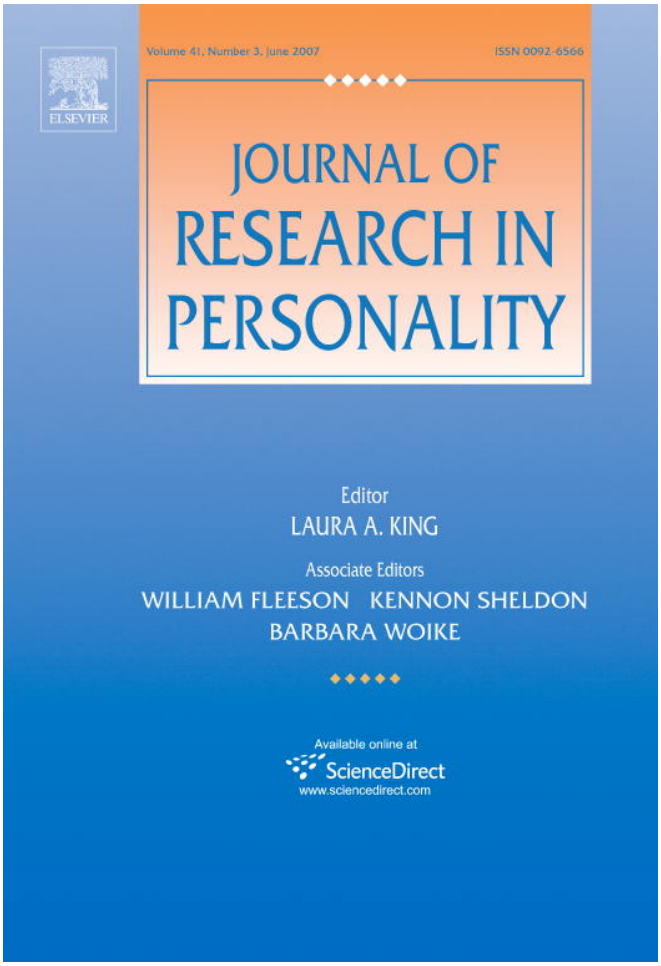

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Genetic and environmental influences on the positive traits of the values in action classification, and biometric covariance with normal personality

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Abstract

Virtually all human individual differences have been shown to be moderately heritable. Much of this research, however, focuses on measures of dysfunctional behavior and relatively fewer studies have focused on positive traits. The values in action (VIA) project is a comprehensive and ambitious classification of 24 positive traits, also known as character strengths (Peterson, C., & Seligman, M. E. P. (2004). *Character strengths and virtues: A handbook and classification.* Washington, DC: American Psychological Association), the majority of which have received no behavior genetic attention. Using a sample of 336 middle-aged twins drawn from the Minnesota Twin Registry who completed the VIA inventory of strengths, we detected significant genetic and non-shared environmental effects for 21 of 24 character strengths with little evidence of shared environmental contributions. Associations with a previously administered measure of normal personality found moderate phenotypic overlap and that genetic influences on personality traits could account for most, but not all, of the heritable variance in character strengths.

Keywords: Positive traits; Values in action; Character strengths; Twin studies; Multidimensional personality questionnaire

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1. Introduction

The dawn of the 21st century has witnessed an explosion of interest in positive psychological traits, and psychologists are employing increasingly powerful methodologies to cast light on the etiologies of these factors (Caccioppo, Hawkley, Rickett, & Masi, 2005). The present study is the first to employ the behavior genetic method to understand the traits known as the values in action classification of strengths (VIA-CS; Peterson & Seligman, 2004). The classification encompasses an impressive array of strengths, providing a foundation from which to explore the genetic and environmental influences on positive traits in general.

Character strengths are viewed as individual differences that are culturally valued. One conceptual feature of character strengths is that they are stable traits, yet their augmentation and cultivation is a principal priority. In addition, they are purportedly ubiquitous across cultures and history (Peterson & Seligman, 2004). A summary of recent research indicated that individuals from several different countries similarly rank-ordered their relative endorsement of these traits (ranking correlations were said to range in the .80s; Seligman, Steen, Park, & Peterson, 2005). The purpose of this study is to directly address the question of whether character strengths are unique, or whether they are as heritable as other, typically studied personality traits (Bouchard, 2004).

Although the vast majority of character strengths (see Table 1 for list and brief descriptions) have never received behavioral genetic investigation, previous research suggests that genetic influence on the VIA-CS traits may vary. For example, religiousness (related to the strength of spirituality) has received considerable attention. Genetic influences have been demonstrated for religious attitudes, values, and behaviors that are of similar magnitude to those found for other personality traits (21–52% of the variance in these traits was attributable to genetic variation; Bouchard, McGue, Lykken, & Tellegen, 1999; D'Onofrio, Eaves, Murrelle, Maes, & Spilka, 1999; Waller, Kojetin, Bouchard, Lykken, & Tellegen, 1990). Other studies found evidence of genetic influence on self-transcendence, which is also related to spirituality (e.g., 44%; Gillespie, Cloninger, Heath, & Martin, 2003; Kirk, Eaves, & Martin, 1999). Similarly, genetic influences were reported for leadership (47% to 57%; Johnson, Vernon, Harris, & Jang, 2004), hope (i.e., optimism; Plomin et al., 1992), creativity (Waller, Bouchard, Lykken, Tellegen, & Blacker, 1993), and kindness (i.e., altruism; Rushton, Fulker, Neale, Nias, & Eysenck, 1986). Shared environmental influences, those that make persons in the same family more similar (e.g., parenting, shared traumas, etc.), are rarely found, although researchers have suggested that these effects may be more influential for positive traits (Krueger, Hicks, & McGue, 2001). For example, shared environmental influences were reported for romantic love styles, with little genetic influence detected (Waller & Shaver, 1994).

As others have noted, if the development of character is substantially affected by social learning and awareness of cultural perspective, then evidence should emerge of shared environmental influences on character strengths (Gillespie et al., 2003). Some evidence exists for positive traits like positive affectivity (Goldsmith, Buss, & Lemery, 1997), and altruism (e.g., Krueger et al., 2001), as well as its parent construct, pro-social attitudes (Rushton, 2004), although no evidence of shared environmental influence on the related trait of cooperativeness was found in other investigations (Gillespie et al., 2003). Some

