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Personality and intelligence as predictors of academic achievement: A cross-sectional study from elementary to secondary school

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Abstract

General intelligence and personality traits from the Five-Factor model were studied as predictors of academic achievement in a large sample of Estonian schoolchildren from elementary to secondary school. A total of 3618 students (1746 boys and 1872 girls) from all over Estonia attending Grades 2, 3, 4, 6, 8, 10, and 12 participated in this study. Intelligence, as measured by the Raven's Standard Progressive Matrices, was found to be the best predictor of students' grade point average (GPA) in all grades. Among personality traits (measured by self-reports on the Estonian Big Five Questionnaire for Children in Grades 2 to 4 and by the NEO Five Factor Inventory in Grades 6 to 12), Openness, Agreeableness, and Conscientiousness correlated positively and Neuroticism correlated negatively with GPA in almost every grade. When all measured variables were entered together into a regression model, intelligence was still the strongest predictor of GPA, being followed by Agreeableness in Grades 2 to 4 and Conscientiousness in Grades 6 to 12. Interactions between predictor variables and age accounted for only a small percentage of variance in GPA, suggesting that academic achievement relies basically on the same mechanisms through the school years.

Keywords: Academic achievement; Five-Factor model of personality; Intelligence; Elementary and secondary school students

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1. Introduction

Success in school plays an important role in impacting students' future opportunities, making some choices more likely and eliminating others. A myriad of factors have been identified as being related to academic achievement, the two most fundamental of which will be addressed in the present paper: intelligence and personality (see Chamorro-Premuzic & Furnham, 2005). Many researchers agree that both cognitive and personality variables should be taken into account when predicting school performance (Chamorro-Premuzic & Furnham, 2005; Rindermann & Neubauer, 2001; Rothstein, Paunonen, Rush, & King, 1994), neither of them is sufficient on its own.

The prediction of academic success or failure has been the main objective of developing intelligence tests (Ackerman & Heggestad, 1997). An average correlation between IQ scores and grades is approximately 0.5 (Neisser et al., 1996), varying considerably depending on the measures used. The correlation between intelligence and academic achievement appears to decline with age, being highest in primary school and lower in middle school and college (Jensen, 1980, p. 319). As mentioned by Pind, Gunnarsdóttir, and Jóhannesson (2003), the decrease in the magnitude of this correlation is generally explained by the restriction of range that occurs as a result of fewer students being enrolled in the upper echelons of the educational system.

Although the direct relationship between school success and personality traits has also been extensively studied (for reviews, see Chamorro-Premuzic & Furnham, 2005; De Raad & Schouwenburg, 1996), the results are not as straightforward as they are for the relationship between intelligence and academic achievement. Using the Five-Factor personality model as a framework to organize previous research, Farsides and Woodfield (2003) concluded that empirical evidence is mixed concerning the role each of the five traits plays in determining academic success. They proposed several reasons for this discrepancy, among which are age specificity of the relationship (e.g., Neuroticism is positively related to academic achievement in middle school but negatively at college age; similarly, Extraversion predicts higher grades in middle school but lower grades at the college level, De Raad & Schouwenburg, 1996; Eysenck, 1996), small sample sizes, varying time lapses between the collection of predictor and criterion data, and the use of different personality measures and different criteria for academic success.

While a lot of research has been conducted with college students, few studies have related personality to academic achievement in adolescents and younger children. Barbaranelli, Caprara, Rabasca, and Pastorelli (2003) reported a negative correlation between academic achievement as measured by grade point average (GPA) and self-reported Energy as measured by the Big Five Questionnaire for Children, as well as positive correlations between GPA and Intellect/Openness and Conscientiousness in Elementary School and Junior High School children. Hair and Graziano (2003) analysed the correlations between high school GPA and Big Five traits assessed by bipolar adjective scales when the participants were in middle school. A significant positive correlation was found for all personality factors except Emotional Stability, which was insignificantly correlated to GPA. Heaven, Mak, Barry, and Ciarrochi (2002) examined how personality variables measured by the Junior Eysenck Personality Questionnaire (JEPQ) and adjective scales for Agreeableness and Conscientiousness were related to self-rated academic performance in adolescents of 14–16 years of age. They found a negative correlation with Psychoticism and positive correlations with Agreeableness and Conscientiousness. Another study (Maqsud, 1993) using the JEPQ in 14–15 year olds reported a negative relationship between Psychoticism and academic

