Predicting Life Outcomes with Individual Differences in Personality and Cognitive Ability:

A Longitudinal Heritability Study

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Abstract

Numerous studies have examined personality and cognitive ability in relation to life outcomes. However, longitudinal studies examining these relationships are relatively scarce, leaving the extent to which individual differences can account for life outcomes still unclear. The focus of this study was to use the latest European twin data to study personality and cognitive ability as predictors for the life outcomes: education level, occupation, life satisfaction and friendship. Heritability analyses of the variables were performed to provide supporting context to individual differences. A sample of 842 young adults (mean age 23 at Wave 1) using data from the TwinLife project was analysed through a longitudinal within-person correlation analysis with a four-year period between Wave 1 and Wave 2. Heritability was calculated via Falconer's formula using data from monozygotic and dizygotic twin pairs. The results show that cognitive ability was the overall best predictor with robust correlations to education level ($r = .34$) and occupational outcomes ($r = .31$). Conscientiousness was the strongest predictor out of the personality traits and was associated to life satisfaction ($r = .22$), education ($r = .10$) and occupation ($r = .11$). The heritability of all predictor variables, specifically cognitive ability ($h^2 = .88$) and extraversion ($h^2 = .89$), was high and should be considered when interpreting the results. Limitations regarding reliability of scales and attenuation likely yielded conservative estimates on life outcomes overall. Recommendations for future research is studying the heritability with more comprehensive methods, especially the genetic variance of the correlations themselves.

Keywords: personality, cognitive ability, life outcomes, heritability

Prediktion av Livsutfall via Individuella Skillnader i Personlighet och Kognitiv Förmåga: En Longitudinell Heritabilitetsstudie

Sammanfattning

Ett flertal studier har undersökt personlighet och kognitiv förmåga i förhållande till livsutfall. Det är däremot färre longitudinella studier som undersökt dessa samband, vilket medför oklarhet i hur mycket individuella skillnader kan förklara livsutfall. Syftet med denna studie var att använda senaste europeiska tvillingdata för att undersöka personlighet och kognitiv förmåga som prediktorer för livsutfallen: utbildningsnivå, sysselsättning, livstillfredsställelse och vänskap. Heritabilitetsanalyser utfördes även för att kontextualisera individuella skillnader. Ett urval bestående av 842 unga vuxna (medelålder 23 vid första mättillfället) utifrån data från TwinLife-projektet analyserades genom en longitudinell "within-person"-korrelationsanalys med en fyraårsperiod mellan mätpunkterna. Heritabilitet beräknades med hjälp av Falconers formel genom att jämföra data från monozygota och dizygota tvillingpar. Resultaten visar att kognitiv förmåga var den bästa prediktorvariabeln med robusta korrelationer avseende utbildningsnivå ($r = .34$) och yrkesrelaterade variabler ($r = .31$). Samvetsgrannhet var den starkaste prediktorn av personlighetsvariablerna och var kopplad till livstillfredsställelse ($r = .22$), utbildning ($r = .10$) och sysselsättning ($r = .11$). Heritabiliteten av alla prediktorvariabler, specifikt kognitiv förmåga ($h^2 = .88$) och extraversion ($h^2 = .89$), var hög och bör beaktas vid tolkning av övriga resultat. Begränsningar gällande mätskalornas reliabilitet och "attenuation" (försvagning) genererade sannolikt konservativa uppskattningar av korrelationssamband. Rekommendationer för framtida studier är att använda mer omfattande metoder för heritabilitetsanalys, exempelvis i form av att studera den genetiska variansen i korrelationssambanden.

Nyckelord: personlighet, kognitiv förmåga, livsutfall, heritabilitet

Personligt förord

Jag vill inleda uppsatsen med att ge ett stort tack till min handledare Petri som bidragit med ovärderlig hjälp i alla skeden av arbetet och som funnits där när tabeller har strulat och jag varit på bristningsgränsen. Jag vill även ge ett stort tack till Christian Kandler, Markus Cziesla och alla andra forskare och dataansvariga som varit involverade i TwinLife-projektet och som möjliggjort detta arbete genom att dela med sig av sin data. Sist vill jag passa på att tacka min familj och mina vänner som funnits där och hjälpt mig genom hela detta arbete.

Introduction

What are the deciding factors to where we end up in life compared to one another? Understanding the factors that influence life outcomes is a complex but crucial endeavour in psychology. Researchers have studied many potential variables in the pursuit of finding life outcome predictors, such as self-esteem (e.g., Orth et al., 2012), self-control (e.g., Moffitt et al., 2011) and socio-economic status (e.g., Roberts et al., 2007). The results generally indicate that the variables can be used as predictors for life outcomes such as occupational attainment, salary, relationship satisfaction and health problems. However, there seems to be uncertainty surrounding the predictive power of the variables in question. In addition to socio-economic status, Roberts et al. (2007) also studied the predictive value of personality and cognitive ability and found them both to be better predictors of life outcomes.

Personality and cognitive ability are core aspects that define and separate individuals from each other, making them important pieces of the puzzle determining where we end up in life. This is supported by heritability studies which support the notion that personality and cognitive ability are robust constructs that are stable parts of who we are throughout life (Bleidorn et al., 2014; Plomin et al., 1994). This study will consequently focus on personality and cognitive ability as predictors for important life outcomes.

Personality

Personality is a complex concept with numerous models for classifying traits and types, each with varying degrees of supporting evidence. This study will be using the five-factor model of personality, often referred to as the Big Five model (Costa & McCrae, 2008; McCrae & Costa, 1997). This model identifies five core personality traits: extraversion, openness, agreeableness, conscientiousness and neuroticism, which have been shown to be generalisable across different cultures, languages and countries (Kajonius & Mac Giolla, 2017; McCrae & Costa, 1997). Briefly explained, extraversion reflects sociability, excitement-seeking and outgoing behaviour; openness captures a preference for new experiences, curiosity and engagement in creative and intellectual activities; agreeableness reflects trust in others, compliance and sympathetic social behaviour; conscientiousness reflects engagement in goal-driven activities, self-discipline and organisation and lastly neuroticism reflects emotional instability, vulnerability to stress and anxious behaviour (John & Srivastava, 1999). The traits are comprised of several smaller facets reflecting different

1

aspects of the larger dimensions of personality, such as the ones described above (McCrae & Costa, 1997). Furthermore, they have also been shown to predict life outcomes in a similar magnitude to socio-economic status and cognitive ability even after controlling for other factors (Roberts et al., 2007).