Table 1
Genetic profile for the 24 strengths of the VIA-CS traits

Virtue	Strength	α	MZ	DZ	A	CI_A	E	CI_E
Wisdom (cognitive strengths of acquiring and using knowledge)								
	Creativity (thinking of novel means and concepts)	.90	.53	.09	.51	.29, .66	.49	.34, .71
	Curiosity (interest in things, exploring)	.86	.48	.13	.45	.24, .62	.55	.38, .76
	Perspective (understanding world, wise counsel)	.82	.45	.02	.39	.17, .57	.61	.43, .83
	Open-mindedness (weighing all evidence fairly)	.84	.41	.27	.43	.19, .60	.57	.40, .81
	Love of Learning (systematically add knowledge)	.86	.41	.33	.42	.20, .59	.58	.41, .80
Courage (emotional strengths, exercise will to accomplish goals)								
	Persistence (completing tasks one starts)	.83	.56	.36	.58	.41, .70	.42	.30, .59
	Bravery (not shrinking from threat or difficulty)	.82	.50	.19	.48	.27, .64	.52	.36, .73
	Integrity (presenting oneself in a genuine way)	.74	.53	−.09	.38	.04, .63	.62	.37, .96
	Vitality (feeling alive and excited)	.84	.39	.22	.37	.15, .55	.63	.45, .85
Humanity (interpersonal strengths, cultivating relationships)								
	Social Intelligence (understanding social world)	.82	.41	.20	.42	.21, .58	.58	.42, .79
	Kindness (helping and taking care of others)	.82	.41	.04	.36	.05, .59	.64	.41, .95
	Love (valuing close relationships)	.78	.25	.14	.26	.01, .47	.74	.53, 99
Justice (civic strengths underlying healthy community life)								
	Leadership (organizing group activity)	.78	.42	.22	.42	.19, .60	.58	.40, .81
	Fairness (treating everyone fairly and justly)	.81	.42	−.02	.35	.08, .56	.65	.44, .92
	Citizenship (being a good team member)	.76	.31	−.15	.18	0, .47	.82	.53, 1.0
Temperance (strengths protecting against excesses)								
	Forgiveness/mercy (forgiving others)	.83	.58	.06	.57	.30, .73	.43	.27, .70
	Self-regulation (regulating feelings and actions)	.74	.54	.31	.54	.34, .68	.46	.32, .66
	Prudence (choosing actions with care)	.68	.39	.10	.39	.16, .58	.61	.42, .84
	Humility/modesty (not overvaluing self)	.71	.31	−.03	.25	0, .47	.75	.53, 1.0
Transcendence (strengths providing meaning, links with universe)								
	Spirituality (beliefs about purpose and meaning)	.90	.59	.24	.59	.40, .72	.41	.28, .60
	Appreciation of beauty (awareness of excellence)	.84	.56	.03	.53	.27, .69	.47	.31, .73
	Hope (expecting/working toward good future)	.82	.43	.20	.41	.19, .58	.59	.42, .78
	Gratitude (thankfulness for good things)	.82	.39	.18	.40	.12, .60	.60	.40, .88
	Humor (seeing light side of life, liking to laugh)	.88	.22	−.15	.14	0, .38	.86	.62, 1.0

$N = 336$.
Note: MZ is the correlation among members of monozygotic twin pairs; DZ is the correlation among members of dizygotic twin pairs; A is the additive genetic effects; $CI_A = 95\%$ confidence interval for A estimates; E is the nonshared environmental effects/measurement error; $CI_E = 95\%$ confidence interval for E estimates.VIA-CS descriptors adapted from Peterson and Seligman (2004, pp. 29–30).

have argued, however, that genetic factors become more influential with age (Plomin, DeFries, & Fulker, 1988). A pattern of shared environmental influence on adults' early memories and genetic influence on contemporary memories indeed was found for religiousness (Koenig, McGue, Krueger, & Bouchard, 2005).

Estimating the heritability of a trait is of importance because differences in levels of genetic or environmental contributions to variance suggest different etiologies for phenotypes. For example, studies of religiousness generally show substantial genetic influence by adulthood (e.g., D'Onofrio et al., 1999; Koenig et al., 2005; Waller et al., 1990), while there is less consistent evidence of genetic influence and stronger evidence of shared environmental influence for phenotypes such as church affiliation, especially in

childhood (e.g., Kendler, Gardner, & Prescott, 1997; also D'Onofrio et al., 1999 provide a review). These results suggest potential etiological differences between global religious attitudes and more specific manifestations of religiousness, like church affiliation. In addition, they point again to a developmental process, where shared environmental influences may matter more early in life then dissipate with time.

In most previous research, however, non-shared environmental influences have accounted for substantial variance (D'Onofrio et al., 1999; Turkheimer, 2000). A previous report suggests one source of environmental influence, major historical events. The researchers speculated that the events of September 11th led people to value more highly certain VIA-CS strengths (Peterson & Seligman, 2003). To the extent that those events affected all siblings in some families in the same way, but differently than the way they affected siblings in other families (e.g., one family loses a parent vs. another family is unaffected), they would exert shared environmental influence. If genetically similar individuals were differently affected, however, the events would be a source of unique, or non-shared, environmental influence.

Beyond calculating estimates of the heritability of the VIA-CS traits, it is also of importance to investigate the degree to which they are unique from normal personality traits. Correlational analyses provide estimates of how much shared variance exists between VIA-CS traits and other measures of personality, with modest overlap indicative of unique and incremental information regarding individual characteristics. Beyond this level of analysis, we were able to investigate the extent to which genetic influences on normal personality traits could account for heritable variance in the VIA-CS traits. There is evidence that the heritability of a phenotype is often mediated by the heritability of more basic personality traits (e.g., retrospective reports on family environments, Krueger, Markon, & Bouchard, 2003). As such, genetic influences on character strengths may overlap with the genetic effects associated with more basic personality attributes. Consequently, a finding that genetic effects on normal personality traits can account for the heritable variance in character strengths would argue against the need to incorporate character strengths (as defined by the VIA) in a system of human individual differences.

Among the principal aims of the VIA project is encouraging the expression and cultivation of character strengths (Peterson & Seligman, 2004). Thus, information about genetic and environmental influences is especially pertinent to those interested in how the VIA traits develop. Positive traits in adults have received less attention than negative traits in behavior genetic studies, however. This gap in the literature requires a study that is relatively comprehensive in coverage of the positive domain. The present investigation provides etiological information to researchers investigating a substantial portion of the traits at the heart of the surge of interest in psychological strengths. We sought to provide a starting place for future investigations into the genetic and environmental influences on these 24 positive traits. Further, we investigated the psychometric and biometric uniqueness of the VIA-CS from normal personality, as measured by the multidimensional personality questionnaire (Tellegen, 1982) a broadband measure of normal range personality traits.

2. Method

2.1. Participants

Male and female monozygotic (MZ) and dizygotic (DZ) twin pairs were selected from the Minnesota Twin Registry representing birth cohorts from 1950 to 1955. Names were

selected beginning with the 1955 birth cohort within each twin type (male MZ, male DZ, female MZ, female DZ), proceeding until 100 pairs had been identified (400 twin pairs total). A standard questionnaire about twin similarity was used to establish zygosity. This method is 95% accurate compared to using blood samples (Lykken, Bouchard, McGue, & Tellegen, 1990). The Minnesota Twin Registry recruitment procedures and sample characteristics have been described in detail elsewhere (Krueger & Johnson, 2002). Completed surveys were received from 336 individual twins (mean age = 49 years), representing 51 matched MZ pairs and 40 matched DZ pairs, with 154 unmatched individuals.

