

Personality, Behavioural Strengths and Difficulties and Performance of Adolescents with high achievements in Science, Literature, Art and Sports

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Conflict of interest

All authors declare no conflicts of interest.

Abstract

Individual variation in personality is related to differences in behavioral difficulties and achievement in unselected samples, and in samples selected for high achievement in various domains. This is the first study to explore and compare the connections between self-report measures of personality (Big Five and Dark Triad), behavioral strengths and difficulties, and school achievement in four tracks of high-achieving adolescents ($N = 1,179$) selected based on their exceptional performance in: *Science, Arts, Sports and Literature*. Personality was more strongly related to behavioral strengths and difficulties than to achievement in all tracks. As such, personality traits may be indirectly linked with achievement via behavioral strengths and difficulties. For example, narcissism correlated negatively with behavioral difficulties but did not significantly correlate with achievement. However, achievement was correlated negatively with behavioral difficulties. Network analyses indicated that teacher-awarded grades, but not anonymous exam grades, were weakly connected with personality. Specifically, teachers awarded higher grades to students with more ‘desirable’ personality traits such as high agreeableness. Results also showed track differences in the networks of personality, behavior and achievement. These findings are discussed in the context of personality as a resilience factor against behavioural difficulties and as a contributor to school achievement in gifted adolescents.

Keywords: Big Five, Dark Triad, Behavioral Strengths and Difficulties, Networks, Achievement, High-Achievers, Gifted Adolescents.

1.0 Introduction

There is a growing interest in studying the role of personality traits in academic achievement and psychopathology in unselected samples (Carragher, Teesson, Sunderland, Newton, Krueger, Conrod, Slade, 2015; Dumfart & Neubauer, 2016; Papageorgiou, Malanchini, Denovan, Clough, Shakeshaft, Schofield, & Kovas, 2018; Papageorgiou, Denovan, & Dagnall, 2019), as well as in samples selected for high performance in various domains (Eklund, Tanner, Stoll, & Anway, 2015; Mammadov, Cross, & Ward, 2018; Rinn & Majority, 2018; Lee, An & Choe, 2019; Vötter & Schnell, 2019; Wirthwein, Bergold, Preckel, & Steinmayr, 2019).

Accumulating evidence suggests that personality traits associate with achievement through various pathways (Poropat, 2009). For example, research indicates that individual differences in personality traits indirectly contribute to individual variation in academic performance and learning by facilitating the use of cognitive traits, such as intelligence (Rindermann & Neubauer, 2001). The most consistent results in this line of research have derived from studies on the Big Five personality traits, which asserts that individual differences in normal behavior can be classified in terms of five independent dimensions: Agreeableness, Conscientiousness, Extraversion, Neuroticism and Openness to Experience (Furnham, Monsen, & Ahmetoglu, 2009).

Most studies, including meta-analyses, have identified Conscientiousness as the strongest (out of the five traits) predictor of academic achievement in unselected samples (Poropat, 2009; Nofle & Robins, 2007). Conscientiousness is moderately, positively and consistently correlated with various academic outcomes including performance in exams, essays, continuous assessment and supervised dissertations, possibly due to the hard-working, responsible, and achievement-oriented nature of highly conscientious individuals (Furnham et al., 2009; O'Connor & Paunonen, 2007). Openness to experience and Agreeableness have also been linked to academic achievement,

with small effect sizes, whereas the findings on the association between Neuroticism and Extraversion with achievement are not conclusive (De Feyter, Caers, Vigna, & Berings, 2012; Zhou, 2015).

There is only a handful of studies exploring these links in gifted samples. For example, the Big Five traits of Agreeableness, Conscientiousness and Openness to experience were found to predict academic achievement (scores on the American College Testing) in a sample of 161 gifted adolescents who had participated in Northwestern University's Midwest Academic Talent Search and/or the Northwestern University Centre for Talent Development (Mammadov et al., 2018). All three traits exerted significant direct associations of moderate (positive for Conscientiousness and Openness) to strong (negative for Agreeableness) effect on academic achievement. Furthermore, Conscientiousness predicted achievement indirectly through higher self-regulatory efficacy and autonomous motivation; and Openness predicted achievement indirectly through higher autonomous motivation (Mammadov et al., 2018).

Another pathway, through which personality traits may affect achievement, is via their role as resilience factors against behavioral difficulties (defined here as internalizing and externalizing problems) and psychopathology (Tosevski, Milovancevic, & Gajic, 2010). For example, a study has shown that a personality profile characterized by high levels of Agreeableness, Conscientiousness, Extraversion and Openness, and low levels of Neuroticism was linked to reduced internalizing and externalizing behavioral problems among adolescents. Neuroticism was the strongest predictor of adolescents' internalizing and externalizing behavioral problems (Ling, Pheng, Sin, & Soon-Aun, 2017). In turn, higher level of externalizing and internalizing behavioral problems predicted worse academic outcomes (lower grades and classroom adjustment levels) of adolescents in a longitudinal (three assessment waves over a period of two years) study (Ansary

& Luthar, 2009). Other longitudinal research suggests that this effect is bidirectional: higher externalizing problems predict lower teacher-given grades (but not lower grades in standardized achievement tests); and lower grades predict increased future externalizing problems and lower self-esteem in adolescents (Zimmermann, Schütte, Taskinen, & Köller, 2013).

The negative influence of behavioral difficulties on performance was detected as early as six years of age, with externalizing problems leading to school underachievement; which in turn predicts more future internalizing and externalizing problems (Van Lier, Vitaro, Barker, Brendgen, Tremblay, & Boivin, 2012). One study showed that gifted students achieved higher academic performance regardless of internalizing problems. Compared with nongifted peers, gifted adolescents showed higher levels of parent-report internalizing problems. This pattern of results suggests that higher cognitive abilities may attenuate the effects of social, emotional, or behavioral difficulties on academic achievement (Eklund et al., 2015).

It has been argued that the Big Five, does not sufficiently capture variation across the whole spectrum of normal personality. In particular, its heterogeneous broad traits may be too few in number and additional traits are needed to adequately capture personality contribution to various outcomes, such as achievement and behavioral difficulties (Boyle, 2008). In the last decade there has been an increasing interest in the Dark Triad (DT) of personality - a cluster composed of three distinct, but partially overlapping personality traits: Machiavellianism, subclinical narcissism and subclinical psychopathy (Paulhus & Williams, 2002). Machiavellianism is synonymous with manipulation; individuals scoring high on Machiavellianism employ self-serving strategies; are master manipulators and deceivers, who care little for moral and societal norms (Kapoor, 2015). The construct of subclinical or “normal” narcissism includes facets retained from the clinical syndrome: grandiosity, entitlement, dominance, and superiority (Paulhus & Williams, 2002).

Subclinical psychopathy is characterised by high impulsivity and thrill seeking along with low empathy (Paulhus & Williams, 2002).

Previous findings have shown that the Dark Triad traits share a common core of callous-manipulation (see Furnham, Richards, & Paulhus (2013) for a review). This has led some researchers questioning whether the Dark Triad traits are sufficiently distinct (e.g. Muris, Merckelbach, Otgaar, & Meijer, 2017). However, other researchers have argued that grouping Dark Triad traits together may not be particularly informative (e.g. Papageorgiou, Wong, & Clough, 2017). In particular, several studies examining the association among narcissism and other traits, performance measures, and psychopathology symptoms suggested that the inclusion of narcissism in the malevolent side of human personality may need to be reconsidered (e.g. Petrides, Vernon, Schermer, & Veselka, 2011; Zeigler-Hill & Besser, 2011; Veselka, Schermer, & Vernon, 2012; Onley, Veselka, Schermer, & Vernon, 2013; Ng, Cheung, & Tam, 2014; Papageorgiou et al., 2017; Papageorgiou et al., 2018; Papageorgiou, Denovan, & Dagnall, 2019; Papageorgiou, Gianniou, Wilson, Moneta, Bilello, & Clough, 2019).

