Research Report

Happiness Is a Personal(ity) Thing

The Genetics of Personality and Well-Being in a Representative Sample

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ABSTRACT—*Subjective well-being is known to be related to personality traits. However, to date, nobody has examined whether personality and subjective well-being share a common genetic structure. We used a representative sample of 973 twin pairs to test the hypothesis that heritable differences in subjective well-being are entirely accounted for by the genetic architecture of the Five-Factor Model's personality domains. Results supported this model. Subjective well-being was accounted for by unique genetic influences from Neuroticism, Extraversion, and Conscientiousness, and by a common genetic factor that influenced all five personality domains in the directions of low Neuroticism and high Extraversion, Openness, Agreeableness, and Conscientiousness. These findings indicate that subjective well-being is linked to personality by common genes and that personality may form an "affective reserve" relevant to set-point maintenance and changes in set point over time.*

Across cultures, people rate subjective well-being as the most important element of their life and more important than material success (Diener, 2000). Subjective well-being is associated with numerous positive outcomes, including, for example, good work performance and health (Diener, Suh, Lucas, & Smith, 1999). Moreover, subjective well-being appears not only to track life events, but also to play a causal role in the achievement of positive outcomes (Lyubomirsky, King, & Diener, 2005). Currently, the origins of this important construct are only just beginning to be understood, and there is a need for further research to investigate its determinants.

Numerous studies have shown that subjective well-being is related to the Five-Factor Model (FFM) of personality, especially the domains of Neuroticism, Extraversion, and Conscientiousness, and that, although subjective well-being is not subsumed by personality, the two constructs are reliably correlated (DeNeve & Cooper, 1998). At a psychological level, several plausible mechanisms have been proposed to explain the relationship between personality and subjective well-being. For example, some researchers (Cantor & Sanderson, 1999; Carver & Scheier, 1990) have emphasized the roles of Extraversion and Neuroticism in reward and punishment systems, respectively. Others have proposed that the relationship arises from indirect, instrumental effects of personality on the experiences an individual encounters (McCrae & Costa, 1991).

Major life events, as well as political and economic factors, are also related to subjective well-being; however, the effects of these factors leave much of the variance in subjective well-being unexplained (see Diener, Lucas, & Scollon, 2006, for a review). Findings from numerous studies of personality show that genetic effects account for approximately 50% of the variance in the FFM domains (Bouchard & Loehlin, 2001), and variance in subjective well-being also appears to be moderately heritable. In a seminal twin study using the Well-Being scale of the Multiphasic Personality Questionnaire, Lykken and Tellegen (1996) found that approximately half of the variance in well-being resulted from nonadditive Gene × Gene interaction effects, and that common environmental effects shared by twins did not lead to more similar levels of happiness. Similarly, Nes, Røysamb, Tambs, Harris, and Reichborn-Kjennerud (2006) found that

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approximately 50% of the variance in subjective well-being and 80% of the cross-time correlation were accounted for by genetic effects. This study, however, found evidence for additive rather than nonadditive genetic effects. These studies of personality and subjective well-being yielded evidence for only small effects of the shared environment. However, as environmental effects "transact" with genetic differences, leading to complex effects that are not apparent in the main (average) effects (Johnson, 2007), the studies' estimates of environmental effects are probably conservative.

As we have noted, several psychological connections between subjective well-being and personality have been postulated. One possible explanation for the correlation between personality and subjective well-being that has not been explored is that, as is the case with Neuroticism and depression (Kendler, Gardner, Gatz, & Pedersen, 2007; Kendler, Gatz, Gardner, & Pedersen, 2006), personality and subjective well-being may be correlated because they share genes. In the study reported here, we tested this hypothesis in a large representative sample of adult twins in the United States. We hypothesized that the heritable component of subjective well-being is entirely explained by the genetic architecture of the FFM. If supported, this hypothesis would provide important insights for theories of subjective well-being, suggesting that the genetic and environmental models of subjective well-being may be framed in terms of personality.