Cognitive ability

Cognitive ability and intelligence are terms often used broadly and interchangeably. Intelligence as a concept is not universally defined and can differ between eastern and western cultures, for example (Das, 2004). Will and emotion are not typically regarded as parts of intelligence within a western context. A need for a more qualitative view integrating these aspects into the intelligence construct can be argued for, as an alternative to the current quantitative view relying on reasoning and problem-solving ability (Das, 1994). Furthermore, in relatively recent times other ways of regarding intelligence have emerged, such as social intelligence, emotional intelligence and practical intelligence (Lievens & Chan, 2017). However, cognitive ability will be treated in the traditional sense as an IQ-measurement in this study due to it being a well-established, recognised and standardised way of measuring cognitive ability. This also facilitates for comparative analyses to previous studies on the subject. Still, cognitive ability is the term which will be used henceforth to avoid possible misassociation surrounding the word "intelligence".

Cognitive ability has been studied extensively and is widely acknowledged as a predictor for academic and occupational success (e.g., Schmidt & Hunter, 1998). Consequently, it constitutes a valuable factor for analysis within the framework of predicting life outcomes.

Life outcomes

A goal of this study is to explore how personality and cognitive ability predicts important life outcomes, making the selection of outcomes crucial. Competence in academic attainment and friendship has been shown to be significant for development into adulthood and continued competence in addition to occupational and romantic competence later in life, as suggested by previous research (Roisman et al., 2004). This signifies the importance of academic and interpersonal competence as qualities to possess in life, advocating for them as life outcome variables. Additionally, education specifically has indicated to have substantial health benefits, which further reinforces the inclusion of education level as an important life outcome (Groot & Van Den Brink, 2007).

Occupation is another important area of life, where studies have shown wage and occupational status to be important for life satisfaction (Choi & Lim, 2020; Hofmann et al., 2018; Johnson & Krueger, 2006). Occupational status has also been shown to be related to health, for example careers within blue collar occupations being related to poor health outcomes later in life (Fletcher, 2011). The impact of occupation on several areas of life justifies including an occupational measure as a life outcome. However, a prestigious occupation with high income does not necessarily equal happiness or life satisfaction for everyone, which is an important problematisation to highlight when working with these topics (Myers, 2000). Consequently, including a direct subjective measure of the participants' life satisfaction would avoid this potential issue and allow for a more comprehensive image of well-being and happiness.

Personality and cognitive ability as predictors for life outcomes

The relationship between personality, cognitive ability and life outcomes has been studied in different ways in multiple studies over the years. Starting with education as a life outcome, a significant link has been found between educational performance and personality traits (Ahadi & Narimani, 2010). Openness ($r = .15$), agreeableness ($r = .12$) and extraversion ($r = .11$) all showed significant correlations with educational performance, but conscientiousness ($r = .52$) and neuroticism ($r = -.40$) emerged as particularly large correlates. The relationship between personality and academic motivation has been studied by De Caso Fuertes et al. (2020) and showed smaller but similar correlations to the education related correlations found by Ahadi and Narimani (2010). Cognitive ability has also been shown to be a predictor for academic success. A longitudinal study of English adolescents compared cognitive measures (CAT scores) to overall GCSE point scores after a 5-year gap and found large correlations ($r = .69$) (Deary et al., 2007). The importance of cognitive abilities for academic achievement has also been corroborated by additional studies (Tikhomirova et al., 2020).

Regarding occupation, Judge et al. (1999) explored how childhood personality and general mental ability related to career success measured as intrinsic (job satisfaction) as well as extrinsic (income and occupational status). The researchers found a positive correlation between conscientiousness and all areas of career success ($r = .40$). Regarding extrinsic success specifically, smaller but still substantial correlations were found for neuroticism ($r = -.34$) and Openness ($r = .26$). However, general mental ability was the strongest predictor with

a large positive correlation between childhood mental ability and extrinsic career success (r = .53). Measures were also made in adulthood with similar results. Other studies on cognitive ability have shown that IQ has a significant impact on success in life, measured by occupation and income (Firkowska-Mankiewicz, 2002). The relationship between personality traits and occupational variables have also been analysed by Rothmann and Coetzer (2003) in a study on task performance, creativity and management skills. The result show that a combination of extraversion, openness and conscientiousness could explain 15% of variance in task performance and creativity. Furthermore, significant correlations were found between management skills and neuroticism (r = -.31), openness (r = .41) and agreeableness (r = .31). Management skills is a particularly important variable due to its importance for career advancement.

A mega-analysis (a pooled analysis of raw data) by (Beck & Jackson, 2022) investigated the robustness of prospective personality-outcome associations in relation to 14 life outcomes, including higher education and unemployment. The results show that individual differences in personality predicted life outcomes, even after accounting for a wide range of background variables. For education level, the results showed a positive correlation for openness and a negative correlation for conscientiousness. For unemployment, a positive correlation was found for neuroticism and openness. Some of these results are surprising and contradictory to previous research, for example in comparison to previous studies finding a large positive correlation between education variables and conscientiousness (Ahadi & Narimani, 2010; De Caso Fuertes et al. 2020) The authors suggest that some covariates included in the matching procedure might act as mediators and affect the link between personality characteristics and outcome. Nevertheless, the discrepancy between the results of previous studies advocates for additional research to clarify the relationship between the variables.

