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Resilience and risk for alcohol use disorders: A Swedish twin study

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Abstract

Background—Resilience has been shown to be protective against alcohol use disorders (AUD), but the magnitude and nature of the relationship between these two phenotypes is not clear. The aim of this study is to examine the strength of this relationship and the degree to which it results from common genetic or common environmental influences.

Methods—Resilience was assessed on a nine-point scale during a personal interview in 1,653,721 Swedish men aged 17–25 years. AUD was identified based on Swedish medical, legal, and pharmacy registries. The magnitude of the relationship between resilience and AUD was examined using logistic regression. The extent to which the relationship arises from common genetic or common environmental factors was examined using a bivariate Cholesky decomposition model.

Results—The five single items that comprised the resilience assessment (social maturity, interest, psychological energy, home environment, and emotional control) all reduced risk for subsequent AUD, with social maturity showing the strongest effect. The linear effect by logistic regression showed that a one-point increase on the resilience scale was associated with a 29% decrease in odds of AUD. The Cholesky decomposition model demonstrated that the resilience-AUD relationship was largely attributable to overlapping genetic and shared environmental factors (57% and 36%, respectively).

Conclusion—Resilience is strongly associated with a reduction in risk for AUD. This relationship appears to be the result of overlapping genetic and shared environmental influences that impact resilience and risk of AUD, rather than a directly causal relationship.

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Keywords

resilience; alcohol use disorder; twins

Introduction

A substantial literature in the past few decades has investigated the personality traits that are most often associated with alcohol use (AU) and alcohol use disorders (AUD). This research has consistently shown that high levels of openness and neuroticism but low levels of agreeableness and conscientiousness are linked to AU and AUD (Chassin et al., 2004; Malouff et al., 2007; Martin and Sher, 1994; Sher et al., 1999). The personality traits that seem to be most important in the development of AUD are those of disinhibition and impulsivity (Bennett et al., 1999; Chassin et al., 2004; Chassin et al., 2002; Jackson et al., 2000; Sher et al., 1999). More recently, the construct of psychological dysregulation, which is operationalized as the inability to regulate emotions and behavior in response to the environment, has been increasingly shown to predict AUDs (Clark et al., 2012; Clark et al., 2008).

Relatedly, resilience is defined as an “individual’s ability to thrive despite adversity” (Connor and Davidson, 2003; Green et al., 2014; Luthar et al., 2000; Rutter, 1987). Although resiliency is typically not conceptualized as a personality trait per se, personality traits may be an important determinant of resilience (Fergusson and Horwood, 2003; Luthar, 1991; Werner and Smith, 1992; Wyman et al., 1991). For example, low neuroticism and high self-esteem, extraversion, and conscientiousness have been shown to be associated with resilience (Campbell-Sills et al., 2006; Fergusson and Horwood, 2003).

Resilience may also play a key role in attenuating risk for AU problems (Green et al., 2014; Green et al., 2010; Wingo et al., 2014). Both resilience and AUD are influenced by genetic and environmental factors. The heritability of AUD has been consistently estimated to be approximately 50% (Kendler et al., 1994; Verhulst et al., 2015). However, the few studies that have investigated the heritability of resilience have each used different definitions of the stressors and outcomes. Therefore, the heritability has been estimated to be as low as 31% and as high as 71% (Amstadter et al., 2014; Boardman et al., 2008; Kim-Cohen et al., 2004).

The relationship between AUD and resilience is also not well understood. To date, there has only been one study that has examined the genetic and environmental sources of covariation between resilience and AUD. This study showed that the majority of the covariation was attributable to genetic factors, while a negligible amount was due to environmental sources (Amstadter et al., in press). Given the potentially protective role resilience may play in risk for AUD, a clearer understanding of this relationship is important.

In the present study, our measure of resilience was based on a nine-point scale that rated individuals’ functioning across certain predefined sections, such as experiences at school, work, home environment, and leisure time, as well as emotional stability. Higher values indicate better functioning. This scale was used as part of the evaluation for Swedish military service to predict an individual’s ability to cope with stressful situations such as

combat experiences. Although previous reports have referred to this scale as “stress susceptibility” (Nilsson et al., 2001), “psychological functioning” (Nilsson et al., 2004), and “psychological strength” (Kendler et al., 2016; Leboeuf-Yde et al., 2006), we chose to refer to it as resilience. The variables included in the scales as well as the purpose of the scale in the military assessments, which is to “reflect the level of adaptation in everyday life, including psychological and physical endurance under stress” (Leboeuf-Yde et al., 2006, pg. 3–4), is very close to the definition of resilience and consistent with the goal of other commonly used resilience measures, such as the Connor-Davidson Resilience Scale (Connor and Davidson, 2003).