METHOD

Participants

The sample consisted of twin pairs from the MacArthur Foundation Survey of Midlife Development in the United States (MIDUS). Approximately 50,000 households, representative of the population of the United States, were initially screened by telephone. Just under 15% of respondents reported having twins in the family, and 60% of this group gave permission for the twins to be contacted as part of the MIDUS recruitment process (Kendler, Thornton, Gilman, & Kessler, 2000; Kessler, Gilman, Thornton, & Kendler, 2004). Zygosity was determined using self-report questions (e.g., similarity of eye and hair color, similarity in childhood as indicated by misidentification). Previous studies have indicated that these measures have greater than 90% accuracy in identifying the zygosity of twin pairs (Lykken, Bouchard, McGue, & Tellegen, 1990).

Inclusion criteria included being first-degree relatives of the original contact or the contact's partner, being between 25 and 74 years old at the time of recruitment, living in the continental United States, being reachable by telephone, and being able to speak English. The resultant twin sample consisted of 973 twin pairs (365 monozygotic and 608 dizygotic) with a mean age of 44.9 ($SD = 12.1$). Personality or well-being data were available for at least one twin in each pair. Of the monozygotic pairs, 171 were male (mean age = 44.5, $SD = 11.5$) and 194 were female (mean age = 43.5, $SD = 12.2$). Of the dizygotic pairs, 136 were male (mean age = 44.2, $SD = 12.5$), 213 were female (mean age = 45.9, $SD = 12.4$), and 259 were opposite sex (mean age = 45.8, $SD = 11.9$). Subjective well-being data were available for both members of the pair for 347 monozygotic pairs and 543 dizygotic pairs, and personality data were available for both members of 314 monozygotic pairs and 471 (Openness) to 473 (Agreeableness and Conscientiousness) dizygotic pairs. In the analyses, information from all 973 twin pairs was used (Neale & Cardon, 1992).

Measures

Personality

The Midlife Development Inventory (MIDI), a self-administered 25-item personality questionnaire (Lachman & Weaver, 1997), was mailed to each participant. Respondents used 4-point Likert scales to indicate the degree to which each adjective on the questionnaire described them. Our measures of personality were scores on the five previously defined MIDI scales (Lachman & Weaver, 1997). Each score was calculated by obtaining the average of the ratings for items defining that dimension: Neuroticism was defined by *moody*, *worrying*, *nervous*, and *calm* (reverse-scored); Extraversion was defined by *outgoing*, *friendly*, *lively*, *active*, and *talkative*; Openness to Experience was defined by *creative*, *imaginative*, *intelligent*, *curious*, *broad-minded*, *sophisticated*, and *adventurous*; Agreeableness was defined by *helpful*, *caring*, *warm*, *soft-hearted*, and *sympathetic*; and Conscientiousness was defined by *organized*, *responsible*, *hardworking*, and *careless* (reverse-scored).

Subjective Well-Being

We assessed subjective well-being using three questions that were administered by telephone interview. These questions were similar to those used in other studies (see, e.g., Diener et al., 1999). The first question asked how satisfied participants were with life at the present, the second asked how much control subjects felt they had over their lives, and the third asked how satisfied they were with life overall. Each question was answered using a 4-point Likert scale, with lower values indicating higher subjective well-being. For the purpose of the present study, we reverse-coded and summed each participant's responses.

Analysis

A classical twin design, in which the resemblance of monozygotic and dizygotic twins is compared, was used. On the basis of previous findings suggesting the presence of nonadditive genetic effects and the lack of shared environmental effects (Lykken & Tellegen, 1996), we used structural equation modeling to model the covariance of identical twins in terms of additive (A) and nonadditive dominance (D) genetic effects. The covariance of nonidentical twins was specified as $\frac{1}{2}A + \frac{1}{4}D$.

Unshared effects were modeled as unique environment (E). These models were estimated by maximum likelihood in Mx (Neale, Boker, Xie, & Maes, 1999).

To test our hypothesis that genetic variance in subjective well-being stems from the genetics of personality, we used a multivariate Cholesky decomposition of additive genetic, dominance genetic, and unique environmental covariance between the measures. The Cholesky form specifies as many factors as there are variables (sources of variance), each factor having one less loading than the previous one. The fit of theoretical models can be tested by comparing their fit with that of the saturated model. A reduced model (i.e., one with fewer parameters) is favored if the likelihood-ratio chi-square comparing the reduced model with the saturated model (or a model in which the reduced model is nested) is less than the critical value ($\alpha = .05$) of the chi-square distribution, which indicates that there is no significant difference between models. We predicted that we could drop the latent genetic factor specific to subjective well-being without a significant loss of fit.