Life satisfaction is another life outcome that has been studied in relation to personality and cognitive ability. The relationship between personality traits and life satisfaction has been studied by Smith and Konik (2021), showing significant correlations for extraversion (r = .41), conscientiousness (r = .40), neuroticism (r = -.38) and agreeableness (r = .31) as well as a smaller correlation for openness (r = .18). A meta-analysis investigating the relationship between general mental ability and life satisfaction found a positive correlation between the variables, which the authors attributed to a higher attained job complexity and income through additional analyses (Gonzalez-Mulé et al., 2017). However, other studies have failed to

replicate the correlations, suggesting a possible uncertainty regarding the relationship between cognitive ability and life satisfaction (Amdurer et al., 2014; Zettergren & Bergman, 2014).

There appears to be a relative lack of studies on friendship as a life outcome variable. Studies suggest that a similarity of personality and cognitive ability facilitates the forming and quality of friendship (Ilmarinen et al., 2017). Though that does not answer how individual differences in cognitive ability and personality traits on a group level affect friendship-related variables. Regarding personality, a review article by Harris and Vazire (2016) suggest that agreeableness is the personality trait with the strongest effect on friendship development, followed by a negative effect for neuroticism. Extraversion is another personality trait with implications on friendship, with a study by Pollet et al. (2011) showing that extraverts have larger social networks at all network layers, but do not feel closer emotionally to people close to them. A meta-analysis by Buecker et al. (2020) studied the relationship between personality traits and loneliness and found a positive correlation for neuroticism ($r = .36$) and negative correlations for the other personality traits, the strongest being extraversion ($r = -.37$) and agreeableness ($r = -.24$). Judging by the available literature, extraversion, agreeableness and neuroticism seem to be the personality traits with the strongest connection to friendship-related variables.

In conclusion, cognitive ability has been shown to be a strong predictor of objective life outcomes such as education and occupation. The personality traits conscientiousness and (low) neuroticism has also been shown to be beneficial for excelling in these areas. For subjective life outcome variables such as life satisfaction and friendship, cognitive ability seems to have less predictive power in comparison to personality traits as extraversion and (low) neuroticism. Openness and agreeableness have been shown to have a partial impact on life outcomes but tend to generally be the personality traits with the least predictive power. Nevertheless, longitudinal studies examining these relationship between personality, cognitive ability and life outcomes are relatively scarce, leaving the extent to which individual differences can account for life outcomes still somewhat unclear.

Heritability

While establishing that aforementioned variables are related to life outcomes is an important finding in itself, that does little in the way of explaining the underlying mechanisms behind how the predictors can impact the outcome variables. To study these correlations more

thoroughly, for instance through analysing possible moderators or mediators, is unfortunately beyond the scope of this study. However, exploring the nature of the variables themselves can be highly informative for a deeper understanding of the correlations. If the results of this study would show that the predictor variables explain a large part of the variance of life outcome variables, it would be important to understand how the variance of the predictor variables can be explained. One such aspect which is often involved in psychological processes is heritability. One defining aspect important to all variables is how genetically driven they are. Understanding the genetic component of the variables is essential for deciding how to approach the correlation findings. For instance, implementing environmental changes aiming to affect a strong genetically driven variable would likely yield few results. Analysing the genetic component of the variables would therefore deepen our understanding which allows for more informed decision making.

Genetics can be studied in different ways using different designs, the most common being twin, adoption and family studies (Mayhew & Meyre, 2017). The framework of many heritability-related designs and analyses can be understood through three sources of variance which together explain the total variance of an outcome variable: genetic influence (A), shared environment (C) and unique environment (E). These domains can be utilised in twin studies to calculate heritability (h^2) using Falconer's formula. Specific information regarding how Falconer's formula is used to calculate heritability is provided in the method section.

The general model of twin studies and Falconer's formula utilises the assumption that monozygotic twins share 100% of their genetic composition, while dizygotic twins share 50% on average. Since monozygotic twins assumed to share genes (A) and living conditions (C), all variance can be attributed to their unique environment (E). Dizygotic twins also share living conditions (C) but only half of their genes (A), meaning variance can be attributed to both genes and unique environment (A and E). Lastly, the contribution of unique environment is assumed to be the same for monozygotic and dizygotic twin pairs. Establishing these fundaments allows for heritability analyses. Since the environmental impact is assumed to be the same for monozygotic and dizygotic twins, any additional correlations for monozygotic twins must be attributed to genetic factors.

Some limitations of calculating heritability using Falconer's formula are important to underline. The model is a simplification of a complex phenomenon and assumes a non-occurrence of gene-environment interactions and differences in unique environment, which

cannot be guaranteed (Mayhew & Meyre, 2017). Working with heritability at a broad level does not account for nuances and carries the risk of overestimating the impact of heritability. Keeping the limitations in mind, using these measures still provides a general estimation of heritability providing more insight into the study variables.

Previous heritability research regarding the study variables has indicated that they are, at least to some extent, genetically driven. Meta-analyses suggest that the heritability of the personality traits is generally around $h^2 = .40$ for all respective traits (Vukasović & Bratko, 2015). The heritability of cognitive ability has been shown to be higher, studies generally suggest a heritability of around .70 to .80 (Feldman & Otto, 1997; Plomin et al., 1994). Research studying heritability of the outcome variables seem to be scarce, but available studies suggest that $h^2 = .43$ for education level (Silventoinen et al., 2020), $h^2 = .32$ for life satisfaction (Røysamb et al., 2018), $h^2 = .11$ for occupational prestige (Akimova et al., 2023) and h^2 around .40 to .55 for friendship related variables (Neugart & Yildirim, 2022).

The present study

Research Question 1: The primary aim of this study is to analyse how individual differences in personality and cognitive ability predict life outcomes, specifically education, occupation, life satisfaction and friendship.

Research Question 2: The secondary aim of this study is to analyse the heritability of the predictor and outcome variables using the latest European twin data.