We are unaware of any studies that have examined the relationship between AUD and resilience assessed as an individual’s ability to cope with stressful situations. To address these gaps, the aims of the current study are two-fold. Using a nationwide Swedish sample, our first aim is to examine the magnitude of the relationship between AUD and the five traits that were components of the resilience assessment (social maturity, interest, psychological energy, home environment, and emotional control), as well as the total resilience score. Our second aim is to use bivariate twin modeling to explore the extent to which the association between AUD and resilience is the result of common genetic or common environmental factors.

Materials and Methods

Using the unique 10-digit identification number that all Swedish residents are given at birth or immigration, nationwide Swedish registers were joined. To protect anonymity, this number was replaced by a serial number. We used the following eight registries to create our dataset: (1) the Total Population Register for year of birth, sex, and annual data on place of residences; (2) the Twin Register for known zygosity; (3) the Swedish Hospital Discharge Register for hospitalizations of Swedish residents from 1964 to 2010; (4) the Swedish Prescribed Drug Register for prescriptions in Sweden obtained by patients from 2005 to 2010; (5) the Outpatient Care Register for information regarding outpatient clinics from 2001 to 2010; (6) the Swedish Crime Register for data on all convictions in lower court from 1973–2011; (7) the Swedish Suspicion Register for national data on individuals strongly suspected of crime from 1998–2011; and (8) the Swedish Conscription Register for information regarding the resilience assessment used for military service from 1969 to 2008.

Sample

For the regression analysis, all males in the conscription register with an assessment of resilience between age 17 and 25 ($N = 1,653,721$) were included. For the single item regression analyses, only a subset of the sample was available ($n = 49,393$). The bivariate twin models included 5,765 twin pairs (2,750 monozygotic; 3,015 dizygotic). Twin pairs were selected from the Swedish Twin Registry with birth years from 1950 to 1990 (ages 26–66) that also had known zygosity. A larger age range was allowed to identify male twins with AUD. To assign zygosity in the same-sex twin pairs, standard self-report items from mailed questionnaires were used, which were 95–99% accurate when compared with biological markers (for more details, see Lichtenstein et al. 2002). This is an indirect

screening for level of cooperation because at least one of the pair had to return a questionnaire to the twin registry and cooperation was lower in subjects with AUD. Thus, the prevalence is lower in this group, compared to twin pairs not returning the questionnaires.

Measures

Individuals with AUD were identified from a range of Swedish registries. From the Swedish hospital discharge and outpatient registers, we used the following ICD codes: ICD9 (V79B, 305A, 357F, 571A, 571B, 571C, 571D, 425F, 535D, 291, 303, 980) and ICD 10 (E244, G312, G621, G721, I426, K292, K700, K701, K702, K703, K704, K709, K852, K860, O354, T510, T512, T511, T513, T518, T519, F101, F102, F103, F104, F105, F106, F107, F108, F109). The hospital discharge and outpatient registries identified 242,949 individuals with AUD. Additionally, we identified 199,663 individuals with at least two convictions or suspicions (that did not lead to conviction) of drunk driving or drunk in charge of maritime vessel by law 1951:649, paragraph 4, and 4A, and law 1994:1009, paragraph 4 and 5 and the suspicion codes 3005 and 3201. We also identified AUD among 63,169 individuals who had retrieved disulfiram (Anatomical Therapeutic Chemical (ATC) Classification System, N07BB01), acamprosate (N07BB03), and naltrexone (N07BB04) from the Prescription Registry. From these three sources of information, we identified a total of 420,489 individuals with AUD, for a lifetime prevalence of 3.8%.