achievement in languages, but achievement was also found to be significantly negatively correlated with Extraversion and Neuroticism. On the other hand, none of the three factors of Eysenck's PEN model correlated significantly with GPA in a sample of Russian adolescents (Slobodskaya, Safronova, & Windle, 2005). In an additional study (Aluja-Fabregat & Blanch, 2004) assessing personality with Cattell's High School Personality Questionnaire in adolescents with a mean age of 13.4 years, academic achievement was positively related to Intelligence, Emotional Stability, Conformity and Self-Discipline, and negatively related to Impulsivity. These examples clearly illustrate the diversity of methods and results in previous research, which precludes any conclusions regarding age-related differences in how personality traits relate to academic achievement.

1.1. This study

The main objective of this study was to document how intelligence and personality relate to academic achievement in Estonian schools, from elementary to secondary level.

Based on previous research, it was hypothesized that, although intelligence would be more closely related to academic achievement than any of the personality traits at every grade level (Aluja-Fabregat & Blanch, 2004; Lounsbury, Sundstrom, Loveland, & Gibson, 2003; Rindermann & Neubauer, 2001), the association between intelligence and achievement would weaken from elementary to secondary school (Jensen, 1980). Conscientiousness- and Openness-related traits have been most consistently identified as relevant to achievement (Paunonen & Ashton, 2001); hence, these traits were expected to demonstrate higher correlations relative to other personality dimensions. Age-related differences in relations with scholastic performance were expected for Neuroticism and Extraversion (De Raad & Schouwenburg, 1996; Eysenck, 1996), with more neurotic and extraverted pupils being expected to have higher grades in elementary school, and emotionally stable and introverted pupils being expected to have higher grades in secondary school. Using two large samples of schoolchildren from 7 to 19 years of age, the present study attempted to overcome the limitations of previous research pointed out by Farsides and Woodfield (2003). Since basically the same methods were used throughout all grades, findings for different educational levels are directly comparable with each other.

2. Method

2.1. Participants

Two samples of schoolchildren participated in this study. First, a sample consisting of 2746 adolescents (1466 girls and 1280 boys) attending Grades 6, 8, 10, and 12 was tested in 2001. The sample was drawn from 27 Estonian-speaking public secondary schools and gymnasiums from different regions of Estonia. The age of this sample ranged from 11 to 19 years, with a mean age of 14.9 ± 2.0 years.

The second sample was drawn from 17 schools all over Estonia in 2002, and consisted of elementary school children attending Grades 1, 2, 3, and 4. Although first graders participated in completing the psychometric tests, they are not yet given grades in most of the schools and,

therefore, were excluded from being studied in relation to academic achievement. A total of 1435 children (682 girls and 753 boys) from Grades 2, 3, and 4 participated, with a mean age of 9.4 ± 1.0 (ranging from 7 to 11) years.

2.2. Measures

2.2.1. Academic achievement

Almost all academic subjects are taught by the same teacher in Grades 1 to 4, whereas in Grades 5 to 12, different subjects are taught by different teachers. The knowledge, skills and proficiencies of pupils are graded using a five-mark system, where a mark of 5 is "very good", 4 is "good", 3 is "satisfactory", 2 is "deficient" and 1 is "weak". Grading usually begins in Grade 2.

Grade point average (GPA) was computed based on participants' grades for the last semester or two previous quarters in the following academic subjects: Estonian, Literature, two foreign languages (typically English and Russian or German), Mathematics, Chemistry, Physics, Geography, Biology, and History. Grades in Music, Drawing, and Physical Education were not included, because they require specific skills. Since all of these subjects are not taught in all grade levels included in the study (e.g., Geography, Chemistry, and Physics in elementary school), the GPA for each participant is the average of as many grades as were available for her or him.