The Dark Triad traits have received limited attention in relation to educational outcomes in selected or unselected samples, possibly because the Dark Triad traits are considered socially toxic. Narcissism is the only Dark Triad trait that has been explored in relation to achievement. Specifically, a recent longitudinal study has shown that narcissism may increase mental toughness contributing indirectly to higher school grades in adolescents (Papageorgiou et al., 2018). The strongest correlate of narcissism in this study was the mental toughness component of confidence. The link between narcissism and confidence may be key for braking the vicious cycle whereby externalizing problems lead to lower academic performance, which leads to lower self-esteem, which in turn leads to lower academic performance and higher internalizing problems (see model

presented in Zimmermann et al., 2013).

Several further studies have shown that grandiose narcissism may be a resilience factor against psychopathology, including perceived stress and symptoms of depression (Papageorgiou et al., 2019; Papageorgiou, Denovan, & Dagnall, 2019). Furthermore, a study that utilized network analyses reported that narcissism may act as a bridge between the malevolent and prosocial side of human personality (Papageorgiou, Benini, Bilello, Gianniou, Clough, & Costantini, 2019). The study suggested that broadening the domain of personality beyond the Big Five can improve the prediction of important outcomes and that networks may be a useful tool to move forward from a dichotomous way of perceiving personality traits, as beneficial or malevolent, to focusing on a dynamic continuum of personality (Papageorgiou, Benini, et al., 2019).

Networks have been proposed as an alternative approach to models that focus exclusively on latent dimensions (Schmittmann, Cramer, Waldorp, Epskamp, Kievit, & Borsboom, 2013). From the network perspective, the coalescence of several personality characteristics into a few major dimensions is viewed as a consequence of the interactions that take place within networks (Costantini, Epskamp, Borsboom, Perugini, Möttus, Waldorp, & Cramer, 2015). Concurrently modelling many elements of the personality system as a network, provides unique information on their connections with relevant outcomes.

This study is the first to explore and directly compare connections among personality traits (Big Five and Dark Triad), behavioural strengths (prosocial behavior) and difficulties (externalizing and internalizing problems) and school achievement in four groups of adolescents ($N = 1,179$) who showed high achievement in either *Science, Arts, Sports or Literature*. Utilizing correlations, network analyses and stepwise linear regression models we investigated:

1. Correlations among personality (Big Five and Dark Triad); behavioral strengths and difficulties; and achievement (gifted adolescents' last year teacher awarded school grades and exam scores).
2. Differences between groups (Science, Arts, Sports or Literature) in personality, behavioral strengths and difficulties and achievement.
3. Networks of personality traits, behavioral strengths and difficulties and achievement and the degree to which their connections differ by sex and group.
4. The amount of variance explained by the Dark Triad traits in the gifted adolescents' behavioral strengths and difficulties and achievement, over and above the variance explained by the Big Five.

2.0 Methods

2.1 Sample

The sample included 1,191 adolescents (576 males and 603 females; $M = 15.24$; $SD = 1.05$; $range = 14-18$ years). The participants were recruited at the educational centre Sirius (<https://sochisirius.ru/>), in Sochi, Russia, where high-achieving adolescents from different regions of the country come for educational and training purposes. The educational program usually lasts for 1 month. The participants were recruited from four tracks: Science ($N = 600$; 338 males), Arts ($N = 229$; 44 males), Sports ($N = 221$; 180 males) or Literature ($N = 141$; 14 males). Selection criteria for the centre attendance differs for different tracks. For the Science track, selection criteria include high performance in school subjects (biology, chemistry, mathematics, physics etc.) and winning in subject Olympiad (e.g. biology or mathematics) of different level (school, city, regional, state or international). For the Sports track, selection criteria include high performance in sports (hockey, figure skating, and chess), such as winning

an individual or team competition of various levels (regional, state or international). For the Literature track, selection criteria include evidence of high school performance, subject Olympiad (Russian language or literature) and published creative output (article, book, etc.). For the Arts track, selection criteria include high achievement in performing arts, painting or ballet, such as participation in Olympiads, competitions, festivals and examples of their own creative works (e.g. scans of drawings, videotaped performance, etc.).

2.2 Procedure

Participants and their parents or guardians received information regarding the goals of the study and the voluntary basis of their participation. Parents or legal guardians of participants provided written informed consent. Additionally, verbal consent was obtained from participants before data collection. Participants completed computerized self-report questionnaires in groups under similar controlled conditions. The testing session lasted for one and a half hour. The participants did not receive compensation for taking part in the study.

2.3 Measures

Participants filled in a socio-demographic inventory. The inventory asked participants to provide information on their age, sex, educational track (i.e. Science, Arts, Sports or Literature) and their last year and state exam grades on thirteen school subjects: Russian language, Maths (Algebra), Geometry, Informatics, History, Geography, Biology, Social studies, Physics, Chemistry, English/Foreign language, Literature and Astronomy.

2.3.1 Big Five. The Big Five Inventory (BFI; John & Srivastava, 1999) is a 44-item questionnaire measuring the Big Five personality traits. These correspond to Agreeableness, Conscientiousness, Extraversion, Neuroticism and Openness to experience. This measure consists of short statements rated by participants on a Likert scale ranging from 1 (*strongly*

disagree) to 5 (*strongly agree*). Nine items assess Agreeableness (e.g., “*I see myself as someone who is helpful and unselfish with others*”); nine assess Conscientiousness (e.g., “*I see myself as someone who is a reliable worker*”); eight items assess Extraversion (e.g., “*I see myself as someone who is talkative*”); eight items assess Neuroticism (e.g., “*I see myself as someone who is depressed, blue*”). Ten items assess Openness to experience (e.g., “*I see myself as someone who is original, comes up with new ideas*”). Scores for each scale were computed by averaging the scores of the corresponding items. The BFI has been translated and validated to Russian (Shchebetenko, 2014), with high reliability estimates (*Cronbach’s* $\alpha = .68, .79, .78, .79, .80$ for Agreeableness, Conscientiousness, Extraversion, Neuroticism and Openness to experience, respectively) (Mishkevich, 2016). Similar reliability estimates were obtained in the current study (see Table 1 above).

2.3.2 Dark Triad. The Short Dark Triad questionnaire (SD3; Jones & Paulhus, 2014) assesses the Dark Triad traits—Machiavellianism, subclinical narcissism and subclinical psychopathy—as conceptualised by Paulhus and Williams (2002). The SD3 has 27 items, 9 for each scale, and responses are given on a 5-point Likert scale, with 1 = *strongly disagree* and 5 = *strongly agree*. Example items include: “*I like to use clever manipulation to get my way*” (Machiavellianism), “*People see me as a natural leader*” (narcissism) and “*It’s true that I can be mean to others*” (psychopathy). Scores for each scale were computed by averaging the scores of the corresponding items. The questionnaire has been translated and validated to Russian with high reliability estimates ($\alpha > .70$ for all scales; Egorova, Sitnikova, & Parshikova, 2015). The current study utilised the Russian version of the scale and obtained similar reliability estimates (see Table 1).