RESULTS

The phenotypic correlations of subjective well-being and Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness were −.35, .29, .14, .16, and .21, respectively, and thus consistent with previous findings (DeNeve & Cooper, 1998). Table 1 shows the mean scores and standard deviations for the personality domains and subjective well-being, as well as the correlations between co-twins. The correlations for monozygotic twins were substantially greater than those for dizygotic twins, which is consistent with prior findings suggesting that subjective well-being has a nonadditive genetic component and that there is little evidence for shared environmental effects (Lykken & Tellegen, 1996). The substantially greater monozygotic-twin correlations support the inclusion of genetic dominance rather than shared environmental effects in the base model.

Testing for bivariate normality using the %P function in Mx ($z < -3.5$ or > 3.5) identified 8 twin pairs that were outliers. We therefore excluded these twin pairs from the analysis. We also controlled for gender and age, as males had significantly lower mean levels of Neuroticism ($b = -0.11$, $p < .05$), Agreeableness ($b = -0.24$, $p < .05$), and Conscientiousness ($b = -0.10$, $p < .05$) than females, and older participants had lower levels of Neuroticism ($\beta = -.15$, $p < .05$) and Openness ($\beta = -.09$, $p < .05$) than females, and higher scores for Agreeableness ($\beta = .05$, $p < .05$) and subjective well-being ($\beta = .13$, $p < .05$).

The hypothesized model specified that all genetic influences on subjective well-being originated from a general genetic factor that also influenced the five personality domains and from genetic factors for the five personality domains. The model, then, posited general latent additive and dominance genetic effects underlying variance in all five personality domains and subjective well-being and also included specific additive and dominance genetic effects for the five personality domains, which also contributed to variance in subjective well-being (as shown for additive effects in Fig. 1).

There was no significant difference in fit between the hypothesized model and the saturated model, $\Delta\chi^2(10) = 5.69$, $p > .05$, Akaike information criterion (AIC) = −14.31. Next, we performed a powerful test with a single degree of freedom to compare the fit of the hypothesized model with that of a model having additional genetic factors specific to subjective well-being. Dropping either the additive or the dominance factor led to no change in log likelihood, $p = 1.00$. This result is consistent with there being no specific genetic effects on subjective well-being independent of the genetic effects on personality.

The hypothesized model was then further reduced by removing genetic paths from the Agreeableness and Openness domains to subjective well-being. The model with these paths eliminated did not differ significantly from the originally hypothesized model, $\Delta\chi^2(4) = 1.79$, $p > .05$, $AIC = -20.52$. In a final model, we tested whether the dominance effects were significant; eliminating these effects did not significantly reduce model fit, $\Delta\chi^2(14) = 19.99$, $p > .05$, $AIC = -28.52$. The final model included a general additive genetic factor that contributed to variance in all five personality domains and subjective

TABLE 1

Mean Scores for the Five Personality Domains and Subjective Well-Being, and Co-Twin Correlations

	Descriptive statistics									
	MZ twins				DZ twins				Correlation ($r_{T1,T2}$)	
Dimension	M_{T1}	SD_{T1}	M_{T2}	SD_{T2}	M_{T1}	SD_{T1}	M_{T2}	SD_{T2}	MZ	DZ
Neuroticism	2.25	0.72	2.23	0.66	2.21	0.64	2.29	0.66	.52	.23
Extraversion	3.20	0.58	3.24	0.54	3.22	0.56	3.23	0.55	.45	.13
Openness	2.99	0.52	3.00	0.51	2.95	0.52	2.96	0.55	.41	.22
Agreeableness	3.51	0.45	3.52	0.48	3.48	0.48	3.58	0.45	.35	.11
Conscientiousness	3.43	0.45	3.47	0.42	3.42	0.43	3.45	0.42	.47	.18
Subjective well-being	10.92	1.49	10.90	1.43	10.88	1.41	10.90	1.40	.37	.10

Note. MZ = monozygotic; DZ = dizygotic; T1 = Twin 1; T2 = Twin 2.

