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# Personality, cognitive/psychological traits and psychiatric resilience: A multivariate twin study

**Ananda B. Amstadter, PhD**[a,b], **Arden Moscati**, **MA (Oxon)**[a], **Hermine H. Maes, PhD**[a,b,c], **John M. Myers, MS**[a], and **Kenneth S. Kendler, MD**[a,b]

[a]Department of Psychiatry, Virginia Institute of Psychiatric and Behavioral Genetics, Virginia Commonwealth University, Richmond, VA, USA

[b]Department of Human and Molecular Genetics, Virginia Commonwealth University, Richmond, VA, USA

[c]Massey Cancer Center, Virginia Commonwealth University, Richmond, VA, USA

## Abstract

The purpose of this paper is to determine the phenotypic relationships, and etiologic underpinnings, of cognitive/psychological traits with psychiatric resilience. Resilience was defined as the difference between the twins' total score on a broad measure of internalizing symptoms and their predicted score based on their cumulative exposure to stressful life events (SLEs). Cholesky decompositions were performed in a large twin sample (n=7,500 individuals) to quantify the overlap in genetic and environmental factors between resilience and six traits (neuroticism, optimism, self-esteem, mastery, interpersonal dependency, altruism) in bivariate analyses, and in a multivariate model. On a phenotypic level, each trait accounted for variance in resilience in univariate analyses. In the multivariate regression neuroticism accounted for the majority of the variance and attenuated the relationships between the other traits and resilience. The genetic factors that influence the traits account for between 7–60% of the heritability of resilience. In the multivariate genetic model neuroticism accounted for all of the genetic covariance between the traits and resilience; 40% of the genetic influence on resilience was independent. Neuroticism evidenced the largest phenotypic and genetic relationship with resilience, and accounted for nearly all of the phenotypic and genetic variance between resilience and the other traits.

## 1.0

Resiliency, a concept that is most commonly used to describe adaptive functioning in the aftermath of adversity, stress, and trauma, is of great interest [1], as exposure to stressful life events (SLEs) is common (e.g., [2]), and is often associated with psychiatric distress

*Please send all correspondence to: Ananda B. Amstadter, PhD; Virginia Institute of Psychiatric and Behavioral Genetics, Virginia Commonwealth University, Department of Psychiatry, 800 E. Leigh Street, PO Box 980126, Richmond, VA 23298-0126. Phone: 804-828-8800. Fax: 804-828-8801. abamstadter@vcu.edu.

(e.g., [3–5]). However, even in the face of severe SLEs, many individuals remain asymptomatic [6]. Given interest in understanding the vast variability in stressor responses, researchers have made strides in quantifying psychiatric resilience and in determining its etiologic underpinnings. Using a novel definition of resilience, whereby resilience is determined by computing the residual between actual and predicted psychiatric symptoms based on the total number of SLEs experienced [7], we found a modest heritability for resilience (~31%) in univariate models, and a moderate heritability for the latent construct in a measurement model unconfounded by measurement error (~50%). Two other twin studies have examined the etiologic sources of resilience and also demonstrated modest genetic influence [8,9].

As our concept of resilience was functionally defined, it was important to determine what connection it may have with nominally protective (or risk-associated) traits that are more theoretically derived. Traits that are related to the regulation and control of one's mental and emotional state are especially likely to play a role in resilience. Resilience to adverse experiences requires maintenance of psychological equilibrium despite the negative feelings and cognitions that such experiences often bring about. The resources that can be used in this coping process may be physiological or psychological in origin, deriving primarily from within rather than from external protective factors [10]. We chose a number of putative protective factors shown to be genetically influenced (i.e., dispositional optimism [11], self-esteem [12], mastery [13], and altruism [14]) to include in our analyses in relation to resilience.