2.2.2. Intelligence

Raven's Standard Progressive Matrices (SPM; Raven, 1981) was used to measure participants' intellectual abilities. The SPM is a measure of pure non-verbal reasoning ability that is relatively independent of specific learning acquired in a particular cultural or educational context (Jensen, 1998). The SPM is made up of a series of designs with a part missing and those taking the test are expected to select the correct part to complete the designs from a number of options printed beneath (Raven, 2000). Consisting of 5 sets of 12 different matrices gradually increasing in difficulty, the test can be used for a wide age range. The SPM was standardized in Estonia on the same two samples (Lynn, Allik, Pullmann, & Laidra, 2002; Lynn, Pullmann, & Allik, 2003). The internal reliabilities of the SPM ranged from .82 to .88 for the grade levels that were tested.

2.2.3. Personality traits

Participants in the first sample completed the Estonian NEO Five Factor Inventory (NEO-FFI; Costa & McCrae, 1992; Allik, Laidra, Realo, & Pullmann, 2004), which is a 60-item measure of the five major personality domains: Neuroticism (N), Extraversion (E), Openness to Experience (O), Agreeableness (A), and Conscientiousness (C). Each personality dimension is measured by 12 items on a 5-point Likert scale ranging from 0 (*strongly disagree*) to 4 (*strongly agree*).

For the elementary school sample, a more developmentally appropriate measure of personality was needed. Therefore, a 40-item questionnaire was constructed following the example of the "Big Five Questionnaire – Children version (BFQ-C)" by Barbaranelli et al. (2003), an instrument that was developed for measuring the Big Five via self-report in children 8 years and older. However, the Estonian inventory is not an exact replication of the original BFQ-C. The Estonian Big Five Questionnaire for Children (EBFQ-C) includes 7 items for the assessment of Neuroticism (e.g., "I worry about every little thing"), 8 items for Extraversion (e.g., "I make friends easily"), 7 items for Openness (e.g., "I am very smart and I immediately understand everything"), 9 items for

Table 1
Number of valid cases, mean age, and descriptive statistics for GPA, SPM and personality scales

Grade	*N*	Mean age	GPA		SPM		Neuroticism			Extraversion			Openness			Agreeableness			Conscientiousness		
			M	SD	*M*	SD	*M*	SD	α	*M*	SD	α	*M*	SD	α	*M*	SD	α	*M*	SD	α
2	364	8.3	4.5	0.4	31.5	9.1	12.6	2.6	.60	19.1	2.6	.47	16.3	2.6	.57	22.7	2.9	.67	21.8	3.3	.72
3	388	9.5	4.4	0.5	35.7	8.2	12.6	2.8	.65	19.1	2.7	.53	15.7	2.4	.48	22.4	3.1	.71	21.3	3.5	.75
4	430	10.4	4.3	0.6	38.9	8.5	12.4	2.5	.59	19.8	2.6	.58	15.5	2.6	.57	22.7	2.8	.64	21.5	3.4	.75
6	609	12.4	4.0	0.7	46.3	7.0	23.9	8.5	.76	29.2	7.5	.70	23.1	8.0	.69	31.1	6.9	.70	30.6	7.6	.77
8	697	14.4	3.9	0.7	49.3	6.1	25.2	9.2	.82	29.5	8.6	.80	23.0	8.5	.76	29.0	6.7	.67	29.1	8.0	.80
10	642	16.1	3.8	0.6	52.4	4.9	23.1	9.1	.86	30.7	8.5	.86	24.2	8.3	.81	28.6	5.9	.67	29.0	7.7	.84
12	488	17.8	3.8	0.6	53.2	4.7	22.8	8.8	.86	29.8	8.9	.87	25.4	8.8	.83	27.4	5.9	.67	28.4	7.8	.83

Note: N = number of valid cases, GPA = grade point average, SPM = Standard Progressive Matrices, M = mean, SD = standard deviation, α = Cronbach's alpha.
Different personality inventories were used in Grades 2 to 4 and Grades 6 to 12.

Agreeableness (e.g., "I am kind with everybody"), and 9 items for Conscientiousness (e.g., "I always keep my promises"). Children provided their self-reports on a 3-point Likert scale (*1 = disagree*, *2 = somewhat agree*, *3 = agree*).