Method

Sample

The sample of this study is based on data from the TwinLife project, a part of GESIS - Leibniz Institute for the Social Sciences. TwinLife is a longitudinal twin family study which incorporates over 4,000 German families, with the aim of studying social inequalities from a genetic and psychosocial perspective over the life course (Hahn et al., 2016; Mönkediek et al., 2019). Monozygotic twins, same-sex fraternal twins as well as additional family members were interviewed face-to-face at the start of the project in 2014 and continuously every other year, together with supplementary phone-based surveys (Mönkediek et al., 2019). Twins were sampled into four different cohorts (5, 11, 17 and 23 mean age at first wave of data collection). The data was collected from all regions of Germany and sampled randomly by using resident

registers, with an overall response rate of 37% (Hahn et al., 2016). The response rate is comparable to other German twin studies (Spinath & Wolf, 2006). Regarding the socio-economic structure of the TwinLife sample, the share of participants with German citizenship was 84.7% and the percentage of university educated households was 43.5% (Lang & Kottwitz, 2020). These numbers are similar but elevated compared to a sample representative of the German population.

For the analyses, only the cohort of young adults ($M = 23.1$, $SD = 1.83$ at first wave of data collection, 57% female) was chosen due to previous findings showing personality being variable to a greater extent during adolescence but stabilising during early adulthood (Borghuis et al., 2017). Only monozygotic twins (N = 404), same-sex fraternal twins (N = 347) and full siblings of similar age (N = 91) were included in the analyses. Additionally, only the first and third waves of data collection were included in this study due to those waves being the only ones with data matching the selected variables and cohort. The TwinLife wave 1 and wave 3 will be referred to as Wave 1 and Wave 2 in this study.

To allow for a longitudinal within-person design, only 842 participants were included in the study compared to the 2400 who participated in the first wave of data collection due to non-responses in following waves. The risk of selective dropout bias in the TwinLife data has been studied by Klatzka et al. (2019) who found no consistent patterns in personal characteristics (personality, relational characteristics between family members, age cohort and sex) regarding dropout. Despite a relatively large exclusion of participants, a sample size of 842 should still be large enough to establish stable correlations and is above the recommended sample size of 250 for stable estimates (Schönbrodt & Perugini, 2013).

Measurements

Personality

Personality was measured using a German version of the Big Five Inventory – Short version (BFI-S), based on work by Gerlitz & Schupp (2005). Each of the five personality scales was comprised of three items each, except for openness which was comprised of four. A question of scale could be "I see myself as a person who is original, comes up with new ideas" (openness), "…does a thorough job" (conscientiousness), "…is talkative" (extraversion), "…has a forgiving nature" (agreeableness), "…gets nervous easily" (neuroticism). Participants were asked to answer each question on a scale of 1 to 7 with "does

not apply to me at all" and "applies to me perfectly" at each end. The scale of each personality trait consequently ranges from 3 to 21, except for openness which ranges from 4 to 28.

Cognitive ability

Cognitive ability was measured at Point 1 by using Cattell's Fluid Intelligence Test (CFT-20-R, Weiß et al., 2006). The CFT-20-R is comprised of four subtests (figural reasoning, figural classification, matrices and reasoning) with 15 items each, with increasing difficulty. For this study, correct answers were only counted if given within the predetermined time limit of each question. The test was administered in a computer-based format. Sum scores were calculated and used for analyses. The scale ranges from 0 to 60, based on number of correct answers.

Education

Education level was measured by the International Standard Classification of Education (ISCED 1997) which is a system comprised of levels from 0 to 6, with additional sublevels, made to classify education programmes by complexity (OECD, 1999; Schneider, 2008). A zero is representative of kindergarten-level education while six equals a doctorate degree. For the analyses in this study the classifications were recoded into an ordinal scale from 1 to 10 consisting of all the ISCED levels and sublevels, where a higher number translates to a higher education level.

Occupation

Occupation was measured with two different variables in this study due to the complexity of comparing occupations as a life outcome in a comprehensive way. The chosen variables were prestige and socioeconomic status of occupation.

Occupational prestige was measured using the Standard Index of Occupational Prestige Scale (SIOPS) which is a prestige ranking scale (ranging from 0-100) of the participants' current job position, based on classifications from the International Standard Classification of Occupations (ISCO-08) (Ganzeboom & Treiman, 1996). A higher number indicates higher occupational prestige.

Socioeconomic status of occupation was measured using the European Socio-Economic Classification (ESeC) which is a classification system used to categorise occupations based on their position on the labour market (Harrison & Rose, 2006). The classifications were recoded

into an ordinal scale ranging from 1 to 9 where a higher number translates to occupational positions with higher autonomy and socioeconomic status.

Life satisfaction

Life satisfaction was measured using the Satisfaction With Life Scale (SWLS) which is comprised of five items with statements about the participants' lives (Diener et al., 1985). A 5-point scale was used to indicate agreement (ranging from strongly disagree to strongly agree). Sum scores of the items were calculated and used for analyses. The combined scale ranges from 5 to 25 where a higher value represents higher reported life satisfaction.

Friendship

The number of friends of participants was used as a social life outcome and collected through a self-report measure, where participants were asked how many close friends they have. The value of this variable is a direct transcription of the number of close friends reported by participants.

Zygosity

Zygosity data was collected through a physical similarity questionnaire (Oniszczenko et al., 1993). The questionnaire has been validated by Lenau et al. (2017), where comparisons to DNA-tests were used to determine an accuracy rate of 92-96%.

Analyses

Correlation analysis

A longitudinal within-person correlation analysis (N = 843) was performed using the following predictor variables from Wave 1: personality (Extraversion, Openness, Agreeableness, Conscientiousness, Neuroticism) and Cognitive ability. Correlations were examined in relation to the following life outcome variables from Wave 2 collected four years later: Education level, Occupational prestige, Socioeconomic status of occupation, Life satisfaction and Friendship. Age (M = 27.1; SD = 1.83) and Sex (57% female) collected in Wave 2 were also included in the correlation analysis. No further regression analyses were performed due to the design of this study utilising bivariate correlations to study the associations between predictor variables and life outcome variables.

