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The Heritability of Job Satisfaction Reconsidered: Only Unique Environmental Influences Beyond Personality

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Abstract

Purpose: The purpose of this study was to investigate the degree to which genetic and environmental influences explain differences in job satisfaction and its relationship to personality in order to explain the heritability of job satisfaction.

Design: Behavior genetic analyses are based on a dataset containing 622 individuals, including 185 MZ (M = 39.5 years) and 126 DZ twin pairs (M = 40.1 years).

Findings: The results showed that all genetic influences (28%) on job satisfaction could be explained by its relation to personality, especially Neuroticism, Extraversion and Conscientiousness, representing a high genetic overlap between job satisfaction and personality. Non-shared environmental influences explained the remaining three fourths of the variance.

Implications: By showing that genetic influences of job satisfaction overlap completely with personality, including common non-additive genetic influences, the results support an interactionist view of job satisfaction in that both situational and dispositional determinants of job satisfaction are relevant.

Originality: In contrast to previous studies, we used a more appropriate behavior genetic approach meaning that our approach allows to directly estimate parameters of specific and common (additive and non-additive) genetic and environmental influences. Building on this, interpretations of behavior genetic findings were explained in detail to avoid common misunderstandings.

Keywords: job satisfaction, Heritability, personality, social inequality, behavior genetics

The Heritability of Job Satisfaction Reconsidered: Only Unique Environmental Influences Beyond Personality

For most people, work is a central source of their personal identity (Judge & Klinger, 2008; Fryers, 2006). Given the importance of work in a person's daily life, general satisfaction with one's job appears desirable, especially in consideration of its reciprocal relation to one's life satisfaction (i.e., job satisfaction affects life satisfaction and vice versa, Judge & Watanabe, 1994). Furthermore, there is no doubt that individuals differ in the extent to which they are satisfied with their jobs (Weitz, 1952). Therefore, it's not surprising that job satisfaction has been identified as the most extensively studied topic in the field of industrial and organizational psychology (Judge & Church, 2000), not only in relation to individual welfare (Staw, Bell, & Clausen, 1986) but also in relation to organizational concerns (e.g., absenteeism, turnover, and effectiveness; Judge & Klinger, 2008). The main research question here is why some workers are more satisfied with their job than others.

In the area of behavior genetic research, this question generally plays an important role regardless of the specific construct of interest. In the past century, a large body of behavior genetic studies out of different areas of psychology have led to the conclusion that all human characteristics show a heritable component (labeled as the First Law of Genetics; Turkheimer, 2000) and that "genetic influences are involved in all aspects of psychology and behavior" (Johnson, Turkheimer, Gottesman, & Bouchard, 2009, p. 217). Genetic variation is obviously a major source of individual differences in reactions to social conditions, such as job characteristics. Moreover, ignoring these influences leads not only to less complete but also to less precise explanations. By the same token, some studies have supported the argument for a genetic basis of job satisfaction (e.g., Arvey, McCall, Bouchard, Taubman, & Cavanaugh, 1994) as an addition to other - more environmental - predicting factors (e.g., work conditions, Hackman & Oldham, 1976). However, in behavior genetic research the question of "how much" genetic versus environmental influences explain, is now being replaced by studies

investigating how to explain the heritability and to identify potential mediating mechanisms. Arvey, Bouchard, Segal, and Abraham (1989) already suggested theoretical arguments for such an explanation regarding job satisfaction. In a nutshell, they proposed that genetic influences on job satisfaction might be due to genetic factors that are common with broad personality characteristics. Ilies and Judge (2003) investigated this assumption for the first time by evaluating the extent to which personality mediate genetic influences on job satisfaction. Contrary to their expectations, the results showed that the Big Five personality traits mediated only 24% of all genetic influences on overall job satisfaction. As a conclusion, Ilies and Judge proposed that there should be other genetic influences than personality based to explain the heritability of job satisfaction.

In the present study, we would like to challenge the conclusions offered by Illies and Judge (2003) by reinvestigating the relationship between personality and job satisfaction while testing the degree to which the relationships among all variables in the model are genetic *and* environmental in nature. As we will explain in more detail later, it is of crucial importance to verify specific assumptions of behavior genetic models and their impact on the results because heritability estimates can be heavily influenced by the appropriateness of the assumptions made in a particular study (Johnson, Penke, & Spinath, 2011). Ilies and Judge (2003) already mentioned several limitations of their study such as the modeling procedure to estimate the mediating effect and the nature of the data. We would like to overcome these limitations by using a more appropriate methodological approach including heritability estimates on personality and job satisfaction as well as estimates on the environmental *and* genetic mediation of personality within one twin sample of adult monozygotic (MZ) and dizygotic (DZ) twins. The main contribution of this study is the use of an improved methodological approach to reexamine the genetic overlap between job satisfaction and personality, which lead to different conclusions and implications of the results than those

assumed by Ilies and Judge (2003). In the next section of the paper, we briefly introduce the theoretical background and the derived behavior genetic model.

Theoretical background

Early research efforts that attempted to explain the origins of job satisfaction, "a pleasurable or positive emotional state resulting from the appraisal of one's job or job experiences" (Locke, 1976, p. 1300), concentrated first and foremost on external factors. For example, Hackman and Oldham (1976) postulated several core job dimensions, such as skill variety, task identity, job feedback, and autonomy as important for a positive evaluation of one's job. However, in most cases, the observed relation between various external job characteristics and individually reported job satisfaction was modest. For example, a recent meta-analytic study showed a true correlation between salary and job satisfaction of $\rho = .15$ (Judge, Piccolo, Podsakoff, Shaw, & Rich, 2010). Such results imply that working conditions and job characteristics are not the only causes of job satisfaction.

Other researchers have started to study job satisfaction from a dispositional point of view. In their pioneering study, Arvey et al. (1989) examined the heritability of job satisfaction in a sample of 34 MZ twin pairs who were reared apart. In this design, twin similarity measured by intraclass correlations provide a rough direct estimate of genetic influences because the twins did not share environmental factors that could lead to similarity (Plomin, DeFries, Knopik, & Neiderhiser, 2012). Arvey and colleagues reported a significant twin similarity in general job satisfaction ratings of .31 ($p < .05$) suggesting that genetic influences accounted for 31% of the variance in job satisfaction. In 1994, Arvey et al. confirmed this result by analyzing data from two additional samples. They presented evidence that intrinsic job satisfaction has a substantial genetic component of around 25% within a sample of male MZ twins ($N = 95$) and DZ twins ($N = 80$) reared together. In their second sample of 1,236 MZ twins and 1,165 DZ twins reared together, the genetic influence on overall job satisfaction was 27%.

As stated by Ilies and Judge (2003), the prevailing task is to explain the heritability of job satisfaction. Since it is unlikely to assume specific job satisfaction genes, the next important step should be the development of models that can explain genetic effects through mediating mechanisms. In this context, Arvey et al. (1989) already argued that genetic influences on job satisfaction might be due in part to genetic factors that are common with broad personality characteristics (i.e., personality as the mediator of the heritability of job satisfaction). This argument fits well with two established findings in the literature: the correlation on the phenotypic level between personality and job satisfaction and evidence of the heritability of personality.