Dispositional optimism, the tendency for an individual to expect good things to happen, has been shown to have a strong negative association with many indices of psychopathology, as well as positive correlations with superior life adjustment and physical health [15]. High self-esteem, an explicit or implicit sense of one's personal worth, is found to contribute to emotional stability and protect against negative emotionality [16], while also encouraging more adaptive interpersonal behavior. Mastery, the extent to which an individual views their life as under their control, has been shown to positively associate with quality of life, and may be related to successful recovery from illness [17]. Finally, altruism, the tendency to promote others' wellbeing without regard to self-interest, has been theorized to be a capacity that resilience naturally encourages in people, along with self-actualization – the progressive achievement of one's potential [18]. We also included two risk factors, neuroticism [19] and interpersonal dependency [20] in our analyses. Neuroticism is a well-studied measure of individual emotional instability that has been associated with a wide range of psychiatric syndromes [21]. Interpersonal dependency, like neuroticism, is thought to negatively associate with resilience, being positively associated with a range of psychopathological outcomes from mood disorders and eating disorders to alcoholism [22]. We therefore had some evidence to posit that that these constructs would be related to resilience, and also that they were in part genetically influenced, but it was not clear whether connections between these traits and resilience were likely causal (due to direct effects of the trait on resilience, for instance) or mediated by common genetic factors.

Thus, the present study had three goals. First, we aimed to determine the phenotypic relationships between a broad set of personality, cognitive/psychological traits and psychiatric resilience in a population based twin sample. Second, we sought to decompose the phenotypic relationship between the traits and resilience into genetic and environmental components to determine the degree to which the genes contributing to resilience were overlapping or independent from the traits. Lastly, using a multivariate Cholesky decomposition twin model, we examined the traits jointly to determine their impact on the genetic and environmental factors of resilience. We were particularly interested in determining the degree to which the genetic influences on resilience would be entirely accounted for by genetic influences on these other associated traits or whether some proportion of the genetic factors impacting on resilience would be independent.

## 2.0 Methods

### 2.1 Sample

Participants were derived from two inter-related Virginia Adult Twin Studies of Psychiatric and Substance Use Disorders (VATSPSUD) of Caucasians [23], ascertained from the birth-certificate based Virginia Twin Registry. Female-female (FF) twin pairs, born 1934–1974, were eligible if both members responded to a mailed questionnaire in 1987–1988. Nearly all variables used in these analyses were conducted at the first interview wave (FF1) conducted in 1987–1989. Data on the male-male and male-female pairs (MMMF) came from a sample (birth years 1940–1974) initially ascertained from registry records containing all twin births. The first interview (MMMF1) was completed by phone in 1993–1996, and the second interview, which provided nearly all of the data for these analyses, (MMMF2) was conducted in 1994–1998. Response rates ranged from 72–83%.

Zygosity was determined by discriminate function analyses using standard twin questions validated against DNA genotyping in 496 pairs [24]. The mean (SD) age and years of education of the twins were 30.1 (7.6) and 13.5 (2.0) at the FF1 interview, and 37.0 (9.1) and 13.6 (2.6) at the MMMF2 interview. These analyses utilized data from 7,500 twins, including both members of 3,084 pairs (503 monozygotic (MZ) FF, 346 dizygotic (DZ) FF, 703 MZ MM, 485 DZ MM, and 1,047 opposite sex DZ pairs) and 1,325 twins without their cotwin[1].

### 2..2 Definition of Resilience

Participants completed a shortened version of the Symptom Checklist-90 SCL-90; [25], which utilized a past month timeframe (FF1, MMMF2). There were 27 items from four of the SCL subscales: depression (10 items), somatization (5 items), anxiety (7 items), phobic anxiety (5 items), and 3 items that assessed sleep difficulty. This measure demonstrated relatively high internal reliability for both waves (Cronbach's $\alpha$=.74). We assessed SLEs that were personal in nature(assault, serious marital problems, divorce, job loss, loss of a confidant, serious illness, major financial problem, being robbed, serious legal problems), and "network" events (i.e., events that occurred primarily to, or in interaction with, an individual in the respondent's social network): death or severe illness of the respondent's spouse, child, parent, cotwin, or other relative, serious trouble getting along with others close to the respondent. Inter-rater reliability for determining the occurrence of the events was high

[1]These numbers do not sum because all possible pairings for triplet and quadruplet sets were included

kappa=.93; [4]. Consistent with prior research on cumulative effects of stressors [7,26–28], a sum of SLEs was computed.

Resilience was operationalized as the residual of the SCL score after the effect of recent number of SLEs has been regressed out (i.e., the difference between actual and predicted SCL). The residual was used as a continuous measure of resilience. If a twin's SCL was lower than predicted by the regression this would result in a negative residual, reflecting a higher level of resilience; if a twin's SCL was higher than expected, this would result in a positive residual, reflecting low levels of resilience.