Heritability analyses

A heritability analysis was performed using Falconer's formula on monozygotic and dizygotic twin data (N = 751). All predictor variables from Wave 1 (Personality: Extraversion, Openness, Agreeableness, Conscientiousness, Neuroticism; Cognitive ability) and life outcome variables from Wave 2 collected four years later (Education level, Occupational prestige, Socioeconomic status of occupation, Life satisfaction, Friendship) were included in the heritability analysis. Correlations for monozygotic twins (r_{MZ}) and dizygotic twins (r_{DZ}) were calculated. The zygosity-specific correlations were used to determine the relative variance of the variables explained by genetic influence (A), shared environment (C) and unique environment (E) through using Falconer's formula, as is explained in Figure 1. Due to limitations of Falconer's formula for variables where r_{MZ} was twice as large as r_{DZ}, shared environment (C) is unable to be modelled and unique environment (E) was instead calculated by the formula: $E = 1 - A$, as suggested by previous research (Hagenbeek et al., 2023).

All data analysis was conducted using Jamovi version 2.3.28.

Figure 1

Example model of variance decomposition and Falconer's formula in the context of a classical twin study design
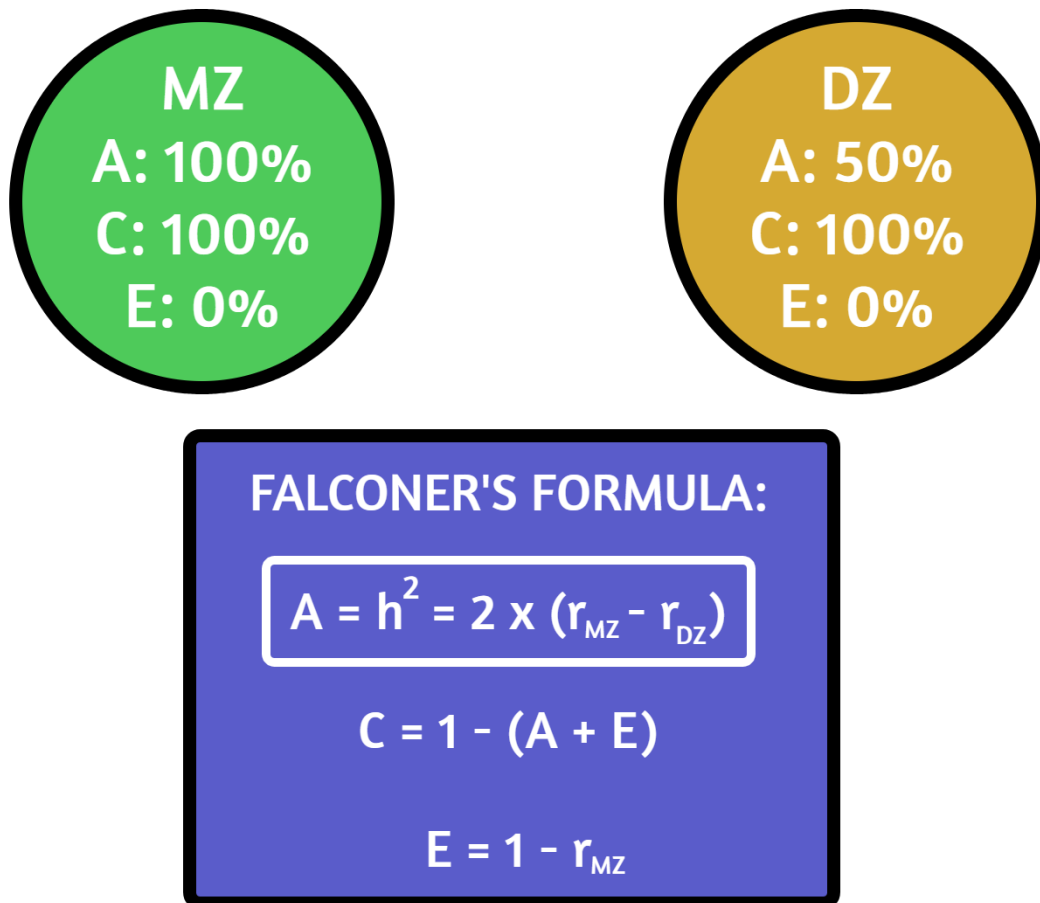
Note. The figure describes how variance is deconstructed in a classical twin study design and how it is used to calculate heritability through Falconer's formula (Hagenbeek et al., 2023; Mayhew & Meyre, 2017; Rice, 2008). Percentages reflect overlap between twin pairs. MZ = monozygotic twins, DZ = dizygotic twins, A = genetic influence, C = shared environment, E = unique environment, r_{MZ} = monozygotic twin correlations, r_{DZ} = dizygotic twin correlations, h^2 = heritability. The highlighted section of Falconer's formula describes how heritability is calculated in this study. To read more about how heritability is calculated with twin pairs, see Hagenbeek et al. (2023).

Ethics declarations

The TwinLife project has been ethically approved by the German Psychological Association (protocol numbers: RR 11.2009 and RR 09.2013). Participants were informed of the study aim, data protection regulations and their right to withdraw at any time. All participants had given informed consent prior to their participation.

Results

A descriptive table of means, standard deviation, reliability coefficient and skewness of the variables used in the study is presented in Table 1. Information regarding each variable is presented in the methods section. For additional information on the items and scales used by TwinLife during data collection see Klatzka et al. (2023).

Table 1

Descriptive statistics of the study variables

Predictors	*M*	*SD*	γ1	α
Extraversion	14.5	4.10	-0.38	.81
Openness	20.0	4.00	-0.15	.60
Agreeableness	16.8	2.75	-0.82	.48
Conscientiousness	16.1	3.06	-0.53	.59
Neuroticism	12.5	3.72	-0.04	.62
Cognitive ability	39.3	6.94	-0.69	
Life outcomes	*M*	*SD*	γ1	α
Education	7.16	2.15	-0.86	
Occupation (Prestige)	47.1	13.1	0.01	
Occupation (SES)	3.35	2.60	1.03	
Life satisfaction	19.5	4.07	-0.79	.86
Friendship	9.08	6.32	4.12	

Note. *M* = Mean. *SD* = Standard deviation. γ1 = kurtosis. α = Cronbach's alpha. Information explaining the scales of how variables are measured can be found in the methods section.