In 1986, Staw et al. already proposed that job satisfaction could be significantly predicted by personality characteristics such as affective dispositions. Later on, the phenotypic correlation between personality and job satisfaction has been summarized in the meta-analysis of Judge et al. (2002), in particular between Neuroticism, Extraversion, and Conscientiousness and job satisfaction. Since neurotic (or emotionally unstable) people are more likely to experience feelings such as anxiety, anger, envy, guilt, and a depressed mood (Costa & McCrae, 1992) and since neurotic people tend to select situations that foster negative affect (Emmons, Diener, & Larsen, 1985), people high on Neuroticism will more frequently experience negative situations in their work context. Thus they will experience lower job satisfaction, which has also been found by Judge et al. (2002) at the level of a correlation of -.29. Extraverted persons take pleasure in social interactions and are generally more enthusiastic, talkative, and assertive and are predisposed to experience positive emotions (Costa & McCrae, 1992). Consistent with these arguments, Judge et al. reported a correlation between Extraversion and job satisfaction of .25. A highly conscientious person is characterized by a high degree of organized, careful, self-disciplined, and responsible behavior (Costa & McCrae, 1992) and by high engagement in one's work, leading to a greater likelihood of obtaining satisfying rewards (e.g., pay, benefits, respect, commendations; Organ

& Lingl, 1995), which should in turn lead to greater job satisfaction. This corresponds well with meta-analytic correlation of .26 found by Judge et al. The two other Big Five traits, Agreeableness and Openness, seem to play minor roles as Judge et al.'s regression analysis showed that only Neuroticism, Extraversion, and Conscientiousness made significant contributions.

The heritability of the Big Five dimensions is also well established: Behavior genetic studies based on different designs (e.g., twin studies, adoption studies, or extended twin family studies) have consistently shown a substantial genetic influence on each personality trait (e.g., Plomin, DeFries, McClearn, & McGuffin, 2008; Bouchard & Loehlin, 2001; Eaves, Eysenck, & Martin, 1989; Loehlin, 1992). Heritabiliy estimates for the Big Five dimension range between 40% and 60% depending on the used behavioral genetic model, the measurement and other related factors (for a review see: Johnson, Vernon, & Feiler, 2008; Bouchard, 2004; Loehlin, McCrae, Costa & John, 1998). Moreover, the five factors are in part genetically dependent on each other (Riemann & Kandler, 2010), which means that genetic influences on a particular personality trait are not necessarily unique to this trait.

Although these two established findings support the argument that the heritability of job satisfaction is due to the heritability of Neuroticism, Extraversion, and Conscientiousness and their influence on job satisfaction, there is only one study so far (Ilies & Judge, 2003) that aimed at testing this empirically. Their study showed, contrary to previous assumptions, that only a small proportion of about 24% of all genetic influences on job satisfaction (29% in total) was mediated by personality, whereas the remaining 76% of the total heritability were specific genetic influences on job satisfaction that are independent of personality. Such a result means that only a small amount of this heritability can be explained by personality.

However, Ilies and Judge's study rests on questionable assumptions and limitations. To understand why their assumptions are questionable, it is necessary to explain such genetic analyses in more detail.

The Basic Concept of Behavior Genetics

Behavior genetic studies investigate the genetic and environmental origins of individual differences by partitioning the observed phenotypic variance of a measured behavior, attitude or ability into its genetic as well as environmental variance components (Plomin et al., 2012). Genetic variance indicated as overall heritability (H) comprises different genetic effects which can be classified as additive and non-additive genetic influences. Additive genetic influences (commonly denoted as A) encompass all allelic (i.e. variant forms of the same gene) effects within and across genes in sum and are passed down directly from parent to offspring. In contrast, non-additive genetic influences refer to effects of genes that transact with each other, though generally estimated solely as dominance, and therefore denoted as D. Outstanding personalities, such as Beethoven for example may have been so genius because of their specific combination and interaction of genes, and the fact that this perfect combination would not be passed on to their children the same way can be explained by D influences involved. Environmental influences comprises shared (denoted as C) and non-shared environmental influences (denoted as E). C refer to environmental experiences common to all members of the same family. These effects are defined as those influences that cause similarity between family members. In contrast, E refer to environmental factors that are specific to each individual and therefore contribute to dissimilarity (Plomin et al., 2012) of family members. While socio-economic status is often described as an example of a shared environmental factor within families which leads to similarity between family members, different experiences within the family (such as a broken leg of one family member) or outside the family (such as different experiences at school or with peers) are often introduced as factors of non-shared environment.

Recent studies in the behavioral genetic field (Hahn, Spinath, et al., 2012; Ozaki, Toyoda, Iwama, Kubo, & Ando, 2011) have shown that all possible influences (i.e., A, D, C, and E influences) have to be considered in order to reduce biased estimates and to obtain a

complete picture of genetic and environmental causes of individual differences. For example, studies on personality have already shown that the picture of a 50:50 relation of genetic and environmental influences (Johnson et al., 2008) is likely oversimplified (Hahn, Spinath, et al., 2012). Often, genetic influences are estimated only as additive genetic influences, while non-additive genetic influences are fixed at zero, which typically results in an overestimation of the overall heritability if D influences are actually of importance (Coventry & Keller, 2005). For most of the Big Five personality traits, especially Neuroticism, Extraversion as well as Conscientiousness, there is substantial evidence for non-additive genetic influences (Eaves et al., 1999; Hahn, Spinath, et al., 2012; Kandler, Riemann, & Kämpfe, 2009). In addition, research on life satisfaction has also shown that D influences are more important than A influences. So far, behavior genetic studies on job satisfaction (Arvey et al., 1989, 1994) were based on reduced models excluding D influences. But, if D influences are also relevant for job satisfaction, it can be assumed that environmental influences were underestimated in relation to genetic influences in previous research.

The distinction between genetic (A and D) and environmental (C and E) influences is not only an academic one to avoid over- and underestimations of all effects involved, but has also implications with regard to the amount of transmission of characteristics from one generation to the next. The transmission of D influences is less likely than the transmission of A influences and therefore family resemblances are diminished if D influences are involved. Therefore, testing for D influences seems to be important.

The idea of decomposing the variance of a variable into its underlying genetic and environmental components can also be transferred to the covariation between two or more variables. As generally shown in Figure 1, one personality trait, job satisfaction as well as the effect of the personality trait on job satisfaction (represented as arrow) can be roughly decomposed into its genetic and environmental origins.