2.2. Procedure

In early 2004, packets containing consent and survey materials were mailed to the twins, along with a $7 incentive to participate, a pre-addressed business reply envelope, and a cover letter. A number of packets were returned due to outdated address ($n = 17$). Overall response rate was 42%. Data on normal personality was obtained from archival records of a wave of data collection occurring between 1984 and 1988 for the participants in the present sample. Thus, data collection for personality preceded data collection for the VIA-CS traits by 16–20 years.

2.3. Materials

2.3.1. Character strengths and virtues

Character strengths were assessed using the VIA inventory of strengths (VIA-IS; Peterson & Seligman, 2003). The 24 strengths shown in Table 1 are organized into superordinate categories, called virtues. Participants rated 10 items for each strength using a 1 (very much like me) to 5 (very much unlike me) scale. The psychometric properties and criterion-related validity of the VIA-IS are satisfactory (Park, Peterson, & Seligman, 2004). In the present study, internal consistency reliability was generally good (α from .68 to .90, M $\alpha = .81$).

2.3.2. Normal personality

Normal personality was assessed using the multidimensional personality questionnaire (MPQ; Tellegen, 1982; Tellegen & Waller, in press). The MPQ was developed using a factor analytic approach, and consists of 300 items assorted into 11 subscales. Four scales comprise the positive emotionality higher-order factor, which indexes the attainment of well-being: Well-being (which assesses optimism, enthusiasm, and cheerfulness), social potency (which assesses dominance, attention seeking behavior, and leadership), achievement (which assesses mastery motivation and perfectionism), and social closeness (which assesses sociable and affectionate behavior). Three scales comprise the negative emotionality higher-order factor, which is a broad index of negative affective temperament: stress reaction (which assesses anxiety, mood instability, and tendency to break down under stress), alienation (which assesses feelings of victimization, blame externalization, and suspiciousness), and aggression (which assesses perpetration of violence, willingness to hurt others, and interpersonal hostility). Three scales comprise the higher-order factor of constraint, which indexes tendencies toward behavioral control and restraint: control (which assesses cautious and reflective behavior), harm avoidance (which assesses avoidance of dangerous activities; preference for routine over risk), and traditionalism (which assesses

conservative views and lack of rebelliousness). In addition, the MPQ includes a scale measuring absorption (which assesses capacity for abstract thought and vivid imagination). These individual scales can be used to form higher-order factors, although these are not of interest in the present investigation. The twins completed the MPQ between 1984 and 1988. During the initial data collection on the MPQ, only a 2-choice version was available, which most of the sample completed (304 participants). A small number of participants completed a 4-choice version (22 participants). Because the 4-choice version did not have a midpoint, we collapsed the four choices into two choices and combined the data from the two subsamples. Support for the validity of the MPQ can be found in Patrick, Curtin, and Tellegen (2002).

2.4. Biometric modeling

We fit standard biometric models to the raw data using maximum likelihood estimation as implemented by the computer program Mx (Neale, 1997). This approach takes into account cases with missing data, and so allowed us to retain the unmatched members of a twin pair in the analysis while also yielding less biased parameter estimates compared to listwise or pairwise deletion methods. Mx attempts to fit raw data, using a covariance structure that is essentially equivalent to the intraclass twin correlation. Classical twin design models assume three sources of variance in a phenotype: additive genetic factors (A); environmental factors that siblings share, such as parental rearing styles (C); and non-shared environmental factors, those that are unique to individual siblings (E) (Neale & Cardon, 1992). These estimates are derived from comparisons of the correlations observed among members of MZ and DZ twin pairs. Because MZ twins share all their genes while DZ twins share on average half of their segregating genes, higher correlations among MZ than DZ twins indicates some level of similarity due to genetic factors. Shared environmental factors increase similarity among siblings, and a DZ correlation greater than one half the MZ correlation is indicative of shared environmental contributions. MZ twin correlations less than 1.0 are indicative of non-shared environmental influences that contribute to differences among twins. Measurement error is also included in the non-shared environmental variance component.

The basic univariate heritability analyses were extended using a standard bivariate Cholesky decomposition to delineate the genetic and environmental components of variance and covariance between each VIA-CS scale and a composite variable that accounted for the overlap with normal personality (see results). The bivariate Cholesky model includes two types of ACE effects: those that are unique to one variable in the analysis, and those that contribute to both variables. For this analysis, the variance of each VIA-CS scale and its complement personality composite were standardized to 1.0, and the genetic and environmental components of variance decomposed into those common to VIA-CS scale and normal personality and those unique to each VIA-CS scale. We also reported the percentage of the phenotypic correlation between each VIA-CS scale and its complement personality composite that was due to genetic effects. Lastly, we reported the genetic correlation between each VIA-CS scale and its complement personality composite, which indexes the amount of heritable variance that overlaps across the two variables with a genetic correlation of 1.0 indicating that the two variables share all of their genetic effects, and a genetic correlation of zero indicative of genetic independence.

3. Results

3.1. Heritability of the VIA-CS traits

As can be seen in Table 1, correlations among MZ twins are generally large, with some exceptions, whereas correlations among DZ twins are generally small to medium. These results would lead us to expect substantial genetic effects, and this is what we observe when we fit ACE models. Two scales exhibited weak evidence of shared environmental effects: open-mindedness, $c^2 = .10$ (95% confidence interval [CI]: .00, .49), and love of learning, $c^2 = .18$ (95% CI: .00, .56). Because there was so little evidence of shared environmental influences, we tested AE models for each of the scales.

As can be seen in Table 1, the estimates of additive genetic factors (A), ranging between .14 (14% genetic influence) and .59 (59%), with a median estimate of .42 (42%), indicate a level of genetic influence similar to that observed for other psychological traits (Bouchard, 2004). Lower bounds of 95% confidence intervals were greater than zero for 21 character strengths. There is also substantial evidence of non-shared environmental influence (E) on variability in character strengths, with estimates ranging between .41 (41%) and .86 (86%; median = .58, or 58%).

3.2. Phenotypic covariation between VIA-CS traits and normal personality

Archival MPQ scores were available for 326 participants (completed 16–20 years previously). Bivariate correlations among the VIA-CS traits and the MPQ subscales are presented in Table 2. MPQ scales that comprise the positive emotionality factor exhibited the most consistent and strongest associations with the VIA-CS traits, with the largest correlation coefficient being .46 (VIA-vitality with MPQ-wellbeing), corresponding to a large effect size. The wellbeing primary scale was the most consistent correlate of the VIA-CS traits, with 16 significant correlation coefficients, followed by social potency (11), and absorption (11 each) and achievement (8).