A study to validate the EBFQ-C in relation to the NEO-FFI was conducted in a separate sample of 90 pupils (40 boys and 50 girls) from Grades 6 to 8, with a mean age of 13.6 ± 0.9 years. The EBFQ-C and the NEO-FFI were administered on two consecutive days. Convergent correlations of the scales were .69 for Neuroticism, .61 for Extraversion, .44 for Openness, .54 for Agreeableness, and .69 for Conscientiousness. The convergence of these two personality measures appears to be acceptable, as the convergent correlations are in the typical range of intercorrelations among the facets of the Revised NEO Personality Inventory that measure the same trait (see Costa & McCrae, 1992, Appendix F). Alpha coefficients of the EBFQ-C in this sample were .71 (N), .75 (E), .42 (O), .63 (A), and .76 (C), indicating problems with the internal consistency of the Openness scale.

2.3. Procedure

Data for both samples were collected during the second half of the school year (from February to April). Written consent was obtained from participants' parents; children who did not want to participate were free to decline. The measures were administered collectively in classrooms during school hours. First, the SPM was administered without time limits, followed by the personality questionnaire. For second graders, the items of the personality questionnaire were read aloud.

Grades were obtained from school records. Unfortunately, not all schools agreed to provide information on their students' academic achievement; therefore, GPA could not be computed for a significant portion of participants. Cases with incomplete data were excluded from further analyses, which led to a decrease in the number of valid cases by 13.5%. Distribution of the remaining sample by grade is presented in Table 1. Comparison of the initial and final sample regarding the scores of personality scales and SPM did not indicate any significant differences between the two.

3. Results

Table 1 presents means and standard deviations for GPA and all predictor variables, as well as Cronbach's alphas for the personality scales. Alphas are quite low for the elementary school sample, even below .5 for two scales. There is a continuous decrease in GPA from Grade 2 to Grade 12, which likely reflects teachers' different grading standards at different educational levels; as pupils get older, grading typically becomes more demanding.

For the following correlation and regression analyses, the data were standardized by sex and grade level in order to control for sex and developmental effects. For example, girls typically have better grades and score higher on Agreeableness than boys, which may lead to the overestimation of the correlation between GPA and Agreeableness. On the other hand, younger pupils have better grades but give fewer correct answers on SPM than older pupils, which may lead to the underestimation of the correlation between GPA and intelligence when data from different grade levels are analysed together.

Table 2 shows Pearson correlations between GPA and scores of the personality scales and intelligence test. In all grades, correlations with GPA were highest for intelligence, although they be-

Table 2
Pearson's correlations between predictors and GPA

Grade	SPM	*N*	*E*	*O*	*A*	*C*
2	0.54 (0.54)***	−0.15**	0.03	0.26***	0.23***	0.14**
3	0.46 (0.50)***	−0.13*	0.06	0.25***	0.29***	0.19***
4	0.49 (0.53)***	−0.12*	0.07	0.28***	0.25***	0.23***
6	0.53 (0.64)***	−0.25***	0.14**	0.12**	0.23***	0.32***
8	0.48 (0.63)***	−0.16***	−0.00	0.13**	0.08*	0.21***
10	0.43 (0.65)***	−0.19***	−0.01	0.18***	0.12**	0.30***
12	0.32 (0.54)***	−0.11*	−0.04	0.11*	0.00	0.20***

Note: GPA = grade point average, SPM = Standard Progressive Matrices, *N* = Neuroticism, *E* = Extraversion, *O* = Openness, *A* = Agreeableness, *C* = Conscientiousness.
Correlations corrected for restriction of range are shown in parentheses.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

came somewhat weaker in Grade 8 and onwards. The moderating effect of age on the relationship between GPA and intelligence was tested by regressing GPA on intelligence, (standardized) age, and their cross-product. The interaction term was negative and significant, $\beta = -0.04$, $t = -2.65$, $p < 0.01$, indicating lower correlations between GPA and intelligence in older students. However, the standard deviation of intelligence scores decreased substantially from Grade 2 to 12 (see Table 1), suggesting a possible restriction of range effect in older grades. Based on the assumption that the true variance in SPM scores should be equal at every age, the standard deviation of SPM in Grade 2 was used as the reference standard deviation to correct the GPA-SPM correlations for restriction of range. In corrected correlations (shown in parentheses in Table 2) the age-related decrease disappeared.