This background information helps now to explain why the results reported by Ilies and Judge (2003) may not be accurate. Above all, the methodology applied by Ilies and Judge (2003) was based on a set of unverified assumptions. As shown in example (1) of Figure 1, their rationale for the partial heritability relied on the assumption that the proportion of genetic and environmental influences can be applied to the regression coefficient and this is not necessarily the case (for more details see Footnote[1]). Based on the formula used, it can be seen that the authors used regression coefficients of the Big Five personality traits found for the total phenotypic variance of job satisfaction, put them into perspective to the heritability of the personality traits and applied the sum of the resulting coefficients only to the genetic variance in job satisfaction. As illustrated in Figure 1, it is possible, that the relation of genetic and environmental influences for the association between a personality trait and job satisfaction is different (2). Furthermore, it could also be the case that the entire effect of a personality trait on job satisfaction is completely genetic in nature (3) or caused solely by environmental influences (4). For example, if one factor (factor 1) explains 10% of the variance of another factor (factor 2) and both factors show a heritability of 50%, it could be that only half of the 10% are genetically mediated (as assumed by Ilies & Judge) which would lead to the conclusion that 5% of the heritability (remember 50%) in factor 2 are mediated by factor 1. In another scenario, it could be that the entire 10% are genetically mediated which would mean that 10% of the heritability in factor 2 could be explained by factor 1. However, Ilies and Judge were not able to disentangle the extent to which the variance in job satisfaction explained by the personality traits was genetic, environmental or both in nature. Apart from the methodological aspect, Ilies and Judge (2003) took heritability estimates for job satisfaction and correlations between personality and job satisfaction from a set of

[1] Ilies and Judge (2003) used the following formula to compute the partial heritability (h_p^2) for job satisfaction mediated by the Big Five ($h_p^2 = \sum(h_i ß_i)^2$). First, this means that the values for $ß_i$ were assumed to affect genetic and environmental variance to the same extent. But it could also be the case that $ß_i$ involves only genetic or environmental influences or both to different degrees. Second, they summarized the effect of each personality trait based on the assumption of orthogonal factors. With regard to job satisfaction, it could also be the case that the variance components explained by the personality traits were not completely independent.

different meta-analyses and combined them then to compute the partial heritability (i.e., the genetic influence on job satisfaction that was not independent of the genetic influence on personality) of job satisfaction indirectly. Further assumptions were that influences of the Big Five traits on job satisfaction are distinct from one another and that genetic influences on the Big Five traits are independent. Moreover, the heritability estimate for job satisfaction was based on a reduced model, which did not account for non-additive genetic influences.

To investigate the genetic and environmental relations between personality and job satisfaction and to properly evaluate the genetic and environmental influences on job satisfaction that are common with or independent of personality, so called multivariate genetic analyses can be used. Therefore, direct estimates of genetic and environmental influences on job satisfaction, personality, and their potential overlap have to be used to disentangle the causes of covariation between all constructs as well as causes of the remaining unique variance. Furthermore, the specific contributions of different genetic influences (A and D influences) and the environment have to be considered.

To overcome the problems of the methodological approach in the Ilies and Judge (2003) study, we used a more appropriate behavior genetic approach that allows direct parameter estimations of specific and common genetic (A and D influences) and environmental influences, which enabled us to investigate the genetic and environmental components of job satisfaction by taking into account its covariation with personality. More precisely, we were able to investigate (a) how much variance in job satisfaction could be explained by personality and (b) how much of this common variance can be explained by genetic and environmental influences. At this point, we did not have to make specific assumptions, but we were rather in a position to explicitly test all possible kinds of genetic and environmental relations to explain the heritability of job satisfaction.

Method

Participants

The sample for this study consisted of twins who were recruited in the framework of the SOEP twin study (for details see: Hahn, Spinath, et al., 2012). To obtain an appropriate twin sample, we reverted to contact information of twins who had participated in part in previous twin studies (JeTSSA, BiLSAT, TwinPaw), which have been described in detail elsewhere (BiLSAT: Spinath, Angleitner, Borkenau, Riemann, & Wolf, 2002; JeTSSA: Stößel, Kämpfe, & Riemann, 2006; TwinPaw: Spinath & Wolf, 2006). In addition, new contacts were made by random screenings of the German population in cooperation with TNS infratest[2]. Here, people were asked first whether they were a member of a twin pair and if so, whether they would like to participate in a twin study. Altogether, 940 twin pairs were contacted. Initially, 562 pairs (60%) agreed to participate by completing either an online or a paper–pencil version of our questionnaire. Ultimately, 349 pairs (37% overall response rate) provided complete information. We excluded participants who indicated that they were unemployed as well as participants who did not complete the questionnaire and therefore revealed more than 75% missing values. With respect to the five personality factors and the job satisfaction scale, we only included participants with valid information on two-third of the respective scale (i.e., in sum we excluded $n = 76$ individuals). The resulting data set contained 622 individuals in 311 pairs, including 185 MZ (75.7% female, $M = 39.5$ years) and 126 DZ twin pairs (63.1% female, $M = 40.1$ years).

Our questionnaire included the same questions used in the German socio-economic panel study (GSOEP)[3] as well as additional topics. We adopted parts of the GSOEP questionnaire to potentially combine existing panel data with twin data. In the current study, we concentrated on the twin sample, which consisted of 185 MZ twin pairs and 126 DZ twin pairs. The zygosity of the twins was established through a standardized self-report

[2] TNS Infratest is a German institute for market and opinion research. Homepage at http://www.tns-infratest.com/.
[3] SOEP questionnaires are available online at http://panel.gsoep.de/soepinfo2011/.

questionnaire (Oniszczenko, Angleitner, Strelau, & Angert, 1993). This inventory assesses the frequency with which the twins have been mistaken for each other by relatives, teachers, and peers across their life spans as well as physical similarity (concordance with genetic fingerprinting data is 93.2%; Becker et al., 1997).

Measures

Big Five personality dimensions. We used the GSOEP Big Five Inventory (BFI-S; Gerlitz & Schupp, 2005) to measure the Big Five personality characteristics. For economic reasons and the need for short scales due to strict time limitations in broad panel surveys, it was not possible to include more items in the GSOEP. The BFI-S captures the Big Five personality dimensions (Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness) by means of three items each. Answers are given on a scale ranging from 1 (*does not apply*) to 7 (*applies*). Item selection and construction of the BFI-S has been described in detail by Gerlitz and Schupp (2005). The BFI-S has shown satisfactory factorial validity (Dehne & Schupp, 2007), and the validity of this short personality measure compared to the NEO-PI R (Costa & McCrae, 1992) was approved by Hahn, Gottschling, and Spinath (2012). However, in order to balance the content-related scope of the full Big Five scales and internal consistency, reliability coefficients of the short scales are accordingly lower. In the present data set, the Five-Factor structure was confirmed in a factor analysis and explained 61% of the total variance.

Job satisfaction. Due to the fact that our measurements were based on the questionnaire used in the GSOEP, we assessed job satisfaction using three work-related items based on content and face validity (Item 1: “How satisfied are you with your job? (if employed)”; Item 2: “How satisfied are you with your personal income?”; Item 3: “I do not really enjoy my work”). Respondents were asked to provide self-reports on Items 1 and 2 on an 11-point scale ranging from 0 (*totally unhappy*) to 10 (*totally happy*) and on Item 3 on a 4-

point scale ranging from 1 (*completely*) to 4 (*not at all*). Item 3 was recoded and all items were z-standardized to control for the different scaling. A factor analysis revealed a one-factor solution that explained 63% of the total variance. Consistent to the literature (Judge & Klinger, 2008), the correlation between the 3-item job satisfaction measure and global life satisfaction was .52 ($p < .01$). Furthermore, the 3-item measure showed convergent validity in relation to the 7-item work satisfaction scale of the "Fragebogen zur Lebenszufriedenheit (FLZ, "Life satisfaction questionnaire", Fahrenberg, Myrtek, Schumacher & Brähler, 2000) in an additional sample ($N = 105$, age range 25-60 years, 67% female, all employed) given a significant correlation of .75 ($p < .01$; corrected for attenuation).

