Personality and Vocabulary IQ: Predicting Verbal Ability from Personality traits in Adolescence

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Predicting Verbal Ability from Personality traits in adolescence

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Abstract

General intelligence is often viewed as a composite of subdomains, one of which is verbal ability. Studies suggest that verbal ability impacts the development of personality, and as development in verbal ability plateaus in adolescence, this age group is particularly interesting for studying the relationship between verbal ability and personality. This exploratory study investigates the relationship between personality traits and Vocabulary Intelligence Quotient (VIQ) among adolescents between 13–18 years old (n = 1710). Employing Exploratory Structural Equation Modeling and Multiple Linear Regression on data from the Open-source Psychometrics Project, (https://openpsychometrics.org/_rawdata/, data last updated 13/3/2018), the study identified personality factors and examined their predictive power on VIQ. Results for all included respondents (ages 13 to 18), early adolescents (ages 13 to 16) and late adolescents (ages 17 to 18) showed that models with 7 to 8 factors were the most adequate for encapsulating adolescents' personalities. As expected, Regression analysis showed that age positively correlated with VIQ, along with Quirkiness, Curiosity, Ambitiousness, Openness, Belief, and Adaptability. Notable differences were found in the significance of various personality traits as predictors of VIQ between the early adolescents (n = 804), late adolescents (n = 906), and the total sample, supporting the hypothesis of personality maturation and the emergence of new personality traits in adolescents as they develop. These findings highlight age-related variations in the relationship between personality expression and VIQ, and underscore the importance of considering diverse personality traits in predicting verbal ability. This study contributes to understanding adolescent personality development and its implications for vocabulary intelligence.

Layman's Abstract

The study looked at the relationship between personality and vocabulary in 1710 adolescents between the ages of 13 years old and 18 years old. The research identified personality traits from responses to an online questionnaire. After identifying personality traits in the responses, the research attempted to answer whether these personality traits would be good at predicting performance in a vocabulary intelligence task. The identified personality traits were used to evaluate differences between early and late adolescence. Findings showed that age had influenced vocabulary intelligence along with Quirkiness, Curiosity, Ambitiousness, Openness, Belief, and Adaptability in early adolescents and Quirkiness, Critical Thinking, Curiosity, and Leadership in late adolescence. The research shows meaningful differences in personality traits throughout adolescence. In the total sample (adolescents between ages 13 and 18 years old), higher scores in Curiosity, Ambitiousness, and Adaptability predicted higher vocabulary intelligence.

Introduction

Spearman (1904), posited that general intelligence was the primary underlying factor that explained why people perform better across different cognitive domains, observing that good performance in one of these domains often correlated with good performance in other cognitive domains. In the framework of Cattell-Horn-Carroll theory, general intelligence is observed as an amalgam of subdomains (Schneider, & McGrew, 2018). One of these subdomains, Verbal Ability (for the purpose of this study used interchangeably with Vocabulary Intelligence (VIQ) has been found to be important for academic performance (Rohde, & Thompson, 2007). Prior research has found that development in verbal ability plateaus in adolescence, between 12 and 14 years old (Ricketts, et al., 2020). While there is limited research specifically on the vocabulary development of mid-to-late adolescents, a possible explanation for this developmental pattern can be derived from neuroscience. Adolescence comes with significant brain development in the prefrontal cortex, supporting the development of social skills and verbal ability. As adolescents become more exposed to social situations over time, they are able to practice and expand on their verbal abilities (Konrad, et al., 2013).

Personality is defined as characteristic patterns of thoughts, feelings and behaviors (Diener, & Lucas, 2019). The Big Five Aspect Scale (BFAS) is a commonly used tool for mapping out personality using five distinct domains: Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism (De Young, et al., 2014). BFAS has been found to be a useful tool in adolescent populations in at least one study (using the NEO PI-R Inventory) with a sample of 469 adolescents between 12 years old and 17 years old to compare personality consistency with what is known about the young adult population's personalities (De Fruyt et al., 2000). However, according to Hill and Edmonds (2017), there are concerns regarding the lack of attention surrounding self-reported personality in adolescents, despite the significant attention given to personality inventories such as the Hierarchical Personality Inventory for Children (HiPIC) and BFAS.

Within the adolescent population, studies have found increased agreeableness and mixed results for extraversion and openness between early (average age of 12.4 years old) and late adolescence (average age of 16.4 years old) (Allik, et al., 2004; Klimstra, et al., 2009). Studies have found significant differences in personality as people age, suggesting that on average people become more agreeable and conscientious over time (Costa, & McCrae, 1976; Allemand, et al., 2008). This difference in personality across stages of development is hypothesized to be due to personality maturation, a process whereby personality traits change as people develop (Klimstra, et al., 2009). A study by Allik et al. (2004) using Exploratory Structural Equation Modeling (ESEM) explored personality trait structure in 2,560 Estonian adolescents between the ages of 12 to 18 years old and

found that a five factor personality structure was recognizable in the children throughout the sample. The researchers found no evidence for additional factors other than those that make up BFAS, stating that by the time that respondents were 14–15 years old, the personality factor structure was indistinguishable from that of adults. A key finding from this study provided evidence for the differentiation hypothesis, finding that as the mental capacities of adolescents develop, the correlation between personality factors and intelligence becomes weaker. In contrast to other research (Costa, & McCrae, 1976; Allemand, et al., 2008), Allik et al. (2004) found that Openness increased throughout adolescence and that Agreeableness and Conscientiousness decreased throughout adolescent development. Research from Brandt et al. (2020) also used ESEM to explore personality factor structure across ages from 11 to 84 years old and appeared to corroborate the finding that factors from BFAS are applicable to adolescents from late childhood onward (defined in the study as 11 years of age and older) These findings signal the need for further investigation as there is a lack of consensus in the literature concerning the maturation and breadth of personality traits throughout adolescence (Hill, & Edmonds, 2017).

VIQ has been suggested to impact the development of personality and findings from research have found a relationship between verbal intelligence and openness (De Young, et al., 2014), however the development of the relationship between VIQ and personality over the course of adolescence is insufficiently researched. Studies have shown that specific personality traits such as Conscientiousness and Openness-to-experience could have an effect on educational achievement, but it is unknown what the impact is on verbal ability (Caspi et al., 2005). Harris et al. (2005) administered the Multidimensional Aptitude Battery as a measure of intelligence, which included a vocabulary subtest, in addition to the personality research form on a sample of 516 adult participants. The research did not focus on the relationship between personality and the vocabulary scores. It is not known if the differentiation hypothesis of personality is applicable to VIQ or only to general IQ, however Detterman and Daniel (1989) had found that vocabulary had a high factor loading on general intelligence (as measured using the WAIS and WISC-R) suggesting the hypothesis' applicability.

Research objective(s) & Implications

The present study is exploratory in nature, with the aim of gaining a better understanding of the relationship between personality and VIQ within adolescents between 13 and 18 years old. The study focused on two principal objectives. The first objective is to identify personality factors that can be grouped from a personality questionnaire. Secondly, the study explored the relationship between personality and VIQ in this total adolescent sample, as well as the development of this relationship across two age groups: early adolescence (ages 13 to 16 years old) and late adolescence (ages 17 to 18

years old). Inspecting differences in the association between personality and VIQ from early to late adolescence could give a better understanding of how the development of adolescents' verbal ability may be influenced by their personalities.

Findings from this study may show that personality could relate to a subdomain of intelligence. In doing so, this study deepens our understanding of the relationship between VIQ and personality, as well as the development of this relationship over time.

Hypothesis/hypotheses

Personality items in the present study do not provide an existing personality framework such as the BFAS or HiPIC with which to assess the personality traits of respondents. A directional hypothesis could therefore not be formed a priori in regard to the relationship between personality and VIQ, as the personality factors have not yet been explored. Based on the current literature and available data, the following hypotheses were formulated:

Hypothesis 1: Different age ranges within adolescence will exhibit different personality traits, consistent with personality maturation (Costa, & McCrae, 1976; Allemand, et al., 2008). These personality traits were investigated using ESEM to identify factors which were labeled based on the content of the items that the factor consisted of.

Hypothesis 2: Personality factors determined through Exploratory Structural Equation Modeling will be significant predictors of VIQ (Francis, et al., 2018). This hypothesis was investigated using Multiple Linear Regression following the identification of personality factors.

Methods

Design

The design of the present study was cross-sectional, using responses submitted to the Open-Source Psychometrics Project by respondents at a single time point, and compared responses between respondents to explore relationships between personality and VIQ across age.

Participants

Respondents were not directly screened for this research, but rather were gathered through the Open-source Psychometrics Project, (https://openpsychometrics.org/_rawdata/, data last updated 13/3/2018), using data collected between July 2017 and March 2018. Respondents were asked for consent to record and use their VIQ test responses for research before answering personality questions. Responses of those who did not consent were removed. All data was anonymous.

While under some definitions adolescence could be defined as including young people up to the age of 24 years old (Sawyer, et al., 2018), the sample of interest for this study was adolescents between the ages of 13 and 18 to gain an adequate understanding of the variables chosen in this study for respondents likely involved in educational systems (e.g., high school). Moreover, the lowest age included in the original dataset was 13 years old, preventing the inclusion of respondents from age 10 to 12 years old.

Respondents not meeting the age criteria or not having completed all the questions relating to VIQ and personality were excluded from the analysis. The study's sample included respondents within the ages mentioned, across 74 countries. The total number of respondents meeting the inclusion criteria was 1710, 21 of which did not fill in a gender, 626 identified as male, 975 identified as female and 88 identified as other. Of the total number of respondents meeting the inclusion criteria, 1209 were English native speakers, 495 were not, and an additional six did not respond to this question.

Measures

The variable of VIQ was determined using the full score of respondents on the VIQ test used in the Open-Source Psychometrics Project's dataset. Personality factors were identified, through ESEM, from the responses to personality questions from a personality questionnaire that was presented to respondents after completing the main task of VIQ. Respondents completed a test consisting of 45 questions that were used to determine VIQ, 30 questions regarding personality and several questions about the respondents' demographic information. Respondents' responses to the 45 VIQ questions were used to compose an overall score per participant. The overall score is the number of correct responses, with a 0.35 point penalty for each incorrect answer and one point awarded per correct answer. The overall score is calculated in the dataset under the variable score_full.

Multiple linear regression was used to determine if the personality factors identified from exploratory structural equation modeling are predictive of VIQ.

Procedure

Respondents who took part were given a short introduction regarding vocabulary intelligence and intelligence quotients, as well as possible limitations of VIQ. The procedure consisted of 45 (VIQ) questions, each question consisted of five words, two of which shared the same meaning. The respondents were tasked with checking the boxes of the two words per question, which could be synonymous. Respondents were warned that they would be penalized for getting answers wrong and to select an additional option "I don't know" if they did not know the correct answer. Upon completion of this section, the respondents were asked whether they made their best effort, whether their data could be stored for research purposes and whether they would be willing to answer

additional questions which are suggested to take three to five minutes to answer. If the participant opted to not answer additional questions, the research ended and their responses were not recorded in the dataset. If the participant agreed to continue answering questions, they were given 30 statements relating to personality. These personality questions were answered on a 5-point Likert scale ranging from disagree to agree and with a neutral option in the center (1=Disagree, 5=Agree). Respondents who did not respond to an item were scored a 0 for the item.

Below the personality questions, the respondents were additionally asked about their highest completed education, what type of area they lived in as children (Urban, Suburban or Rural), their gender, age, and whether English was the participant's native language. Upon completion, the participant was shown a Vocabulary IQ score along a normal distribution curve.

Ethics

The student did not have an active role in obtaining ethics approval, as that was completed by the research Supervisor. The CEP number of the request was V1-5058, and it was approved by the ethics committee on 04-11-2023.

Statistical analyses

The present research used exploratory structural equation modeling (ESEM), to establish an understanding of the potential multidimensional relationship between different personality traits and VIQ. Specifically, ESEM, a technique used to examine and specify complex relationships between observed and latent variables, was used on the individual personality items to extract one or more meaningful factors, which were used to group the personality items to subsequently create average personality scores for each trait to include in the multiple regression analysis.

The ESEM performed on the personality indicators followed the methodology outlined by Marsh et al. (2014) to clarify factor structure, and was assessed using traditional fit indices. The Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) were calculated for model selection, with a lower value being preferable, indicating a simpler model and avoiding overfitting (Wagenmakers, & Farrell, 2004; Vrieze, 2012).

The ESEM used Maximum Likelihood for estimating the parameters of a model. The rotation method applied was Geomin Oblique to make factor loadings more interpretable and allow the factors to be correlated. The epsilon parameter for the Geomin rotation was set to 0.001, controlling the level of simplicity in the rotation, and Generalized Procrustes Analysis was used as the rotation algorithm with 30 restarts, attempting to find the best solution by trying 30 different starting points to improve consistency. The standardized metric option was set to TRUE, standardizing the data prior to

conducting the analysis. No row weights were applied in the analysis, and each observation in the data was treated equally.