The resilience scale was designed to measure the ability to cope with psychologically stressful situations that might occur in military service. It is assessed with a 1 to 9 graded scale corresponding to a categorized normal distribution centered at 5. Specially trained psychologists assigned the resilience score by administering a semi-structured interview that took on average 20–25 minutes to complete. Their training is conducted nationally and therefore their performance did not differ from region to region. During this free form interview, the conscript was asked to describe his everyday life. There are five predefined sections (experiences from school, work experiences, leisure time, home environment, and emotional stability), although the order in which the sections are administered can vary. The interviewer was provided with background information such as school grades, job experiences, and other test results in advance.

As part of the complete resilience assessment procedure, five single items from the assessment were made available to us during the years of 1969–1970 only ($n = 49,393$). These individual items assessed social maturity, interest, psychological energy, home environment, and emotional control. Each category corresponded to a categorized normal distribution.

We are not able to provide example questions from these five individual items because the Swedish military has classified these items. However, we consider it likely that they map onto some of the questions included in the Connor-Davidson Resilience Scale (Connor & Davidson, 2003), as follows: “know where to turn for help” for social maturity; “likes challenges/strong sense of purpose” for interest; “bounce back after hardship/think of self as a strong person” for psychological energy; “close and secure relationships” for home

environment; and “can handle unpleasant feelings/can deal with whatever comes” onto emotional control.

The Swedish army has demonstrated the predictive power of the resilience scale (Carlstedt, 1999). The quality of military performance in both enlisted men and officers in the Air Force, under battle conditions, and for support troops was strongly predicted by the scale. For example, for enlisted men serving in the Air Force who were assigned a resilience score of 3, a rating of a good performance was given to only 30%, compared to 75% who were assigned a score of 8 (scores of 3 and 8 were the lowest and highest scores for which adequate data were available; Carlstedt, 1999). There was also a strong link between resilience scores and the probability of acceptance into the military: 1 – 2.0%, 2 – 14.3%, 3 – 38.7%, 4 – 58.1%, 5 – 66.6%, 6 – 70.5%, 7 – 73.6%, 8 – 75.1%, and 9 – 76.1%.

Statistical methods

First, we assessed the unique associations between the five single resilience constructs and AUD by conducting five separate logistic regressions. We then assessed the association between the total resilience score and AUD with logistic regression. Linear and quadratic terms were included in all regressions, and birth year was included as a covariate to adjust for age, as older males are more likely to be an AUD case than younger males. These analyses were performed in SAS 9.3 (SAS Institute Inc, 2011).

Second, we used classical bivariate twin modeling, which assumes three sources of liability to AUD and the total resilience score: additive genetic (A), shared environment (C), and unique environment (E). The model assumes that monozygotic (MZ) twins share 100% of their genes, while dizygotic (DZ) twins share, on average, 50% of their genes. Therefore, the expected twin pair correlations for the additive genetic effects are 1.0 and 0.5, respectively. The model also assumes that the shared environment, which reflects family and community experiences, is equal between MZ and DZ twins. Finally, the unique environment reflects experiences not shared by twins, random developmental effects, and random measurement error. The model is based on the idea of an underlying unobserved distribution of liability to AUD, only measured as a binary outcome, and a resilience score measured by nine categories. By assuming a normal distribution for resilience, ordered thresholds can be estimated. These thresholds can then be conceptualized as “cut points” along the unobserved distribution. The probability of being in a respective category corresponds to the threshold for the lowest category and then increases linearly for each successive category. The correlation within each twin pair corresponds to the proportion of variance explained by the genes (A) and environment (C) they share. The polychoric correlation is a parameter in a multivariate normal distribution and the likelihood function was set so that the parameter estimates are the values giving it its maximum value.

The bivariate model was built using the Cholesky decomposition where the first factor loads on both resilience and AUD while the second loads only on the latter. This method can handle missing items and includes both individuals and pairs without a resilience assessment who still contribute to the AUD estimates. Path estimates from this bivariate model are re-scaled into correlations, which have no directional interpretation. Based on recommendations from Sullivan and Eaves (2002), who used simulations to demonstrate that

parameter estimates from the full model are usually more accurate than those from submodels even if the submodels provide a better model fit, estimates are presented from the full bivariate ACE model with 95% CIs. The OpenMx software (Boker et al., 2011) was used to fit the models.