### 2.3 Personality and Cognitive/Psychological Traits

Six personality and cognitive-psychological traits (here forward referred to as "traits") were measured: Neuroticism was measured with the 12 items of the shortened from of the Eysenck Personality Questionnaire [29], dispositional optimism was measured using 5 items from the Life Orientation Test [30], self-esteem (SE) was measured with the full 10-item Rosenberg Self-Esteem Scale, which measures global SE, which is the facet of SE thought to be most relevant to psychological well-being [31], mastery was assessed by 6 items from the powerlessness subscale of the Alienation subtest [32], interpersonal dependency was measured using the 10 items from the Emotional Reliance on Another Personal Subscale of the Interpersonal Dependency Inventory [33]. Altruism, was measured with the 7 items from The Interpersonal Reactivity Index [34] assessing sensitivity to the needs and feelings of others.

### 2.4 Data Analytic Plan

**2.4.1 Phenotypic Relationships—**Correlations were conducted between resilience and all of the traits. Next, six univariate regressions, controlling for sex and age, were conducted with each trait predicting resilience. Finally, a multivariate regression was conducted, controlling for sex and age, again predicting resilience with all of the traits entered simultaneously.

**2.4.2 Twin Modeling—**Phenotypic variation in twin models is decomposed into additive genetic factors (A) which contribute twice as much to the correlations between MZ twins as they do for DZ twins, common environmental factors (C) which are the shared factors (e.g., parental attitudes) that make twins reared together similar and contribute equally to the correlation between MZ and DZ twins, and individual specific environmental (E) sources, which reflect environmental experiences not shared by twins and therefore contribute to differences between the twins and errors of measurement.

To test the degree to which the covariation between the personality-like traits and resilience results from common factors, we applied a series of bivariate Cholesky models [35]. These models specify three latent factors ($A_1$, $C_1$, and $E_1$) influencing both resilience and the personality-like trait, in addition to three factors ($A_2$, $C_2$, and $E_2$) accounting for residual influences specific to resilience. We chose to order the personality traits before resilience, as we were mainly interested in the degree to which the genetic contribution to resilience was unique from the traits.

We began by testing for quantitative sex differences (i.e., if there is equality in the estimates of the genetic contribution in males and females) by constraining the estimates of A, C, and E to be equal in males and females. The best-fit model was selected from these quantitative sex effect models, and we then tested for qualitative sex effects (i.e., whether or not the same genetic factors influenced liability to personality trait and resilience for males and females, quantified by $r_{g\text{-}trait}$ and $r_{g\text{-}resilience}$). In prior analyses of this data (Amstadter et al, in press) a qualitative sex effect was demonstrated for resilience, thus all models included this effect. To text for a qualitative sex effect on the traits, we fit a model that constrained $r_{g\text{-}trait}$ to 1.0). Finally, full models (ACE) were tested against nested submodels with reduced numbers of parameters (AE; CE). To evaluate the fit of the twin models, full information maximum likelihood approach to raw data was implemented in OpenMx. Akaike's Information Criteria (AIC) is used as a guide to evaluating different models. AIC produces an index of goodness of fit i.e., balance of explanatory power and parsimony; [36].

**2.4.3 Multivariate Cholesky—**All of the traits, with the exception of altruism, which had a low genetic covariance with resilience in the bivariate model, were examined jointly in a multivariate Cholesky model with resilience as the downstream variable using similar modeling procedures described above.

## 3.0 Results

### 3.1 Phenotypic Relationships

As shown in Table 1, resilience was moderately correlated with most of the trait variables. The strongest relationship was found with neuroticism ($r$=-.58), and the weakest relationship was with altruism ($r$=.05). The traits that can be considered positive in nature (i.e., altruism, optimism, self-esteem, mastery) were all moderately positively correlated with each other, and they were all negatively correlated with neuroticism and interpersonal dependency.

On a univariate level, in the regressions controlling for age and sex, each of the traits was significantly related to resilience in the expected direction (i.e., positive betas for the putative protective traits, and negative betas for traits thought to be risk factors, neuroticism and interpersonal dependency; See Table 2). Neuroticism was the strongest predictor of resilience (beta was close to twice as large, on average, as the other traits). Optimism, self-esteem, mastery, and interpersonal dependency all demonstrated similar predictive strength. However, a much weaker relationship was found between resilience and altruism. In the multivariate regression with all of the traits entered simultaneously, the relationship between optimism and resilience was no longer significant. Although the beta decreased slightly for neuroticism, the strength of relationships between resilience and all of the other variables diminished substantially.