Research Question 1

Personality as a predictor for life outcomes

Individual differences in personality traits did predict life outcomes, with varying effect for each trait (see Table 2). Extraversion was related to higher life satisfaction ($r = .21$, $p < .001$) and more close friends ($r = .14$, $p < .001$). Agreeableness was related to higher education level ($r = .08$, $p < .05$), higher life satisfaction ($r = .11$, $p < .01$) and higher socio-economic status of occupation ($r = .09$, $p < .05$). Conscientiousness predicted all life outcome measures apart from friendship. Conscientiousness was related to higher education level ($r = .10$, $p < .01$), higher life satisfaction ($r = .22$, $p < .001$) and higher occupational measures of both prestige ($r = .08$, $p < .05$) and socio-economic status ($r = .11$, $p < .01$). Neuroticism was only related to lower life satisfaction ($r = .14$, $p < .001$). Openness was not significantly correlated to any of the selected life outcomes in this study.

Cognitive ability as a predictor for life outcomes

Individual differences in cognitive ability did predict life outcomes, also with stronger effect in comparison to personality traits (see Table 2). Cognitive ability was related to higher education level ($r = .34$, $p < .001$), higher life satisfaction ($r = .11$, $p < .01$) and higher occupational measures of both prestige ($r = .27$, $p < .001$) and socio-economic status ($r = .31$, $p < .001$). The only life outcome cognitive ability did not predict in this study was friendship ($r = .02$, $p > .05$).

Table 2

*Correlation matrix of all
study variables*

	1	2	3	4	5	6	7	8	9	10	11	12	13
1.Age	—												
2.Sex	.02	—											
3.Cognitive ability	.01	-.07*	—										
4.Extraversion	-.03	.04	-.09*	—									
5.Openness	-.02	.05	.11**	.21***	—								
6.Agreeableness	-.02	.13***	.01	-.06	.13***	—							
7.Conscientiousness	.07	.21***	-.06	.17***	.09*	.20***	—						
8.Neuroticism	.01	.23***	-.08*	-.15***	-.01	.02	-.07*	—					
9.Education level	.07*	.13***	**.34***	.02	.00	**.08*	**.10**	.04	—				
10.Occupation (Prestige)	.11**	.07	**.27***	.03	.05	.06	**.08*	.02	.43***	—			
11.Occupation (SES)	.11**	.13**	**.31***	-.01	-.01	**.09*	**.11**	.06	.48***	.74***	—		
12.Life satisfaction	-.03	.07*	**.11**	**.21***	-.01	**.11**	**.22***	**-.14***	.25***	.19***	.17***	—	
13.Friendship	.02	-.08*	.02	**.14***	.02	.06	.03	-.01	.08*	.09*	.02	.17***	—

Note. * p < .05, ** p < .01, *** p < .001. For Sex (2): positive values represent female correlations. Boldened values signify significant correlations with direct connection to the research questions.

Research Question 2

Heritability of variables

Heritability data and variance decomposition of the variables is presented in Table 3 and Figure 2. The heritability was highest for cognitive ability ($h^2 = .88$) and extraversion ($h^2 = .89$). The other personality traits openness ($h^2 = .63$), agreeableness ($h^2 = .63$), conscientiousness ($h^2 = .70$) and neuroticism ($h^2 = .52$) have lower but similar estimates, with some variability. Significantly lower heritability estimates were found for the outcome variables: education level ($h^2 = .23$), life satisfaction ($h^2 = .12$), friendship ($h^2 = .37$) as well as occupation (prestige) ($h^2 = .27$) and occupation (SES) ($h^2 = .28$).

Table 3

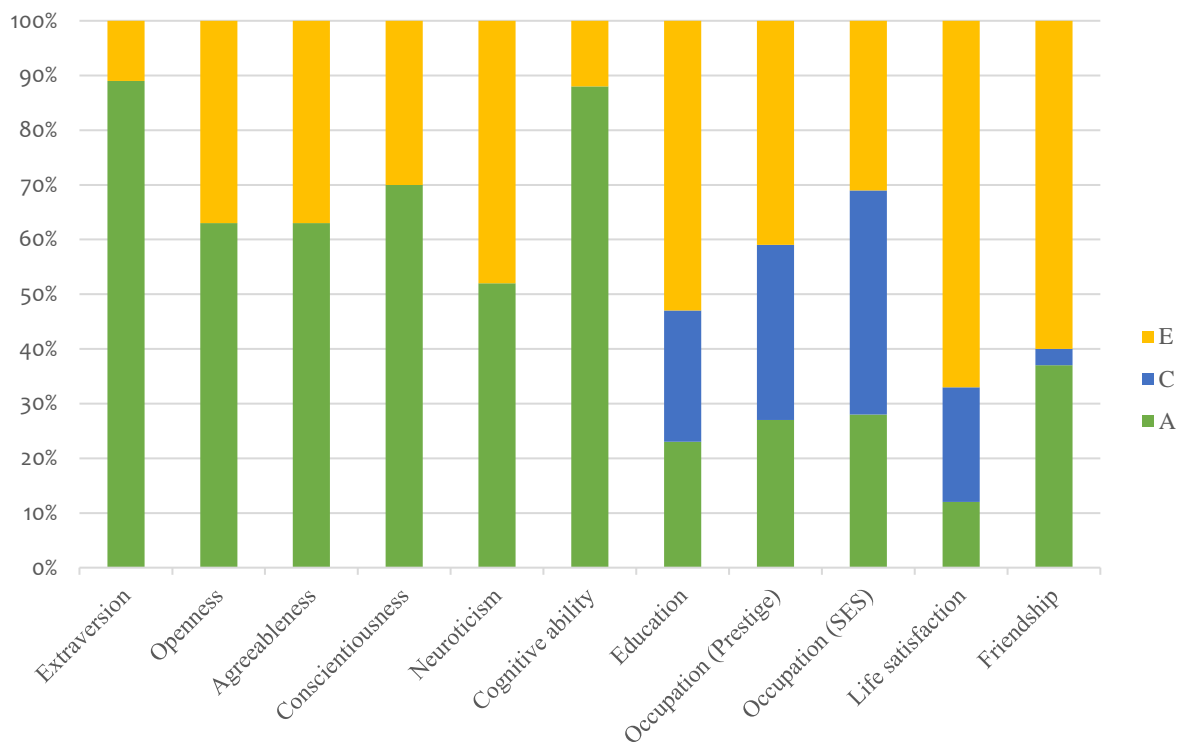*Heritability and explained variance for the study variables*