Twin Method and Analytical Approach

Classical twin design. Genetic analyses were based on the standard assumptions of the classical twin design (for details see: Plomin et al., 2012). Within this basic quantitative genetic model, it is assumed that MZ twins are genetically identical, whereas DZ twins share, on average, 50% of their segregating genes. Based on these assumptions, the observed phenotypic trait variance can be partitioned into A, D, C, and E components. E components are usually modeled as residual variance that includes measurement error (Neale & Maes, 2004). C and D are confounded in the classical twin design and therefore cannot be estimated simultaneously (Ozaki et al., 2011). Given the assumption of the relatedness of MZ twins and DZ twins mentioned previously, A and D correlations are 1.0 for MZ twins, whereas for DZ twins, the A correlation equals .50 and the D correlation equals .25 (DZ twins inherit the same alleles at a given locus from both parents with a probability of 25%). Shared environmental relatedness is 1.0 for both MZ and DZ twins, whereas non-shared environmental relatedness is .00 for both of them.

Different patterns of twin similarity are indicative of the relative impacts of A, D, C, and E influences. Whether C or D are expected in a particular model depends on the pattern of MZ and DZ twin similarities, calculated as intraclass correlations (ICC). In general, higher

MZ correlations than DZ correlations are indicative of genetic influences in general because of the higher genetic similarity of MZ twins. If MZ correlations are more than twice the size of DZ correlations, A influences are implied and D variance is expected. Because MZ twins are genetically identical (including A and D influences), less than perfect MZ twin correlations ($r_{MZ} < 1$) suggest E influences.

Analytical approach. First, job satisfaction was regressed on the Big Five traits on a phenotypic level using structural equation modeling to estimate the predictive power of each personality trait while controlling for measurement error[4] and taking relations between the Big Five traits into account (see Figure 2 for the best fitting model). The statistics package Amos 19 (Arbuckle, 2006) was used to estimate the relative contributions of genetic and environmental influences on job satisfaction and the Big Five personality characteristics as well as genetic and environmental influences on their covariation. A so-called multivariate Cholesky decomposition model (Loehlin, 1996; Neale & Maes, 2004) was used to estimate the genetic and environmental contributions toward the variation and covariation of job satisfaction and personality (see Figure 3). Based on the phenotypic correlations, the multivariate model focused only on the relevant personality traits in relation to job satisfaction. Given the patterns of resemblance between MZ and DZ twin pairs, D influences were modeled instead of C influences. Using this Cholesky decomposition approach, the genetic and environmental variance can be split into different components: (a) a general genetic and environmental factor (A_1, D_1, and E_1) that influences all variables, (b) a genetic and environmental factor (A_2, D_2, and E_2) that influences only the second, third, and fourth variable but is independent of (a) and so on, and finally (c) a specific genetic and environmental factor that is independent of all previous factors and influences only the fourth variable in the Cholesky model (A_4, D_4, and E_4) which is job satisfaction. The Cholesky

[4] As the personality traits were not independent, we also modeled all possible intercorrelations between the Big Five personality traits in the regression model.

decomposition can be used (a) to determine the importance of genetic and environmental influences on the association between variables independent of their influence on other variables and (b) to analyze the extent to which genetic as well as shared and non-shared environmental influences on the variables overlap.

The overall model fit was evaluated using the chi square statistic (χ^2) in combination with the root mean square error of approximation (RMSEA). For the RMSEA, values below .05 indicate a good fit and values between .05 and .08 indicate an acceptable fit (Browne & Cudeck, 1992). Since sex and age effects on the personality scores or job satisfaction were not the focus of this paper, all measures were regressed on age and sex and standardized residuals were used in all subsequent analyses. Moreover, age and sex of twins are perfectly correlated across pairs, which could inflate the correlation between twins and thus could be misinterpreted as indicating shared environmental influences (McGue & Bouchard, 1984). Differences in means and variances between MZ and DZ twins can affect the overall model fit and were inspected. For the phenotypic correlations, scale scores were computed by taking the mean of the items for each personality factor and job satisfaction. For the behavior genetic models, all factors were modeled as latent variables to account for the reliability coefficients and therefore to allow for structural relations to be distinguished from random measurement error (Bollen, 1989).

Results

Phenotypic Relations between Personality and Job Satisfaction

Missing value analyses revealed relatively low missing value rates (with a maximum of 12% across all items) and indicated that missing values were at random (MAR). Missing values were substituted by maximum likelihood estimates, using the expectation maximization (EM) algorithm (Little & Rubin 2002). Descriptive statistics, bivariate phenotypic correlations between the Big Five personality traits and job satisfaction as well as phenotypic similarities (Intraclass correlation) for MZ and DZ twins are presented in Table 1.

The pattern of correlations was largely in line with the meta-analysis by Judge et al. (2002), showing a negative correlation between job satisfaction and Neuroticism (r = -.30) and a positive correlation between job satisfaction and the remaining personality traits. Conscientiousness showed the second largest relation (r = .19), followed by Agreeableness (r = .16) and Extraversion (r = .13). As expected, Openness showed no significant relation to job satisfaction. The results of the regression model showed that the best fitting model included Neuroticism ($ß$ = -.37), Extraversion ($ß$ = -.08) and Conscientiousness ($ß$ = .21) whereas Openness and Agreeableness could be removed from the model without a significant loss of fit (Model: χ^2 = 523.58, χ^2/df = 4.36, df = 120, RMSEA = .07; χ^2-difference test: LRT(df) = 3.64, p = .16). Overall, 19% of the variance in job satisfaction could be explained. Given that Neuroticism, Extraversion, and Conscientiousness have also shown the strongest and most consistent relations to job satisfaction in the literature (Judge, Heller, et al., 2002; Viswesvaran & Ones, 2000), we included these personality factors in our subsequent multivariate behavior genetic model.

Behavior Genetic Analyses

Given the fact that the MZ intraclass correlation (ICC) for job satisfaction was more than twice the size of the ICC for DZ twins, the presence of non-additive genetic influences could be expected. Based on the pattern of the ICCs and in terms of a better comparison of the models for each factor, the full ADE model was used for all factors in the multivariate model. The multivariate Cholesky decomposition model for the four variables of interest is shown in Figure 3. All correlations between the personality factors (Neuroticism, Extraversion, and Conscientiousness) and job satisfaction, as well as between the personality factors themselves were modeled. In the following, we will concentrate on the genetic and environmental influences on each variable in the model to determine the heritability as well as on the genetic and environmental relations between the personality factors and job satisfaction. The intercorrelations between the personality factors were not the focus of this study and were

therefore neglected. The multivariate model provided a good fit (χ^2/df = 1.47, df = 514, RMSEA = .04), and the estimates of common and unique genetic and environmental influences are shown in Table 2. To reconstruct genetic and environmental influences on individual variables in the model regardless of their covariance, all estimates for a particular variable (specific and common) must be summed. For job satisfaction, the phenotypic variance could be explained by mainly by non-additive genetic influences (D = .25), a small proportion of additive genetic influences (A = .03) and non-shared environmental (E = .72) influences. Altogether, job satisfaction showed a heritability of 28% including a substantial amount of non-additivity. For the personality factors, genetic influences (A and D) accounted for 62% (Extraversion) and respectively 63% (Neuroticism and Conscientiousness) of the phenotypic variance. Consistent with other studies, non-additive genetic influences range between 17% (Conscientiousness) and 35% (Neuroticism), whereas non-shared environmental influences explained the remaining major part of the variance (Hahn, Spinath, et al., 2012; Kandler, Riemann, Spinath, & Angleitner, 2010; Keller, Coventry, Heath, & Martin, 2005).