Next, we regressed each VIA-CS scale onto all 11 MPQ subscale to examine the unique relations with each MPQ scales and to estimate the total amount of variance in individual VIA-CS scale scores that could be accounted for by a broadband measure of normal personality. These results are presented in Table 3. The most consistent significant predictors of the VIA-CS traits were wellbeing (significant predictor of 14 VIA-CS traits), absorption (12), social potency (10), and achievement (6). In contrast to the correlation analyses, aggression and control emerged as significant predictors of seven traits in the regression analysis, with aggression exhibiting significant inverse relations with scales associated with good interpersonal relationships and civic involvement, and control exhibiting significant relations with scales associated persistence, contemplation, and responsibility. The primary scales harm avoidance (0), alienation (2) and traditionalism (4) exhibited few significant relations with the VIA-CS scales. Overall, the MPQ subscales accounted for significant amounts of the variance in each VIA-CS subscale score (all R^2: $p < 001$), ranging from 8% (self-regulation and integrity) to 26% (creativity and curiosity). These effect sizes are medium to large, and considering the many years between the administration of MPQ and VIA, strongly suggest that appreciable variance in VIA-CS scores can be accounted for by normal personality traits.

Table 2
Correlations among VIA subscales and MPQ scales

	WB	SP	AC	SC	SR	AL	AG	CL	HA	TD	AB
Wisdom											
Creativity	**.25**	**.38**	**.23**	−.03	−.07	.03	.04	−.01	**−.23**	−.15	**.34**
Curiosity	**.44**	**.23**	**.23**	.04	**−.21**	**−.20**	−.12	−.01	−.16	−.10	**.24**
Perspective	**.32**	**.36**	.16	.09	−.17	−.14	−.05	.09	−.14	−.07	**.22**
Open-mindedness	.20	**.22**	.19	.03	−.05	−.18	−.08	**.29**	−.07	−.07	.17
Love of learning	**.22**	.19	.09	.03	−.07	−.16	−.14	.05	−.11	−.16	**.29**
Courage											
Persistence	**.23**	.10	**.28**	.03	**−.20**	−.10	−.09	**.21**	.02	.11	−.02
Bravery	**.22**	**.35**	.11	.02	−.10	.01	.07	.02	−.14	.00	**.24**
Integrity	.17	.02	**.20**	.05	−.13	−.12	−.17	.19	.01	.08	.07
Vitality	**.46**	**.29**	**.30**	.14	**−.27**	−.16	−.07	−.03	−.10	.02	.10
Humanity											
Social intelligence	**.32**	**.41**	.13	.15	−.09	−.12	.02	.00	−.07	−.12	**.24**
Kindness	**.24**	.11	**.23**	.18	.08	−.01	−.13	−.01	.08	.05	**.23**
Love	**.29**	.14	.15	**.34**	−.01	−.15	−.19	−.03	.10	−.03	**.22**
Justice											
Leadership	**.25**	**.27**	**.24**	**.20**	.03	−.03	−.11	−.03	−.04	.01	**.24**
Fairness	.18	−.04	.18	.10	−.01	−.06	**−.23**	.03	.01	.03	.17
Citizenship	**.22**	.04	.14	**.31**	−.03	−.15	**−.23**	.04	.10	.04	.11
Temperance											
Forgiveness/mercy	**.28**	−.03	.15	.13	−.12	−.17	**−.36**	−.02	.06	.04	.12
Self-regulation	.17	.05	.14	−.06	**−.20**	−.11	−.07	.18	−.03	.13	−.02
Prudence	.11	−.11	.09	.07	−.05	−.16	−.16	**.31**	**.21**	.12	−.04
Humility/modesty	.04	**−.28**	.09	−.09	.00	−.08	−.17	.13	.06	.13	−.06
Transcendence											
Spirituality	.18	.01	.13	.07	−.05	−.09	−.17	.17	.13	**.33**	.19
Appreciation of beauty	.17	.15	.12	.02	.14	.05	−.03	.01	−.04	−.08	**.39**
Hope	**.44**	**.29**	**.21**	.12	**−.24**	−.19	−.02	.02	−.06	.01	.13
Gratitude	**.24**	.13	.17	.18	.06	−.03	−.09	.03	.12	.10	**.24**
Humor	**.32**	**.28**	.19	.13	−.13	−.11	−.01	−.10	−.10	−.05	.14

$N = 323$–324.
Note: Correlation coefficients in boldface are significant at Bonferroni-adjusted p of .00038 (.05/132; i.e., $r > |.200|$); WB is wellbeing, SP is social potency, AC is achievement, SC is social closeness, SR is stress reaction, AL is alienation, AG is aggression, CL is control, HA is harm avoidance, TD is traditionalism, and AB is absorption.

Certain VIA-CS traits tended to be related to certain MPQ scales, suggesting shared dispositional roots among some of the VIA-CS traits. Using $\beta > |.30|$ as a convenient benchmark, a reasonable pattern of relations emerges. For example, curiosity, vitality, and hope were distinguished by substantial relations with wellbeing, suggesting a common trait dimension, perhaps consisting of a positive, appetitive orientation to one's surroundings and future. Likewise, creativity, perspective, bravery, and social intelligence were distinguished by substantial relations with social potency, suggesting a common root in a dispositional tendency to make an impact on one's social surroundings. Love and citizenship were most strongly related to social closeness, which makes intuitive sense, as those who can love and be loved and treat others fairly would seem likely to develop close relationships. Finally, creativity and appreciation of beauty were most strongly related to absorption,