The overall model fit was assessed using the root mean square error of approximation (RMSEA), where a value of 0.06 or lower would be taken as a good fit. The comparative fit index (CFI) was also used to determine goodness-of-fit with 0.95 or higher defined as good fit (Hu, & Bentler, 1999). Chi-square was also inspected for the different models to evaluate the fit and test for significance at the 0.05 level.

ESEM was conducted on the total participant sample as well as in two groups divided by the median age reflecting early-adolescence and late adolescence. By splitting the dataset into these groups the research addresses Simpson's paradox which, briefly explained, posits that trends can be found in a sample that are reversed or disappear when groups are combined (Blyth, 1972). This creates groups of respondents aged 13-16 years old (n=804) and 17-18 years old (n=906). ESEM was used on each age group to identify whether there are differences in the factor structure of personality across the two age groups. The ESEM was carried out from one factor to 10 factors for each age group to evaluate which model best explains the data. The winning model was selected by first ensuring that there was a good model fit using RMSEA, CFI and Chi-square and then later comparing AIC and BIC to opt for the simplest acceptable model. The most parsimonious model was selected as the winning model. In the case that AIC and BIC were mismatched in the selection of a model, a preference was given for a lower BIC as differences in BIC of over 10 indicate significant improvement in model fit (Raftery, 1995 as cited in Booth, & Hughes, 2014). For the ESEM, factors were free to be correlated with other factors and variables were free to load onto multiple factors. The highest correlation for each item was used to match variables to factors. In the case that there were cross-loadings, the highest correlation was used to group the variable. The content of the items was then used to produce the labels (personality traits).

Multiple Linear Regression (MLR) is a statistical method for modeling the relationship between a dependent and multiple independent variables. MLR was employed to see if personality factors can be predictive of VIQ. Once the winning model was identified with ESEM, the raw scores from each factor were averaged to create a composite score to represent that factor. The composite scores were then used to predict VIQ using MLR. (measured by the variable score_full). The assumption of multicollinearity was tested using variance inflation factor (VIF), with a value of 10 or lower being acceptable (Lavery et al., 2019). Linearity will be tested graphically using a scatter plot to ensure that all assumptions are met for MLR. Strengths of predictors were evaluated using R^2, adjusted R^2 and Beta coefficients. An alpha level of 0.05 was considered statistically significant. This statistical method makes three assumptions: homoscedasticity, linearity, and normality of residuals.

Homoscedasticity means that the residuals have a constant variance across predicted values, which can be checked using a scatter plot of residuals versus predicted values. An even spread without a pattern indicates homoscedasticity. Linearity assumes a linear relationship between predictors and the outcome, which can be inspected with the same scatter plot. If the residuals are spread randomly around zero without forming a trend, the assumption of linearity is met. Normality of residuals assumes that they are normally distributed, which can be assessed using a Q-Q plot; if the residuals are close to the line of equality, they are considered approximately normal.

The R package lavaan (Rosseel, 2012) was used for conducting the ESEM and MLR analyses, the dplyr package was used for manipulating data, and ggplot2, GGally and car libraries were used for data visualization.

Results

Descriptive statistics

Respondents in the study were between 13 and 18 years old. Figure B1 shows the frequency of each age within the total sample of eligible respondents. The histogram shows that the groups are not equally distributed; however, by grouping respondents that are 13–16 years old in one group (n = 804) and 17–18 years old in another (n = 906), the two groups become more balanced. Most of the responses within these age ranges came from the U.S.A. (n = 891), Great Britain (n = 144), Canada (n = 110), the Philippines (n = 74), and Australia (n = 62). In most of these countries, English is spoken as a native tongue (for a more complete overview of respondent descriptive statistics, see subheading Participants). Scores on VIQ as measured by score_full, ranged from -15.75 to 45, with 45 points reflecting a perfect score (see Table B1). The mean of the total sample of selected respondents was 23.72 (SD = 8.33) with a variance of 69.41. The variance indicates that some scores were much higher and others much lower than the mean, resulting in high variability in VIQ performance.

Evidence of personality differences across ages

To test both of the hypotheses, ESEM was employed for each sample (total sample, early adolescence, and late adolescence) to break down the personality data into personality traits. Different models going from one to 10 factors per sample were assessed to find a winning model. The winning models all had to first meet the criteria for goodness of fit and were subsequently compared by AIC and BIC. In the case of a mismatch between AIC and BIC, models with a lower BIC were given preference to prioritize the simplicity of the model (Raftery, 1995 as cited in Booth, & Hughes, 2014). The winning model's factor loadings were further inspected and used to produce personality traits. Personality traits were assigned based on the content of items' highest correlated factor. Items

were free to correlate with multiple factors resulting at times in cross-loadings. Items that loaded onto multiple factors were grouped with the factor for which the item was most highly correlated and excluded from other correlated factors.

ESEM Total sample

The test was carried out on all respondents between 13–18 years old who had answered all the questions from the VIQ and the personality task (n =1710). An exploratory approach was used to identify latent variables within the dataset and explore the relationship between personality traits and VIQ. z-scores were used for the identification of potential outliers in the answers to the personality questions (S1 through S30) and no observations met the criteria for exclusion ($-3 \leq$ z-score ≥ 3), suggesting that the data does not contain any extreme values that may influence the results of further analysis. The dataset was additionally tested for skewness and kurtosis to examine normality using the rules of thumb as used by Curran et al. (1996). The skewness values in the dataset largely fell within between -1 and 1, with S17 (Skewness = 1.263, Kurtosis = 0.456) ("I could do an impressive amount of push ups") and S23 ("I have studied how to win at gambling.") (Skewness = 1.073, Kurtosis = -0.190) as exceptions (see Table B21 for the skewness and kurtosis values for all items). All responses for the two variables were left in the dataset, as there was insufficient justification for the exclusion of participants after a visual inspection of the responses for the two variables. All values for kurtosis within the dataset were below three, indicating that the variables in the dataset do not show significant tail-heaviness. ESEM was used to compare the fit of 10 models which included from one factor to 10 factors to evaluate which model best explains the data. Factors were free to correlate freely with all variables and with each other. If cross-loadings were found, in the analysis, items were grouped with the factor with the highest factor loading. The lowest AIC value was found in the 10 factor model (nf_{10} AIC = 165425), however, the lowest BIC value is at the 6-factor model (nf_6 BIC = 166824.4). AIC suggests that the best balance of complexity and fit may be at 10, whereas the BIC indicates that the 6-factor model more adequately explains the data. The χ^2 p-value was below .001 for the different models.

The winning model was the 8-factor model, for which both the RMSEA (0.029) and CFI (0.959) are adequate. The 8 factor model met the criteria for a good fit in RMSEA and CFI (AIC = 165570.6, BIC = 166888.1, $\chi^2(223) = 538.750$, p = 0, CFI = 0.959, RMSEA = 0.029). The combination of the factors in the winning model account for 33.2% of the variance in VIQ (R^2_{cum}= 0.332). This model was chosen as the winning model because it had a lower BIC than the 9 factor model, therefore it prioritized simplicity of the model. The 8-factor model included the following latent variables: Introversion, Quirkiness, Expressiveness, Curiosity, Ambivalence, Ambitiousness,

Traditionalism, and Adaptability. Other models that met the goodness of fit criteria were the 9 factor model (AIC = 165487.5, BIC = 166924.8, $\chi^2(201) = 411.674$, p = 0, CFI = 0.972, RMSEA = 0.025) and the 10-factor model (AIC = 165425.0, BIC = 166976.7, $\chi^2(180) = 307.213$, p = 0, CFI = 0.983, RMSEA = 0.020). The 9-factor model accounted for 34.6% of variance in VIQ (R^2_{cum}= 0.346) and the 10-factor model accounted for 35.7% of variance in VIQ (R^2_{cum}= 0.357). While either of these models explain a greater amount of the variance in VIQ compared to the 8 factor model, the 8-factor model was preferred as it was the most parsimonious.

ESEM Early Adolescence Model

ESEM was carried out on the early adolescent sample (n_{EA} = 804) from one factor to 10 factors to evaluate which model best explains the data. The ESEM was carried out again on respondents between 13–16 years old who had answered all the questions from the VIQ and the personality task. Just as in the total sample, z-scores were used for the identification of potential outliers in the answers to the personality questions (S1 through S30) and no observations met the criteria for exclusion ($-3 \leq$ z-score ≥ 3). Just as with the total sample, all values for kurtosis within the data were below three, indicating that the variables in the dataset do not show significant tail-heaviness. The skewness values in the dataset largely fell within between -1 and 1, with S17 (Skewness = 1.273, Kurtosis = 0.509) ("I could do an impressive amount of push ups"), S23 ("I have studied how to win at gambling.") (Skewness = 1.127, Kurtosis = -0.020) and S30 ("I am not quite sure what I want") (Skewness = -1.021, Kurtosis = -0.074) as exceptions (see Table B22 for the skewness and kurtosis values for all items). All responses for the two variables were left in the dataset, as there was insufficient justification for the exclusion of participants after a visual inspection of the responses for the two variables.

The winning model was the 8-factor model, for which both the RMSEA (0.030) and CFI (0.953) are adequate for the early adolescent group (AIC = 77569.02, BIC = 78703.91, $\chi^2(223) = 386.512$, p = 0, CFI = 0.953, RMSEA = 0.030). The combined factors in the winning model explained 33.1% of the variance in VIQ (R^2_{cum} = 0.331). The goodness of fit measures show that at 8 factors, this model meets the CFI, RMSEA criteria and has a significant χ^2 indicating a good fit. For early adolescence, the 9-factor model (AIC = 77526.18, BIC = 78764.23, $\chi^2(201) = 299.670$, p = 0, CFI = 0.972, RMSEA = 0.025) and the 10-factor model (AIC = 77508.84, BIC = 78845.38, $\chi^2(180) = 240.335$, p = .002, CFI = 0.983, RMSEA = 0.020) also met the criteria for goodness of fit. The combination of predictors in the 9-factor model explained 35% of the variance in VIQ (R^2_{cum} = 0.350). The 10-factor model accounted for 36.4% of variance in VIQ (R^2_{cum} = 0.364). The 8-factor model was

opted for as the winning model due to its simplicity over the 9 or 10-factor model for early adolescence.

The early adolescent 8-factor model identified the following personality traits: Introversion, Quirkiness, Curiosity, Ambivalence, Ambitiousness, Openness, Belief, and Adaptability. The questionnaire items corresponding to each trait can be found in Table B11 in the Appendix. Notably, there were several personality traits that were also identified in the total sample (Introversion, Quirkiness, Curiosity, Ambivalence, Ambitiousness and Adaptability). However, in the early adolescent sample two new personality traits were identified: Openness and Belief.

ESEM Late Adolescence Model

The ESEM for the late adolescent model (n_{LA} = 906) was tested for factors one through 10 models. The ESEM was carried out again on respondents between 17–18 years old who had answered all the questions from the VIQ and the personality task. Just as in the previous ESEM, z-scores were used for the identification of potential outliers in the answers to the personality questions (S1 through S30) and no observations met the criteria for exclusion ($-3 \leq$ z-score ≥ 3). In late adolescence again, all values for kurtosis within the data were below three, indicating that the variables in the dataset do not show significant tail-heaviness. The skewness values in the dataset largely fell within between -1 and 1, with S17 (Skewness = 1.252, Kurtosis = 0.399) ("I could do an impressive amount of push ups") and S23 ("I have studied how to win at gambling.") (Skewness = 1.026, Kurtosis = -0.338) as exceptions (see Table B23 for the skewness and kurtosis values for all items). All responses for the two variables were left in the dataset, as there was insufficient justification for the exclusion of participants after a visual inspection of the responses for the two variables.

Like in early adolescence, the goodness of fit measures seem to indicate a good fit with the 8-factor model (AIC =88079.81, BIC = 89243.60, $\chi^2(223) = 384.420$, p = 0, CFI = 0.962, RMSEA = 0.028). This model explained 35.3% of variance in VIQ ($R^2_{cum} = 0.353$). A 7-factor model appeared to be simpler than the 8-factor model while remaining a good fit according to the goodness of fit measures (AIC =88108.03, BIC = 89161.21, $\chi^2(246) = 458.642$, p = 0, CFI = 0.950, RMSEA = 0.031), explaining 33.1% of variance ($R^2_{cum} = 0.331$). The 8-factor model has a lower AIC than the 7 factor model, however, the 7-factor model has a lower BIC (ΔAIC =28.22 and ΔBIC = -82.39). The 9-factor model (AIC = 88049.43, BIC = 89319.01, $\chi^2(201) = 310.037$, p = 0, CFI = 0.974, RMSEA = 0.024) and the 10-factor model (AIC =88030.31, BIC = 89400.89, $\chi^2(180) = 248.924$, p = .001, CFI = 0.984, RMSEA = 0.021) also met the criteria for a good fit according to the goodness of fit measures but were not chosen as the winning models due to a higher BIC than the 7-factor model. The 9-factor model explained 36.5% of the variance in VIQ ($R^2_{cum} = 0.365$) while the 10-factor model explained

38.3% of the variance in VIQ (R^2_{cum} = 0.383). The 7-factor model was the winning model for LA due to its simplicity and lower BIC. This model identified the following personality traits: Quirkiness, Independence, Introversion, Critical Thinking, Curiosity, Ambivalence, and Leadership.