2.3.3 Behavioral strengths and difficulties. The Strengths and Difficulties Questionnaire (SDQ; Goodman, 2001) is a 25-item behavioral screening questionnaire that assesses prosocial behavior and behavioral problems in children and adolescents (4-17 years). Specifically, the questionnaire includes five scales: hyperactivity (e.g., “*I am restless, overactive, cannot stay still for long*”), emotional problems (e.g., “*I worry a lot*”), peer problems (e.g., “*I am rather solitary, often play alone*”), conduct problems (e.g., “*I often have temper tantrums or hot tempers*”), prosocial behavior (e.g., “*I usually consider other people's feelings*”). Each scale is assessed using 5 short statements rated by participants on a Likert scale ranging from 0 (not true) to 2 (*certainly true*). Scores for each scale were computed by summing the scores of the corresponding items. A total behavioral difficulties score is computed by summing the points derived from the answers on the twenty questions for the four scales (all scales except the prosocial behavior scale). The questionnaire has high internal consistency (*mean Cronbach's $\alpha = .73$*) and test-retest reliability after 4 to 6 months (*mean $r = .62$*) (Goodman, 2001).

The current study utilized the existing 25-items version translated and validated into Russian language (Ruchkin, Koposov, & Schwab-Stone, 2007). Previous research using a Russian sample showed satisfactory reliability for most scales ($\alpha = .44$ for peer problems scale to $\alpha = .70$ for emotional problems scale) (Ruchkin et al., 2007). In the current study we used four scales as it is recommended when conducting research with low-risk samples (Goodman, Lamping, & Ploubidis, 2010): prosocial behavior; externalizing problems (this scale was computed by summing the scores of the hyperactivity and conduct problems scales); internalizing problems (this scale was computed by summing the scores of the emotional problems and peer problems scales); total behavioral difficulties.

2.3.4 School achievement. Students were asked to report their last year grades and grades on year 9 state exam in the subjects of Russian language and Maths (Algebra). These two subjects are compulsory for admission to most universities in Russia. Last year grade is a teachers' assessment of students' performance in Russian and Maths, on a scale of 2 = fail; 3 = satisfactory; 4 = good; and 5 = excellent. An average of last year grades in Russian language and Maths was used in a current study as the main measure of achievement (i.e. Achievement last year grade). For part of the analyses, we also used a composite of their state exam scores in year 9 (Achievement state exam) by averaging student-report exam scores in two subjects: Russian language and Maths. State exam is a standardized measure of students' performance as assessed during a formal examination taken at the end of year 9. State exam is a major education assessment tool with scores ranging from 0 to 70. These scores are converted into grades from 2 to 5 to match the scores of the teachers' assessment of the students (i.e. year grades). For example, state exam scores of 0-14, 15-24, 25-33, 34-39 in Russian language corresponds to grades of 2, 3, 4 and 5, respectively. In the current study, students were asked to report their state exam scores from 2 to 5. The analyses involving the measure of Achievement state exams have utilized data from 578 out of 1,191 participants since only this subsample had completed year 9 at the time of data collection.

2.4 Statistical analyses

2.4.1 Track differences. The possible effects of age and sex on personality, behavioral strengths and difficulties and achievement were tested – the alpha values were set to .05. The effects of sex and age were regressed out from all outcome measures, as suggested by Kohler and Kreuter (2012, p.278). These standardized residuals were used for all further analysis except for network analysis. Separate one-way Analysis of variance (ANOVA) models were used to test

whether educational tracks significantly predicted personality, behavioral strengths and difficulties and achievement. As the number of participants differed across groups, Levene's test was used to test for equality of variances assumption. Welch ANOVA's were used for those outcomes for which this assumption was violated.

2.4.2 Network analyses. We employed network analysis to examine the connections among adolescents' personality traits, strengths and difficulties and achievement. Networks are models that include nodes interconnected by edges. Nodes represent variables (e.g., traits) whereas edges represent pairwise relationships among nodes. Networks are typically estimated through Gaussian Graphical Model (GGM; Epskamp et al., 2018), in which edges encode conditional dependence/independence relations among nodes in the form of partial correlations. A missing edge indicates that two nodes are conditionally independent given the others. Partial correlation networks are typically estimated using a *lasso* regularization via the graphical lasso algorithm, which reduces overfitting and results in more parsimonious and replicable network models (Epskamp & Fried, 2018). GGMs can therefore be seen as parsimonious models that encode predictive relationships among a set of variables. Unlike Structural Equation Modelling (SEM) and similar techniques, GGM allow for the examination of all possible pairwise relationships among a large number of variables through a model that is both parsimonious and exploratory (Costantini, Richetin, Preti, Casini, Epskamp, & Perugini, 2019). Similar to SEM, GGM results in sparse models that include a limited number of parameters. In GGM networks, if two variables are not connected by an edge, this means that they are linearly independent conditioning on the others (Lauritzen, 1996). This makes GGM more informative than a simple correlational model (Costantini et al., 2015). However, unlike SEM, conditional independence relationships are determined using data-driven methods. Furthermore, each SEM model is

characterized by many equivalent models that fit the data equally well, thus making edge directions often undetermined (MacCallum, Wegener, Uchino, & Fabrigar, 1993), whereas each GGM is uniquely determined (Epskamp, Rhemtulla, & Borsboom, 2017).

Once a network is computed, node predictability can be used to quantify the proportion of variance of each node that is explained within the network model (Haslbeck & Waldorp, 2018). Nodes with zero predictability value cannot be predicted by the model, whereas nodes with a predictability value of 1 can be perfectly predicted. Predictability can also be seen as the upper bound estimate of the controllability of a node. If all GGM edges incident to a node indicated causal connections directed to that node, the predictability would be equal to the amount of variance of that node that could be controlled by acting on other nodes in the network (Haslbeck & Fried, 2017).

Recently, the replicability of psychological networks has been at the centre of a debate (Borsboom et al., 2017; Fried, Eidhof, Palic, Costantini, Huisman-van Dijk, Bockting, & Karstoft, 2018). For this reason, we estimated whether network estimates were sufficiently stable using bootstrap (Epskamp et al., 2018). In particular, we used the *correlation stability coefficient* (CS-coefficient), which allows assessing the stability of node-level indices such as predictability. The CS-coefficient is defined as the proportion of cases that can be dropped such that the resulting estimate correlates more than .7 with the original estimate with 95% probability in case-dropping bootstrap resamples. Cutoff values of .25 and .50 have been suggested to indicate respectively sufficient stability and good stability (Epskamp et al., 2018).

We were also interested in examining whether the relationships among personality, behavioral strengths and difficulties and achievement differed by gender and by education tracks. First, we used the *Network Comparison Test* to test whether two independently estimated GGMs

are significantly different from each other (van Borkulo et al., 2017). In particular, invariance of *network structure* is operationalized by the largest difference between two corresponding edges in the two networks (index M), and the invariance of global strength (index S), the absolute sum of all edge weights in a network (van Borkulo et al., 2017). Since comparing four tracks with one another involved performing six tests, we applied a Bonferroni correction to keep Type-I error to the nominal value. If differences in networks across groups are expected, the Fused Graphical Lasso regularization can be employed instead of the graphical lasso algorithm to jointly estimate networks in different groups. This method applies a regularization on the differences among groups, thus resulting in more accurate edge estimates (Danaher, Wang, & Witten, 2014; Costantini et al., 2019). Since the CS-coefficient is not available for networks estimated using Fused Graphical Lasso, we approximated it using the CS of the corresponding networks estimated using the graphical lasso (see also Fried et al., 2018).

Networks were estimated using the packages *bootnet* (Epskamp et al., 2018), *qgraph* (Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012; Epskamp, Costantini, Haslbeck, Cramer, Waldorp, Schmittmann, & Borsboom, 2018) and *Estimate Group Network* (Costantini & Epskamp, 2017) in the *R* statistical software package (R Core Team, 2017). The network comparison test was performed using package *Network Comparison Test* (van Borkulo, 2016).