Table 3
Multiple regressions of the VIA-CS subcales onto the MPQ subscales

	β										Adj. R^2
	WB	SP	AC	SC	SR	AL	AG	CL	HA	TD	AB	
Wisdom												
Creativity	**.16**	**.28**	.05	**−.13**	.00	.04	−.04	**.12**	−.08	**−.14**	**.25**	.26
Curiosity	**.38**	.08	.07	**−.14**	.03	**−.13**	−.08	.03	−.03	−.10	**.17**	.26
Perspective	**.21**	**.29**	−.02	−.05	.00	−.06	−.06	**.16**	−.05	−.06	**.17**	.21
Open-mindedness	**.16**	**.28**	.05	**−.13**	.00	.04	−.04	**.11**	−.08	**−.14**	**.25**	.21
Love of learning	**.17**	**.14**	−.05	−.11	.07	**−.13**	**−.14**	.11	−.03	**−.15**	**.27**	.17
Courage												
Persistence	.11	.05	**.23**	−.04	−.13	−.01	−.02	**.17**	.05	.07	−.02	.14
Bravery	.11	**.30**	−.06	−.06	−.05	.04	.01	.11	−.03	.02	**.19**	.15
Integrity	.07	−.03	**.15**	−.00	−.07	−.04	−.11	**.15**	−.01	.06	.09	.08
Vitality	**.32**	**.14**	**.18**	−.02	−.07	−.05	−.03	−.04	.03	.03	.01	.24
Humanity												
Social intelligence	**.25**	**.35**	−.05	−.04	.10	−.10	−.00	.07	.06	−.10	**.14**	.23
Kindness	**.22**	.04	**.14**	.08	**.20**	−.02	**−.14**	−.03	.06	.04	**.12**	.14
Love	**.19**	.05	.06	.21	.12	−.09	**−.15**	−.07	.09	−.00	**.16**	.20
Justice												
Leadership	**.14**	**.21**	**.12**	.11	**.16**	−.01	**−.15**	−.01	−.02	.03	.11	.16
Fairness	.13	−.11	**.14**	.06	.06	.00	**−.22**	.00	−.03	.02	**.14**	.10
Citizenship	.13	−.02	.09	**.24**	.10	−.07	**−.19**	−.03	.02	.06	.07	.15
Temperance												
Forgiveness/mercy	**.22**	−.08	.09	.01	.03	−.05	**.33**	−.10	.06	.04	.11	.20
Self-regulation	.10	.03	.08	−.12	−.13	−.04	−.01	**.16**	.00	.10	.01	.08
Prudence	**.14**	−.08	.06	−.02	.04	−.10	−.04	**.24**	.13	.06	.00	.13
Humility/modesty	.13	**−.30**	**.14**	−.09	.08	−.09	−.08	.05	−.03	.08	−.03	.12
Transcendence												
Spirituality	.08	.00	.05	−.00	−.03	−.08	−.11	.09	.10	**.31**	**.24**	.19
Appreciation of beauty	**.22**	.09	−.03	−.10	**.20**	−.01	−.09	.09	.01	−.10	**.31**	.18
Hope	**.34**	**.16**	.07	−.06	−.03	−.12	.04	.02	.06	.01	.06	.21
Gratitude	**.21**	.08	.06	.07	.14	−.03	−.09	.01	.12	.10	**.17**	.14
Humor	**.22**	**.17**	.09	.00	.03	−.09	−.00	−.08	.01	−.02	.05	.13

$N = 323$–324.
Note: Standardized regression coefficients in boldface are significant at the p, .05 level; WB is wellbeing, SP is social potency, AC is achievement, SC is social closeness, SR is stress reaction, AL is alienation, AG is aggression, CL is control, HA is harm avoidance, TD is traditionalism, and AB is absorption.

suggesting a shared tendency toward immersion in aesthetic or creative domains. The remaining MPQ scales were either strongly related to only one VIA-CS trait (e.g., $\beta = -.36$ between aggression and forgiveness/mercy) or less strongly related to multiple traits.

3.3. Genetic and environmental covariation between VIA-CS and normal personality

Finally, we estimated the genetic and environmental contributions to the covariance between VIA-CS scales and normal personality. This was accomplished by using weights from the regression equations for each VIA-CS trait regressed onto all 11 MPQ scales to calculate composite scores to serve as a measure of the overlap between the VIA-CS and normal personality traits. We then assessed the amount of additive genetic

and environmental overlap between the personality composite variables and each VIA-CS trait.

Results of the bivariate biometric analyses are presented in Table 4. Overall, most of the covariance between normal personality and the VIA-CS traits was due to additive genetic factors, that is, for 20 of 24 VIA-CS traits genetic effects accounted for greater than 50% of the covariance with normal personality. Similarly, the correlation between the genetic components of normal personality and VIA-CS traits was greater than .50 in 18 of 24 cases. Additionally, for 20 of 24 VIA-CS scales, the genetic overlap with normal personality exceeded the level of non-shared environmental overlap. Finally for 18 of the 24 VIA-CS scales, the genetic overlap with normal personality accounted for a significant portion of the total variance in the VIA-CS scale with estimates ranging from 9% (kindness) to 40% (spirituality). Thus, it appears that the majority of the covariance between normal personality and character strengths is due to common genetic factors. Nonetheless, several VIA-CS traits exhibited significant residual heritable variance (10 of 24), indicative of some genetic independence from normal personality. The VIA-CS scales that exhibited significant residual heritable variance do not appear to have any thematic link common to all traits (i.e., creativity, curiosity, judgment, persistence, bravery, social intelligence, leadership, fairness, forgiveness/mercy, and hope).

The environmental factors associated with normal personality and with VIA-CS traits appeared largely independent. All of the estimates of environmental independence were significant (24 of 24), although in 10 of 24 cases, the estimates of environmental overlap were significant as well, indicative of some environmental contribution to the covariance between the VIA-CS scales and normal personality. There did not appear to be any theme linking the VIA-CS traits that exhibited significant environmental overlap with normal personality (i.e., curiosity, perspective, judgment, vitality, social intelligence, kindness, citizenship, forgiveness/mercy, humility/modesty, and humor).

4. Discussion

The purpose of the present investigation was to use behavior genetic methods to shed light on the etiology of a broad and representative group of positive traits. Our results suggest that, like most psychological traits, the VIA strengths demonstrate appreciable genetic influence. Not long ago it was widely believed that variance in psychological traits was solely environmentally determined. Times have changed, and as Rutter (2002) has argued "any dispassionate reading of the evidence leads to the inescapable conclusion that genetic factors play a substantial role in the origins of individual differences with respect to all psychological traits, both normal and abnormal (p. 2)." Our findings extend Rutter's argument further into the domain of positive traits and confirm the broader biological argument that "all psychological traits are heritable" (Bouchard, 2004 (p.148)). To paraphrase one of the guiding tenets of the "positive psychology" movement, it is insufficient to explore exclusively how our genes 'make us wrong,' we also need to investigate how they 'make us right' (cf. Seligman & Czikszentmihalyi, 2000). Our results provide a starting point for researchers interested in the full spectrum of human character and personality, both maladaptive and virtuous.

Behavior genetic studies based on single measures tell us very little. Properties of specific instruments may impact estimates of genetic and environmental influences (Goldsmith

Table 4
Estimates of overlapping and independent effects of genetic and environmental influences on the VIA-CS subscales and personality derived from the MPQ subscales