Findings from the ESEMs only partially supports the hypothesis that personality traits are different for different adolescent age groups. Personality traits such as Independence, Critical Thinking and Leadership all emerged in the late adolescence sample, without having been present in the early adolescence sample. This difference suggests that personality maturation may influence the expression of certain personality traits. Personality traits such as Quirkiness, Introversion, Ambivalence and Curiosity on the other hand, were exhibited as distinct personality traits in both the early and late adolescence samples, suggesting that some personality traits may be more consistent throughout adolescent development.

Evidence that personality is predictive of VIQ

To evaluate if personality traits could be predictive of VIQ performance, multiple linear regression (MLR) was employed for each sample (total sample, early adolescence, and late adolescence). Personality traits that were identified from the winning models of each of these age groups as independent variables were used to predict the dependent variable, VIQ. To create a composite score for each personality trait, the raw scores of the items that comprised each factor were averaged. The composite scores were then used to predict VIQ using MLR.

Multicollinearity and VIF

Before proceeding with the MLR, the assumptions for multicollinearity (VIF) were checked, ensuring that each factor met the criteria of VIF < 10. The VIF values per factor for each group can be found in Table B20. There were no VIF values above 10 for any of the samples. For the total sample, the lowest VIF was 1.074 and the highest was 1.248. For the early adolescence sample, the lowest VIF was 1.056 and the highest value was 1.205. For the late adolescence sample, the lowest VIF was 1.058 and the highest value was 1.200.

MLR Total Sample

Additional testing was done to ensure that the assumption of linearity was met through visual inspection of scatter plots as the residuals are spread randomly around zero without forming a trend. The assumptions for multicollinearity were met ($1.074 \leq VIF \leq 1.248$). The scatter plots show that the variables are normally distributed.

After testing assumptions, MLR was conducted for the purpose of testing the predictive capacity of eight identified personality factors from the total sample. Score_full (dependent variable) as a measure of VIQ was regressed onto the personality factors (F1 - Introversion, F2 - Quirkiness, F3 - Expressiveness, F4 - Curiosity, F5 - Ambivalence, F6 - Ambitiousness, F7 - Traditionalism, and F8 - Adaptability). The results of the MLR can be found in the table below.

Table 1

Regression Coefficients of the Total Sample model

Predictor	B	SE	t	p
(Intercept)	16.38	1.96	8.37	**<.001*****
F1	-0.04	0.21	-0.21	.831
F2	0.11	0.23	0.46	.644
F3	0.34	0.27	1.26	.207
F4	0.82	0.24	3.51	**<.001*****
F5	-0.10	0.23	-0.45	.651
F6	1.62	0.33	4.93	**<.001*****
F7	-1.60	0.25	-6.34	**<.001*****
F8	1.16	0.20	5.72	**<.001*****

Note. *: Significance at the .05 level ($p < .05$), **: Significance at the .01 level ($p < .01$), ***: Significance at the .001 level ($p < .001$).

The overall model was significant $F(8,1701) = 21.42$, $p < 0.001$, $R^2 = 0.092$, $R^2_{adj} = 0.087$. Of the eight factors, F4, F6, F7, and F8 are significant predictors (each significant at $p < 0.001$), with the other predictors not contributing significantly to the model. In this model, F4, F6, F7, and F8 represent the personality traits of Curiosity, Ambitiousness, Traditionalism and Adaptability, respectively. Additionally, it appears that respondents with higher Traditionalism scores perform worse on VIQ ($\beta_{F7} = - 1.60$, $p > .001$), with each one unit increase in Traditionalism having a decrease in VIQ of 1.60 units. Ambitiousness had the largest weight of the predictors in this model ($\beta_{F6} = 1.62$, $p < .001$), with each one unit increase in Ambitiousness leading to an increase in VIQ of 1.62 units. Each one unit increase in Curiosity led to an increase in VIQ of 0.82. An increase of one unit in Adaptability led to an increase of 1.16 units in VIQ. The second hypothesis states that personality is predictive of VIQ performance is supported in the total sample. The results of the MLR on the total

sample reject the null hypothesis (hypothesis 2) as several personality traits (F4, F6, F7, and F8) are found to be significant predictors of VIQ.

MLR Early Adolescence Model

As with the total sample, the assumptions were checked using scatter plots for the early adolescence model. The assumption of linearity was met through visual inspection of scatter plots as the residuals are spread randomly around zero without forming a trend. The assumptions for multicollinearity were met ($1.056 \leq VIF \leq 1.205$) and the distributions approached normality.

After inspection of the scatter plots and testing the assumptions, the early adolescence sample ($n_{EA} = 804$). MLR was conducted, regressing VIQ (score_full) onto F1, F2, F3, F4, F5, F6, F7, F8, as was done for the total sample (F1 - Introversion, F2 - Quirkiness, F3 - Curiosity, F4 - Ambivalence, F5 - Ambitiousness, F6 - Openness, F7 - Belief, and F8 - Adaptability). The results of the MLR can be seen in the table below.

Table 2

Regression Coefficients of the Early Adolescence model

Predictor	B	SE	t	p-value
(Intercept)	14.08	2.68	5.26	**< .001** ***
F1	-0.46	0.29	-1.59	.112
F2	0.75	0.33	2.26	**.024** *
F3	0.73	0.33	2.24	**.025** *
F4	-0.46	0.36	-1.28	.200
F5	2.51	0.49	5.17	**< .001** ***
F6	-0.94	0.37	-2.54	**.011** *
F7	-0.77	0.30	-2.61	**.009** **
F8	1.15	0.29	3.973	**< .001** ***

Note. *: Significance at the .05 level ($p < .05$), **: Significance at the .01 level ($p < .01$), ***: Significance at the .001 level ($p < .001$).

The early adolescence Model ($R^2 = 0.114$, $R^2_{adj} = 0.106$) was significant ($F(8, 795) = 12.84$, $p < .001$), with F2, F3, F5, F6, F7, and F8 contributing significantly to the model (see Table B13). In this model that means that Quirkiness, Curiosity, Ambitiousness, Openness, Belief and Adaptability

all contributed significantly to the model ($p < .05$). F5 (Ambitiousness) had the largest weight in the model out of the predictors tested ($\beta_{F5} = 2.51$, $p < .001$), with each one unit increase in Ambitiousness leading to a 2.51 increase in VIQ. This finding mirrors the finding in the total sample, where Ambitiousness was also found to significantly predict VIQ. Adaptability was a significant predictor of VIQ ($\beta_{F8} = 1.15$, $p < .001$) with each increase of one unit in Adaptability leading to an increase of 1.15 in VIQ. Openness ($\beta_{F6} = -0.94$, $p = .011$) and Belief ($\beta_{F7} = -0.77$, $p = .009$) were also found to be significant predictors of VIQ, however the Beta coefficients indicate that the relationship is such that increases in these factors lead to a decrease in VIQ.

The results of the MLR on the Early Adolescence Model reject the null hypothesis (hypothesis 2) as several personality traits (F2, F3, F5, F6, F7, and F8) are found to be significant predictors of VIQ while F1 and F4 were not. The hypothesis that personality is predictive of VIQ performance is sustained in the Early Adolescence sample.

MLR Late Adolescence Model

Next the late adolescence Model was tested ($n_{LA} = 906$), as with the prior analyses, the assumptions were assessed using a scatter plot. The scatter plots for the model show normal distributions and approximate linearity. The assumption of linearity was met through visual inspection of scatter plots as the residuals are spread randomly around zero without forming a trend. The assumptions for multicollinearity were met ($1.058 \leq VIF \leq 1.200$).

An MLR was conducted to regress VIQ onto F1, F2, F3, F4, F5, F6, and F7 (F1 - Quirkiness, F2 - Independence, F3 - Introversion, F4 - Critical Thinking, F5 - Curiosity, F6 - Ambivalence, and F7 - Leadership). The late adolescence model ($R^2 = 0.067$, $R^2_{adj} = 0.059$) was significant ($F(7, 898) = 9.179$, $p < .001$), with F1, F4, F5 and F7 contributing significantly to the model. These factors represent Quirkiness ($\beta_{F1} = 0.68$, $p = .040$), Critical Thinking ($\beta_{F4} = 1.52$, $p < .001$), Curiosity ($\beta_{F5} = 1.31$, $p < .001$) and Leadership ($\beta_{F7} = -1.26$, $p = .011$), respectively. An increase of one unit in Quirkiness led to an increase of 0.68 in VIQ. Increases of one unit of Critical thinking led to an increase of 1.52 units of VIQ. Increases of one unit of Curiosity led to an increase of 1.31 in VIQ. Similarly, an increase of one unit in Leadership, led to a decrease of 1.26 units in VIQ. The MLR results can be seen in the table below.

Table 3

Regression Coefficients of the Late Adolescence model

Predictor	B	SE	t	p-value
(Intercept)	16.17	2.71	5.97	**<.001*** **

F1	0.68	0.33	2.05	**.040 ***
F2	-0.02	0.35	-0.06	.951
F3	-0.23	0.32	-0.70	.483
F4	1.52	0.37	4.14	**<.001*****
F5	1.31	0.32	4.06	**<.001*****
F6	0.26	0.37	0.69	.493
F7	-1.26	0.50	-2.55	**.011 ***

Note. *: Significance at the .05 level ($p < .05$), **: Significance at the .01 level ($p < .01$), ***: Significance at the .001 level ($p < .001$).

The results of the MLR on the late adolescence Model reject the null hypothesis (hypothesis 2 under heading Hypotheses) as several personality traits (F1, F4, F5, and F7) are found to be significant predictors of VIQ while F2, F3 and F6 were not (see Table B19). The alternative hypothesis that personality is predictive of VIQ performance is sustained in the late adolescence sample.

Discussion

Objectives and findings

The principal aim of this study was to explore the relationship between personality and verbal ability in adolescence. Other objectives were to explore what types of personality traits could be found within the adolescent sample and explore whether verbal ability could be predicted from these personality traits. Findings from this study suggest that common and popular personality scales, such as the Big Five Aspect Scale and Hierarchical Personality Inventory for Children, use categories that may be too broad to capture the diversity of personality traits that are present within adolescence. This is in contradiction to prior findings by Brandt et al. (2020) that determined that the Big Five Aspect Scale was sufficient for use throughout adolescence, but in line with Hill, & Edmonds (2017) who question the validity and sufficiency of existing personality scales for this population. Furthermore, the findings provide evidence of meaningful differences in how personality is expressed between older and younger adolescents. This is in line with studies on personality maturation across adolescence (Klimstra et al., 2009). The study found that personality traits could be effective in predicting VIQ across adolescent age groups, and that the predictive power of personality traits differed between early and late adolescents.

The results of the exploratory structural equation modeling performed on early and late adolescents gave insight into the uniqueness of personality traits within each group. Quirkiness, Introversion, Ambivalence and Curiosity stand out as consistent personality traits across all groups. Despite similarities and consistency of certain personality traits across groups, traits were identified that were unique to adolescents of a specific age range.

An MLR was conducted to regress VIQ on the personality factors of each model. The findings showed that Quirkiness, Curiosity, Ambitiousness, and Adaptability were all significantly and positively correlated with increases in VIQ in early adolescents. For the same early adolescence sample, Openness and Belief were significantly negatively correlated to VIQ, with increases in these factors predicting lower VIQ. In late adolescence Quirkiness, Critical Thinking, Curiosity and Leadership were all significant predictors of VIQ, where high scores in Leadership predicted lower VIQ. The other significant predictors in this sample were associated with increases in VIQ. In the total sample, higher Curiosity, Ambitiousness, and Adaptability all predicted increased performance on VIQ, while higher Traditionalism in the total sample was predictive of lower VIQ performance.