2.4.3 Associations between personality, behavioral strengths and difficulties and achievement. Stepwise regressions were computed to explore personality as a predictor of behavioral strengths and difficulties and achievement in gifted adolescents. The Big Five traits were included as predictors of behavioral strengths and difficulties and achievement in the first step (Step 1); The Dark Triad traits were included as predictors of behavioral strengths and difficulties and achievement in the second step (Step 2); the Big Five and Dark Triad traits were

included as predictors of behavioral strengths and difficulties and achievement in the third step (Step 3).

3.0 Results

3.1 Descriptive statistics, reliabilities and covariates

Descriptive statistics and reliability estimates for all measures are presented in Table S1 for the total sample. Tables S2, S3, S4 and S5 present descriptive statistics and reliability estimates separately for the Science, Arts, Sports and Literature tracks. Kurtosis and skewness were calculated to test for normality in the distributions (*threshold was set to 1.0 for both*). Cronbach's alphas were calculated to estimate the measures' internal consistency. All variables were approximately normally distributed, with the exception of the two composite variables of achievement: Achievement last year grade and Achievement state exam. These two variables were normalized using van der Waerden's formula and the normalized scores were used in further analysis.

Age and sex were explored as potential covariates (Table S6 for the total sample and Table S7 to S11 for the tracks of Science, Arts, Sports and Literature, respectively). Age and sex were used as covariates in further analyses.

3.2 Correlations

Partial correlations (controlling for age and sex) between all study variables are presented in Table S12 (for the total sample) and in Tables S13 – S16 (for the tracks of Science, Arts, Sports and Literature, respectively).

3.3 Track differences

Significant track differences were found for most variables, with partial η^2 ranging from .02 to .56. Table S17 presents the results of the Analysis of Variance (ANOVA) post hoc tests. Means and Standard Deviations (SDs) for all variables are presented in Table 1. Figure 1, presents track differences across all measures.

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Variables	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>F/Welch (df)</i>	<i>Partial η²</i>
Agre	568	-.11	.98	215	.07	1.00	214	.40	.92	132	-.04	1.03	14.95**** (3; 1125)	.038
Cons	568	-.18	.99	215	.12	.91	214	.53	.84	132	-.07	1.05	30.60*** (3; 1125)	.075
Extr+	568	-.13	1.03	215	.09	.95	214	.48	.70	132	-.13	1.09	32.81*** (3; 406.85)	.194
Neur+	568	.00	1.03	215	.15	.99	214	-.07	.73	132	-.06	1.16	2.55 (3; 402.75)	.018
Open	568	-.15	1.06	215	.33	.93	214	-.02	.86	132	.28	.84	17.42*** (3; 421.93)	.110
Mach+	572	.04	.99	215	-.00	.95	215	.35	.84	132	-.53	1.08	22.55*** (3; 400.10)	.144
Narc+	572	-.13	1.01	215	.10	.95	215	.47	.85	132	-.13	1.00	25.35*** (3; 405.56)	.157
Psyc	572	-.07	.97	215	.08	.92	215	.52	.92	132	-.43	1.00	31.67*** (3; 1130)	.077
Pros	566	-.14	1.01	215	.13	1.00	214	.41	.88	132	-.07	.92	17.14*** (3; 1123)	.043
Exte	566	-.02	.96	215	.07	.97	214	.28	1.05	132	-.28	.99	9.98*** (3; 1123)	.025
Inte+	566	.00	.96	215	.08	1.00	214	.06	.97	132	-.12	1.15	1.19 (3; 388.46)	.009
Total BD	566	-.01	.94	215	.09	.96	214	.19	1.10	132	-.23	1.03	5.78** (3; 1123)	.015
ALY+	578	.31	.80	215	-.36	1.11	215	-.81	.93	133	.40	.64	103.20*** (3; 404.46)	.433
ASE	327	.22	.81	96	-.61	1.08	18	-1.11	1.57	109	.03	.96	29.68*** (3; 68.94)	.563

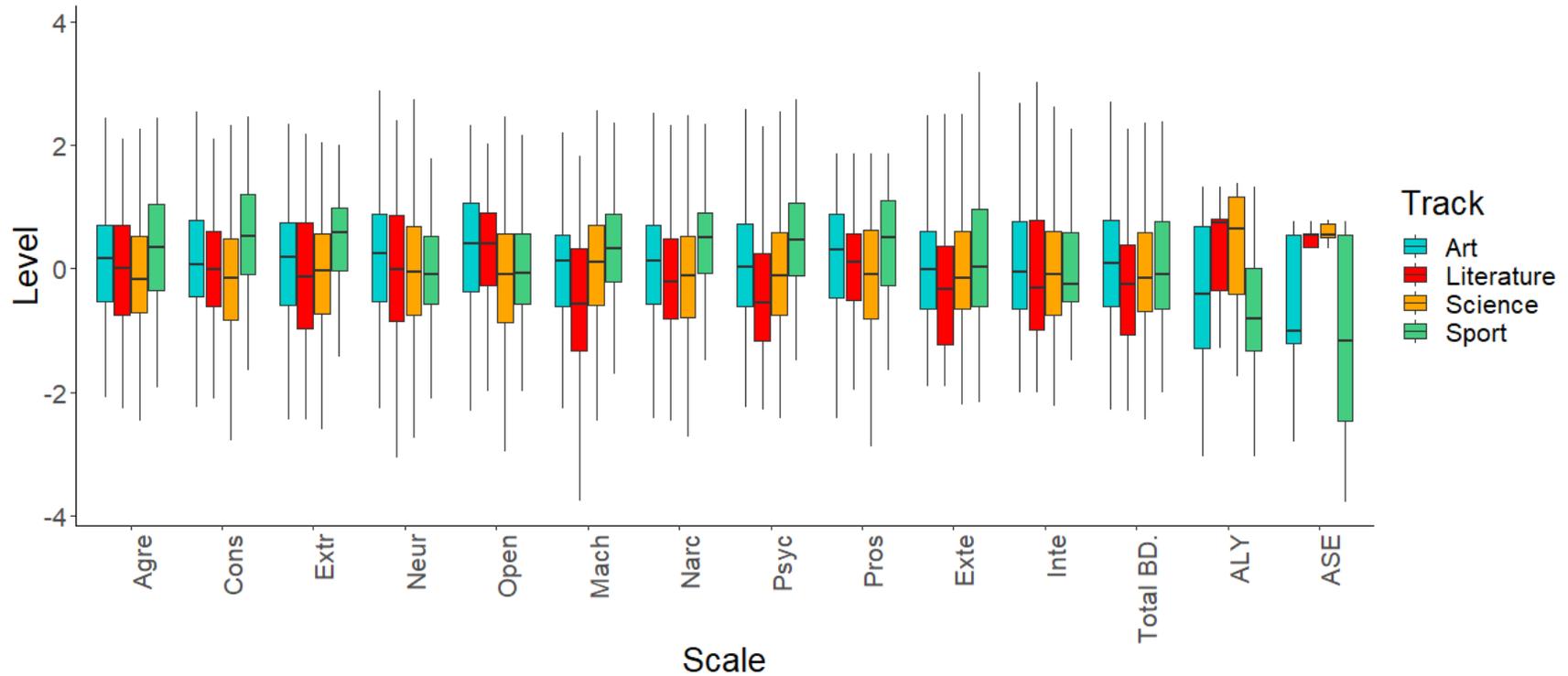
Note: * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$; Agr: Agreeableness; Cons: Conscientiousness; Extr: Extraversion; Neur: Neuroticism; Open: Openness to experience;

Mach: Machiavellianism; Narc: Narcissism; Psyc: Psychopathy; Pros: Prosocial behaviour; Exte: Externalizing problems; Inte: Internalizing problems; Total

BD: Total behavioural difficulties; ALY: Achievement last year grade; ASE: Achievement state exam; Achievement last year grade and Achievement state exam

variables have been normalized using van der Waerden's transformation to account for high skewness in the distribution. All means are in standardized residuals; Welch statistic was reported instead of F whenever Levene's test was significant (indicated by + in the first column).