With respect to the genetic relations between personality and job satisfaction, the multivariate model showed only small additive genetic influences on job satisfaction, but all these influences were common additive genetic influences with Conscientiousness (see line four in Table 2). For non-additive genetic influences, the analyses also revealed that the non-additive genetic influences on job satisfaction (25%) could be explained by the corresponding influences on the personality traits; mainly Neuroticism and Extraversion. In sum, there were no specific influences of A or D variance on job satisfaction, whereas all the genetic variance in job satisfaction could be described as genetic variance that was common to both job satisfaction and personality. Considering the environmental relations between personality and job satisfaction, only a small proportion of the variance in job satisfaction (17% of the total variance in job satisfaction; 24% of all non-shared environmental variance) could be

explained by common non-shared environmental variance with the personality traits. About 55% of the variance in job satisfaction was accounted for by unique non-shared environmental influences that were independent of personality. Part (2) of Figure 3 illustrates that the phenotypic variance of job satisfaction could be explained by common genetic influences (A and D), common non-shared environmental influences, both with Neuroticism and Conscientiousness and most important by specific non-shared environmental influences independent of personality (e44).

Discussion

Job satisfaction is one of the core concepts in work and organizational psychology, and it is therefore of great importance to investigate how and to what extent it is influenced by dispositional and situational factors. The present study utilized a direct approach to estimate the heritability of job satisfaction and the role of personality as a mediator. In contrast to the results found by Ilies and Judge (2003), we found a high genetic overlap between job satisfaction and personality. Moreover, using an approach that avoids some restrictions and assumptions Ilies and Judge had to deal with, not only the amount of overlap but also the specific nature of genetic variance could be further specified. By accounting for different kinds of genetic sources, the current study showed the importance of non-additive genetic influences on job satisfaction.

Prior to the genetic analyses, we examined the relations between job satisfaction and the Big Five personality factors and found the expected correlational pattern. The results were in line with the meta-analysis by Judge et al. (2002) such that the highest correlations with job satisfaction were found for Neuroticism, Conscientiousness, and Extraversion. Additionally, a multivariate regression model revealed that these three factors had significant effects on job satisfaction, whereas the remaining two personality factors (Agreeableness and Openness) could be removed from the model. A difference between the present study and previous

investigations is that we allowed for intercorrelations between the Big Five factors, given the fact that these intercorrelations typically exist and can reach substantial levels (Ostendorf & Angleitner, 2004). In addition to previous conclusions that Neuroticism and Extraversion were the most important personality factors, our analyses also showed a meaningful connection between job satisfaction and Conscientiousness. Summarizing two studies on the relations between personality traits and different aspects of job satisfaction, Furnham et al. (2002) concluded that Conscientiousness seemed to be a powerful predictor of work-related behavior in general. In their study, Conscientiousness and age were even the only two predictors of global job satisfaction. Overall, the same personality traits that were identified as important for life satisfaction (Steel, Schmidt, & Shultz, 2008) seemed to be the major factors for job satisfaction too. This finding reinforces the assumption that personality traits provide a general basis for satisfaction.

Given these results on the phenotypic level, the next step was to determine how personality influences job satisfaction. Using a behavior genetics design, we explicitly tested whether the relation between personality and job satisfaction is based on a genetic path, an environmental connection, or a combination of both common genetic and environmental factors. First, the phenotypic variance in job satisfaction in the present sample could be explained by genetic (28%) and non-shared environmental (72%) influences. If these 28% are seen as heritability in general, this result is consistent with the results of Arvey et al. (1989; 1994) and the estimated heritability of .29 reported by Ilies and Judge (2003).

However, our results indicate that the genetic variance in job satisfaction is mainly non-additive in nature, rather than additive. This is in contrast to the assertion that most or all of the genetic variation in job satisfaction is additive (Arvey, McCall, Bouchard, & Taubman, 1994), but in line with findings for general life satisfaction (Hahn, Johnson & Spinath, 2013; Bartels et al., 2005). Assuming that the non-additive genetic influences cannot be explained by other mechanisms (e.g., MZ-specific environment), our results imply that a large part of

the genetic variance in job satisfaction in parents will not be transmitted from the parents to their offspring because the genes involved are only effective in combination with other genes, and there is only a 25% chance that parents and their offspring will share all of these genes. More precisely, these combinations are fully shared by MZ twins but are unlikely to be shared by siblings or parents and offspring. The presence of non-additive genetic influences could complicate molecular genetic efforts trying to find specific "job satisfaction genes".

We found no evidence for shared environmental influences on job satisfaction, which is a common result in classical twin studies on psychological traits (for a review, see (Turkheimer, 2000). This implies that sharing a family environment with siblings or parents does not contribute importantly to the similarity between family members in job satisfaction. However, this does not mean that the family environment is unimportant, which is one of the biggest misunderstandings in behavior genetics to date (Plomin et al., 2012). Experiences shared by family members (e.g. socio-economic status) can also contribute to job satisfaction through another path or through non-shared environmental influences. Besides the genetic component, non-shared environmental influences explained the remaining three fourths of the variance (i.e., E variance). This strengthens the importance of individual experiences of family members – most likely experiences outside the family home later on at work or within peer groups – and contributes to differences between them. Considering job satisfaction and its connection to life satisfaction in general, specific work characteristics, the socio-economic status, and personal income could be part of these environmental influences. Johnson and Krueger (2006), for example, identified the perceived financial situation and perceived control as specific non-shared environmental influences on life satisfaction.

Based on this, the relations between job satisfaction and Neuroticism, Extraversion, and Conscientiousness were explored. The results showed clearly that all the genetic influences on job satisfaction could be explained by common genetic influences with personality. These results are consistent with the expectations of the present study and also

with those of Ilies and Judge (2003), who originally expected a greater overlap of genetic influences between job satisfaction and personality, but inconsistent with the actual finding of Ilies and Judge (2003).

By explicitly estimating common genetic and environmental pathways between job satisfaction and personality, our model showed that the overlap between job satisfaction and personality could be attributed mainly to common genetic influences (see comparison to the approach used by Ilies and Judge (2003) in the Appendix). About 62% of the common variance between job satisfaction and personality could be explained by common genetic influences ($A_{common} + D_{common}$/ $A_{common} + D_{common} + E_{common}$) that are mainly non-additive in nature, whereas common non-shared environmental influences explained the remaining 38% of the common variance (E_{common}/ $A_{common} + D_{common} + E_{common}$). The results could be understand as there is a third factor, namely parts of our genetic makeup, influencing how satisfied someone would be with his or her job as well as how neurotic and conscious one tends to be. However, this does not explain all of the covariation.

Common environmental influences were found between job satisfaction and Neuroticism as well as Conscientiousness while Extraversion seemed to have no specific impact on job satisfaction. As outline for the genetic part, specific environmental experiences such as a safe workplace environment can also be hidden behind the common non-shared environmental variance. In this manner, our results were contrary to the assumption of additive contributions from all five personality factors made by Ilies and Judges (2003) in their study. The pattern of common and specific genetic and environmental influences in our study was comparable to the results found for overall life satisfaction (Weiss, Bates, & Luciano, 2008). Moreover, Song, Li, and Arvey (2011) already argued that certain genes could explain part of the phenotypic variation in job satisfaction because of their importance for personality. They found two genetic markers, a dopamine receptor gene (DRD4 VNTR) and a serotonin transporter gene (5-HTTLPR), to be associated with job satisfaction.