Interpretation of results

Factor correlations in different models reveal relationships between the identified factors. In the total sample model, four significant correlations (see Table B7) suggest relationships between Quirkiness and Traditionalism, Adaptability and Ambitiousness, Curiosity and Ambitiousness, and Curiosity and Traditionalism. A negative correlation between Ambitiousness and Curiosity shows that these two traits may not measure alike concepts. A significant positive correlation of the same factors in the early adolescents model (see Table B12), indicates an age-related interaction. Significant early adolescent correlations include Quirkiness with Curiosity and Ambivalence, and Openness with Belief, suggesting Quirkiness with Ambivalence and Curiosity as subdomains. In the late adolescents model (see Table B18), Quirkiness correlates with Curiosity. Critical Thinking and Curiosity are also significantly correlated, pointing to a dynamic between these three traits.

Striking similarities in the personality traits can be extracted between the late adolescence, early adolescence and total sample groups. Namely, the identification of Quirkiness, Introversion, Curiosity, and Ambivalence. There is also a significant overlap in the grouping within factors, such as items S18 (“I put work first”), S20 (“I do more than what's expected of me”), S23 (“I have studied how to win at gambling”) and S24 (“I naturally emerge as a leader”) which load onto Ambitiousness in both early adolescence and the total sample but onto Leadership in the late adolescence sample. This difference between the late adolescence subgroup and the other two samples, could be a result of

the Simpson paradox (Blyth, 1972), as the personality trait of leadership that emerges in this sample is obscured by the broader trend seen in the total sample.

In the late adolescence group, new personality traits emerge that were not identified in the total sample model nor in the early adolescence model. Several of the items that comprised the factor of Ambivalence in the early adolescence are different in late adolescence, however, they still encapsulate the same concept. S22 (“I am a perfectionist”) and S27 (“I like to play devil's advocate”), together with S19 (“I do not have a very expressive face.”), load onto Critical Thinking in late adolescence, despite loading onto Ambitiousness in early adolescence. For all groups analyzed, this study found unique personality traits, not identified in other personality inventories and found traits that would likely not easily be mapped onto BFAS or HiPIC (De Fruyt, et al., 2000; Lee, & Ashton, 2019), such as Quirkiness and Traditionalism.

The relationship between the personality factors and VIQ also differed between the three winning models. Quirkiness was a significant predictor of VIQ in the early and late adolescence models, but not in the total sample. Interpreting this result required additional scrutiny of the Quirkiness items across the three winning models. In both the early adolescent model and the late adolescent model the item S3 (“I had an imaginary friend as a child”) loaded onto Quirkiness, while in the total sample, it loaded onto Expressiveness. This item was loaded onto Expressiveness as a result of the procedure for cross-loadings, however, it correlated second-best onto Quirkiness, possibly explaining the discrepancy in the results.

Limitations

The design of the study was cross-sectional due to constraints in data collection. A within-subject longitudinal design would have been more effective at providing insights into personality development in adolescents. The present study explores the emergence of distinct personality traits and potential relationships between them, and identifies traits across two age ranges.

The use of Open-source data allows for a higher level of reproducibility, but might allow bias. In this study, results and conclusions are heavily dependent on 30 personality items (see Appendix C), yet these items have not previously been validated in other research, and might lack breadth to align closely with established personality measurement instruments. The personality traits proposed in this exploratory research suggest factors that have not been validated, despite several personality traits having content validity as they are frequently found in scientific literature such as Openness, Conscientiousness, Introversion, and Curiosity, which are present in either the BFAS or HiPIC (Hill, & Edmonds, 2017).

Respondents not meeting selection criteria were excluded (see heading Participants), however no screening process was conducted prior to data collection, meaning that respondents could have been dishonest in their responses. The respondents represented in the dataset are likely to belong to the western, educated, industrialized, rich and democratic demographic, known as WEIRD demographics (Henrich, Heine, & Norenzayan, 2010), given that there is an over representation of US respondents (n = 891), and that respondents required sufficient command of the english language and access to the internet needed to complete the study. Moreover, items S17 and S23 introduced skewness in the dataset, however there was insufficient justification for their removal after visual inspection. This could have had a slight impact on the results of analyses.

ESEM was used to group items into personality traits without prior assumptions of potential factor structures, essential for testing Hypotheses 1 and 2 and exploring latent factors. ESEM was chosen for its capacity to handle complex models and assess goodness of fit easily. Principal Component Analysis could have been an adequate alternative, focusing on factor structures while reducing the complexity of the models. However, ESEM was preferred for its emphasis on factor exploration over dimension reduction, aligning with the study's objectives. Assumptions were checked prior to conducting each MLR necessary for addressing Hypothesis 2, and interpretability and overfitting was not an issue due to the number of independent variables in each MLR. In the inspection of normality for the early adolescents MLR, it was unclear if F5 was normally distributed or if there was a bimodal distribution, which may have influenced the results.

Implications

The study demonstrates that traditional personality scales may be insufficient for gaining an accurate understanding of many dimensions of personality within the adolescent population. To expand on the findings of this study, future research should consider a longitudinal within-subject design to provide more information on how adolescents mature and what the effect of maturation is on verbal ability. The findings from this study suggest that adolescents' personalities have an impact on verbal ability, hinting that there could be implications for the predictability of other general intelligence subdomains from these traits. Future studies could also assess the structure of the factors that were found in these analyses to investigate potential subdomains, such as a closer investigation of the relationship between quirkiness and the two proposed subdomains, ambivalence and curiosity.

Conclusions

The study provides cross-sectional support for personality maturation, and finds that independence, critical thinking, and leadership emerge as distinct personality traits in late adolescence. Early adolescents on the other hand showed Ambitiousness, Openness, Belief and

Adaptability as traits unique to this age group. Findings from this study suggest that certain personality traits are good predictors of verbal ability. Specifically, there is evidence that curiosity, ambitiousness and adaptability are good measures of personality for predicting adolescents' verbal ability and that traditionalism is predictive of poor verbal ability. If the adolescents are separated into early and late adolescence, early adolescents verbal ability is best predicted by quirkiness, curiosity, ambitiousness, openness, belief and adaptability, while for late adolescents it is best predicted by quirkiness, critical thinking, curiosity, and leadership.

This study suggests that personality research on adolescents should consider the breadth of personality traits present within the group, and highlights the importance of considering developmental stages when studying personality. Additional research should be conducted to assess the suitability of the personality items in the dataset, using additional analyses to assess the psychometric properties of the questionnaire. Future research should also consider a longitudinal approach in order to infer causal relationships with more clarity, and capture within-subjects developmental changes. Additionally, further research could provide insight into how life events, such as changes in home environment, may moderate the relationship between personality and VIQ. Follow-up studies should consider employing a confirmatory factor analysis to assess the validity of the factor structures in the present study and for additional comparisons across age groups. The study finds that personality traits can be good predictors of VIQ in adolescents, which leads to an opportunity for the exploration of other ways in which adolescents' personalities may have an impact on other subdomains of general intelligence.

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Appendix A

R Script

```
##Load libraries and data
#Load libraries
library(lavaan)
library(dplyr)
library(ggplot2)
library (GGally)
library(car)
library(e1071)
#setseed(123)
#Load raw data
raw_data <- read.csv("VIQT_data.csv", sep = "\t")

##Data cleaning
#Filter for age
filter_data <- raw_data[raw_data$age >= 13 & raw_data$age <= 18, ]
#Exclude non-complete entries
exclude_rows_missing <- apply(filter_data, 1, function(row) any(is.na(row)))
exclude_rows_q <- apply(filter_data[, paste0("Q", 1:45)], 1, function(row) any(row == 0))
exclude_rows_s <- apply(filter_data[, paste0("S", 1:30)], 1, function(row) any(row == 0))
exclude_rows_qs <- exclude_rows_q | exclude_rows_s
data <- filter_data[!exclude_rows_missing & !exclude_rows_qs, ]

##Descriptive statistics
ggplot(data, aes(x = age)) +
geom_histogram(binwidth = 1, fill = "skyblue", color = "black", aes(y = ..count..)) +
labs(title = "Histogram of Age", x = "Age", y = "Frequency") +
theme_minimal()
mean_score <- mean(data$score_full, na.rm = TRUE)
median_score <- median(data$score_full, na.rm = TRUE)
std_dev_score <- sd(data$score_full, na.rm = TRUE)
variance_score <- var(data$score_full, na.rm = TRUE)
```

```
min_value <- min(data$score_full, na.rm = TRUE)
max_value <- max(data$score_full, na.rm = TRUE)

#Create personality item data frames
s_q <- c("S1", "S2", "S3", "S4", "S5",
         "S6", "S7", "S8", "S9", "S10",
         "S11", "S12", "S13", "S14", "S15",
         "S16", "S17", "S18", "S19", "S20",
         "S21", "S22", "S23", "S24", "S25",
         "S26", "S27", "S28", "S29", "S30")
sviq_q <- c(s_q, "score_full")
TS_S <- data[, s_q, drop = FALSE]
TS_SVIQ <- data[, sviq_q, drop = FALSE]

#Age split
EA_data <- data[data$age >= 13 & data$age <= 16, ]
EA_S <- EA_data[, s_q, drop = FALSE]
EA_SVIQ <- EA_data[, sviq_q, drop = FALSE]
LA_data <- data[data$age >= 17 & data$age <= 18, ]
LA_S <- LA_data[, s_q, drop = FALSE]
LA_SVIQ <- LA_data[, sviq_q, drop = FALSE]

##Testing for outliers
#Total Sample
outliers_list <- list()  # Initialize an empty list to store outliers for each variable
for (variable in paste0("S", 1:30)) {
  z_scores <- scale(data[[variable]])  # Compute z-scores for the current variable
  outliers <- which(abs(z_scores) > 3)  # Identify indices of outliers (z-score > 3 or < -3)
  outliers_list[[variable]] <- outliers  # Store the indices of outliers in the list
}
table_S17 <- table(data$S17)
#Early Adolescence
outliers_list <- list()  # Initialize an empty list to store outliers for each variable
for (variable in paste0("S", 1:30)) {
```

```
  z_scores <- scale(EA_data[[variable]])  # Compute z-scores for the current variable
  outliers <- which(abs(z_scores) > 3)  # Identify indices of outliers (z-score > 3 or < -3)
  outliers_list[[variable]] <- outliers  # Store the indices of outliers in the list
}
#Late Adolescence
outliers_list <- list()  # Initialize an empty list to store outliers for each variable
for (variable in paste0("S", 1:30)) {
  z_scores <- scale(LA_data[[variable]])  # Compute z-scores for the current variable
  outliers <- which(abs(z_scores) > 3)  # Identify indices of outliers (z-score > 3 or < -3)
  outliers_list[[variable]] <- outliers  # Store the indices of outliers in the list
}

##Testing for skewness and kurtosis
#Early adolescence
variables <- EA_S[, paste0("S", 1:30)]
#Calculate skewness
skewness_values <- apply(variables, 2, function(x) skewness(x, na.rm = TRUE))
#Calculate kurtosis
kurtosis_values <- apply(variables, 2, function(x) kurtosis(x, na.rm = TRUE))
#Combine skewness and kurtosis values into a data frame
skewness_kurtosis_df <- data.frame(
  Variable = colnames(variables),
  Skewness = skewness_values,
  Kurtosis = kurtosis_values
)

##Data Analysis
##Hypothesis 1
##Total Sample
#ESEM 10-factor model
fit10 <- efa(data = TS_S, nfactors = 1:10)
summary(fit10)
#Matching factor loadings
fit10[["nf10"]]
```

```
fit10[["loadings"]]$nf10

#ESEM 8-factor model
fit8 <- efa(data = TS_S, nfactors = 1:8)
summary(fit8)
#Matching factor loadings
fit8[["nf8"]]
fit8[["loadings"]]$nf8

#Specifying MLR model
TS_SVIQ <- TS_SVIQ %>%
  mutate(F1 = (S2 + S4 + S19)/3,
         F2 = (S6 + S12)/2,
         F3 = (S1 + S3 + S5 + S11 + S15 + S21 + S29)/7,
         F4 = (S13 + S14 + S16)/3,
         F5 = (S9 + S26 + S30)/3,
         F6 = (S17 + S18 + S20 + S22 + S23 + S24 + S27)/7,
         F7 = (S8 + S10 + S25)/3,
         F8 = (S7 + S28)/2)
TS_model <- TS_SVIQ %>%
  select(tail(names(TS_SVIQ), 10))

##Early Adolescence
#ESEM 10-factor model
fit10 <- efa(data = EA_S, nfactors = 1:10)
summary(fit10)
#Matching factor loadings
fit10[["nf10"]]
fit10[["loadings"]]$nf10

#ESEM 8-factor model
fit8 <- efa(data = EA_S, nfactors = 1:8)
summary(fit8)
#Matching factor loadings
```

```
fit8[["nf8"]]
fit8[["loadings"]]$nf8

#Specifying MLR model
EA_SVIQ <- EA_SVIQ %>%
  mutate(F1 = (S2 + S4 + S19)/3,
         F2 = (S3 + S6 + S12)/3,
         F3 = (S13 + S14 + S16)/3,
         F4 = (S9 + S10 + S26 + S30)/4,
         F5 = (S1 + S18 + S20 + S21 + S22 + S23 + S24 + S27)/8,
         F6 = (S5 + S8 + S11 + S15 + S29)/5,
         F7 = (S17 + S25)/2,
         F8 = (S7 + S28)/2)
EA_model <- EA_SVIQ %>%
  select(tail(names(EA_SVIQ), 10))

#Specifying MLR model
EA_SVIQ <- EA_SVIQ %>%
  mutate(F1 = (S2 + S4 + S19)/3,
         F2 = (S3 + S6 + S12)/3,
         F3 = (S13 + S14 + S16)/3,
         F4 = (S9 + S10 + S26 + S30)/4,
         F5 = (S1 + S18 + S20 + S21 + S22 + S23 + S24 + S27)/8,
         F6 = (S5 + S8 + S11 + S15 + S29)/5,
         F7 = (S17 + S25)/2,
         F8 = (S7 + S28)/2)
EA_model <- EA_SVIQ %>%
  select(tail(names(EA_SVIQ), 10))

##Late Adolescence
#ESEM 10-factor model
fit10 <- efa(data = LA_S, nfactors = 1:10)
summary(fit10)
#Matching factor loadings
```

```
fit10[["nf10"]]
fit10[["loadings"]]$nf10

#ESEM 7-factor model
fit7 <- efa(data = LA_S, nfactors = 1:7)
summary(fit7)
#Matching factor loadings
fit7[["nf7"]]
fit7[["loadings"]]$nf7

##Hypothesis 2
##Total Sample
#MLR Assumptions
mlr_fit <- lm(score_full ~ F1 + F2 + F3 + F4 + F5 + F6 + F7 + F8, data = TS_model)
vif_values <- vif(mlr_fit)
plot_data <- data.frame(
        F1 = rnorm(100),
        F2 = rnorm(100),
        F3 = rnorm(100),
        F4 = rnorm(100),
        F5 = rnorm(100),
        F6 = rnorm(100),
        F7 = rnorm(100),
        F8 = rnorm(100),
        score_full = rnorm(100)
        )
ggpairs(plot_data)


#MLR Analysis
mlr_model <- '
score_full ~ F1 + F2 + F3 + F4 + F5 + F6 + F7 + F8
'
mlr_fit <- lm(mlr_model, data = TS_model)
```

```
summary(mlr_fit)

##Early Adolescence
#MLR Assumptions
mlr_fit <- lm(score_full ~ F1 + F2 + F3 + F4 + F5 + F6 + F7 + F8, data = EA_model)
vif_values <- vif(mlr_fit)
plot_data <- data.frame(
        F1 = rnorm(100),
        F2 = rnorm(100),
        F3 = rnorm(100),
        F4 = rnorm(100),
        F5 = rnorm(100),
        F6 = rnorm(100),
        F7 = rnorm(100),
        F8 = rnorm(100),
        score_full = rnorm(100)
        )
ggpairs(plot_data)

#MLR Analysis
mlr_model <- '
score_full ~ F1 + F2 + F3 + F4 + F5 + F6 + F7 + F8
'
mlr_fit <- lm(mlr_model, data = EA_model)
summary(mlr_fit)

##Late Adolescence
#MLR Assumptions
mlr_fit <- lm(score_full ~ F1 + F2 + F3 + F4 + F5 + F6 + F7 + F8, data = LA_model)
vif_values <- vif(mlr_fit)
plot_data <- data.frame(
        F1 = rnorm(100),
        F2 = rnorm(100),
        F3 = rnorm(100),
```

```
            F4 = rnorm(100),
            F5 = rnorm(100),
            F6 = rnorm(100),
            F7 = rnorm(100),
            score_full = rnorm(100)
            )
ggpairs(plot_data)

#MLR Analysis
mlr_model <- '
score_full ~ F1 + F2 + F3 + F4 + F5 + F6 + F7
'
mlr_fit <- lm(mlr_model, data = LA_model)
summary(mlr_fit)

#Specifying MLR model
LA_SVIQ <- LA_SVIQ %>%
  mutate(F1 = (S3 + S6 + S12)/3,
            F2 = (S1 + S5 + S11 + S15 + S21 + S29)/6,
            F3 = (S2 + S4 + S8)/3,
            F4 = (S19 + S22 + S27)/3,
            F5 = (S13 + S14 + S16)/3,
            F6 = (S7 + S9 + S26 + S28 + S30)/5,
            F7 = (S10 + S17 + S18 + S20 + S23 + S24 + S25)/7)
LA_model <- LA_SVIQ %>%
  select(tail(names(LA_SVIQ), 9))

#Diagnostic plots
par(mfrow = c(2, 2))
plot(h3_model, which = 1)  # Residuals vs Fitted
plot(h3_model, which = 2)  # Normal Q-Q
plot(h3_model, which = 3)  # Scale-Location
plot(h3_model, which = 5)  # Residuals vs Leverage
par(mfrow = c(1, 1))
```