### 3.2 Bivariate Genetic Modeling

For all of the bivariate models tested in Table 3, models were compared with the saturated model (I). We began in model II by testing for quantitative sex effects, which were not significant for any of the traits. Model III tested for qualitative sex effects on the traits. There was evidence of a qualitative sex effect for neuroticism and interpersonal dependency only, and for these traits model II was chosen as the best-fit model to fit the sub-models (AE; CE). For all other traits, model III was chosen for all traits to fit the sub-models (AE; CE). Results from all of the models suggested that C could be dropped from the models without sacrificing fit (models V), but A could not be dropped (models IV), suggesting that the AE models were the best-fit for all traits. Of greatest interest to us, the cross paths from both the genetic and environmental etiologic factors for most of the positive traits (optimism, self-esteem, mastery) to resilience were modest and positive (range for genetic cross-paths: 0.31 to 0.33; range for environmental cross-paths: 0.22 to 0.24) whereas the genetic and environmental cross-paths for altruism were substantially lower (0.04 and 0.05, respectively). For the two negative traits, neuroticism and interpersonal dependency, the genetic (−0.45 and −0.23, respectively) and environmental cross-paths (−0.38 and −0.20, respectively) were moderate to modest and negative.

The heritability of resilience across these models was estimated between 33–34%. As shown in Table 4, the genetic factors contributing to resilience were largely unique from those of most traits (ranging from 40–93%). Resilience had the largest genetic overlap with neuroticism; optimism, self-esteem, mastery, and interpersonal dependency all had modest overlap in their genetic influences with resilience (range 26–32%), whereas the genetic influences on altruism were largely unrelated to those of resilience. Of the 67–68% of variance in liability to resilience that was environmental, the vast majority of this variance was unique to resilience (78–100%).

### 3.3 Multivariate Genetic Modeling

All of the traits expect altruism had a modest overlap in genetic influence with resilience. Thus, these traits, excluding altruism, were examined in a multivariate Cholesky model (Table 5). Given that we demonstrated a qualitative sex effect for resilience in prior work, as well as for neuroticism and interpersonal dependency in the bivariate models, qualitative sex effects were included in all models for all traits. Similar to our modeling framework described above, the models were compared with the saturated model (I). We began in model II by testing for quantitative sex effects, which were not significant. Model III tested for qualitative sex effects, for which there was evidence (most of the $R_g$ estimates were .5 or higher, suggesting reasonable overlap of genetic factors for males and females). Following, model II was chosen to fit the sub-models (AE; CE). Results from all of the models suggested that C could be dropped from the models without sacrificing fit (model V), but A could not be dropped (model IV). Subsequently, the AE model with qualitative sex effects was the best-fit model (Figure 1). Resilience had an overall heritability of 33%, of which 40% of the genetic variance was specific to resilience, and the remaining 60% was shared with the other traits. By far the largest contribution to resilience came from the first genetic factor, which had a very strong positive loading on neuroticism and substantial loadings on all the other variables in the model including resilience. Of the environmental contribution to resilience (~64%), the vast majority was unique to resilience (77%), with 1% overlap with optimism, and 22% overlap with neuroticism.

## 4.0 Discussion

The present paper had three goals. First, we sought to examine the phenotypic relationship between resilience and a diverse set of conceptually related personality like traits. Second, we aimed to decompose the phenotypic variance between the traits and resilience in a series of bivariate twin models. Lastly, given that many of the traits are genetically related, we fitted a multivariate twin model to examine the traits jointly to determine their impact on the genetic and environmental factors of resilience. The results of each of these goals will be discussed in turn.

### 4.1 Phenotypic Relationships

We examined the relationship between resilience and six traits, two of which were hypothesized "risk factors" (i.e., neuroticism and interpersonal dependency) and four of which were thought to be "protective factors" (i.e., optimism, self-esteem, mastery, altruism) in relation to one's response to stressors. As expected, we found a strong negative correlation between neuroticism and resilience, and a weaker negative relationship between interpersonal dependency and resilience. All of the protective traits were modestly positive correlated with resilience. Also, the traits demonstrated moderate correlations among themselves, which is consistent with prior studies [37]. The multivariate regression results revealed that neuroticism accounted for the majority of the variance, with the strength of the relationships between resilience and the other traits being greatly attenuated.