However, these genetic markers were not exclusively associated with job attitudes and given the small effect sizes (less than 1%) of such relations, we are far from the use of genotyping to better identify workers who are likely to be satisfied in their jobs.

However, it seems important to point out that even though personality traits explained all the genetic influences on job satisfaction, we also found a substantial amount of environmental variance in job satisfaction that was mainly independent of personality. This means that the environment is important and that individual-based environmental factors should be considered in particular, an idea that seems feasible given that we investigated adult twins who work in different companies. Non-shared environmental influences can involve several job characteristics (e.g., working conditions: Böckerman & Ilmakunnas, 2008; leadership: Fiedler, 1967; task design: Herzberg, Mausner, & Snyderman, 1959; working climate: Schneider & Snyder, 1975; pay: Judge, Piccolo, Podsakoff, Shaw, & Rich, 2010) as well as different characteristics of the family environment. Factors of the family environment are usually considered to be shared environmental influences, but they can also be non-shared as a consequence of different perceptions, meanings, and impacts on every individual in the family. James and James (1989) postulated that perception and cognition play roles in job satisfaction statements. The central issue raised with the finding of genetic influences on job satisfaction is concerned with expectations regarding the stability and malleability of an individual's job satisfaction. For instance, proponents of the dispositional approach suggested using job satisfaction in personnel selection (Staw & Ross, 1985). However, Dormann and Zapf (2001) reported a test-retest stability of job satisfaction of .33 with an upper limit of .51 based on a meta-analysis. Recent discussions in the area of behavior genetic research have questioned the widely accepted connection between the heritability of a factor and its stability (see Johnson, Penke, & Spinath, 2011). Heritability of a factor alone provides little information about the expected stability of these genetic effects over time and therefore limited information about the stability of the factor or the degree to which the trait may

respond to environmental changes. However, the presence of substantial genetic influences on job satisfaction and its stability over time have to be kept in mind with respect to large scale changes for all individuals due to interventions. Even though genetic influences on job satisfaction cannot be used as a limiting factor of its malleability per se, it may very well be a factor that contributes to individual differences in job satisfaction beyond mean effects caused by interventions or environmental change. A simple thought experiment illustrates this: An exorbitant pay rise to a population of workers would probably lead to an average increase of job satisfaction, but at the same time there would still be individual differences in people's job satisfaction which could be explained by genetic differences operating in part via different reactions of individuals to environmental conditions. Moreover, practitioners should also consider to work on interventions that focus on perceptions and evaluations of the job beyond job redesign and social influence.

Strengths and Limitations

Like most studies, we had to deal with several limitations in this study. First, there are some limitations that are inherent to most behavior genetic studies concerning the model and different assumptions of the classical twin design (for an overview, see: Plomin et al., 2012). In particular, our behavior genetic model did not include the possibility that shared environmental influences and non-additive genetic influences could work simultaneously. If an ADE model is modeled when shared environmental influences might have an effect on the variability of job satisfaction, this may lead to incorrect results (Ozaki et al., 2011) and typically to an overestimation of heritability (Coventry & Keller, 2005). However, previous research on personality traits (Plomin et al., 2012) has shown that shared environmental influences are typically negligible, whereas non-additive genetic influences can have an important impact. Furthermore, the pattern of twin similarity in job satisfaction suggested that non-additivity could be expected.

In addition, the effect of the gene-environment correlation and interaction could also explain parts of the phenotypic variance, and this means that an interaction of a specific gene set with a specific environment can have different effects on the trait. Gene-environment correlations and interactions can also mean that different persons will react and respond differently to their environment based on their genes. One of the most prominent examples of a gene-environment interaction was found by Caspi et al. (2002), who showed that a particular gene is strongly associated with antisocial behavior but only for individuals who suffered severe childhood maltreatment. To investigate the effects of gene-environment correlations and interactions, information about specific environmental characteristics or specific genes is required.

Another general limitation is that our study relied on twin data only. Reassuringly, studies have shown that twins are generally comparable to the general population concerning different characteristics such as personality traits (Johnson et al., 2002). Nevertheless, the next step in this line of research should be to investigate twins and other family members to extend the design and to ensure that the results are representative of the population.

Furthermore, we had to deal with short scales for both personality traits and job satisfaction, resulting in aggregate scores that are psychometrically inferior compared to standard, full-length scales. This might have had an effect on the level of the correlations in our study and in consequence might have affected our etiological estimates. However, the correlational pattern between the Big Five scales and job satisfaction was highly comparable to the results of the meta-analysis by Judge, Heller and Mount (2002), which provides evidence that the validity of the short scales is sufficient. However, with regard to the specific items used to operationalize job satisfaction, the scale covers only some facets of job satisfaction (e.g. pay satisfaction), whereas other facets were not explicitly addressed. By modeling latent personality and job satisfaction traits, we controlled for those variance components, but the degree of measurement error can also include other contributions like

facet- or item-specific variance. Based on previous research (e.g. Staw et al., 1986), we assumed a causal direction from personality to job satisfaction in our model, but we did not explicitly test this assumption. This is important for the interpretation of the genetic overlap between personality and job satisfaction, which we would have also found in the other direction. Although we do not know the specific processes behind the genetic correlation, we know that all genetic effects on job satisfaction are connected with personality. At this point, longitudinal genetically sensitive data are needed to better illuminate the direction of causation between these two concepts.

Conclusion

The present study used a direct approach to investigate genetic and environmental influences on job satisfaction and the relation of job satisfaction to the Big Five personality traits to gain a better understanding of the causes of individual differences in job satisfaction. Using this approach, we clearly showed that genetic influences of job satisfaction overlap completely with personality, including common non-additive genetic influences. The results of this study are specifically supportive of an interactionist view of job satisfaction in that both situational and dispositional determinants of job satisfaction are relevant. Based on the finding of genetic influences on job satisfaction, it seems reasonable to implement more individual interventions in organizations to achieve positive results and to maximize the success of interventions.

Appendix

In order to compare the methodology of the presents study to those performed in the Ilies and Judge (2003) study, we directly transferred our Cholesky decomposition model into their formula ($h_p^2 = \sum(h_i ß_i)^2$). We used ßi-values from our latent path regression model and heritability estimates (h_i) from our latent behavior genetic model. If we use the Ilies and Judge's formula, we find a partial heritability of job satisfaction of about 11.7%, which would imply that 42% of the total heritability of job satisfaction (h^2_{total} = 28%) would seem to be mediated by common genetic effects with personality. As can be seen by the direct comparison of the results, the partial heritability of job satisfaction controlled for the personality traits would be underestimated when the formula of Ilies and Judge (2003) is used.

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Figure caption

Figure 1. Illustration of three different possible relations of job satisfaction and personality with respect to genetic and environmental causes. One personality trait, job satisfaction as well as the effect of the personality trait on job satisfaction (represented as arrow) can be roughly decomposed into its genetic and environmental origins

Figure 2. Latent regression model including personality and job satisfaction. N = Latent factor of neuroticism, Ex = Latent factor of extraversion, Co = Latent factor of conscientiousness, JS = Latent factor of job satisfaction.