Appendix B

Table B1

Descriptive statistics of the score_full variable

Variable	Min. value	Max. value	Mean	Median	SD	Variance
score_full	-15.75	45	23.72	2.45	8.33	69.41

Table B2

Summary of Factor Analysis Settings

Setting Description	Value
Estimator	ML
Rotation Method	GEOMIN OBLIQUE
Geomin Epsilon	0.001
Rotation Algorithm (rstarts)	GPA (30)
Standardized Metric	TRUE
Row Weights	None

Note. ML = Maximum Likelihood estimation; GEOMIN OBLIQUE refers to the type of oblique rotation used; GPA = Gradient Projection Algorithm.

Table B3

Measures of Fit for the Total Sample ESEM models with 1 through 10 factors

N factors	AIC	BIC	Chi-Square	df	p-value	CFI	RMSEA
1	170304.7	170631.3	5636.844	405	0	0.317	0.087
2	168684.9	169169.4	3959.052	376	0	0.532	0.075
3	167360.3	167997.3	2578.448	348	0	0.709	0.061
4	166221.7	167005.7	1385.904	321	0	0.861	0.044
5	165930.4	166856.0	1042.609	295	0	0.902	0.038
6	165762.8	166824.4	824.967	270	0	0.928	0.035
7	165643.9	166836.2	658.115	246	0	0.946	0.031

8	165570.6	166888.1	538.750	223	0	0.959	0.029
9	165487.5	166924.8	411.674	201	0	0.972	0.025
10	165425.0	166976.7	307.213	180	0	0.983	0.020

Table B4

Factor Loadings of the 5-factor Total Sample ESEM model

item	f1	f2	f3	f4	f5
S1	0.080	-0.015	0.024	0.012	**0.211***
S2	**0.626***	**0.473***	-0.009	0.007	0.035
S3	**0.194***	-0.027	0.003	-0.048	**0.363***
S4	**0.515***	**0.581***	-0.029	**-0.016***	-0.015
S5	-0.035	0.024	-0.031	**0.095***	**0.348***
S6	**0.415***	0.014	0.012	**0.118***	**0.382***
S7	**0.215***	0.008	**0.139***	**0.154***	**-0.102***
S8	**-0.147***	**0.358***	0.018	**-0.286***	**-0.104***
S9	0.060	**-0.117***	0.004	**0.634***	-0.026
S10	-0.010	0.015	**-0.306***	**0.140***	**-0.177***
S11	0.001	**0.241***	-0.055	0.003	**0.440***
S12	**0.480***	-0.079	-0.008	0.056	**0.335***
S13	**0.126***	-0.011	**0.383***	-0.016	-0.067
S14	-0.007	**0.198***	**0.928***	0.016	0.008
S15	-0.052	0.006	0.071	**-0.093***	**0.491***
S16	**0.248***	**-0.157***	**0.286***	-0.015	**0.252***
S17	0.051	**-0.294***	0.001	**-0.108***	**-0.159***
S18	**0.178***	-0.006	-0.048	**-0.647***	**-0.138***
S19	**0.360***	**0.234***	0.036	0.004	**-0.266***
S20	**0.192***	-0.076	0.012	**-0.766***	0.003
S21	**0.138***	0.017	0.005	**-0.093***	**0.290***

S22	**0.209***	0.022	0.042	**-0.377***	**0.128***
S23	**0.285***	**-0.331***	0.067	0.003	-0.082
S24	-0.008	**-0.567***	0.000	**-0.227***	0.081
S25	**-0.153***	-0.001	0.108*	-0.072	**0.237***
S26	0.002	-0.019	-0.027	**0.662***	0.041
S27	**0.244***	**-0.280***	**0.192***	**0.200***	-0.014
S28	-0.012	-0.082	**0.121***	**0.248***	0.063
S29	**-0.137***	0.003	-0.004	**0.090***	**0.492***
S30	0.035	**0.211***	0.043	**0.313***	**0.189***

Significance at $p < 0.01$ are indicated with *

Table B5

Factor Loadings of the 8-factor Total Sample ESEM model

item	f1	f2	f3	f4	f5	f6	f7	f8
S1	0.044	0.017	**0.211***	-0.001	0.021	**0.146***	0.040	**0.136***
S2	**0.650***	0.218	0.012	-0.006	0.000	**0.157***	-0.008	-0.073
S3	0.016	**0.226***	0.238	-0.001	-0.097	0.071	-0.026	**0.157***
S4	**0.646***	0.190	-0.038	-0.026	**-0.103***	-0.008	0.067	0.002
S5	-0.001	-0.009	**0.397***	-0.026	**0.195***	0.142	**0.251***	-0.010
S6	0.021	**0.626***	0.058	0.064	0.016	-0.091	0.009	0.006
S7	0.091	**0.170***	-0.227	0.117	0.045	0.013	-0.012	**0.177***
S8	**0.191***	-0.205	0.005	0.022	**-0.318***	-0.135	**0.280***	0.014
S9	-0.001	0.089	-0.045	0.001	**0.654***	0.059	-0.005	-0.039
S10	0.018	-0.026	**-0.171***	**-0.320***	**0.120***	-0.007	**0.170***	0.053
S11	**0.155***	0.059	**0.472***	-0.037	-0.004	-0.061	0.081	-0.014
S12	-0.030	**0.662***	-0.028	0.040	-0.017	-0.001	0.015	0.000
S13	0.000	**0.133***	-0.175	**0.398***	-0.021	0.005	0.001	-0.050
S14	0.121	-0.016	-0.008	**0.902***	0.003	-0.010	0.118	0.006

S15	-0.026	-0.004	**0.528***	0.082	-0.019	0.091	0.017	-0.014
S16	-0.079	**0.282***	0.065	**0.302***	0.006	**0.142***	-0.011	0.032
S17	**-0.237***	0.032	**-0.256***	0.001	-0.010	**0.207***	**0.167***	-0.007
S18	0.000	0.003	-0.205	-0.045	**-0.585***	0.173	**0.157***	0.007
S19	**0.367***	0.043	**-0.263***	0.021	0.010	0.133	0.036	-0.034
S20	-0.009	-0.060	-0.006	0.000	**-0.641***	**0.296***	0.007	0.000
S21	0.099	0.013	**0.326***	-0.008	-0.012	**0.209***	-0.024	0.000
S22	0.097	0.008	**0.157***	0.061	**-0.211***	**0.244***	-0.025	**-0.208***
S23	-0.050	-0.015	-0.100	0.022	**0.195***	**0.536***	0.006	0.016
S24	**-0.458***	0.005	-0.001	-0.003	-0.015	**0.390***	0.072	-0.033
S25	**-0.155***	0.001	0.215	0.143	-0.002	0.013	**0.413***	-0.012
S26	0.011	0.109	0.003	-0.028	**0.653***	-0.015	**0.186***	0.046
S27	0.006	0.000	-0.003	0.142	**0.328***	**0.417***	**-0.226***	0.022
S28	-0.010	0.013	0.005	0.011	-0.010	-0.004	-0.127	**0.709***
S29	-0.097	0.067	**0.479***	0.020	0.096	-0.058	0.086	0.025
S30	**0.241***	-0.024	**0.274***	0.019	**0.280***	0.005	0.003	0.064

Significance at $p < 0.01$ are indicated with *

Table B6

Personality Traits, and Corresponding Items of the 8-factor Total Sample ESEM model

Factors	Personality Trait	Items
F1	Introversion	S2, S4, S19
F2	Quirkiness	S6, S12
F3	Expressiveness	S1, S3, S5, S11, S15, S21, S29
F4	Curiosity	S13, S14, S16
F5	Ambivalence	S9, S26, S30
F6	Ambitiousness	S17, S18, S20, S22, S23, S24, S27
F7	Traditionalism	S8, S10, S25

F8	Adaptability	S7, S28

Table B7

Factor correlations of the personality factors found in the Total Sample model

	f1	f2	f3	f4	f5	f6	f7	f8
f1	1.000							
f2	0.207	1.000						
f3	-0.170	0.176	1.000					
f4	-0.105	0.157	0.100	1.000				
f5	0.075	0.022	0.000	0.066	1.000			
f6	0.196	0.123	**-0.187***	**-0.152***	-0.218	1.000		
f7	-0.016	**0.287***	-0.139	**0.377***	-0.007	-0.240	1.000	
f8	0.046	0.118	-0.015	0.143	-0.064	0.268	0.092	1.000

Note. Factor correlations: (* = significant at 1% level)

Table B8

Regression Coefficients of the Total Sample model

Predictor	B	SE	t	p
(Intercept)	16.38	1.96	8.37	**<.001*****
F1	-0.04	0.21	-0.21	.831
F2	0.11	0.23	0.46	.644
F3	0.34	0.27	1.26	.207
F4	0.82	0.24	3.51	**<.001*****
F5	-0.10	0.23	-0.45	.651
F6	1.62	0.33	4.93	**<.001*****
F7	-1.60	0.25	-6.34	**<.001*****
F8	1.16	0.20	5.72	**<.001*****

Note. *: Significance at the .05 level ($p < .05$), **: Significance at the .01 level ($p < .01$), ***: Significance at the .001 level ($p < .001$).