VIA scale	A	E	A		E		Covar due to A (%)	r_g
			Overlap	Independent	Overlap	Independent		
Wisdom								
Creativity	.49 (.28, .65)	.51 (.35, .72)	**.26 (.12, .41)**	**.24 (.04, .40)**	.03 (0, .14)	**.47 (.32, .67)**	81	**.72 (.53, .94)**
Personality	.70 (.55, .80)	.30 (.20, .45)						
Curiosity	.47 (.26, .63)	.53 (.37, .74)	**.21 (.07, .37)**	**.26 (.10, .40)**	**.09 (.02, .23)**	**.44 (.32, .61)**	64	**.67 (.45, .85)**
Personality	.58 (.38, .72)	.42 (.28, .62)						
Perspective	.36 (.14, .55)	.64 (.45, .86)	**.16 (.05, .32)**	.20 (0, .38)	**.07 (.01, .21)**	**.57 (.40, .78)**	67	**.66 (.40, 1.00)**
Personality	.65 (.48, .76)	.35 (.24, .52)						
Open-mindedness	.43 (.20, .61)	.57 (.34, .69)	**.18 (.04, .36)**	.25 (.07, .41)	**.07 (.01, .21)**	**.50 (.34, .69)**	62	**.65 (.37, .89)**
Personality	.52 (.31, .66)	.48 (.34, .69)						
Love of learning	.43 (.21, .59)	.57 (.41, .79)	**.25 (.11, .42)**	.17 (0, .36)	.01 (0, .08)	**.56 (.40, .77)**	88	**.77 (.53, 1.00)**
Personality	.62 (.45, .74)	.38 (.26, .55)						
Courage								
Persistence	.58 (.41, .70)	.42 (.30, .59)	**.19 (.04, .49)**	**.39 (.11, .55)**	.03 (0, .12)	**.39 (.27, .54)**	63	**.57 (.28, .90)**
Personality	.35 (.11, .53)	.65 (.47, .89)						
Bravery	.46 (.24, .63)	.54 (.37, .76)	**.17 (.05, .33)**	**.29 (.07, .48)**	.02 (0, .12)	**.52 (.36, .73)**	79	**.60 (.36, .89)**
Personality	.66 (.50, .77)	.34 (.23, .50)						
Integrity	.37 (.04, .63)	.63 (.37, .96)	.06 (0, .52)	.32 (0, .61)	.06 (0, .14)	**.56 (.29, 86)**	35	.39 (0, 1.00)
Personality	.23 (0, .45)	.77 (.55, 1.0)						
Vitality	.36 (.14, .54)	.64 (.46, .87)	**.18 (.06, .33)**	.18 (0, .34)	.09 (.01, .24)	**.55 (.40, .74)**	65	**.70 (.46, 1.00)**
Personality	.65 (.48, .77)	.35 (.23, .52)						
Humanity								
Social intelligence	.42 (.21, .58)	.58 (.42, .79)	**.15 (.04, .27)**	**.27 (.11, .42)**	.12 (.03, .28)	**.46 (.33, .64)**	63	**.59 (.37, .79)**
Personality	.70 (.54, .80)	.30 (.20, .46)						
Kindness	.35 (.04, .58)	.65 (.42, .96)	**.09 (.01, .24)**	.25 (0, .46)	.08 (.01, .26)	**.57 (.37, .84)**	60	**.52 (.19, 1.00)**
Personality	.64 (.47, .76)	.36 (.24, .53)						
Love	.24 (.04, .45)	.76 (.55, .96)	**.16 (.04, .34)**	.08 (0, .28)	.07 (0, .23)	**.70 (.50, .84)**	66	**.82 (.47, 1.00)**
Personality	.61 (.42, .74)	.39 (.26, .58)						

Justice								
Leadership	.41 (.17, .59)	.59 (.41, .83)	**.14 (.03, .28)**	**.27 (.06, .45)**	.05 (0, .18)	**.54 (.37, .76)**	70	**.58 (.32, .87)**
Personality	.66 (.50, .77)	.34 (.23, .50)						
Fairness	.36 (.09, .57)	.64 (.43, .91)	.08 (0, .27)	**.27 (.05, .46)**	.05 (0, .19)	**.59 (.41, .83)**	55	**.48 (.01, .86)**
Personality	.46 (.22, .63)	.54 (.37, .78)						
Citizenship	.17 (0, .46)	.83 (.54, 1.0)	.03 (0, .16)	.14 (0, .40)	.19 (.04, .42)	**.64 (.41, .87)**	29	.39 (0, 1.00)
Personality	.53 (.31, .69)	.47 (.31, .69)						
Temperance								
forgiveness/mercy	.57 (.31, .73)	.43 (.27, .69)	**.14 (.01, .33)**	.43 (.22, .59)	.09 (.02, .24)	**.34 (.21, .55)**	54	**.49 (.16, .74)**
Personality	.47 (.24, .64)	.53 (.36, .76)						
Self-regulation	.54 (.34, .68)	.46 (.32, .66)	.12 (0, .50)	.42 (.05, .58)	.03 (0, .12)	**.43 (.30, .61)**	56	**.48 (.07, .96)**
Personality	.28 (.04, .48)	.72 (.52, .96)						
Prudence	.40 (.17, .58)	.60 (.42, .83)	**.17 (.01, .49)**	.23 (0, .43)	.04 (0, .15)	**.57 (.40, .78)**	60	**.65 (.22, 1.00)**
Personality	.33 (.08, .53)	.67 (.47, .92)						
Humility/modesty	.23 (0, .46)	.77 (.54, 1.00)	.01 (0, .13)	.22 (0, .41)	**.18 (.05, .34)**	**.59 (.43, .78)**	15	.20 (0, .62)
Personality	.38 (.15, .59)	.62 (.41, .85)						
Transcendence								
Spirituality	.58 (.40, .72)	.42 (.28, .60)	**.40 (.14, .70)**	.18 (0, .44)	.02 (0, .09)	**.40 (.27, .58)**	77	**.83 (.51, 1.00)**
Personality	.32 (.09, .54)	.68 (.46, .91)						
Appreciation of beauty	.50 (.26, .67)	.50 (.33, .74)	**.30 (.14, .46)**	.20 (0, .41)	0 (0, .05)	**.50 (.33, .73)**	96	**.77 (.54, 1.00)**
Personality	.62 (.45, .74)	.38 (.26, .55)						
Hope	.41 (.20, .58)	.59 (.42, .80)	**.18 (.05, .35)**	.23 (.04, .40)	.06 (0, .19)	**.53 (.38, .72)**	69	**.66 (.40, .93)**
Personality	.61 (.41, .74)	.39 (.26, .59)						
Gratitude	.38 (.09, .59)	.62 (.41, .91)	**.12 (.02, .29)**	.26 (0, .47)	.04 (0, .19)	**.58 (.38, .85)**	69	**.56 (.25, 1.00)**
Personality	.63 (.45, .75)	.37 (.25, .55)						
Humor	.12 (0, .36)	.88 (.64, 1.00)	.04 (0, .30)	.08 (0, .29)	.18 (.03, .40)	**.70 (.49, .88)**	45	**.60 (.09, 1.00)**
Personality	.74 (.60, .82)	.26 (.18, .40)						

$N = 323–324$.