Figure 1. Differences in personality, behavioural strengths and difficulties and achievement among tracks



Note: The boxplot presents five summary statistics for the corresponding scale (the median, two hinges and two whiskers). The lower and upper hinges correspond to the first and third quartiles (the 25th and 75th percentiles). The upper and lower whiskers extend from the hinges to the most extreme data points. Agr: Agreeableness; Cons: Conscientiousness; Extr: Extraversion; Neur: Neuroticism; Open: Openness to experience; Mach: Machiavellianism; Narc: Narcissism; Psyc: Psychopathy; Pros: Prosocial behavior; Exte: Externalizing problems; Inte: Internalizing problems; Total BD: Total behavioural difficulties; ALY: Achievement last year grade; ASE: Achievement state exam; all scores are in standardized residuals.

3.4 Networks of personality, behavioural strengths and difficulties and achievement

The network of Big Five, Dark Triad, behavioural strengths and difficulties and Achievement last year grade is reported in Figure 2 with corresponding network edges reported in Table 2. Gaussian Graphical Model (GGM; Epskamp, Waldorp, Möttus, & Borsboom, 2018) estimates require list-wise deletion of missing values (see method section for detail). As such, the network was estimated on 1,177 individuals. In the main analysis, reported in Figure 2, we operationalized achievement using only the last year grade, as the state exam had been taken by only 578 of the participants at the time of the study. Additional analyses were conducted to estimate a network involving both measures of achievement on a subset of 578 participants (see Figure 4 and Tables S18 and S19 in the Supplementary Material).

Table 2. Network edges (above the main diagonal) and correlations (below the main diagonal) in the overall network

	Extr	Agre	Cons	Neur	Open	Narc	Mach	Psyc	Pros	Inte	Exte	ALY
Extr		0.05	0.13	-0.19	0.13	0.34	-0.10	0.07	0.15	-0.38	0.29	0
Agre	.20***		0	-0.12	0.02	0	-0.17	-0.33	0.45	-0.02	-0.09	0
Cons	.29***	.30***		-0.08	0.06	0.21	0.02	-0.05	0.10	0.08	-0.44	0
Neur	-.43***	-.25***	-.34***		0.13	0	-0.08	0	0.11	0.40	0.16	0.12
Open	.30***	.18***	.21***	.03		0.21	-0.02	-0.03	0.17	0.03	0	0.10
Narc	.54***	-.03	.30***	-.22***	.33***		0.24	0.19	0	-0.05	0.03	0
Mach	-.04	-.41***	-.05	.02	-.04	.28***		0.24	-0.06	0.07	-0.05	0
Psyc	.10**	-.55***	-.24***	.13***	-.05	.29***	.45***		0	0	0.26	-0.10
Pros	.26***	.58***	.27***	-.05	.31***	.08**	-.27***	-.28***		0.07	0.02	-0.02
Inte	-.55***	-.26***	-.29***	.63***	-.07*	-.29***	.11***	.14***	-.10***		0.26	0
Exte	.02	-.39***	-.53***	.38***	-.02	.04	.15***	.49***	-.15***	.38***		-0.12
ALY	-.06	.09**	.09**	.09**	.13***	-.03	-.06*	-.19***	.05	.02	-.18***	0

Note. * $p < .05$, ** $p < .01$, *** $p < .001$; *Extr:* Extraversion; *Agr:* Agreeableness; *Cons:* Conscientiousness; *Neur:* Neuroticism; *Open:* Openness to Experience; *Narc:* Narcissism; *Mach:* Machiavellianism; *Psyc:* Psychopathy; *Pros:* Prosocial behavior; *Inte:* Internalizing problems; *Exte:* Externalizing problems; *ALY:* Achievement last year grade.

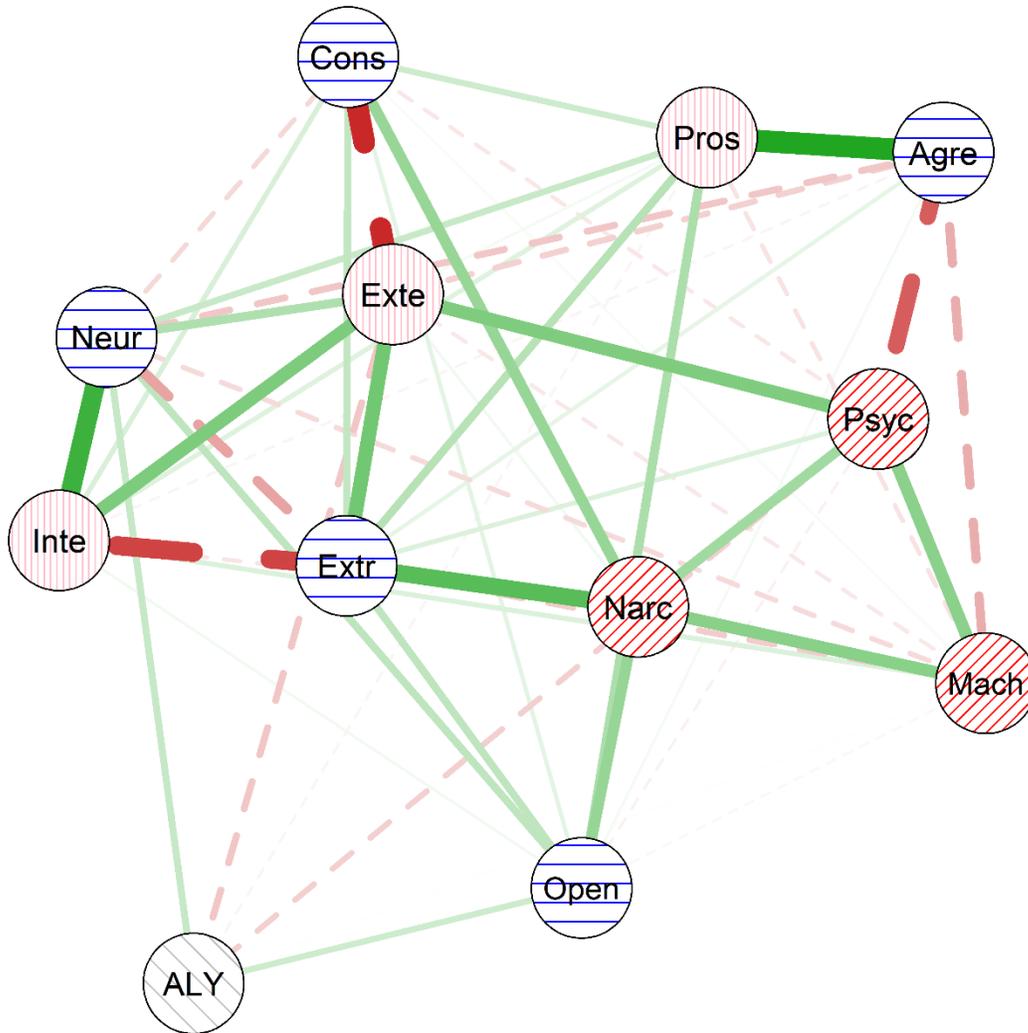


Figure 2. Network of personality, behavioural strengths and difficulties and Achievement last year grade in the overall sample; Agr: Agreeableness; Cons: Conscientiousness; Extr: Extraversion; Neur: Neuroticism; Open: Openness to experience; Mach: Machiavellianism; Narc: Narcissism; Psyc: Psychopathy; Pros: Prosocial behaviour; Exte: Externalizing problems; Inte: Internalizing problems; ALY: Achievement last year grade. Green lines indicate positive connections; red lines indicate negative connections; the thickness of the lines represent the strength of the connection.