Table B9

Measures of Fit for the Early Adolescence ESEM models with 1 through 10 factors

N factors	AIC	BIC	Chi-Square	df	p-value	CFI	RMSEA
1	79532.98	79814.36	2714.477	405	0	0.337	0.084
2	78834.30	79251.67	1957.792	376	0	0.546	0.072
3	78309.86	78858.54	1377.356	348	0	0.704	0.061
4	77820.71	78496.01	834.202	321	0	0.853	0.045
5	77708.83	78506.06	670.326	295	0	0.892	0.040
6	77647.59	78562.06	559.082	270	0	0.917	0.036
7	77596.83	78623.86	460.329	246	0	0.938	0.033
8	77569.02	78703.91	386.521	223	0	0.953	0.030
9	77526.18	78764.23	299.670	201	0	0.972	0.025
10	77508.84	78845.38	240.335	180	.002	0.983	0.020

Table B10

Factor Loadings of the 8-factor Early Adolescence ESEM model

item	f1	f2	f3	f4	f5	f6	f7	f8
S1	0.016	0.070	-0.063	-0.019	**0.235***	0.009	-0.004	**0.205***
S2	**0.588***	**0.196***	0.001	0.015	0.132	-0.089	-0.028	-0.028
S3	0.001	0.244	0.105	-0.093	0.009	0.151	-0.028	**0.202***
S4	**0.714***	0.141	-0.038	-0.065	-0.017	0.016	0.004	0.022
S5	0.015	0.009	-0.031	**0.217***	0.109	**0.320***	0.018	-0.024
S6	0.056	**0.562***	0.004	0.108	0.031	-0.014	-0.001	-0.019
S7	**0.210***	0.152	0.064	-0.009	-0.007	**-0.278***	0.087	**0.220***
S8	**0.140***	**-0.185***	-0.020	**-0.299***	-0.023	**0.263***	0.000	0.030
S9	0.037	0.029	-0.029	**0.643***	-0.006	**-0.186***	0.007	-0.047
S10	0.015	0.024	**-0.413***	0.120	0.029	0.006	0.102	0.050
S11	0.001	0.126	0.005	0.161	0.028	**0.285***	**-0.302***	-0.029

S12	0.005	**0.759***	-0.015	0.001	-0.023	0.002	0.168	0.014
S13	0.021	0.043	**0.535***	-0.011	-0.156	**-0.195***	0.007	-0.132
S14	0.117	-0.133	**0.700***	0.000	0.021	-0.003	0.083	-0.010
S15	-0.101	-0.003	**0.263***	0.004	-0.005	**0.407***	-0.078	0.084
S16	-0.013	**0.215***	**0.322***	0.008	0.095	0.093	**0.206***	0.084
S17	-0.119	-0.004	-0.079	-0.120	0.137	-0.025	**0.298***	-0.044
S18	0.003	0.019	-0.027	**-0.626***	**0.232***	-0.006	0.067	-0.085
S19	**0.387***	-0.027	0.019	0.003	0.063	**-0.248***	0.052	-0.036
S20	0.000	0.015	0.006	**-0.745***	**0.357***	0.002	0.003	-0.004
S21	0.047	0.014	0.017	-0.015	**0.292***	0.078	-0.139	0.060
S22	0.014	0.008	0.114	-0.231	**0.279***	0.007	**-0.182***	**-0.221***
S23	0.003	-0.014	0.093	0.038	**0.337***	**-0.189***	**0.206***	0.109
S24	**-0.467***	-0.004	-0.002	-0.159	**0.466***	0.000	0.162	-0.005
S25	0.010	0.003	0.014	-0.003	0.005	**0.862***	**0.731***	-0.010
S26	0.038	0.025	-0.084	**0.637***	-0.006	0.004	0.027	-0.003
S27	-0.029	0.009	**0.229***	0.198	**0.275***	**-0.363***	-0.009	0.042
S28	0.004	0.024	-0.002	0.118	-0.005	-0.189	0.001	**0.570***
S29	-0.095	0.108	0.105	0.183	-0.090	**0.390***	0.000	0.018
S30	**0.208***	-0.018	-0.009	**0.260***	0.016	0.007	**-0.218***	0.160

Significance at $p < 0.01$ are indicated with *

Table B11

Personality Traits, and Corresponding Items of the 8-factor Early Adolescence ESEM model

Factors	Personality Trait	Items
F1	Introversion	S2, S4, S19
F2	Quirkiness	S3, S6, S12
F3	Curiosity	S13, S14, S16
F4	Ambivalence	S9, S10, S26, S30

F5	Ambitiousness	S1, S18, S20, S21, S22, S23, S24, S27
F6	Openness	S5, S8, S11, S15, S29
F7	Belief	S17, S25
F8	Adaptability	S7, S28

Table B12

Factor correlations of the personality factors found in the Early Adolescence model

	f1	f2	f3	f4	f5	f6	f7	f8
f1	1.000							
f2	0.183	1.000						
f3	-0.130	**0.340***	1.000					
f4	0.160	**0.208***	-0.028	1.000				
f5	0.075	0.308	**0.290***	0.144	1.000			
f6	0.044	0.083	-0.027	-0.021	0.036	1.000		
f7	-0.145	-0.151	0.121	-0.006	0.044	**-0.520***	1.000	
f8	-0.169	0.119	0.195	0.166	-0.041	0.116	-0.107	1.000

Note. Factor correlations: (* = significant at 1% level)

Table B13

Regression Coefficients of the Early Adolescence model

Predictor	B	SE	t	p-value
(Intercept)	14.08	2.68	5.26	**< .001** ***
F1	-0.46	0.29	-1.59	.112
F2	0.75	0.33	2.26	**.024** *
F3	0.73	0.33	2.24	**.025** *
F4	-0.46	0.36	-1.28	.200
F5	2.51	0.49	5.17	**< .001** ***
F6	-0.94	0.37	-2.54	**.011** *
F7	-0.77	0.30	-2.61	**.009** **

F8	1.15	0.29	3.973	**< .001** ***

Note. *: Significance at the .05 level (p < .05), **: Significance at the .01 level (p < .01), ***: Significance at the .001 level (p < .001).

Table B14

Measures of Fit for the Late Adolescence ESEM models with 1 through 10 factors

N Factors	AIC	BIC	Chi-Square	df	p-value	CFI	RMSEA
1	90693.91	90982.46	3362.523	405	0	0.308	0.090
2	89771.00	90199.00	2381.610	376	0	0.530	0.077
3	88974.00	89536.65	1528.607	348	0	0.724	0.061
4	88430.12	89122.62	930.728	321	0	0.857	0.046
5	88263.21	89080.74	711.817	295	0	0.902	0.039
6	88153.48	89091.25	552.095	270	0	0.934	0.034
7	88108.03	89161.21	458.642	246	0	0.950	0.031
8	88079.81	89243.60	384.420	223	0	0.962	0.028
9	88049.43	89319.01	310.037	201	0	0.974	0.024
10	88030.31	89400.89	248.924	180	.001	0.984	0.021

Table B15

Measures of Fit of the 8-factor Late Adolescence ESEM model

item	f1	f2	f3	f4	f5	f6	f7	f8
S1	0.008	-0.042	0.030	**0.346***	-0.004	0.051	0.038	0.184
S2	**0.746***	0.003	-0.055	0.017	-0.015	0.013	0.184	-0.001
S3	0.046	0.072	-0.002	**0.341***	-0.149	0.003	0.099	**0.230***
S4	**0.610***	0.090	-0.039	-0.007	0.012	0.131	-0.014	0.119
S5	-0.007	-0.011	0.001	**0.498***	0.210	0.079	0.089	-0.109
S6	-0.006	**0.855***	0.105	0.005	0.019	-0.006	0.004	-0.003
S7	0.010	0.078	0.112	-0.079	0.082	0.020	**0.169***	**0.190***
S8	**0.180***	-0.091	0.014	0.055	-0.011	**0.381***	**-0.344***	0.000

S9	0.004	0.021	0.015	-0.009	**0.540***	**-0.204***	**0.354***	0.003
S10	0.031	0.055	**-0.254***	-0.117	**0.254***	**0.211***	0.010	0.008
S11	**0.183***	0.037	-0.037	**0.405***	-0.011	0.008	**-0.225***	-0.004
S12	0.110	**0.286***	0.006	0.137	-0.025	-0.040	**0.303***	0.009
S13	0.013	0.034	**0.301***	-0.047	-0.029	0.070	**0.217***	-0.008
S14	0.017	-0.003	**0.999***	-0.002	-0.003	0.002	0.009	0.055
S15	0.049	-0.052	0.020	**0.474***	-0.120	-0.104	-0.008	-0.056
S16	-0.004	0.066	**0.229***	0.113	**-0.173***	-0.156	**0.309***	-0.005
S17	**-0.242***	-0.005	0.022	-0.012	-0.002	**0.262***	**0.365***	0.005
S18	-0.005	0.032	-0.034	0.001	**-0.421***	**0.551***	0.008	0.020
S19	**0.357***	-0.038	0.011	-0.159	0.073	**0.191***	**0.236***	-0.007
S20	-0.030	-0.015	0.016	-0.020	**-0.593***	**0.219***	0.001	**-0.208***
S21	0.060	0.042	-0.005	**0.267***	-0.157	-0.062	0.005	0.029
S22	**0.154***	0.022	0.030	0.020	**-0.284***	-0.014	0.105	**-0.385***
S23	0.002	-0.144	-0.010	-0.019	-0.006	-0.017	**0.671***	-0.206
S24	**-0.373***	0.001	-0.020	0.062	-0.139	0.030	**0.400***	**-0.260***
S25	**-0.136***	0.000	**0.165***	**0.408***	0.133	**0.247***	-0.039	-0.013
S26	-0.007	-0.001	-0.011	**0.216***	**0.707***	-0.003	**0.326***	0.180
S27	-0.004	-0.178	0.133	0.001	0.014	**-0.275***	**0.506***	0.041
S28	-0.111	-0.005	0.109	0.112	-0.014	-0.066	0.016	**0.444***
S29	-0.073	0.010	-0.006	**0.529***	0.047	-0.075	-0.135	0.068
S30	**0.170***	0.002	0.073	**0.207***	**0.321***	-0.152	0.000	-0.004

Note. Factor correlations: (* = significant at 1% level)

