. <https://doi.org/10.1016/j.paid.2004.09>.
- Sax, L. J., & Harper, C. E. (2007). Origins of the gender gap: Pre-college and college influences on differences between men and women. *Research in Higher Education*, 48, 669–694. <https://doi.org/10.1007/s11162-006-9046-z>.
- Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online*, 8, 23–74. Retrieved from <http://www.dgps.de/fachgruppen/methoden/mpo-online/>.
- Schippers, M. C., Scheepers, A. W. A., & Peterson, J. B. (2015). A scalable goal-setting intervention closes both the gender and ethnic minority achievement gap. *Palgrave Communications*, 1(15014), 1–12. <https://doi.org/10.1057/palcomms.2015.14>.
- Silvia, P. J., & Nusbaum, E. C. (2012). What's your major? College majors as markers of creativity. *International Journal of Creativity and Problem Solving*, 22, 31–43. Retrieved from <https://www.questia.com/library/p440044/the-international-journal-of-creativity-and-problem>.
- Stieger, M., Flückiger, C., Rügger, D., Kowatsch, T., Roberts, B. W., & Allemand, M. (2021). Changing personality traits with the help of a digital personality change intervention. *Proceedings. National Academy of Sciences. United States of America*, 118(8), Article e2017548118. <https://doi.org/10.1073/pnas.2017548118>.
- Terracciano, A., McCrae, R. R., Brant, L. J., & Costa, P. T., Jr. (2005). Hierarchical linear modeling analyses of NEO-PI-R scales in the Baltimore Longitudinal Study of Aging. *Psychology and Aging*, 20, 493–506. <https://doi.org/10.1037/0882-7974.20.3.493>.
- Trapmann, S., Hell, B., Hirn, J.-O. W., & Schuler, H. (2007). Meta-analysis of the relationship between the Big Five and academic success at university. *Journal of Psychology*, 215, 132–151. <https://doi.org/10.1027/0044-3409.215.2.132>.
- Van der Molen, H. T., Schmidt, H. G., & Kruisman, G. (2007). Personality characteristics of engineers. *European Journal of Engineering Education*, 32, 495–501. <https://doi.org/10.1080/03043790701433111>.
- Vartanian, O., Wertz, C. J., Flores, R. A., Beatty, E. L., Smith, I., Blackler, K., ... Jung, R. E. (2018). Structural correlates of openness and intellect: Implications for the contribution of personality to creativity. *Human Brain Mapping*, 39, 2987–2996. <https://doi.org/10.1002/hbm.24054>.
- Vedel, A. (2014). The Big Five and tertiary academic performance: A systematic review and meta-analysis. *Personality and Individual Differences*, 71, 66–76. <https://doi.org/10.1016/j.paid.2014.07.011>.
- Vedel, A. (2016). Big Five personality group differences across academic majors: A systematic review. *Personality and Individual Differences*, 92, 1–10. <https://doi.org/10.1016/j.paid.2015.12.011>.
- Vedel, A., & Poropat, A. E. (2020). Personality and academic performance. In V. Zeigler-Hill, & T. K. Shackelford (Eds.), *Encyclopedia of personality and individual differences* (pp. 3529–3538). Cham: Springer. https://doi.org/10.1007/978-3-319-24612-3_989.
- Vedel, A., Thomsen, D. K., & Larsen, L. (2015). Personality, academic majors and performance: Revealing complex patterns. *Personality and Individual Differences*, 85, 69–76. <https://doi.org/10.1016/j.paid.2015.04.030>.
- Verbree, A.R., Hornstra, T.E., Maas, L., & Wijngaards-de Meij, L.D.N.V. (under review). Conscientiousness as one predictor of the gender gap in academic achievement. *Research in Higher Education*.
- Vianello, M., Schnabel, K., Sriram, N., & Nosek, B. (2013). Gender differences in implicit and explicit personality traits. *Personality and Individual Differences*, 55, 994–999. <https://doi.org/10.1016/j.paid.2013.08.008>.
- Wen, X., Zhao, Y., Yang, Y. T., Wang, S., & Cao, X. (2021). Do students with different majors have different personality traits? Evidence from two Chinese agricultural universities. *Frontiers in Psychology*, 12(641333), 1–10. <https://doi.org/10.3389/fpsyg.2021.641333>.
- Wicherts, J. M., & Dolan, C. (2010). Measurement invariance in confirmatory factor analysis: An illustration using IQ test performance of minorities. *Educational Measurement: Issues and Practice*, 29, 39–47. <https://doi.org/10.1111/j.1745-3992.2010.00182.x>.