Figure 3. Basic multivariate Cholesky model of the relations between three personality traits and job satisfaction. For reasons of simplicity, the model is shown only for one member of a pair. N = Latent factor of neuroticism, Ex = Latent factor of extraversion, Co = Latent factor of conscientiousness, JS = Latent factor of job satisfaction; Manifest variables for the factors are represented as rectangles. The phenotypic variance is decomposed into latent additive genetic influences (A), non-additive genetic influences (D), and non-shared environmental influences (E).

Figures

Figure 1.

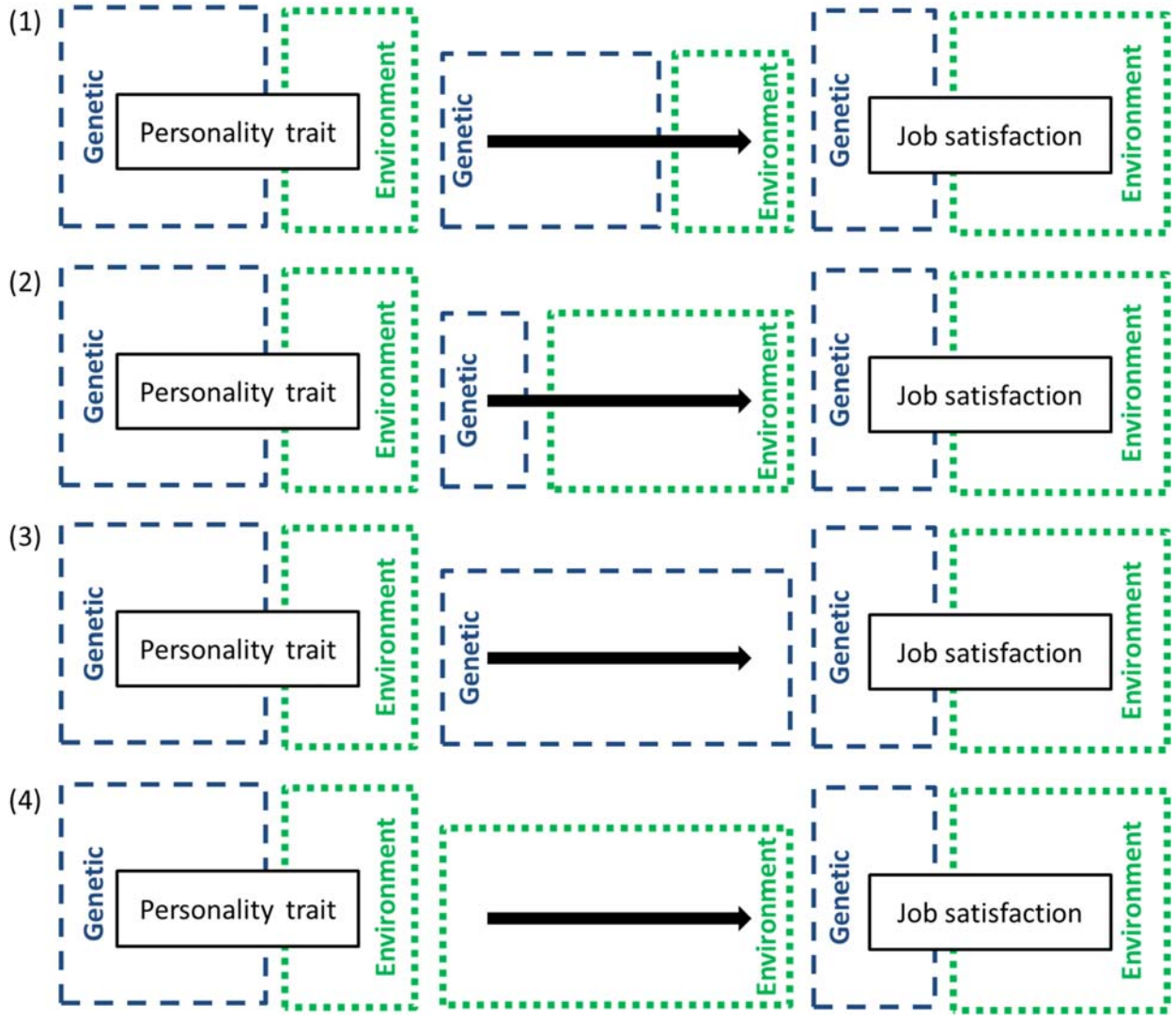


Figure 2

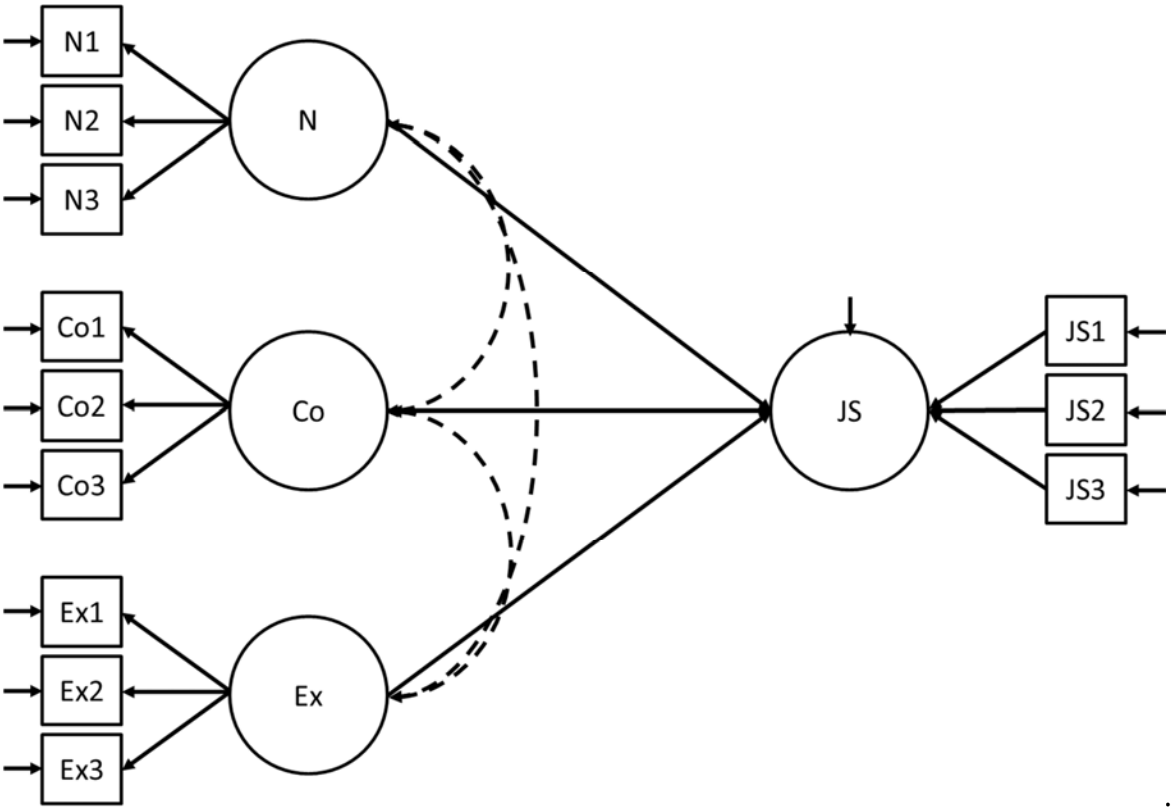
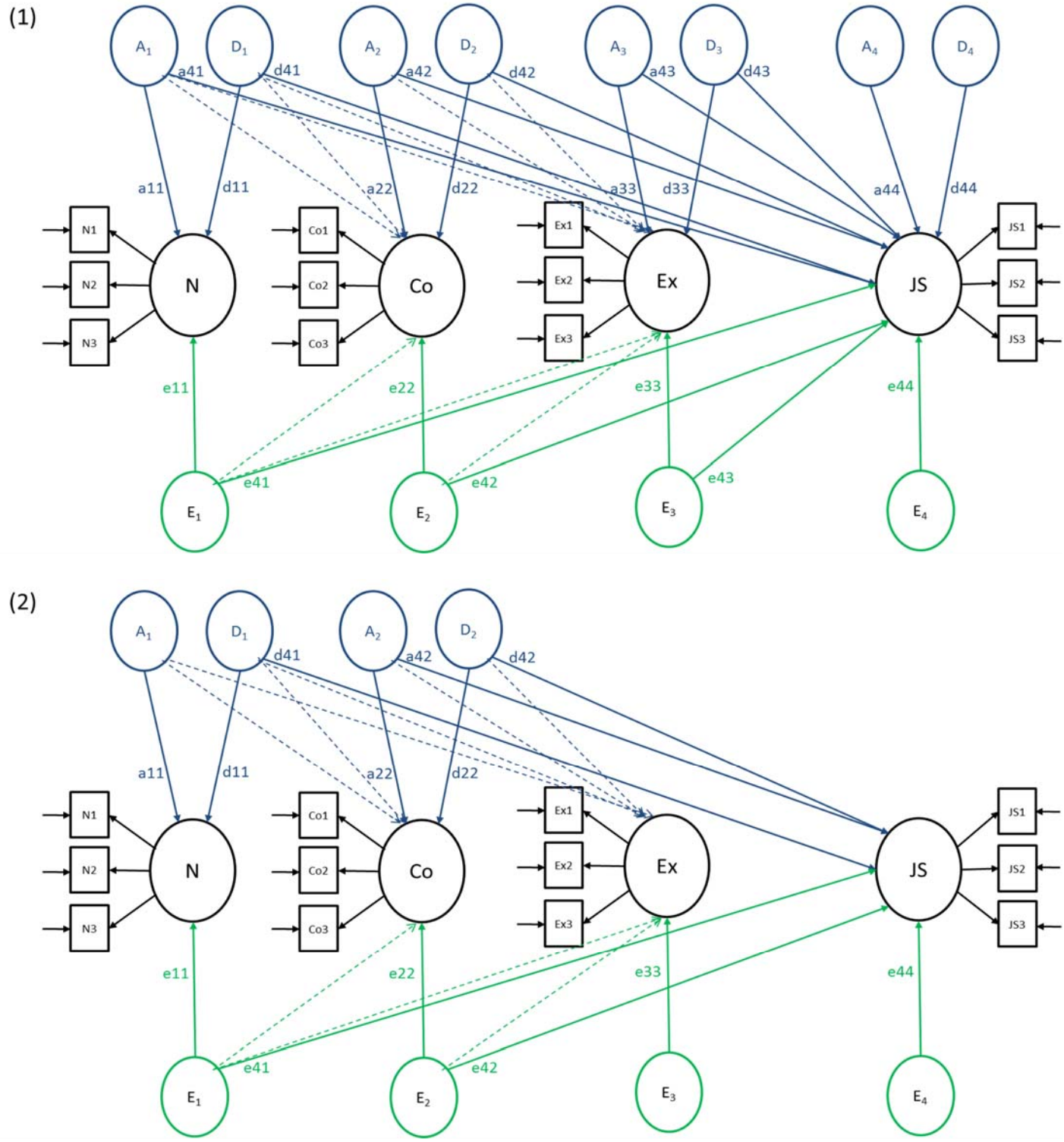


Figure 3


(1)
A1
D1
A2
D2
A3
D3
A4
D4
a41
d41
a42
d42
a43
d43
a11
d11
a22
d22
a33
d33
a44
d44
N1
N2
N3
N
Co1
Co2
Co3
Co
Ex1
Ex2
Ex3
Ex
JS
JS1
JS2
JS3
e11
e22
e33
e44
e41
e42
e43
E1
E2
E3
E4
(2)
A1
D1
A2
D2
d41
a42
d42
a11
d11
a22
d22
N1
N2
N3
N
Co1
Co2
Co3
Co
Ex1
Ex2
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JS
JS1
JS2
JS3
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e33
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E1
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E3
E4

Tables

Table 1

Descriptive Statistics and Intercorrelations of the Five Personality Factors and Job Satisfaction

	Descriptives			Intercorrelations					Intraclass correlation	
	M	*SD*	α	1	2	3	4	5	MZ	DZ
1. Neuroticism	4.08	1.23	.64	-					.61	.29
2. Extraversion	4.82	1.25	.75	-.26**	-				.62	.31
3. Openness	4.58	1.17	.60	-.09*	.36**	-			.67	.10