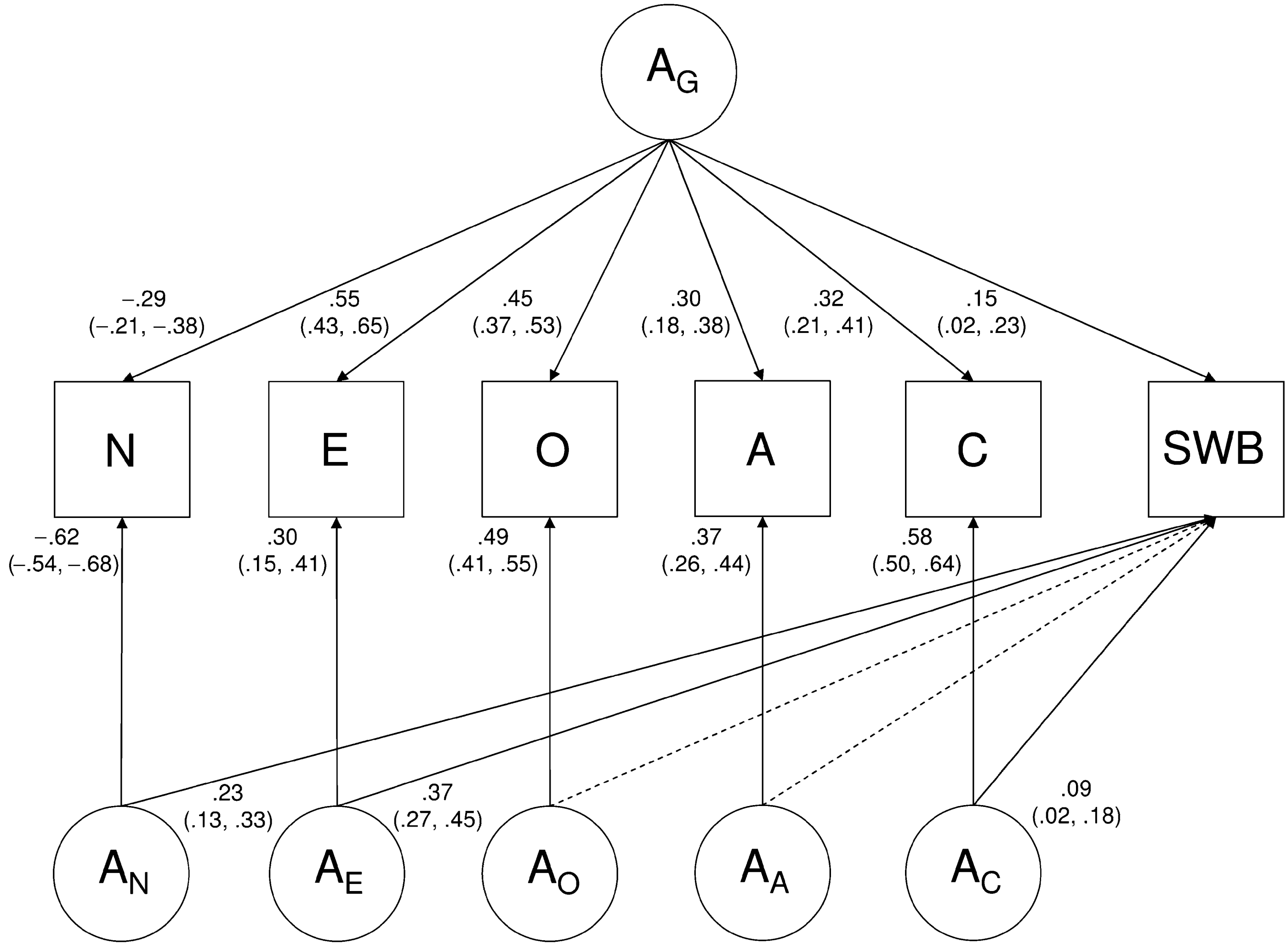

Fig. 1. The best-fitting model, which shows how general additive genetic effects (A_G) and unique additive genetic influences of Neuroticism (A_N), Extraversion (A_E), Openness (A_O), Agreeableness (A_A), and Conscientiousness (A_C) account for individual differences in Neuroticism (N), Extraversion (E), Openness (O), Agreeableness (A), Conscientiousness (C), and subjective well-being (SWB). Solid lines represent paths in the final model, and dashed lines represent dropped paths. Values outside of parentheses are path coefficients, and values within parentheses indicate 95% confidence intervals.

well-being, specific genetic factors influencing each personality domain separately, and paths from the independent genetic influences on Neuroticism, Extraversion, and Conscientiousness to subjective well-being (see Fig. 1). The corresponding unique environmental effects (*E*) for this model were also modeled as a Cholesky decomposition (see Table 2). In this model, the genetic correlations (r_g) between subjective well-being and Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness were equal to .58, .66, .21, .20, and .32, respectively.