The predictability of each node (Haslbeck & Fried, 2017; Haslbeck & Waldorp, 2018) is reported in the first column of Table 3. The correlation stability coefficient for predictability was .90 (Epskamp, Borsboom, & Fried, 2018), indicating that even when 90% of the sample was randomly dropped, the predictability values had a 95% probability to show a correlation with the original values of at least .70, thus confirming the accuracy of the predictability index in the overall network.

Table 3. Predictability of personality, behavioural strengths and difficulties, and achievement last year exam for all tracks, the sports track and for all tracks other than sports.

node	Science, Art, & Literature Tracks		
	All 4 tracks	Sports track	
Agre	.55	.46	.49
Cons	.44	.43	.35
Extr	.58	.46	.49
Neur	.49	.44	.43
Open	.24	.15	.21
Mach	.32	.19	.26
Narc	.47	.28	.41
Psyc	.51	.41	.45
Pros	.42	.25	.38
Exte	.55	.61	.44

Inte	.56	.55	.49
ALY	.09	.06	.04

Agr: Agreeableness; Cons: Conscientiousness; Extr: Extraversion; Neur: Neuroticism; Open: Openness to experience; Mach: Machiavellianism; Narc: Narcissism; Psyc: Psychopathy; Pros: Prosocial behavior; Exte: Externalizing problems; Inte: Internalizing problems; ALY: Achievement last year grade. The results for the Sports track are presented separately because the Sports track network showed different structure to all other networks.

Dark Triad traits were positively connected with each other in the network but showed different connections to the Big Five. Narcissism was positively connected to Extraversion and Conscientiousness, whereas Machiavellianism and psychopathy were negatively connected to Agreeableness. Externalizing and internalizing problems were both connected to Neuroticism, but they showed differential connections with Extraversion and Conscientiousness: Externalizing problems were positively connected to Extraversion and negatively to Conscientiousness, whereas internalizing problems were positively connected to Conscientiousness and negatively to Extraversion. Externalizing problems were also positively connected to psychopathy. Achievement last year grade was positively connected to Openness and Neuroticism, and negatively to externalizing problems and psychopathy. The most predictable node was Extraversion. Internalizing and externalizing problems ranked third and fourth in predictability, with more than half of their variance being modelled within the network. In contrast, Achievement last year grade had the lowest predictability, 9%.

The Network Comparison Test (NCT; van Borkulo, Boschloo, Kossakowski, Tio, Schoevers, Borsboom, & Waldorp, 2017) employs a permutation procedure to test whether two networks are significantly different in terms of their structure, operationalized by the maximum

absolute difference between two corresponding edges (M), and in terms of global strength, which is the sum of all absolute edge weights in a network (S). Using the NCT, we inspected whether the network structure was different in males and females and in different tracks. The results showed that network connections were not significantly affected by sex, both in the structure ($M = .14, p = .18$) and in global strength ($S = .93, p = .23$). We performed six pairwise comparisons among the four track networks, using a Bonferroni correction. The NCT revealed that the sports track was significantly different from all other tracks. In particular, the sports track network had a different structure compared to the science ($M = .29, p = .016$), arts ($M = .38, p = .001$) and literature ($M = .44, p < .001$) tracks. Furthermore, the sports track differed significantly in network density compared to the science ($S = 2.83, p = .029$) and the arts tracks ($S = 2.42, p = .010$). No other significant differences among tracks emerged.

We further investigated this result by estimating two networks, one involving adolescents in the sports track and the other including all other participants, using a Fused Graphical Lasso regularization. The resulting networks are reported in Figures 3A-B; predictability is reported in the last two columns of Table 3. The corresponding network edges are reported in Tables S18 and S19 in the supplementary material.

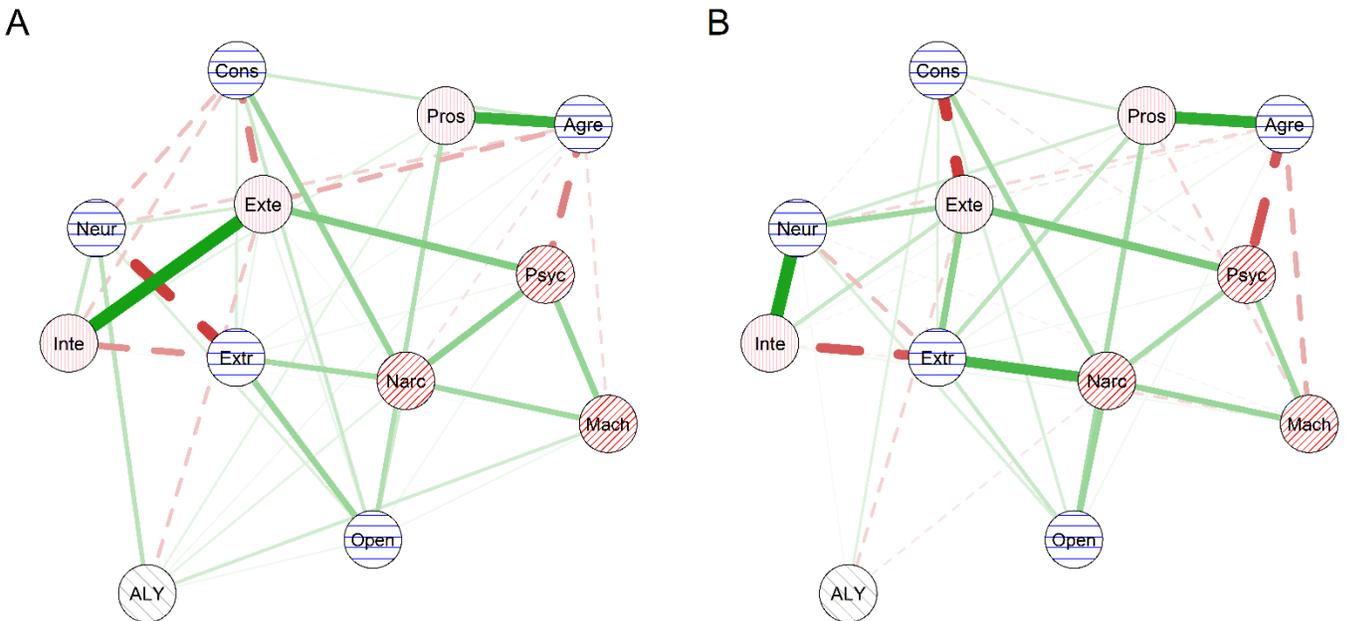


Figure 3. Networks of personality, behavioral strengths and difficulties and Achievement last year grade estimated in the sports track (A) and in the Art, Literature and Science tracks (B); Agr: Agreeableness; Cons: Conscientiousness; Extr: Extraversion; Neur: Neuroticism; Open: Openness to experience; Mach: Machiavellianism; Narc: Narcissism; Psyc: Psychopathy; Pros: Prosocial behavior; Exte: Externalizing problems; Inte: Internalizing problems; ALY: Achievement last year grade.