Regarding personality traits, Openness and Conscientiousness exhibited significant positive correlations, and Neuroticism negative correlations with GPA throughout all grades. Correlations with Agreeableness got weaker from Grade 6 onward. Extraversion was significantly correlated to GPA only in Grade 6. Interactions between personality traits and age in predicting GPA were tested with regression models in which age, each of the five traits in turn, and their cross-product served as predictors. Separate analyses were conducted for Grades 2 to 4 and Grades 6 to 12 because different personality measures were used. Interaction terms with age were significant only for Conscientiousness in elementary school ($\beta = 0.08$, $t = -2.72$, $p < 0.01$), and Extraversion in secondary school ($\beta = -0.05$, $t = -2.43$, $p < 0.05$), suggesting that the effect of age on the relationship between personality traits and GPA was minimal.

The five personality factors and intelligence are intercorrelated (see Allik et al., 2004, Table 3). In order to determine the independent contribution of each predictor, regression analyses were run including GPA as the criterion variable and age, intelligence, five personality traits, and their interactions with age as predictor variables (see Table 3). The model explained 31.5% of the variance in GPA in elementary school [multiple $R = 0.56$, $F(13,1168) = 41.27$, $p = 0.00$], and 26.0% of the variance in secondary school [multiple $R = 0.51$, $F(13,2422) = 65.37$, $p = 0.00$]. In both samples, intelligence was clearly the factor that accounted for the largest portion of variance, being followed by Agreeableness in elementary school and Conscientiousness in secondary school.

Table 3
Regression results: Prediction of GPA

Predictors	Grades 2 to 4		Grades 6 to 12	
	Beta	*t*	Beta	*t*
SPM	0.46	18.6***	0.42	23.4***
Neuroticism	−0.04	−1.5	−0.05	−2.2*
Extraversion	−0.06	−2.2*	−0.07	−3.6***
Openness	0.09	3.0**	0.06	3.4***
Agreeableness	0.15	4.6***	−0.00	−0.1
Conscientiousness	0.07	2.1*	0.21	10.1***
Age	−0.00	−0.1	−0.03	−1.9
SPM*Age	0.02	0.7	−0.05	−2.5*
Neuroticism*Age	0.01	0.3	−0.01	−0.5
Extraversion*Age	−0.02	−0.6	−0.05	−2.5*
Openness*Age	−0.05	−1.7	0.04	2.4*
Agreeableness*Age	0.04	1.3	−0.03	−1.4
Conscientiousness*Age	0.09	2.7**	0.02	1.1

Note: GPA = grade point average, SPM = Standard Progressive Matrices.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Four personality factors contributed independently to GPA in both samples, three of which were the same at different educational levels (Conscientiousness, Openness, and Extraversion) and one was different (Agreeableness in elementary school vs. Neuroticism in secondary school). Interactions with age were generally modest; the most salient was the increase in the effect of Conscientiousness during the elementary school years.

Further analyses revealed that the two strongest predictors together (intelligence and Agreeableness or Conscientiousness) accounted for 29.1% and 24.6% of the variance in elementary and secondary school GPA, respectively, indicating that the role of other predictor variables was limited. However, the prominence of Agreeableness among the personality factors in elementary school was not as straightforward as the prominence of Conscientiousness in secondary school. When elementary school GPA was predicted from intelligence and each of the personality traits, Agreeableness, Conscientiousness, and Openness yielded quite similar results in terms of explained variance (29.1%, 28.0%, and 27.5%, respectively). For comparison, intelligence and Agreeableness in secondary school accounted for 4.3% of the variance less than intelligence and Conscientiousness (20.3% vs. 24.6%). The relative prominence of Agreeableness in the joint analysis as compared with Openness and Conscientiousness may result from the high level of collinearity between the three personality factors among younger children.

4. Discussion

Possible age-related differences in how academic achievement is related to personality traits and intelligence from elementary to secondary school were investigated in Estonian schoolchildren.

Due to the diversity of methods used in previous research, the results of different studies are not directly comparable; therefore, this study intended to clarify some of these contradictions by using essentially the same methods at different educational levels. This study appears to be the first study investigating the determinants of academic achievement in students of such a wide age range, spanning from elementary to secondary school.