**Bivariate Relationships—**A series of bivariate Cholesky decomposition models were fitted with the trait as the downstream variable and resilience as the upstream variable to decompose the demonstrated phenotypic relationships into their etiologic components. These analyses revealed that although each trait had a modest genetic overlap with resilience, the majority of the genetic etiology of resilience was unshared with the measured traits (40–93%). The strongest overlap in genetic etiology with resilience was with neuroticism (~2/3rds overlap in genetic influence), and on the other end of the spectrum was altruism, which only shared 7% of genetic factors with resilience. Genetic influences have been demonstrated for many traits, such as self-esteem [12], neuroticism [19], optimism [11], and mastery [13]. Genetic influences are also important in the etiology of coping strategies [38]. Thus, it is not surprising that a modest degree of genetic overlap existed between these traits and resilience, which we have demonstrated to be moderately heritable [7]. Although this is the first study to examine the genetic overlap between the traits and resilience, prior studies have modeled the shared genetic contribution of optimism and mental health, finding approximately a 20% genetic overlap [11], which is consistent with the present results. As a whole, our results suggest at least partial genetic mediation of the phenotypic relationships between the traits and resilience.

Common environmental factors had no discernable influence on the variation in any of the traits or the association between the traits and resilience. Compared to the overlap in genetic influence, the overlap in unique environmental variance between each trait and resilience was far smaller with between 78–100% of unique environmental influence being specific to resilience. What might account for the overlapping environmental influence between the traits and resilience? The unique environmental component may include exposure to early life traumatic events that may both affect the trait (e.g., decrease one's self-esteem) and lower resilience to future stressors later in life. Alternatively, the unique environmental relationship between the traits and resilience may be partially causal in nature. For example, mastery enables people to cope better with stressors [39], and thus, it may have a direct role in increasing resilience.

### 4.2 Multivariate Relationships

When the traits were modeled simultaneously in a multivariate Cholesky, a striking result appeared. Over 1/3$^{rd}$ of the genetic variance for resilience is not accounted for by this diverse set of traits, suggesting that the genetic architecture for resilience is overlapping, but at least partially distinct, from these well-established correlates of mental health and coping. In the multivariate genetic model, similar to the multivariate phenotypic regression, the majority of the variance between resilience and the traits was accounted for by first genetic factor dominated by neuroticism. In fact, after accounting for the shared genetic influence of this first factor, none of the other traits on their own contributed substantial genetic variance to resilience. These results suggest that the influence of the traits on resilience on a genetic level is indexed largely by neuroticism. Given that neuroticism is predictive of poor social support [40], which is a key protective factor in aftermath of traumatic stress [41], and related to resilience [42], this relationship is consistent with the literature. Qualitative effects were found in this model, suggesting that the genes that impact upon the phenotypes may not be the same in males and females. As in the bivariate models, common environmental influences were not found. The unique environmental influences on resilience were largely specific (77%) and the remaining variance attributable to unique environmental influence was shared with neuroticism (22%) and optimism (~1%).

### 4.3 Limitations

A number of limitations are noteworthy. Although our SLE assessment was thorough it was not exhaustive, and it did not measure the impact of the events. Additionally, a simple count of SLEs was utilized in the regression on SLC-90 to obtain the residual score reflecting resilience. There are many nuances that this approach does not capture, such as the potential for forms of SLEs to be differentially impactful, or for the potential of sex based differences for forms of SLEs. Future research could examine these effects to obtain a more sophisticated metric of resilience. Although none of our measures are considered "state" measures, estimates of these traits may fluctuate over time, and thus, longitudinal measurements of these constructs is an important next step in the literature. For example, similar to any self-report measures, reporting on these traits may be influenced by various sources of error (e.g., stress prior to completion of the research measures, lack of sleep, fight with spouse), and thus, obtaining multiple measurements would allow for modeling to correct for measurement error. Additionally, the models presented represent computationally difficult analyses, and obtaining confidence intervals would be extremely time intensive, and therefore they are not presented. Lastly, although population based, our study was composed of white twins from the Mid-Atlantic region of the US, and therefore generalizability is limited.