Results

Descriptive Statistics

The sample sizes and prevalences of individuals with AUD by level of the resilience score are shown in Table 1. The prevalence of AUD dramatically increases as the resilience score decreases (also see Figure 1). At the highest level of resilience, the prevalence of AUD is 2.9%, whereas at the lowest level, the prevalence is 23.2%.

The twin correlations for the total resilience score and AUD are displayed in Table 2. The within-pair, cross trait MZ twin correlations, shown on the off diagonals, were modest (-0.23 and -0.26). The within-pair, cross trait DZ twin correlations were lower than the MZ correlation, but also modest (-0.14 and -0.18), suggesting genetic factors are important in the relationship between resilience and AUD. However, the DZ correlations are slightly greater than half of the MZ correlations, which suggest that shared environmental influences are also important, but may have a minor impact.

Logistic Regression Analyses

The results of the associations between AUD and the five single items from the subsample of the conscript registry are shown in Table 3. Across all five items, Model 4 was always the best fitting model as per the AIC, which included birth year and the quadratic term. The odds ratios (ORs) from the linear effects clearly indicate that all five items reduced risk of AUD. Social maturity had the strongest effect, while interest was the weakest. However, because the quadratic term was also significant across all five items, these effects were not solely linear.

The results of the association between AUD and the total resilience score are presented in Table 4 and depicted graphically in Figure 1. Focusing first on the linear effect (Model 1), the OR is 0.71, indicating that each increasing point on the resilience scale is associated with a 29% reduction in the odds of AUD. In Model 3, birth year was adjusted for and a quadratic effect of resilience was added, which was significant. The quadratic effect is clearly shown in Figure 1, as the association between resilience and AUD is stronger at lower levels of resilience than at higher levels, where the reduction in risk of AUD stabilizes.

Bivariate twin analyses of resilience and AUD

A Cholesky decomposition model was fit to the total resilience score and AUD. The within-individual phenotypic correlation for these traits is -0.25 . The heritability of resilience is 55%. As seen in Figure 2, the cross-path from the genetic effects common to resilience and to AUD (-0.18) is of similar strength to the shared environmental cross-path (-0.23). However, both of these were stronger than the individual-specific environmental cross-path (-0.03). The genetic and shared environmental covariation-paths were both significant.

These results are presented in two other informative ways in Table 5, with genetic and environmental correlations shown in the left panel and proportions of the phenotypic correlation shown in the right panel. First, the genetic and environmental correlations show negative associations. The shared environmental correlations are quite high between resilience and AUD (-0.63), while the genetic correlation is more moderate (-0.25). The individual-specific environmental correlation is small (-0.06). Second, we used the parameter estimates from model fitting to decompose the total phenotypic correlation between resilience and AUD (-0.25). The proportion of the phenotypic correlation resulting from common individual-specific environmental risk factors is very modest (7%), while the proportion of the phenotypic correlation resulting from shared environmental factors is higher (36%), and is highest from genetic risk factors (57%).

Discussion

The goals of this study were to examine the magnitude of the relationship between AUD and resilience, and then explore the degree to which the relationship results from common genetic or common environmental factors. First, using logistic regression, the association between AUD and the five single items that were used as part of the resilience assessment (social maturity, interest, psychological energy, home environment, and emotional control; available on a subsample) was examined. All five of these items relatively strongly reduced the risk of AUD, although they were of different strengths. Similar to a recent report investigating the association between resilience (referred to as “psychological strength”) and criminal behavior, social maturity showed the strongest association while interest showed the weakest (Kendler et al., 2016). This study also reported results of a factor analysis that revealed a one-factor solution with significant loadings from all five items (Kendler et al., 2016), which supports the validity of the resilience measure.

Also using logistic regression, the association between the total resilience score and AUD was investigated. Consistent with previous studies (Green et al., 2014; Green et al., 2010; Wingo et al., 2014), we showed that resilience substantially reduced the risk of AUD. The linear effect indicated that a one-point increase on the resilience scale was associated with a 29% decrease in odds for AUD. The change in risk for AUD for a given change in resilience was much greater at lower resilience levels than at higher levels. At resilience levels of 6 or higher, the reduction of risk for AUD did not continue to decrease linearly as resilience levels increased, but instead showed a negligible impact.