TABLE 2
Standardized Path Coefficients for Unique Environmental Effects

	Dimension					
Dimension	Neuroticism	Extraversion	Openness	Agreeableness	Conscientiousness	Subjective well-being
Neuroticism	−.73					
Extraversion	.05	.78				
Openness	.12	.36	.64			
Agreeableness	.02	.44	.11	.75		
Conscientiousness	.19	.11	.13	.11	.69	
Subjective well-being	.20	.12	.04	.09	.06	.84

DISCUSSION

These results show that the genetic structure of the FFM and subjective well-being can be modeled without genetic influences specific to subjective well-being. That is, there were no genetic effects unique to subjective well-being. Instead, these findings show that the genetic variance underlying individual differences in happiness is also responsible for individual differences in Neuroticism, Extraversion, and, to a lesser extent, Conscientiousness. We also found evidence for a general genetic factor underlying individual differences in the FFM domains and subjective well-being.

In this sample, it was possible to drop the dominance effects without significantly reducing fit. This result is consistent with some (Nes et al., 2006), but by no means all (Lykken & Tellegen, 1996), findings. One reason for the disparate findings concerning dominance effects on subjective well-being is that classical twin designs have low power to detect dominance effects (Neale & Cardon, 1992). Thus, an extended twin design or larger sample would be needed to definitively address the question of whether dominance or something like dizygotic sibling-contrast effects (Eaves & Silberg, 2005) are responsible for the fact that co-twin correlations for subjective well-being are substantially higher for monozygotic than for dizygotic twin pairs.

The most important finding of this study is that subjective well-being was genetically indistinct from personality traits, especially those reflecting, in part, emotional stability (low Neuroticism), social and physical activity (high Extraversion), and constraint (high Conscientiousness). The close genetic relationship between positive personality traits and happiness traits is the mirror image of comorbidity in psychopathology (Kendler et al., 2006, 2007). Weiss, King, and Enns (2002) coined the term “covitality” to describe the genetic correlation between a personality domain, Dominance, and subjective well-being in chimpanzees.

One unexpected finding of this study is that we found evidence for a single genetic effect that contributed to variance in all five personality domains and to subjective well-being. The presence of this general genetic factor suggests that a higher-order factor, perhaps reflecting life-history strategy (Figueredo, Vásquez, Brumbach, & Schneider, 2004, 2007), is reflected in subjective well-being and personality. However, because our study did not include multiple methods (see, e.g., Riemann, Angleitner, & Strelau, 1997), it is impossible to rule out the possibility that the general genetic factor reflects common-method variance or a heritable tendency toward positive self-presentation.

The present findings suggest that the relationship between subjective well-being and a range of health and social-relationship factors may also be mediated by common genetic effects. In future twin studies, researchers may wish to examine the relationships between subjective well-being and factors such as marital stability, social support, and religious attendance (Myers, 2000), controlling for personality, preferably at a behavior-genetic level. Such studies could determine whether these relationships are also moderated by common genetic effects.

Our findings also have implications for the set-point theory of subjective well-being. Recent results have revealed not only that there are individual differences in the subjective well-being set point, but also that environmental events can lead to lasting changes in this set point and that the degree of adaptation to circumstances differs among individuals (Lucas, Clark, Georgellis, & Diener, 2003; Lucas, Clark, Georgellis, & Diener, 2004). The present results suggest that genetic effects of personality may affect the rate at which well-being returns to the set point after a disturbance, and the extent to which the set point undergoes lasting change in response to environmental events. Thus, personality may create what might be termed an affective reserve, which can be called upon in times of stress and recovery.

These findings have major implications for studies on the molecular genetics of subjective well-being and other positive psychological traits. To the extent that resilience and the ability to capitalize on positive environmental inputs are related to the same genetic factors that influence personality, geneticists interested in subjective well-being should focus their search for genes on those genes that influence personality and attempt to understand how specific combinations of those genes, possibly in certain environments, contribute to the human experience of happiness.

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