Consistent with several earlier studies (Farsides & Woodfield, 2003; Rindermann & Neubauer, 2001), both intelligence and personality were found to contribute to academic success, but even in combination, they did not account for more than approximately 30% of the total variance in GPA. As expected, intelligence, measured by the Raven's Standard Progressive Matrices, was clearly the best single predictor of academic achievement in all grades. The magnitude of the correlation between GPA and intelligence was generally around 0.5, and in accordance with previous research (Jensen, 1980), showed a decreasing tendency in older grades. However, when corrected for restriction of range for SPM, the age-related decrease disappeared. Lower uncorrected correlations between GPA and SPM in secondary school may reflect both actual restriction of ability range (i.e., more intelligent students may continue studying in secondary schools and gymnasiums, while their less gifted peers may choose to go to vocational schools instead), but may also be caused by the ceiling effect on the SPM. Pind et al. (2003) noted that in Icelandic children the ceiling effect on the SPM scores was evident already in Grade 8, and it poses a challenging measurement problem.

Regarding personality traits, there are two limitations that must be kept in mind when interpreting the results of this study. First, internal reliabilities of the personality scales were quite low in elementary school, especially for Extraversion and Openness, which may indicate that elementary school children are not able to provide very reliable information about their own personality traits. Second, two different (though age-appropriate) personality measures were used in the elementary and secondary school samples. Based on the validation study, the instruments diverged most in Openness and Agreeableness, which likely reflects different conceptualizations of these factors. However, even for these traits the convergent correlations were in the same range with typical intercorrelations among the different facets that measure the same factor, which allowed us to conclude that the two measures had similar structures and measured similar constructs.

In a review on personality and academic achievement, De Raad and Schouwenburg (1996) considered Conscientiousness, the factor that describes how organized, motivated and thorough an individual is, to be the most prominent in school contexts. Concordantly, in this study Conscientiousness was found to correlate significantly to GPA in all grade levels. Although Conscientiousness was not the strongest personality predictor of GPA in elementary school, its role appeared to strengthen during the first school years. The prominent role of intelligence and Conscientiousness in predicting academic achievement agrees with the common sense notion that any kind of success is a result of ability and effort (Gagné & St Pére, 2001).

Another personality factor consistently predicting academic achievement through all grades was Openness, which is related to the ability to grasp new ideas and to the tendency to seek novel educational experiences (Costa & McCrae, 1992). Although correlations between Openness and GPA were higher in elementary school than in the secondary school sample, this is likely caused by the change of the personality measure, as there appeared a sharp difference between the two samples. There is a debate over the interpretation of the Openness factor, with some researchers

(e.g., Costa and McCrae) defining Openness by such characteristics as imaginative, curious and aesthetically sensitive, whereas others (e.g., Goldberg) define it primarily by intellectual characteristics. While the NEO-FFI undoubtedly follows the first definition, a more intellectual definition, which is also deemed to be developmentally more appropriate, is employed in the EBFQ-C.

The association between Agreeableness and GPA was also strongest in elementary school and decreased later. As the correlations were decreasing smoothly from Grade 2 to Grade 12, there seems to be a reason to attribute this decrease to age, not just to the change of instrument. Although direct links to learning outcomes are hard to find for Agreeableness (De Raad & Schouwenburg, 1996), Hair and Graziano (2003) emphasized its role in maintaining good relations with teachers and classmates, which leads to better academic adjustment over the course of development.

Based on previous findings, Neuroticism and Extraversion were expected to have positive relationships with academic success in childhood that converted into negative relationships in adolescence. However, in this cross-sectional study only minimal support for such age-related change was evidenced for Extraversion, but not for Neuroticism. Neuroticism was negatively correlated to GPA through all grade levels, though the relationship became weaker when the other personality traits were controlled for. Being anxious and worried appeared to be a disadvantage rather than an advantage for all students regardless of their age. Extraversion correlated generally close to zero with GPA, but the interaction with age was marginally significant in secondary school. It is possible that the detrimental effect of preferring social activities to socially less stimulating ones becomes more pronounced at college level, although some researchers have found it among adolescents (Barbaranelli et al., 2003; Maqsud, 1993).

4.1. Conclusion

There do not appear to be dramatic differences in the way intelligence and personality dispositions relate to the grades children get in Estonian school at different educational levels. Although some traits have more effect in elementary school (e.g., Agreeableness) and others become relatively more relevant later (e.g., Conscientiousness), students' achievement relies most strongly on their cognitive abilities through all grade levels.

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