It is interesting to note that the personality traits of neuroticism and conscientiousness play a role in the development of both AUD and resilience. Low levels of neuroticism but high levels of conscientiousness are associated with a reduced risk of developing AUD (Chassin et al., 2004; Malouff et al., 2007; Martin and Sher, 1994; Sher et al., 1999), but they are also linked to resilience (Campbell-Sills et al., 2006; Fergusson and Horwood, 2003). However, the nature of these relationships is unclear. It may be that low neuroticism and high conscientiousness promote resilience, or that resilience promotes low neuroticism and high conscientiousness. An alternative explanation is that all three of these variables are tapping the same underlying construct. Therefore, one important area for future research would be to

further examine these relationships, given the protective effects personality and resilience seem to have on the development of AUD.

Second, using a Cholesky decomposition model fit to MZ and DZ twin pairs, the resilience-AUD association was decomposed into its genetic and environmental components. The individual-specific environmental factors contributed very little to the covariance between resilience and AUD. The majority of the covariance could instead be attributed to overlapping genetic and shared environmental factors. In other words, part of the same genes and shared environments that contribute to increased resilience also contribute to reduced risk for AUD. These results support a ‘liability index’ model in which resilience reflects genetic and shared environmental influences that also impact risk for AUD, rather than a direct causal link.

We are aware of only one previous study that also examined these sources of covariation. Amstadter and colleagues (Amstadter et al., in press) showed that most of the covariation was due to genetic influences with the negligible remainder due to overlapping unique environmental influences (E). There was no evidence for overlapping shared environmental influences (C). While we also found that genetic influences were an important source of covariation and that unique environmental factors (E) were not, we conversely showed that 36% of the covariation was attributable to the shared environment (C). Potential explanations for this inconsistency may be due to differences in sample size (5,765 complete twin pairs vs. 3,084 complete twin pairs with 1,325 singletons), different populations (Sweden vs. United States), and different measures of resilience (ability to cope with psychologically stressful situations vs. the difference between twins’ total score of internalizing symptoms and their predicted score based on their cumulative exposure to stressful life events).

Limitations

These results should be considered within the context of two potential limitations. First, our analyses were limited to a Swedish male sample. It is therefore uncertain if our results generalize to other populations. However, it is likely that the results are generalizable to other industrialized countries.

Second, our measure of AUD was based on medical, legal, and pharmacy records. Although this method is not subject to recall or reporting biases, it can produce false negatives and false positives. The extent to which this occurred cannot be estimated. However, a recent report using the same sample found the prevalence of AUD to be lower than estimates from most epidemiologic surveys (Kendler et al., 2015), including the nearby country of Norway (Kessler et al., 1994; Kringlen et al., 2001). Accordingly, it may be that registries detect more severe cases of AUD than population-based interview studies. Despite this, there is support of our measure of AUD from high concordance rates for registration across the different methods (Kendler et al., 2015). In addition, those cases that require hospital care are more clinically relevant than those who are based on population-based interviews.

Conclusions

Using a nationwide Swedish male sample, we showed that higher scores on the five single items that comprised the resilience assessment (social maturity, interest, psychological energy, home environment, and emotional control), as well as a higher total resilience score, are associated with a reduced the risk of AUD. This effect was not linear, but rather quadratic, such that the risk for AUD was most strongly predicted by resilience at resilience levels of 6 or lower. We also showed that the relationship between resilience and AUD was largely attributable to overlapping genetic and shared environmental factors. Future research should aim to identify the specific genetic and shared environmental factors common to resilience and AUD to facilitate prevention efforts.

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Figure 1.
Prevalence of AUD as a function of total resilience score.

Figure 2.

Parameter estimates and 95% confidence intervals from the bivariate Cholesky decomposition for the total resilience score and AUD. 'A' stands for additive genetic effects, C for 'shared environmental effects' and E for 'individual-specific environmental effects'. The subscript '1' refers to the genetic and environmental factors common to both resilience and AUD. The subscript '2' refers to the genetic and environmental factors unique to AUD.