Note: Estimates of additive genetic (A) and non-shared environmental effects (E) were estimated simultaneously for the VIA-CS and relevant MPQ regression weighted composites for each VIA-CS trait, therefore the estimates in this table may differ somewhat from those in Table 3. Significant estimates of overlapping and independent genetic and environmental effects are shown in boldface. Covar due to A (%) is percentage of covariation between VIA-CS trait and MPQ regression weights that is due to additive genetic effects; r_g is the correlation of additive genitive effects.

et al., 1997). Therefore it is worth noting that this study replicated several existing findings with different measures. Our estimates of medium to large genetic influences on spirituality are in accord with work on related constructs like religiousness (e.g., D'Onofrio et al., 1999) and self-transcendence (e.g., Gillespie et al., 2003). We also replicated estimates of medium to large genetic influence on leadership (Johnson et al., 2004), hope (Plomin et al., 1992), and creativity (Waller et al., 1993). Looking across studies of altruism, evidence exists of both genetic and shared environmental influences (Krueger et al., 2001; Rushton, 2004; Rushton et al., 1986). Our finding of genetic influence on kindness is consistent with this literature. Given these replications, we have some confidence that future research on character strengths will replicate our evidence of genetic influence.

One of the novel contributions of this study was the inclusion of a measure of normal personality, allowing for the estimation of both the phenotypic overlap between the VIA-CS scales and normal personality dimensions, as well as the evaluation of whether the VIA-CS traits were heritable because they were linked to more basic personality dimensions that were themselves heritable. Although participants completed the personality measure several years before completing the VIA-CS, normal range personality nonetheless accounted for considerable variance in character strengths. In most cases, specific correlation or regression coefficients were of moderate effect size. Seemingly, then, there is much about character strengths that is distinct from current structural models of normal personality. Researchers interested in character strengths, or in the VIA-CS as a measure of positive psychological traits, should feel somewhat encouraged in terms of these initial indications of the convergent and discriminant validity of the measure.

We were unable to conclusively answer the question of whether the heritability of normal personality explains why most of the VIA-CS traits appeared heritable. Our analysis of the genetic overlap between the MPQ and VIA-CS found that a minority of the VIA-CS traits demonstrated independent genetic factors, whereas genetic overlap was indicated for most of the traits. The consistency of these findings does suggest that the heritability of many of the VIA-CS traits is tied to the heritability of more basic dimensions of personality.

Although traits may be substantially influenced by genetic factors, individuals select, utilize, and adapt to their environments, affecting gene expression. Behavior geneticists distinguish between gene–environment transactions and gene–environment interactions. In most cases, the interface between genetics and environment consists of transactions necessary for growth, reproduction, or development. An example of a transaction in the case of character strengths might be the necessity of extensive social experiences to enable the full development of the genetic disposition for social intelligence or leadership. The term gene–environment interaction refers to a specific process in which the same stimulus affects individuals with differing genes in different ways. Research has revealed several examples of gene–environment interactions that match the diathesis-stress model of psychopathology (e.g., adolescent conduct disorder; Cadoret, Yates, Troughton, Woodworth, & Stewart, 1995). Future investigations may uncover a diathesis-*nutriment* interaction for character strengths like creativity in which those with a genetic predisposition respond to enriched, stimulating environments with augmented creativity whereas those without the predisposition respond less robustly. Future research should endeavor to delineate how the interplay of genes and environments creates character strengths. In addition, future research might attempt to investigate the presence of non-additive effects. Such effects are difficult to detect unless the samples are extremely large, and given the modest sample size of the present investigation, it is better to leave this possibility for future research.

Research that demonstrates a personality or behavioral trait is heritable is usually evidence of "weak biologism," which simply indicates that the trait is a characteristic of the physical human self (Turkheimer, 1998). Often evidence of this kind is overly reductionistic. It may make little sense to try to understand a trait like spirituality as a process of protein synthesis. Heritability evidence does not help us understand how a trait develops, nor does it specify where the biological properties responsible for its expression are located. More refined research often can indicate that traits are due to specific genes, or result from the processes of exact brain regions or neurotransmitters. This type of evidence has been called "strong biologism" (Turkheimer, 1998). For example, curiosity is conceptually related to novelty-seeking and behavioral approach tendencies, and research has been conducted exploring the neurological substrates of these traits (e.g., Depue, Luciano, Arbisis, Collins, & Leon, 1994). The dopaminergic system in particular has been heavily implicated in individual differences in these traits, and gene-linkage studies have further specified the D4 dopamine receptor as a potential "strong biologic" factor in novelty-seeking (Kashdan, 2004). This type of work helps clarify the etiology of curiosity, as well as identify its functional, biological components. Ascertaining the existence of specific biological underpinnings of character strengths is of vital importance for future research.

Limitations of the present study constrain the conclusions that we can presently draw about character strengths. Our relatively small sample size suggests caution in interpreting the genetic profile of the strengths at face value. The general necessity of replicating behavior genetic findings is compounded as a result of our small sample. In addition, all behavior genetic work is best considered to pertain to a single, specific sample at a single, specific point in time.

These limitations extend to our analyses of the shared genetic overlap between the VIA-CS traits and normal personality traits. In particular, the small sample size led to large confidence intervals in our estimates, which made it difficult to detect significant effects. A limitation specific to these analyses concerns the fact that the MPQ was completed nearly 20 years ago. To some degree, this feature focuses the analyses of overlapping influences on the most stable elements of normal personality; those that one would expect to persist over two decades. As such, it potentially increases confidence that the genetic overlap indicated by the present analyses is robust. On the other hand, the length of time between administration of the MPQ and VIA likely attenuated the overlap between the two; therefore, there may be greater overlap (at least contemporaneous) between normal personality and character strengths than was detected in this investigation. Future research using concurrent administration of the VIA-CS and other measures of normal, and abnormal, personality would be highly informative.

Evidence is accumulating that traits can vary in their heritability across the lifespan (Plomin et al., 1988). Age appears to moderate heritability not only for some basic personality traits (Loehlin & Martin, 2001), but also for several traits relevant to this study (e.g., religiousness; Koenig et al., 2005). Thus, replication in different age groups using both cross-sectional and longitudinal designs would refine our understanding of the heritability of character strengths. Some phenotypes also show evidence of sex-related differences (e.g., subjective wellbeing; Røysamb, Harris, Magnus, Vittersø, & Tambs, 2002), which should be extensively explored for character strengths as well.

As interest in positive human traits mounts, the need for comprehensive theories that can account for their etiologies and interrelations among them also increases. We hope that these preliminary findings of genetic influence on character strengths inform theories

about positive traits, and stimulate exploration of how genes and environments shape these traits over the process of development.

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References

Bouchard, T. J., Jr. (2004). Genetic influence on human psychological traits. *Current Directions in Psychological Science, 13*, 148–151.

Bouchard, T. J., Jr., McGue, M., Lykken, D., & Tellegen, A. (1999). Intrinsic and extrinsic religiousness: genetic and environmental influences and personality correlates. *Twin Research, 2*, 88–98.

Caccioppo, J. T., Hawkley, L. C., Rickett, E. M., & Masi, C. M. (2005). Sociality, spirituality, and meaning making: Chicago health, aging, and social relations sStudy. *Review of General Psychology, 9*, 143–155.

Cadoret, R. J., Yates, W. R., Troughton, E., Woodworth, G., & Stewart, M. A. (1995). Gene-environment interaction in the genesis of aggressivity and conduct disorders. *Archives of General Psychiatry, 52*, 916–924.