The CS-coefficients indicated that predictability estimates were highly stable both in the sports track network ($CS = .60$) and in the network of the other tracks ($CS = .90$). Additional analyses were conducted to estimate a network involving both measures of Achievement (last year grade and exam grade). The resulting network is reported in Figure 4 and in Table S20. The predictability indices are reported in Table S21. The CS coefficient indicated that predictability was very stable also in this subsample ($CS = .85$). The Achievement state exam and the Achievement last year grade were strongly connected to each other. Among them, the

Achievement last-year grade had a predictability of .19, which was slightly larger than that of the state exam grade .15.

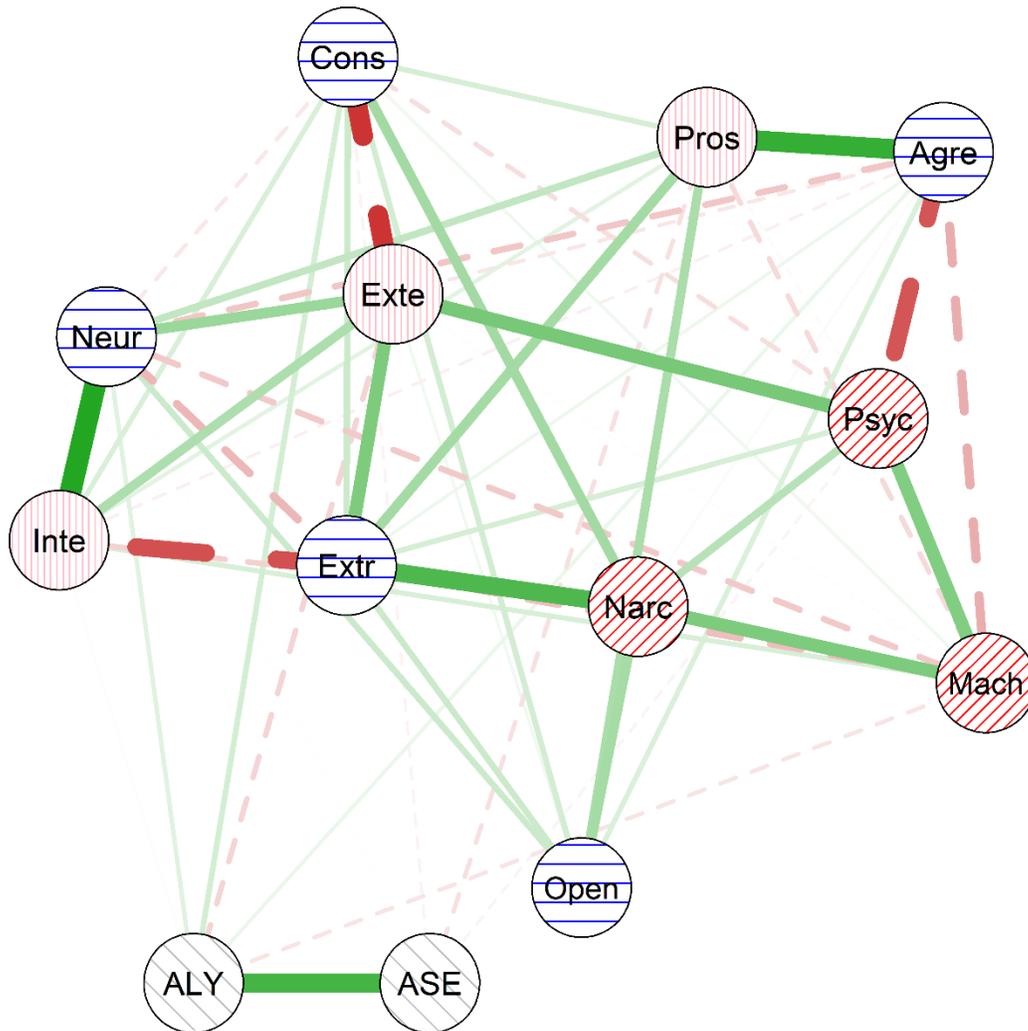


Figure 4. Network including two measures of school achievement. ALY: Achievement last year grade; ASE: Achievement state exam; Agr: Agreeableness; Cons: Conscientiousness; Extr: Extraversion; Neur: Neuroticism; Open: Openness to experience; Mach: Machiavellianism;

Narc: Narcissism; Psyc: Psychopathy; Pros: Prosocial behavior; Exte: Externalizing problems; Inte: Internalizing problems.

3.5 Personality as a predictor of behavioral strengths and difficulties and Achievement

The results of the stepwise regression models are presented in Table 4. At Step 1 the Big Five traits predicted 44%, 38%, 42%, 27% of the variance in prosocial behavior, externalizing problems, internalizing problems and total behavioral difficulties, respectively. In contrast, the Big Five predicted only 1% of the variance in Achievement last year grade in the total sample ($N = 1,191$) and did not predict Achievement state exam ($N = 578$).

At Step 2, Dark Triad traits predicted 8%, 29%, 18% and 51% of the variance in prosocial behavior, externalizing problems, internalizing problems and total behavioral difficulties, respectively. The Dark Triad predicted 6% of the variance in Achievement last year grade in the total sample ($N = 1,191$) and did not predict Achievement state exam ($N = 578$).

At Step 3, Big Five and Dark Triad traits together predicted 44%, 49%, 48% and 51% of the variance in prosocial behavior, externalizing problems, internalizing problems and total behavioral difficulties, respectively. Big Five and Dark Triad traits together explained 8% of variance in Achievement last year grade in the total sample ($N = 1,191$) and did not predict Achievement state exam ($N = 578$).

Table 4. Stepwise regression analysis exploring personality as a predictor of strengths and difficulties and achievement of gifted adolescents

	Pros	Exte	Inte	Total BD	ALY	ASE
Step 1						
Agre	.51***	-.10***	-.25***	-.05*	-.03	.01
Cons	.10***	-.35***	.04	-.17***	.04	.06
Extr	.17***	.43***	-.25***	.08**	-.13***	-.06
Neur	.14***	.43***	.54***	.58***	-.08*	.02
Open	.10***	.01	.04	.03	.01	.01
R^2	.44	.38	.42	.27	.01	.01
F	177.84***	137.75***	163.37***	152.86***	3.89***	1.41
Step 2						
Mach	-.07*	.00	.24***	.15***	.03*	.02
Narc	.28***	-.06*	-.35***	-.26***	-.01*	-.02
Psyc	-.17***	.55***	.25***	.46***	-.26	-.11*
R^2	.08	.29	.18	.51	.06	.01
F	34.73***	155.72***	85.42***	139.27***	25.81***	2.07
Step 3						
Agre	.51***	.04	.10***	.04	-.14***	-.03
Cons	.12***	-.35***	.04	-.35***	.02	.03
Extr	.18***	.28***	-.30***	.28***	-.02	-.04
Neur	.14***	.32***	.47***	.32***	-.00	.04
Open	.11***	.00	.04	.00	.02	-.06
Mach	-.02	.05*	.14**	.05*	.01	.00
Narc	-.03	.00	-.08**	.00	.02	.03
Psyc	.01	.36***	.19***	.36***	-.30***	-.12*
R^2	.44	.49	.48	.51	.08	.02
F	111.44***	138.60***	129.11***	149.83***	12.40***	1.17

Note. * $p < .05$, ** $p < .01$, *** $p < .001$; Agr: Agreeableness; Cons: Conscientiousness; Extr:

Extraversion; Neur: Neuroticism; Open: Openness to experience; Mach: Machiavellianism; Narc:

Narcissism; Psyc: Psychopathy; Pros: Prosocial behavior; Exte: Externalizing problems; Inte:

Internalizing problems; Total BD: Total behavioral difficulties; ALY: Achievement last year grade; ASE: Achievement state exam; Achievement last year grade and Achievement state exam variables have been normalized using van der Waerden's transformation to account for high skewness in the distribution. The sample size when testing the association between personality and ASE is $N = 550$ as opposed to 1,191 participants for all other analyses.