Predictors	$A (h^2)$	E	C	r_{MZ}	r_{DZ}
Extraversion	.89	.11	-	.51	.07
Openness	.63	.37	-	.50	.18
Agreeableness	.63	.37	-	.32	.00
Conscientiousness	.70	.30	-	.47	.12
Neuroticism	.52	.48	-	.50	.23
Cognitive ability	.88	.12	-	.76	.32
Life outcomes	$A (h^2)$	E	C	r_{MZ}	r_{DZ}
Education	.23	.53	.24	.47	.35
Occupation (Prestige)	.27	.41	.32	.59	.46
Occupation (SES)	.28	.31	.41	.69	.55
Life satisfaction	.12	.67	.21	.33	.27
Friendship	.37	.60	.03	.40	.21

Note. Estimates reflect the amount of explained variance for each variable. A = genetic influence, which in this study is synonymous with heritability (h^2). E = nonshared environment. C = shared environment. r_{MZ} = monozygotic twin correlation. r_{DZ} = dizygotic

twin correlation. Due to limitations of Falconer's formula for variables where r_{MZ} was twice as large as r_{DZ}, C was unable to be modelled.

Figure 2

Model of heritability and explained variance of the study variables

Note. Percentages refer to the amount of explained variance for each variable. A = genetic influence, which in this study is synonymous with heritability (h^2). E = nonshared environment. C = shared environment. Due to limitations of Falconer's formula for variables where r_{MZ} was twice as large as r_{DZ}, C was unable to be modelled.

Discussion

The aim of this study was to investigate if individual differences in personality and cognitive ability could predict life outcomes. Analyses show that cognitive ability had the most predictive power, especially for education and work-related outcome variables. Out of the five personality traits, conscientiousness was the trait related to most outcome variables and had a strong correlation with life satisfaction especially. Extraversion was also related to life satisfaction to similar extent and was the only predictor variable related to friendship (number of close friends). Heritability was the highest for cognitive ability and slightly lower for the personality traits, except for extraversion which had similar heritability estimates as

cognitive ability. This emphasises the genetic aspect of the predictor variables which should not be disregarded when interpreting the results.

Understanding and contextualising the findings

The positive correlation found between cognitive ability and education level is unsurprising, given the previously established relation between the variables (e.g., Schmidt & Hunter, 1998). Engaging in educational activities often requires the application of problem-solving skills, which closely align with the constructs of cognitive ability. The relation between cognitive ability and occupational variables could be understood in a similar way, in which cognitive ability provides cognitive skills useful for advancing occupationally. Additionally, occupational variables have been found to correlate with education level as observed in both the present study and prior research (Kuncel et al., 2004). Education level might therefore have a mediating effect on the relationship between cognitive ability and occupation, explaining part of the correlation. A similar manner of reasoning could be applied to the relation between cognitive ability and life satisfaction, where a high cognitive ability is associated with higher education level, occupational status and income, which are all factors associated with life satisfaction in both the present study and prior research (Choi & Lim, 2020; Hofmann et al., 2018; Johnson & Krueger, 2006).

How can the personality-related associations be understood? Conscientiousness was positively associated with education and occupational variables. This might be due to conscientiousness predicting stronger goal-setting and self-efficacy, which are useful attributes to have for excelling in these areas (Judge & Ilies, 2002). Duckworth et al. (2012) found similar associations between conscientiousness and life outcomes such as income and life satisfaction. The authors proposed that individuals with high conscientiousness tend to act in accordance with long-term goals, make careful decisions and resist temptation. These traits are described as helpful in both a career environment as well as in establishing and maintaining healthy social relationships, which is beneficial for subjective well-being and happiness.

It is also important to accentuate that different personality traits can be favourable depending on the type of occupation. For instance, occupations characterized by interpersonal interaction require different skills compared to positions involving isolated, routine tasks (Hurtz & Donovan, 2000). Personality might also matter in other areas of occupation than

work performance. To illustrate, extraverted people have been shown to be better liked by interviewers resulting in more job recommendations (Cook et al., 2000).

The genetic analyses showed that the heritability of the predictor variables, especially cognitive ability and extraversion, was substantial. Cognitive ability has previously been shown to be a trait with high heritability, similar to estimates found in this study (Plomin et al., 1994). The heritability of personality traits found in this study is generally in line with previous research, except for the personality trait extraversion which stands out from the rest (Vukasović & Bratko, 2015). The reasons behind this finding are still unclear, since it appears no authors using the TwinLife data have reported such findings. Twin studies have been found to report higher heritability values in comparison to other methods, which is also the case of Falconer's formula (Vukasović & Bratko, 2015). This could explain a general tendency to overestimate heritability but does not explain the case of extraversion specifically.

The heritability of the life outcome variables was significantly lower. Lower heritability estimates were expected in comparison to the predictor variables, as was suggested by previous research. The heritability estimates of the life outcome variables found in this study differ from previous research in various ways. The heritability for occupational prestige was higher than previous findings; $h^2 = .27$ compared to .11 suggested by Akimova et al. (2023). The heritability estimates for education level ($h^2 = .23$) and life satisfaction ($h^2 = .12$) found in this study were lower than previous recorded estimates $h^2 = .43$ for education level (Silventoinen et al., 2020) and $h^2 = .32$ for life satisfaction (Røysamb et al., 2018). The heritability of friendship was similar to previous findings with both around $h^2 = .40$ (Neugart & Yildirim, 2022). However, this study used a larger dataset from the TwinLife project, partially identical to the data used in this study, which raises concerns regarding the generalisability of the findings. Due to a lack of studies on the heritability of the life outcome variables, the estimates found in this study cannot be compared to a well-established body of knowledge. Conversely, these findings may contribute valuable insights for clarifying heritability estimates of the life outcome variables included in this study.