Table B16

Measures of Fit of the 7-factor Late Adolescence ESEM model

	f1	f2	f3	f4	f5	f6	f7
S1	0.094	**0.195***	0.029	-0.036	0.059	0.045	0.100

S2	**0.233***	0.016	**0.562***	**0.534***	-0.011	-0.007	-0.009
S3	**0.319***	**0.160***	-0.020	-0.018	0.022	-0.002	0.053
S4	**0.228***	-0.066	**0.588***	**0.328***	-0.018	0.001	0.006
S5	-0.008	**0.463***	-0.009	0.016	-0.015	0.091	**0.259***
S6	0.629	0.014	0.021	-0.123	0.062	0.171	-0.002
S7	0.108	**-0.186***	0.006	0.046	**0.137***	0.202	0.055
S8	-0.227	0.007	**0.416***	-0.021	0.010	**-0.275***	0.140
S9	0.022	-0.015	-0.094	0.094	0.005	**0.634***	0.083
S10	-0.083	**-0.173***	0.040	0.021	**-0.319***	0.148	**0.170***
S11	0.115	**0.424***	**0.263***	-0.033	-0.042	-0.078	0.000
S12	**0.558***	-0.025	-0.083	0.018	0.002	0.117	0.069
S13	0.077	**-0.132***	-0.003	0.081	**0.347***	-0.007	0.104
S14	-0.024	-0.002	0.271	0.002	**1.029***	0.010	0.007
S15	0.102	**0.490***	0.003	0.020	0.043	-0.119	0.008
S16	**0.281***	0.055	**-0.161***	0.089	**0.286***	-0.012	-0.016
S17	0.010	**-0.245***	**-0.350***	-0.016	0.014	-0.028	**0.310***
S18	0.056	**-0.252***	-0.002	0.001	-0.035	**-0.583***	**0.272***
S19	-0.005	**-0.227***	**0.262***	**0.364***	0.027	0.008	**0.154***
S20	0.010	-0.011	**-0.127***	0.101	0.029	**-0.714***	0.047
S21	**0.164***	**0.259***	0.009	0.033	0.009	-0.100	-0.020
S22	0.044	**0.164***	-0.009	**0.224***	0.041	**-0.396***	-0.010
S23	-0.107	-0.003	**-0.372***	**0.498***	0.002	0.007	**0.257***
S24	-0.005	0.021	**-0.594***	-0.004	-0.036	**-0.162***	**0.193***
S25	-0.013	**0.234***	0.012	**-0.210***	**0.168***	-0.016	**0.279***
S26	0.037	0.014	-0.009	-0.022	-0.026	**0.761***	**0.274***
S27	0.016	-0.004	**-0.248***	**0.276***	**0.194***	**0.218***	-0.007
S28	0.106	-0.039	-0.033	-0.095	**0.149***	**0.217***	-0.029
S29	0.142	**0.460***	-0.004	**-0.219***	-0.003	0.064	0.022

S30	0.001	**0.287***	**0.214***	0.084	0.077	**0.326***	-0.001

Significance at $p < 0.01$ are indicated with *

Table B17

Personality Traits, and Corresponding Items of the 8-factor Late Adolescence ESEM model

Factors	Personality Trait	Items
F1	Quirkiness	S3, S6, S12
F2	Independence	S1, S5, S11, S15, S21, S29
F3	Introversion	S2, S4, S8
F4	Critical Thinking	S19, S22, S27
F5	Curiosity	S13, S14, S16
F6	Ambivalence	S7, S9, S26, S28, S30
F7	Leadership	S10, S17, S18, S20, S23, S24, S25

Table B18

Factor correlations of the personality factors found in the Late Adolescence model

	f1	f2	f3	f4	f5	f6	f7
f1	1.000						
f2	0.178	1.000					
f3	-0.105	-0.014	1.000				
f4	**0.341***	**-0.242***	-0.240	1.000			
f5	**0.212***	0.110	**-0.399***	**0.183***	1.000		
f6	0.038	-0.146	0.094	0.244	-0.068	1.000	
f7	0.020	-0.039	0.140	-0.114	-0.036	-0.107	1.000

Note. Factor correlations: (* = significant at 1% level)

Table B19

Regression Coefficients of the Late Adolescence model

Predictor	B	SE	t	p-value
(Intercept)	16.17	2.71	5.97	**<.001*****

F1	0.68	0.33	2.05	**.040 ***
F2	-0.02	0.35	-0.06	.951
F3	-0.23	0.32	-0.70	.483
F4	1.52	0.37	4.14	**<.001*****
F5	1.31	0.32	4.06	**<.001*****
F6	0.26	0.37	0.69	.493
F7	-1.26	0.50	-2.55	**.011 ***

Note. *: Significance at the .05 level ($p < .05$), **: Significance at the .01 level ($p < .01$), ***: Significance at the .001 level ($p < .001$).

Table B20

VIF per factor

	F1	F2	F3	F4	F5	F6	F7	F8
Total Sample	1.102	1.248	1.087	1.192	1.223	1.213	1.074	1.093
Early adolescence	1.094	1.205	1.159	1.182	1.165	1.103	1.056	1.138
Late adolescence	1.200	1.099	1.058	1.121	1.141	1.129	1.146	-

Table B21

Skewness and kurtosis values per item in the Total Sample

Variable	Skewness	Kurtosis
S1	-0.118	-1.348
S2	-0.048	-1.103
S3	0.414	-1.462
S4	-0.076	-1.011
S5	-0.261	-1.338
S6	-0.542	-0.505
S7	0.043	-1.158
S8	-0.426	-0.733
S9	0.281	-1.257
S10	0.465	-1.074

S11	-0.82	-0.712
S12	-0.606	-0.268
S13	-0.315	-1.263
S14	-0.898	0.194
S15	0.108	-1.562
S16	-0.884	-0.118
S17	1.263	0.456
S18	0.296	-0.786
S19	0.079	-1.252
S20	-0.085	-0.799
S21	-0.207	-1.167
S22	-0.492	-0.849
S23	1.073	-0.190
S24	0.012	-1.149
S25	0.223	-1.148
S26	0.082	-0.985
S27	-0.191	-1.169
S28	-0.101	-1.147
S29	-0.052	-1.055
S30	-0.945	-0.260

Table B22

Skewness and kurtosis values per item in the Early Adolescence group

Variable	Skewness	Kurtosis
S1	-0.115	-1.295
S2	-0.103	-1.128
S3	0.400	-1.497
S4	-0.085	-0.977
S5	-0.336	-1.290
S6	-0.539	-0.529
S7	0.039	-1.143
S8	-0.511	-0.597
S9	0.423	-1.083
S10	0.415	-1.128
S11	-0.895	-0.512

S12	-0.620	-0.331
S13	-0.282	-1.251
S14	-0.818	0.018
S15	0.085	-1.563
S16	-0.913	-0.056
S17	1.273	0.509
S18	0.374	-0.721
S19	-0.052	-1.200
S20	-0.030	-0.822
S21	-0.200	-1.154
S22	-0.536	-0.832
S23	1.127	-0.020
S24	0.088	-1.114
S25	0.265	-1.108
S26	0.120	-0.976
S27	-0.174	-1.116
S28	-0.118	-1.134
S29	0.008	-1.028
S30	-1.021	-0.074

Table B23

Skewness and kurtosis values per item in the Late Adolescence group

Variable	Skewness	Kurtosis
S1	-0.117	-1.398
S2	0	-1.076
S3	0.425	-1.435
S4	-0.065	-1.047
S5	-0.194	-1.37
S6	-0.533	-0.524
S7	0.046	-1.174
S8	-0.351	-0.832
S9	0.149	-1.361
S10	0.509	-1.023
S11	-0.753	-0.873
S12	-0.591	-0.23

S13	-0.345	-1.274
S14	-0.97	0.362
S15	0.128	-1.564
S16	-0.858	-0.175
S17	1.252	0.399
S18	0.231	-0.848
S19	0.202	-1.252
S20	-0.131	-0.782
S21	-0.214	-1.181
S22	-0.454	-0.864
S23	1.026	-0.338
S24	-0.056	-1.168
S25	0.185	-1.183
S26	0.049	-0.998
S27	-0.203	-1.217
S28	-0.086	-1.162
S29	-0.106	-1.072
S30	-0.879	-0.411

Figure B1

Histogram of age frequency

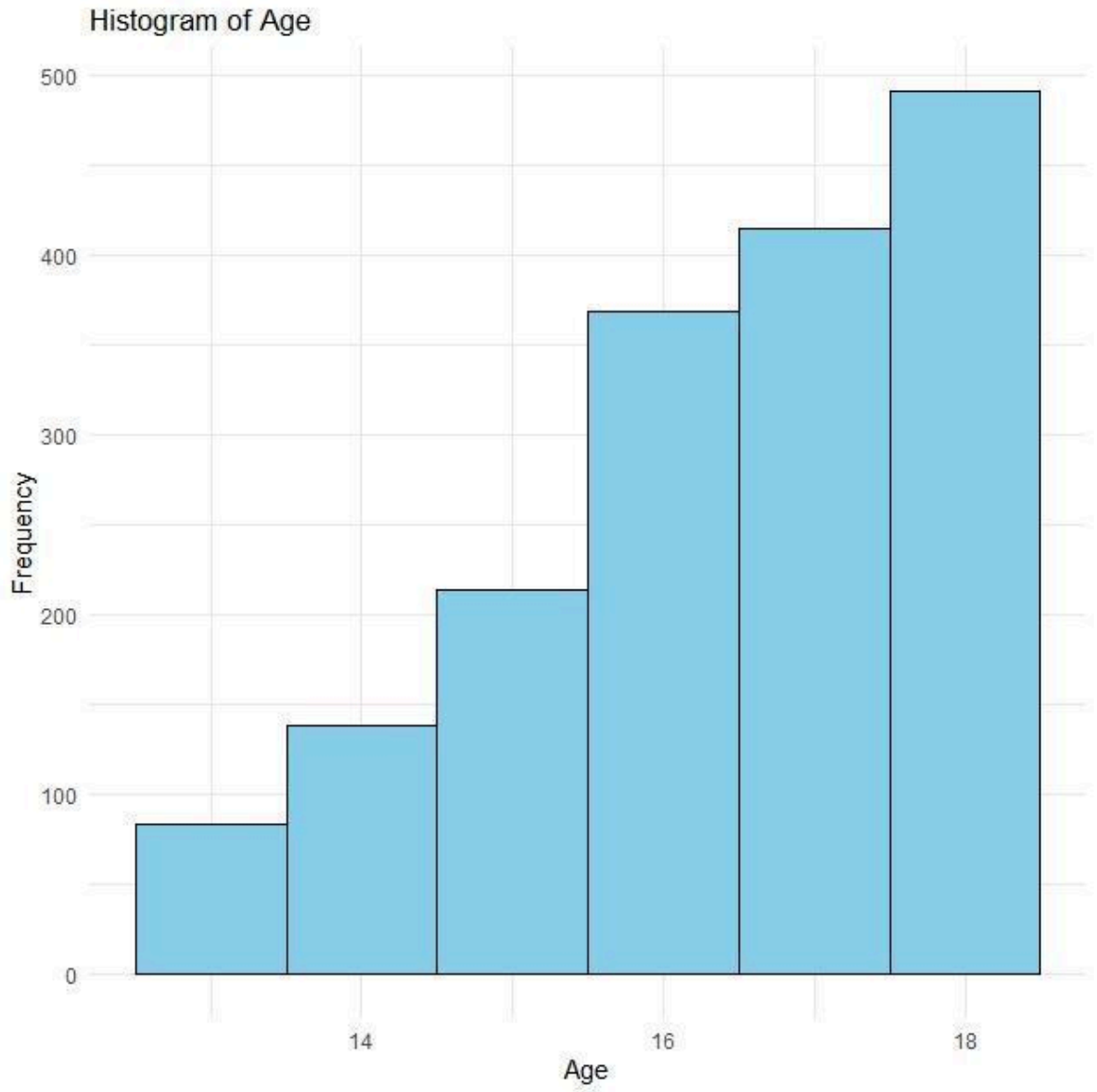


Figure B2

Diagnostic plots for Linear regression (hypothesis 2)