### 4.4. Conclusions

The present study, not without its limitations, has numerous methodological strengths. This is a large representative sample of adult Caucasian twins. The study methodology was sound (e.g., use of standardized measures, advanced statistical modeling), and furthermore, the use of the quantitative measure of resilience is innovative. The present study found that in phenotypic analyses all of the studied traits correlated with resilience on a bivariate level, but in multivariate analyses neuroticism accounted for most of the variance. In bivariate genetic analyses all of the traits had a modest genetic overlap with resilience. In the multivariate genetic analysis neuroticism accounted for the largest amount of genetic variance, and in this analysis, over a third of the genetic variance in resilience is unique from these well-established correlates of mental health. This result suggests that resilience, although related to these oft-studied traits, is indexing a construct that is related, but partially unique etiologically, from the included traits. These findings have implications for gene-finding efforts for resilience.

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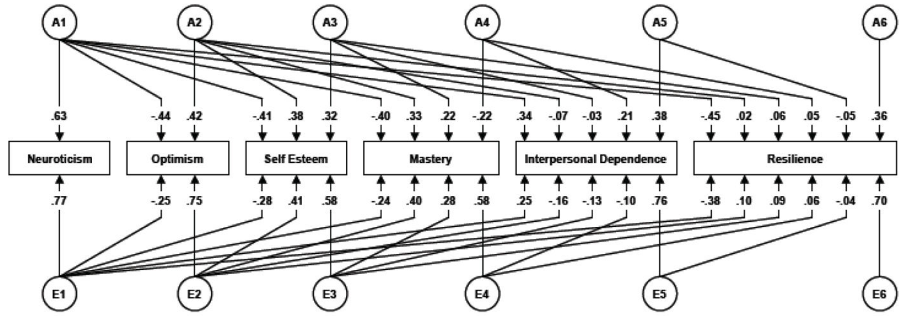


**Figure 1.**
Final multivariate model for traits and resilience.

## Table 1

Correlations among phenotypic variables

| | 1. | 2. | 3. | 4. | 5. | 6. |
|---|---|---|---|---|---|---|
| 1. Resilience | -- | | | | | |
| 2. Neuroticism | −0.58*** | -- | | | | |
| 3. Optimism | 0.37*** | −0.47*** | -- | | | |
| 4. Self-Esteem | 0.40*** | −0.49*** | 0.71*** | -- | | |
| 5. Mastery | 0.38*** | −0.43*** | 0.67*** | 0.74*** | -- | |
| 6. Interpersonal Dependency | −0.31*** | 0.41*** | −0.36*** | −0.40*** | −0.44*** | -- |
| 7. Altruism | 0.05*** | −0.05*** | 0.23*** | 0.29*** | 0.26*** | 0.03* |

Note:

* p<.05,

** p<.01,

*** p<.001.

## Table 2

Linear regressions predicting resilience from trait-level variables

| | Univariate Regressions | | Multivariate Regression | |
|---|---|---|---|---|
| | **Beta** | **SE** | **Beta** | **SE** |
| Neuroticism | −0.58*** | 0.01 | −0.47*** | 0.01 |
| Optimism | 0.35*** | 0.01 | 0.02 | 0.02 |
| Self-Esteem | 0.39*** | 0.01 | 0.09*** | 0.02 |
| Mastery | 0.37*** | 0.01 | 0.08*** | 0.02 |
| Interpersonal Dependency | −0.31*** | 0.01 | −0.05*** | 0.01 |
| Altruism | 0.06*** | 0.01 | −0.03** | 0.01 |

Note:

*p<.05,

**p<.01,

***p<.001.

## Table 3

Results of Cholesky Models for Resilience and Trait Factors.