The relatively high heritability of the personality variables and cognitive ability would mean that individual variance of these variables is largely explained by genetic factors. This implies that the variables would remain relatively stable throughout life, which allows for predictive analyses. The stability of personality traits in regard to heritability has been studied with findings similar to ones found in this study (Bleidorn et al., 2014).

Interpreting low correlation estimates values

For the most part, the relations between the predictors and outcome variables are similar to ones previously found in prior research. However, the correlation estimates found in this study are generally smaller than those previously observed. For instance, the association between conscientiousness and educational performance found by Ahadi and Narimani (2010) was significantly higher than the one found in this study (r = .52 compared to r = .08). The same goes for most personality traits, for example the relationship between life satisfaction and extraversion (r = .41) and neuroticism (r = -.38) found by Smith and Konik (2021) in comparison to the correlations found in this study (r = .21 and r = -.14). Additionally, some previously found correlations were completely absent in this study, such as most neuroticism correlates. On the other hand, the relationship between cognitive ability and life outcomes was largely in line with previous findings. For instance, the relations described by Roberts et al. (2007) for occupation (r = .31) and education (r = .37) are very close to vales found in this study (r = .27 and .31 for occupational variables and r = .34 for education).

The findings related to cognitive ability seem to be in line with previous research, while personality related correlations are much smaller or absent. This poses the question: how can you understand this discrepancy? Firstly, the assessment of what counts as a high Pearson correlation usually suggests that r > .10 = weak, r > .40 = moderate and r > .70 = strong (Schober et al., 2018). This has been questioned in the context of psychological research. Studies comparing correlations found in psychological research specifically propose that a correlation above r > .20 should be considered a moderate effect and r > .30 a strong effect due to effect sizes not reaching the same levels as other fields of research (Gignac & Szodorai, 2016; Hemphill, 2003). Roberts et al. (2007) also argues for why smaller effect sizes should still be considered as substantial and important. The authors emphasise that correlation coefficients often can be hard to interpret but that even small correlations can carry a major practical significance. However, this does not explain the difference in personality trait correlations compared to previous studies.

Second, the variable data of the personality-related measures present a problem regarding the reliability of the scales (see Table 1). The Cronbach's alpha values most personality trait measures insufficient, particularly for Agreeableness with α = .48, which is far from what is often recommended for alpha values, suggesting a minimum of α > .70 (Cortina, 1993). Exploratory factor analyses studying the TwinLife data have been done,

deeming the five-factor structure consistent with theoretical classification of the items (Klatzka et al., 2019). Cronbach's alpha values of the personality scales for the whole TwinLife sample have been studied and established as relatively low (ranging from .44 for Agreeableness to .68 for Extraversion). The authors attribute low alpha coefficient values to the short scales (mostly 3-items) used in data collection**,** describing low alpha values as typical for such scales. Still, this might give an explanation to why the personality-related findings in this study are smaller in comparison to previous studies.

Lastly, the broad life outcome variables selected in this study can be measured in many different ways, making direct comparison difficult. For instance, education was measured on a category-based level in this study compared to other studies opting for direct measurements of GCSE scores (Deary et al., 2007), differentiating the connection to cognitive ability.

Limitations

The previously stated low scale reliability posed challenges in deriving significant findings from the TwinLife personality trait data for some of the variables. Using personality data collected with a more comprehensive scale is recommended.

The sample used in this study also poses some problems. Although the sampling was random, the response rate of 37% raises concerns regarding the representativeness of the sample in relation to the general German population. The socio-demographic structure of the first wave of TwinLife data has been studied by Lang & Kottwitz (2020) who found issues concerning parental education. The amount of university educated households in the TwinLife sample (43.5%) was around ten percentage points higher compared to a sample representative of the German population. These numbers are specific to the oldest cohort, which is the one included in this study. This likely presents issues concerning the restriction of range for several study variables, such as education level and possibly cognitive ability, due to the underrepresentation of the lower end of the spectrum. This could be an additional contributing factor to the lower correlations found in this study in comparison to previous research.

Personality and cognitive ability have been shown to be related to life outcomes, but there might also be other predictor variables which are not included in this study. There is a possibility that such a variable has a moderating or mediating effect and explains much more variance in comparison to the variables included in this study. Socio-economic status could be one such predictor variable and was not included due to limited measurement methods during

data collection. However, socio-economic status has been studied in relation to occupational and educational variables and was found low or comparable to personality and cognitive ability (Roberts et al., 2007). This suggests that the current selection of predictor variables might have been sufficient.

The phenomenon of attenuation is an effect of measurement errors causing a decrease in correlation coefficients, which is a common problem encountered in quantitative research (Wang, 2010). Consequently, disattenuation can be done to correct for these errors. Note that the correlations in the present study are not disattenuated, meaning the results are the most conservative estimates available.

Regarding the heritability analyses, an increased homogeneity of the sample due to restriction of range might have caused inflated heritability estimates for some of the variables. Heritability was also analysed using non-extensive methods. More complex statistical and analytical methods such as structural equation modelling (Stieger et al., 2017) would allow for a more comprehensive insight into heritability, perhaps studying the genetic component of the correlations themselves. This area could favourably be explored further in future studies.

Conclusions

The present study suggests that individual differences in personality and cognitive ability predict life outcomes. Cognitive ability was the overall strongest with strong correlations to education level and occupational outcomes. Conscientiousness was the strongest predictor out of the personality traits and was associated to education, occupation, and life satisfaction. Extraversion also emerged as significant predictor, associated to life satisfaction and friendship. The heritability of all predictor variables, specifically cognitive ability and extraversion, was high and should be considered when interpreting the remaining findings.

To answer the original question: what are the deciding factors to where we end up in life compared to one another? A comprehensive answer is still out of reach, but personality and cognitive ability are undeniably important pieces of the puzzle, in which individual variance seem to be heavily dependent on genetics.

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