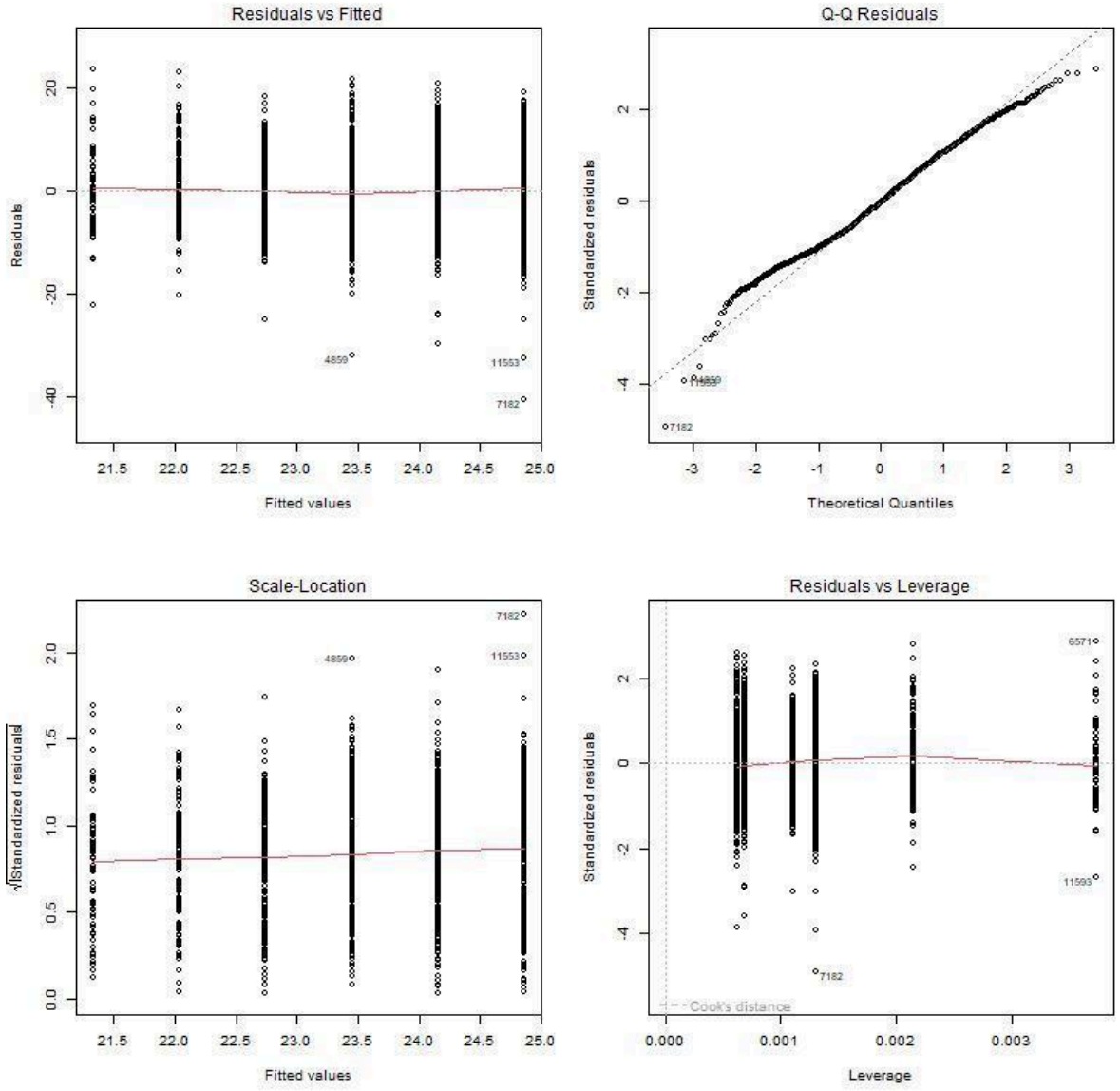
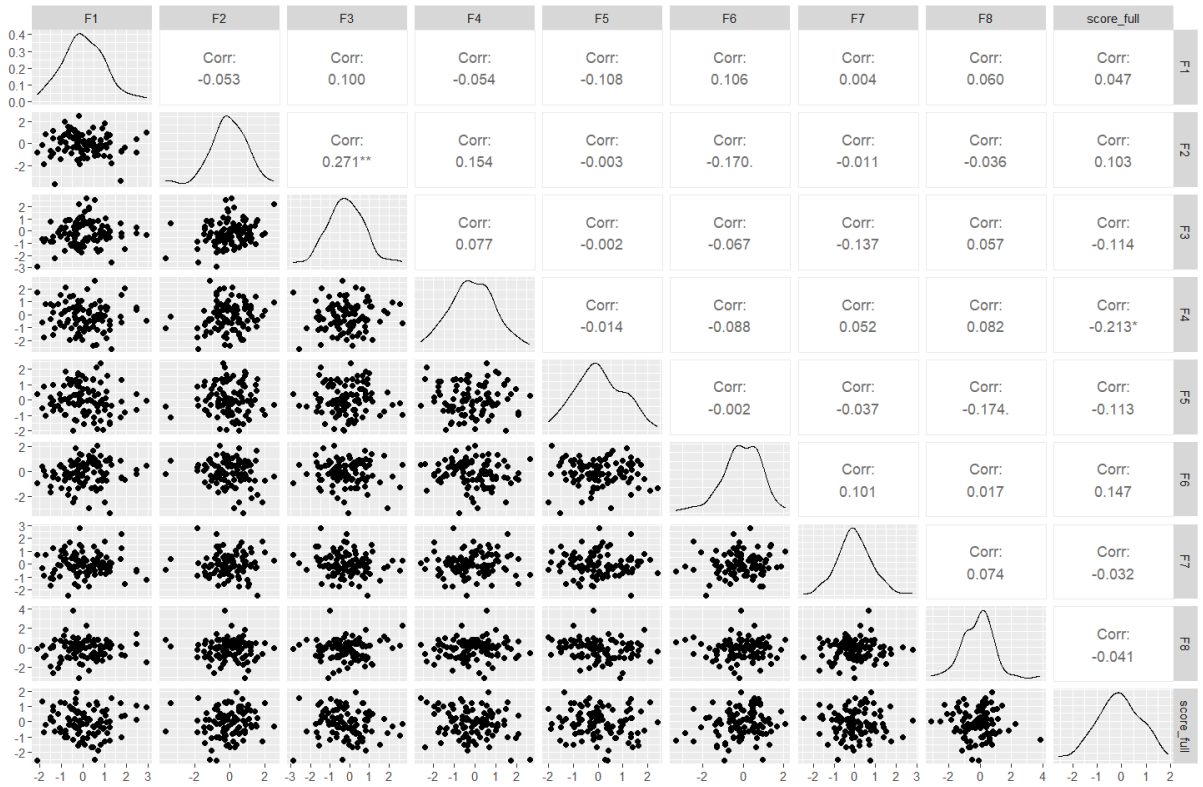


Figure B3

Scatter plots Total Sample - Outliers and multicollinearity



Note. *: Significance at the 0.05 level ($p < 0.05$), **: Significance at the 0.01 level ($p < 0.01$), ***: Significance at the 0.001 level ($p < 0.001$)

Figure B4

Scatter plots Early Adolescence Model - Outliers and multicollinearity

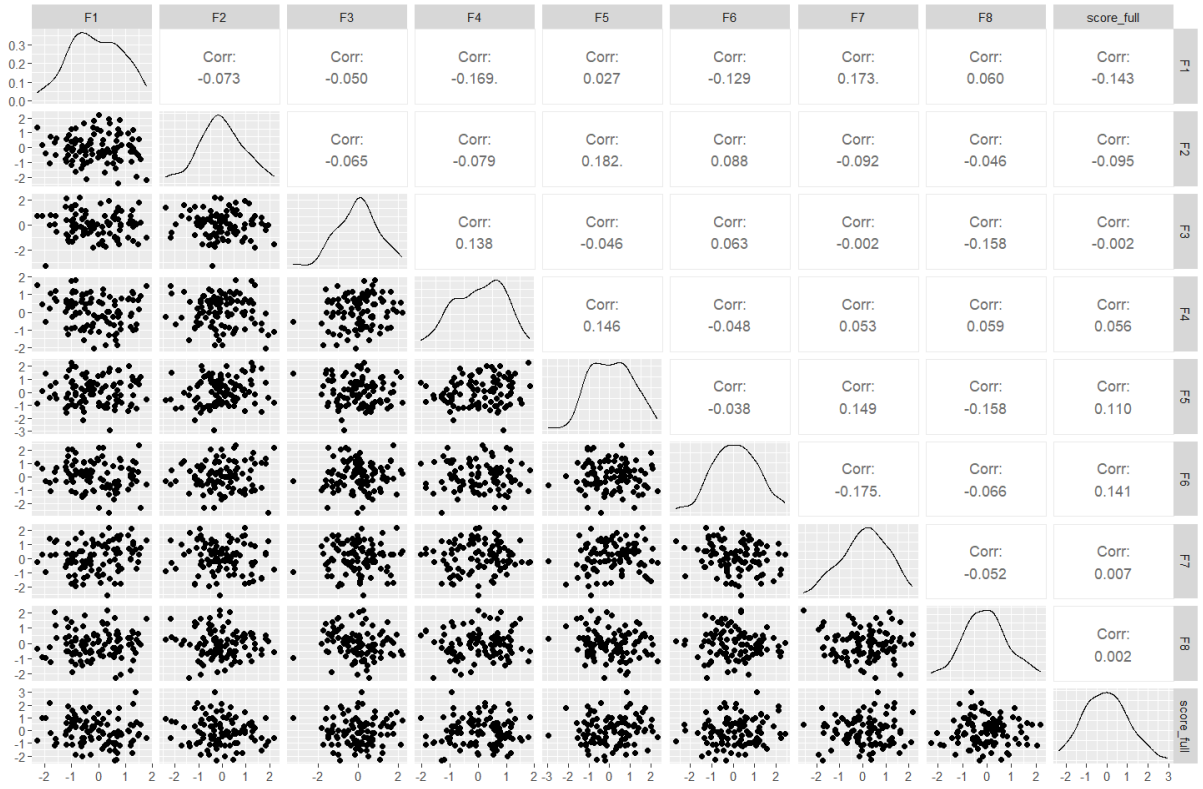
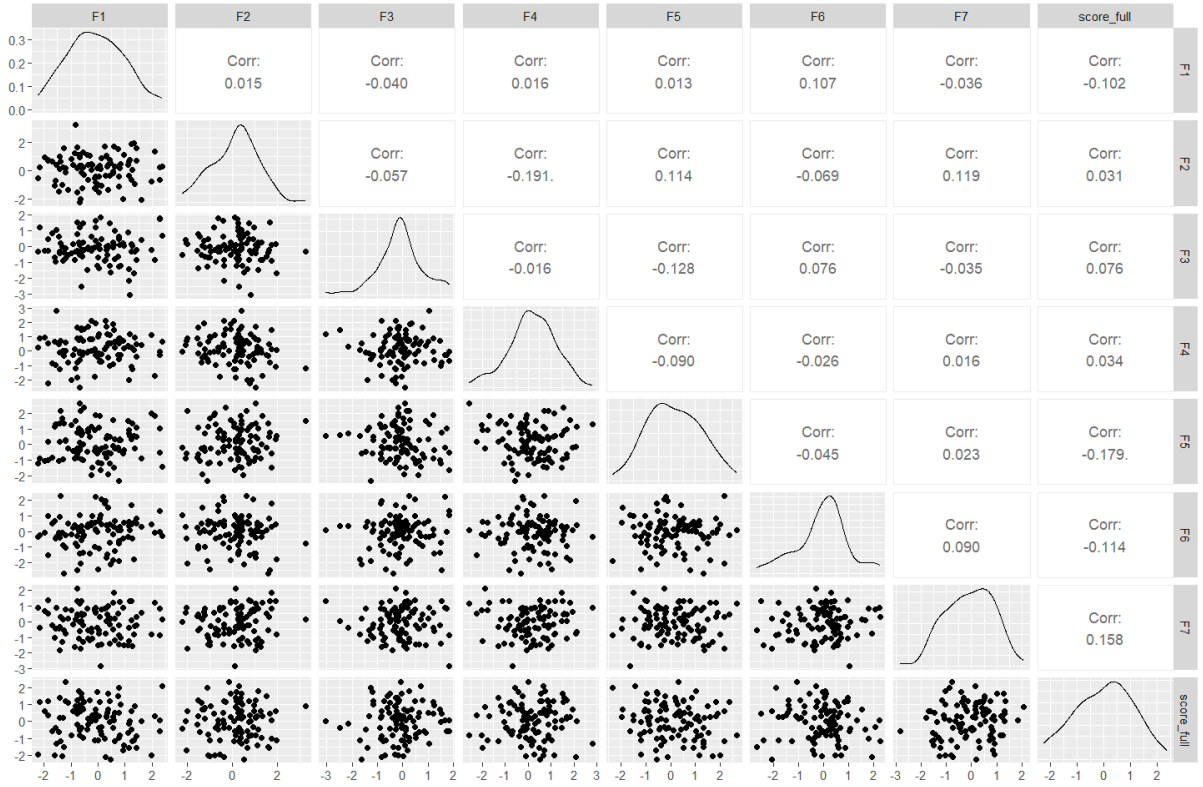


Figure B5

Scatter plots Late Adolescence Model - Outliers and multicollinearity



Appendix C

Codebook – Personality items

Items were answered using a likert scale (1=Disagree, 5=Agree):

S1 I prefer to be barefoot.

S2 I avoid contact with others.

S3 I had an imaginary friend as a child.

S4 I'd rather not have people pay attention to me.

S5 I would be interested in getting my fortune told.

S6 I am not what society wants me to be.

S7 I don't pack much luggage when I travel.

S8 I try my best to follow the rules.

S9 I did not work very hard in school.

S10 I don't like to analyze literature.

S11 I sometimes feel like crying when I get angry.

S12 I am very unusual.

S13 I have been very interested in historical wars.

S14 I think ancient philosophy still is meaningful today.

S15 I have kept a personal journal.

S16 I have lots of my own theories.

S17 I could do an impressive amount of push ups.

S18 I put work first.

S19 I do not have a very expressive face.

S20 I do more than what’s expected of me.

S21 I sit on my legs.

S22 I am a perfectionist.

S23 I have studied how to win at gambling.

S24 I naturally emerge as a leader.

S25 I wish people were more spiritual.

S26 I always do the bare minimum I need to get by.

S27 I like to play devil's advocate.

S28 I am not bothered by messy people.

S29 I am more artistic than scientific.

S30 I am not quite sure what I want.