4.0 Discussion

The current study explored and directly compared personality traits that influence behavioral strengths and difficulties and achievement in four groups (tracks) of adolescents selected for high achievement in *Science, Arts, Sports or Literature*.

Correlation analyses indicated that personality traits shared a larger amount of variance with behavioral strengths and difficulties than with measures of achievement. One explanation for the overlap between personality measures and behavioral strengths and difficulties might be that measures used to assess them partly tap into similar constructs. In addition, at least in selected samples, personality may influence achievement through its shared variance with behavioral strengths and difficulties. For example, narcissism correlated negatively with behavioral difficulties but did not significantly correlate with achievement. At the same time, achievement was correlated negatively with behavioral difficulties. We plan to explore this hypothesis further utilizing mediation analyses.

Further evidence for complex interrelationships among the traits is that narcissism correlated positively with Extraversion and Openness to experience and negatively with Neuroticism and internalizing problems. Machiavellianism and subclinical psychopathy showed a different pattern of positive correlations mainly with externalizing behavioral problems and

negative correlations with Conscientiousness and Agreeableness. These findings suggest that narcissism may be protecting against internalizing problems (see also Papageorgiou, Denovan, & Dagnall, 2019). However, when personality was modelled as a network, narcissism was not connected to any type of behavioral problem. Instead, narcissism showed positive connections with prosocial traits such as prosocial behavior, Extraversion and Conscientiousness, as well as with the other two Dark Traits. These results and the position of narcissism in the network confirms previous findings in unselected samples (see Papageorgiou et al., 2018; Papageorgiou et al., 2019) suggesting that narcissism might act as a bridge between the prosocial and dark side of personality having the potential to influence outcomes for better or for worse.

Analyses on track differences showed that the sports track was significantly different from other tracks for most variables. Specifically, individuals in the sports track scored higher than individuals on other tracks in prosocial traits (e.g. prosocial behavior, Extraversion and Agreeableness) but also in the Dark Triad traits and externalizing problems. In addition, adolescents in the sports track also scored lower in achievement. These findings require further exploration because they seem to suggest that adolescents, who are gifted in sports, exhibit more extreme behaviors and manifestations of normal personality traits across the spectrum of prosociality – dark traits. This finding is consistent with recent perspectives on personality research, which suggest that extreme standing on “desirable” trait continua translates into maladaptive behavior and undesirable outcomes (see Carter, Miller, & Widiger, 2018).

Network analyses facilitated identifying the structure of personality, behavioral strengths and difficulties and achievement across the four tracks. Compared with other tracks, for the sports track, Extraversion had a stronger negative connection with Neuroticism and weaker positive connections with externalizing problems and narcissism. This suggests that Extraversion

might play a more beneficial role in the personality networks of young athletes than for other individuals in terms of reducing behavioural problems; but at the same time, it could affect negatively their achievement. Second, in the sports track, externalizing and internalizing problems had stronger connection with each other than in the other tracks, reflected in higher predictability within the sports track compared to other tracks. This might indicate that young athletes tend to experience either both types of behavioral difficulties or neither; whereas other gifted individuals are more likely to experience more specific types of difficulties. Furthermore, in the sports track externalizing problems were less connected to Conscientiousness and Neuroticism and more connected to Agreeableness than in the other tracks. This finding suggests that each personality trait may have a differential impact on externalizing problems in different samples. As such, increasing Agreeableness in elite athletes may have a stronger positive impact on reducing externalizing behavioral problems as compared to other types of gifted population. In the current sample, many of the athletes were hockey players that necessitate high levels of cooperation and teamwork. Finally, internalizing problems were directly negatively connected to Conscientiousness only in the sports track, suggesting that Conscientiousness might act as a protective factor for internalizing problems for athletes but not for other groups of gifted adolescents.

In terms of achievement, network analyses showed that teacher-rated school achievement, might be more influenced by personality than the objective performance measured by a standardized exam. Unlike Achievement state exam, greater Achievement last year grade was associated with higher Conscientiousness and Agreeableness; lower Machiavellianism and fewer externalizing problems – traits that may have particular interpersonal relevance. Achievement last year grades, but not Achievement state exam, also showed a positive

connection with Neuroticism and a weak positive connection with internalizing problems. Consistent with results of several previous studies (e.g. Wang et al., 2014), this finding hints to the idea that a degree of anxiety (see high neuroticism) may be positive in terms of achieving higher grades and requires further exploration in order to identify optimum levels of these characteristics for increasing academic outcomes. Furthermore, together these results suggest that teacher ratings might reflect some conscious or unconscious biases, such as judging more leniently students that they perceive as more focused on school tasks, who are well behaved in interpersonal contexts and who are more emotionally fragile. This is indirectly supported by another study (Gibb, Fergusson, & Horwood, 2008) that showed reduced sex differences in achievement once teacher-reported behavioral problems were controlled for (males were rated more inattentive, restless and distractible than females). In contrast, performance in state exam was mostly disconnected from personality traits, the only connections being with lower prosocial behavior, psychopathy and Conscientiousness, although the last two connections were very weak.

Stepwise regression analyses showed that both the Big Five and the Dark Triad together explained almost half of the variation in behavioral strengths and difficulties. In contrast, the Big Five explained only a very small portion of the variance in achievement in gifted adolescents: even Conscientiousness, the most robustly linked to achievement (of the Big Five; O'Connor et al., 2007; Furnham et al., 2009) was not associated significantly with either Achievement last year grades or Achievement state exams in our study. The Dark Triad explained a small but considerably larger (as compared to the Big Five) amount of variation in Achievement last year grades (6%). Similarly, to network analyses, the regression models, indicated that Achievement state exam was mainly unaffected by personality. The interpretation of these results is limited by

the fact that Achievement state exam grade was available for only approximately half of the sample (i.e. those individuals that had completed year 9 state exams at the time of testing, $N = 578$). The lack of significant associations between personality and Achievement state exam may have resulted from reduced power to find weak effects. Another potential limitation is that the grading scale used in the schools is too crude to capture most of the variation in achievement. Further research is needed to test whether teachers' perception of the students' personality influence their evaluation of the students' performance, and whether this may differ depending on specific grading systems used in different educational systems.

In conclusion, the present study was first to utilize network analyses in gifted adolescents; the findings provide new insights into the role of personality and behavioral strengths and difficulties in gifted adolescents' performance. The results provided quantitative evidence of differences and similarities across the four tracks in the structure of personality and its interconnections with behavioral strengths and difficulties and achievement. The study with high achieving adolescents supported some recent findings with unselected samples, such as the possible role of narcissism as the bridge between the prosocial and dark side of personality (see Papageorgiou et al., 2019). Narcissism was the only trait (of the Dark Triad) to correlate negatively with internalizing problems, potentially protecting against negative effects of these problems on achievement (Ansary & Luthar, 2009). This indicates that, under some circumstances narcissism may neutralise the influence of dark personality traits on prosocial behavior and behavioral difficulties - boosting performance in selected and unselected samples. The results of the study also suggest that personality traits may play a role as resilience factors against behavioral difficulties - boosting performance indirectly. We plan to use mediation models for gaining further understanding of the pathways through which personality affects

achievement through behavioral strengths and difficulties. We also plan to directly compare selected and unselected samples further subdividing tracks into more homogeneous groups e.g. hockey vs. chess players – once adequate samples reached in the ongoing study.

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