4. Agreeableness	5.46	0.88	.39	-.12**	.04	.04	-		.48	.17
5. Conscientiousness	5.82	0.88	.55	-.13**	.25**	.10*	.25**	-	.60	.35
6. Job satisfaction	-0.01	0.79	.70	-.30**	.13**	.04	.16**	.19**	.48	.05

Note. $N = 622$ individuals; $N = 185$ monozygotic (MZ) and 126 dizygotic (DZ) twin pairs; α = Cronbach's alpha; The mean and standard deviation of job satisfaction were computed based on z-standardized variables; Intercorrelations were based on mean scores of the scales corrected for age and sex effects as age and sex are perfectly correlated within twin pairs (McGue & Bouchard, 1984). * $p < .05$ (two-tailed). ** $p < .001$ (two-tailed).

Table 2.

Results of the Multivariate Cholesky Decomposition

	Additive genetic influence				Non-additive genetic influence				Non-shared environmental influence			
	A_1	A_2	A_3	A_4	D_1	D_2	D_3	D_4	E_1	E_2	E_3	E_4
1. Neuroticism	.28				.35				.37**			
2. Conscientiousness	.26	.21			.11	.05			.07**	.30**		
3. Extraversion	.01	.34	.00		.04	.23	.00		.08*	.09**	.21**	
4. Job satisfaction	.00	.03	.00	.00	.11	.14	.00	.00	.08*	.09*	.00	.55**

Note. N = 185 monozygotic (MZ) and 126 dizygotic (DZ) twin pairs; A = additive genetic influences; D = non-additive genetic influences estimated as dominance influences; E = non-shared environmental influences; All estimates are standardized and squared to refer to the percentage of variance explained. Specific (a_{11}, a_{22}, a_{33}, a_{44}; d_{11}, d_{22}, d_{33}, d_{44}; e_{11}, e_{22}, e_{33}, e_{44}) additive, non-additive, and non-shared environmental influences of the variables are displayed in the diagonals of each block.

* $p < .05$ ** $p < .01$.