Table 1

Sample sizes and prevalence of AUD by resilience score

Resilience score	Number of Individuals	Number of Individuals with AUD (%)
1	37,864	8,799 (23.2%)
2	118,669	15,254 (12.9%)
3	186,940	16,240 (8.7%)
4	276,479	16,547 (6.0%)
5	372,889	16,316 (4.4%)
6	306,998	10,392 (3.4%)
7	229,016	6,743 (2.9%)
8	98,335	2,734 (2.8%)
9	26,531	766 (2.9%)

Table 2

Twin correlations (SE) for resilience and AUD

Monozygotic Twins		
	T2 Resilience	T2 AUD
T1 Resilience	0.68 (0.01)	−0.26 (0.04)
T1 AUD	−0.23 (0.04)	0.66 (0.05)
Dizygotic Twins		
	T2 Resilience	T2 AUD
T1 Resilience	0.42 (0.02)	−0.14 (0.04)
T1 AUD	−0.18 (0.04)	0.43 (0.05)

Table 3

Unique associations between AUD and five items included in the resilience assessment (during the years 1969–1970 only; $n = 49,393$)

Item	Predictors	Model 1	Model 2	Model 3	Model 4
Social Maturity	Resilience (Linear)	0.64 (0.62–0.67)	0.32 (0.27–0.37)	0.65 (0.62–0.67)	0.31 (0.27–0.36)
	Resilience (Quadratic)		1.13 (1.11–1.16)		1.14 (1.11–1.17)
	Birth year			1.07 (1.01–1.13)	1.09 (1.03–1.15)
	AIC	29,276.781	29,193.283	29,273.748	29,186.793
Interest	Resilience (Linear)	0.78 (0.76–0.81)	0.68 (0.59–0.80)	0.78 (0.76–0.81)	0.68 (0.58–0.79)
	Resilience (Quadratic)		1.02 (1.00–1.05)		1.03 (1.00–1.05)
	Birth year			1.12 (1.06–1.19)	1.13 (1.06–1.19)
	AIC	29,661.123	29,659.987	29,646.075	29,644.537
Psychological Energy	Resilience (Linear)	0.68 (0.66–0.71)	0.48 (0.41–0.57)	0.68 (0.66–0.71)	0.48 (0.40–0.56)
	Resilience (Quadratic)		1.06 (1.03–1.09)		1.07 (1.04–1.10)
	Birth year			1.09 (1.03–1.16)	1.10 (1.04–1.16)
	AIC	29,470.288	29,455.017	29,462.775	29,446.368
Home	Resilience (Linear)	0.65 (0.62–0.67)	0.45 (0.39–0.53)	0.65 (0.62–0.67)	0.45 (0.38–0.52)
	Resilience (Quadratic)		1.07 (1.04–1.10)		1.07 (1.04–1.10)
	Birth year			1.13 (1.07–1.20)	1.14 (1.08–1.21)
	AIC	29,320.754	29,302.896	29,303.414	29,283.548
Emotional Control	Resilience (Linear)	0.68 (0.66–0.70)	0.51 (0.44–0.58)	0.68 (0.66–0.70)	0.49 (0.43–0.57)
	Resilience (Quadratic)		1.06 (1.03–1.08)		1.06 (1.03–1.09)
	Birth year			1.13 (1.07–1.20)	1.15 (1.08–1.21)
	AIC	29,321.546	29,307.097	29,304.130	29,286.774

Data are given as odds ratios (95% confidence intervals) or as AIC. AIC: Akaike's information criterion.

Table 4

Association between AUD and total resilience score during years 1969–2008 (entire sample; $n = 1,653,721$)

Item	Predictors	Model 1	Model 2	Model 3
Total score	Resilience (Linear)	0.71 (0.71–0.71)	0.70 (0.69–0.70)	0.49 (0.48–0.50)
	Resilience (Quadratic)		0.96 (0.96–0.96)	1.04 (1.04–1.04)
	Birth year			0.96 (0.96–0.96)
	AIC	687,928.05	670,222.35	667,955.52

Data are given as odds ratios (95% confidence intervals) or as AIC. AIC: Akaike's information criterion.

Table 5

Correlations from bivariate twin model for total resilience score and AUD

Correlation (95% CI)			
	Genetic	Shared environmental	Individual specific environmental
	−0.25 (−0.48, 0.04)	−0.63 (−1.0, 0.05)	−0.06 (−0.18, 0.05)
Phenotypic correlation (95% CI)			
Total	% Genetic	% Shared environmental	% Individual specific environmental
−0.25 (−0.28, −0.20)	56.7 (10.1, 100)	36.2 (−2.1, 73.7)	7.1 (−7.3, 23.0)