| Model | Variables | (Qual Trait / Qual Resilience) / Quan | −2LL | ΔDF | Δ( −2LL) | ΔAIC |
|---|---|---|---|---|---|---|
| | | **Neuroticism** | | | | |
| I | ACE | (+ / +) / + | 5417.93 | - | - | - |
| II | ACE | (+ / +) / − | - | 4 | 4.76 | −3.24 |
| III | ACE | (− / +) / − | - | 5 | 18.04 | 8.04 |
| IV | AE | (+ / +) / − | - | 7 | 7.71 | −6.29 |
| V | CE | (− / −) / − | - | 9 | 90.93 | 72.93 |
| | | **Altruism** | | | | |
| I | ACE | (+ / +) / + | 50453.45 | − | - | - |
| II | ACE | (+ / +) / − | - | 4 | 4.29 | −3.71 |
| III | ACE | (− / +) / − | - | 5 | 4.29 | −5.71 |
| IV | AE | (− / +) / − | - | 8 | 4.62 | −11.38 |
| V | CE | (− / −) / − | - | 9 | 47.89 | 29.89 |
| | | **Optimism** | | | | |
| I | ACE | (+ / +) / + | 49741.38 | - | - | - |
| II | ACE | (+ / +) / − | - | 4 | 3.14 | −4.86 |
| III | ACE | (− / +) / − | - | 5 | 3.78 | −6.22 |
| IV | AE | (− / +) / − | - | 8 | 4.77 | −11.23 |
| V | CE | (− / −) / − | - | 9 | 53.33 | 35.33 |
| | | **Self-Esteem** | | | | |
| I | ACE | (+ / +) / + | 49903.02 | - | - | - |
| II | ACE | (+ / +) / − | - | 4 | 3.55 | −4.45 |
| III | ACE | (− / +) / − | - | 5 | 3.51 | −6.49 |
| IV | AE | (− / +) / − | - | 8 | 4.63 | −11.37 |
| V | CE | (− / −) / − | - | 9 | 65.99 | 47.99 |

| Model | Variables | (Qual Trait / Qual Resilience) / Quan | −2LL | ΔDF | Δ( −2LL) | ΔAIC |
|---|---|---|---|---|---|---|
| **Interpersonal Dependency** | | | | | | |
| I | ACE | (+ / +) / + | 49819.45 | - | - | - |
| II | ACE | (+ / +) / − | - | 4 | 4.81 | −3.19 |
| III | ACE | (− / +) / − | - | 5 | 7.52 | −2.48 |
| IV | AE | (+ / +) / − | - | 7 | 6.42 | −7.58 |
| V | CE | (− / −) / − | - | 9 | 52.78 | 34.78 |
| **Mastery** | | | | | | |
| I | ACE | (+ / +) / + | 49968.51 | - | - | - |
| II | ACE | (+ / +) / − | - | 4 | 3.63 | −4.37 |
| III | ACE | (− / +) / − | - | 5 | 3.80 | −6.20 |
| IV | AE | (− / +) / − | - | 8 | 4.55 | −11.45 |
| V | CE | (− / −) / − | - | 9 | 55.10 | 37.10 |

Notes: A: additive genetic factors; C: common environmental factors: E: individual specific environment factors.

## Table 4

Percent of genetic and unique environmental effects specific to resilience in bivariate models

| Trait | Percent of Non-Overlapping Genetic Variance for Resilience Unshared with each Trait | Percent of Non-Overlapping Unique Environmental Variance for Resilience Unshared with |
|---|---|---|
| Neuroticism | 40 | 78 |
| Optimism | 68 | 92 |
| Self-esteem | 71 | 89 |
| Mastery | 71 | 91 |
| Interpersonal Dependency | 74 | 94 |
| Altruism | 93 | 100 |

## Table 5

Results of Multivariate Cholesky Models for Traits and Resilience.

| Model | Variables | (Qual N / Qual O/ Qual SE / Qual M / Qual ID / Qual Res) / Quan | −2LL | ΔDF | Δ( −2LL) | ΔAIC |
|---|---|---|---|---|---|---|
| I | ACE | (+ / + / + / + / + / +) / + | 128122.1 | - | - | - |
| II | ACE | (+ / + / + / + / + / +) / − | - | 63 | 86.4 | −39.53 |
| III | ACE | (− / − / − / − / − / −) / − | - | 6 | 0.0 | −12.02 |
| IV | AE | (+ / + / + / + / + / +) / − | - | 84 | 100.0 | −67.95 |
| V | CE | (+ / + / + / + / + / +) / − | - | 90 | 231.8 | 51.78 |

Notes: Qual: qualitative sex effect; Quant: quantitative sex effect; N: Neuroticism; O: openness; SE: self-esteem; M: mastery; ID: interpersonal dependency; Res: resilience; A: additive genetic factors; C: common environmental factors: E: individual specific environment factors.