Depue, R. A., Luciano, M., Arbisis, P., Collins, P., & Leon, A. (1994). Dopamine and the structure of personality: Relations of agonist-induced dopamine activity to positive emotionality. *Journal of Personality and Social Psychology, 67*, 485–498.

D'Onofrio, B. M., Eaves, L. J., Murrelle, L., Maes, H. H., & Spilka, B. (1999). Understanding biological and social influences on religious affiliation, attitudes, and behaviors: A behavior genetic perspective. *Journal of Personality, 67*, 953–984.

Gillespie, N. A., Cloninger, C. R., Heath, A. C., & Martin, N. G. (2003). The genetic and environmental relationship between Cloninger's dimensions of temperament and character. *Personality and Individual Differences, 35*, 1931–1946.

Goldsmith, H. H., Buss, K. A., & Lemery, K. S. (1997). Toddler and childhood temperament: expanded content, stronger genetic evidence, new evidence for the importance of environment. *Developmental Psychology, 33*, 891–905.

Johnson, A. M., Vernon, P. A., Harris, J. A., & Jang, K. L. (2004). A behavior genetic investigation of the relationship between leadership and personality. *Twin Research, 7*, 27–32.

Kashdan, T. B. (2004). Curiosity. In C. Peterson & M. E. P. Seligman (Eds.), *Character strengths and virtues: A handbook and classification* (pp. 125–141). Washington, DC: American Psychological Association and Oxford University Press.

Kendler, K. S., Gardner, C. O., & Prescott, C. A. (1997). Religion, psychopathology, and substance use and abuse: A multi-measure, genetic-epidemiologic study. *The American Journal of Psychiatry, 154*, 322–329.

Kirk, K. M., Eaves, L. J., & Martin, N. G. (1999). Self-transcendence as a measure of spirituality in a sample of older Australian twins. *Twin Research, 2*, 81–87.

Koenig, L. B., McGue, M., Krueger, R. F., & Bouchard, T. J., Jr. (2005). Genetic and environmental influences on religiousness: Findings for retrospective and current religiousness ratings. *Journal of Personality, 73*, 471–488.

Krueger, R. F., Hicks, B. M., & McGue, M. (2001). Altruism and antisocial behavior: Independent tendencies, unique personality correlates, distinct etiologies. *Psychological Science, 12*, 397–402.

Krueger, R. F., & Johnson, W. (2002). The Minnesota Twin Registry: Current status and future directions. *Twin Research, 5*, 488–492.

Krueger, R. F., Markon, K. E., & Bouchard, T. J., Jr. (2003). The extended genotype: The heritability of personality accounts for the heritability of recalled family environment in twins reared apart. *Journal of Personality, 71*, 809–833.

Loehlin, J. C., & Martin, N. G. (2001). Age changes in personality traits and their heritabilities during the adult years: Evidence from Australian twin registry samples. *Personality and Individual Differences, 30*, 1147–1160.

Lykken, D. T., Bouchard, T. J., Jr., McGue, M., & Tellegen, A. (1990). The Minnesota Twin Family Registry: Some initial findings. *Acta Geneticae Medicae et Gemellologicae, 39*, 35–70.

Neale, M. C. (1997). *Mx: Statistical modeling* (4th ed.). Unpublished computer program, Department of Psychiatry, Medical College of Virginia.

Neale, M. C., & Cardon, L. R. (1992). *Methodology for genetic studies of twins and families*. Boston: Kluwer Academic Publishers.

Park, N., Peterson, C., & Seligman, M. E. P. (2004). Strengths of character and well-being. *Journal of Social and Clinical Psychology, 23*, 603–619.

Patrick, C. J., Curtin, J. J., & Tellegen, A. (2002). Development and validation of a brief form of the multidimensional personality questionnaire. *Psychological Assessment, 14*, 150–163.

Peterson, C., & Seligman, M. E. P. (2003). Character strengths before and after September 11. *Psychological Science, 14*, 381–384.

Peterson, C., & Seligman, M. E. P. (2004). *Character strengths and virtues: A handbook and classification*. Washington, DC: American Psychological Association.

Plomin, R., DeFries, J. C., & Fulker, D. W. (1988). *Nature and nurture in infancy and early childhood*. Cambridge, England: Cambridge University Press.

Plomin, R., Scheier, M. F., Bergeman, C. S., Pedersen, N. L., Nesselroade, J. R., & McClearn, G. E. (1992). Optimism, pessimism and mental health: A twin/adoption analysis. *Personality and Individual Differences, 13*, 921–930.

Røysamb, E., Harris, J. R., Magnus, P., Vittersø, & Tambs, K. (2002). Subjective well-being. Sex-specific effects of genetic and environmental factors. *Personality and Individual Differences, 32*, 211–223.

Rushton, J. P. (2004). Genetic and environmental contributions to pro-social attitudes: A twin study of social responsibility. *Proceedings of the Royal Society of London, 271*, 2583–2585.

Rushton, J. P., Fulker, D. W., Neale, M. C., Nias, D. K. B., & Eysenck, H. J. (1986). Altruism and aggression: The heritability of individual differences. *Journal of Personality and Social Psychology, 50*, 1192–1198.

Rutter, M. (2002). Nature, nurture, and development: From evangelism through science toward policy and practice. *Child Development, 73*, 1–21.

Seligman, M. E. P., & Czikszentmihalyi, M. (2000). Positive psychology: An introduction. *American Psychologist, 55*, 5–14.

Seligman, M. E. P., Steen, T. A., Park, N., & Peterson, C. (2005). Positive psychology practice: Empirical validation of interventions. *American Psychologist, 60*, 410–421.

Tellegen, A. (1982). *Brief manual for the multidimensional personality questionnaire. Unpublished manuscript*. Minneapolis: University of Minnesota.

Tellegen, A., & Waller, N. G. (in press). *Exploring personality through test construction: Development of the multidimensional personality questionnaire*. Minneapolis: University of Minnesota Press.

Turkheimer, E. (1998). Heritability and biological explanation. *Psychological Review, 105*, 782–791.

Turkheimer, E. (2000). Three laws of behavior genetics and what they mean. *Current Directions in Psychological Science, 9*, 160–164.

Waller, N. G., Bouchard, T. J., Jr., Lykken, D. T., Tellegen, A., & Blacker, D. M. (1993). Creativity, heritability, familiality: Which word does not belong? *Psychological Inquiry, 4*, 235–237.

Waller, N. G., Kojetin, B. A., Bouchard, T. J., Jr., Lykken, D. T., & Tellegen, A. (1990). Genetic and environmental influences on religious interests, attitudes, and values: A study of twins reared apart and together. *Psychological Science, 1*, 138–142.

Waller, N. G., & Shaver, P. R. (1994). The importance of nongenetic influences on romantic love styles: A twin-family study. *Psychological Science, 5*, 268–274.