Personality and comorbidity of common psychiatric disorders

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Background  We know little about the degree to which comorbidity, so commonly seen among psychiatric disorders, arises from variation in normal personality.

Aims  To study the degree to which variation in normal personality accounts for the comorbidity of eight common psychiatric and substance use disorders.

Method  Internalising disorders (major depression, generalised anxiety and panic disorders, phobias), externalising disorders (alcohol and drug dependence, anti-social personality and conduct disorders) and personality dimensions of neuroticism, extraversion and novelty seeking were assessed in 7588 participants from a population-based twin registry. The proportion of comorbidity explained by each personality dimension was calculated using structural equation modelling.

Results  Neuroticism accounted for the highest proportion of comorbidity within internalising disorders (20–45%) and between internalising and externalising disorders (19–88%). Variation in neuroticism and novelty seeking each accounted for a modest proportion (10–12% and 7–14%, respectively) of the comorbidity within externalising disorders. Extraversion contributed negligibly.

Conclusions  High neuroticism appears to be a broad vulnerability factor for comorbid psychiatric disorders. Novelty seeking is modestly important for comorbid externalising disorders.

Declaration of interest  None. Funding detailed in Acknowledgements.

High comorbidity among psychiatric disorders is consistently reported (Kessler et al, 1994; Merikangas et al, 1996). Among many proposed explanations, one possibility is that personality mediates part of this comorbidity (Jardine et al, 1984; Clark et al, 1994; Battaglia et al, 1996; Bienvenu et al, 2001; Krueger & Markon, 2001). This study examines the association of variation in personality traits of neuroticism, extraversion and novelty seeking and the comorbidity among eight disorders: major depression, generalised anxiety disorder (GAD), panic disorder, any phobia, alcohol dependence, drug dependence, anti-social personality disorder and conduct disorder. This study not only attempts to replicate previous work using a large epidemiological sample, including more comprehensive diagnostic categories and different statistical methodology, but also attempts to quantify the proportion of comorbidity among psychiatric disorders explained by individual personality dimensions.

METHOD

Participants

Our sample derives from two related projects utilising the population-based Virginia Twin Registry, which was formed from a systematic review of all birth certificates in the Commonwealth of Virginia and now constitutes part of the Mid-Atlantic Twin Registry. The female–female (FF) twin pairs used in this study come from birth years 1934–1974. Twin pairs became eligible to participate if both members had responded previously to a mailed questionnaire, the response rate to which was 64%. Eighty-eight per cent of our sample were first interviewed face to face in 1987–1989 (wave 1) and subsequently have participated in up to three additional telephone interviews (waves 2–4).

The male–male and male–female (MM/MF) twin pairs, covering the birth years 1940–1974, were ascertained in a separate study beginning in 1993. We interviewed 72% of the eligible sample, usually by telephone, in our wave 1 study. This sample was followed up in a second wave of face-to-face interviews (1994–1998) that were completed with 79.4% of eligible participants.

We examine here the results of combined data from the MM/MF and FF samples, based on the second and fourth wave of interviews, respectively, because these were the most recent waves in which we had measured both personality and psychiatric diagnoses. Our sample consisted of 7388 individual twins, with 4240 males (55.9%) and 3348 females (44.1%). All participants were Caucasian, ranging in age from 20 to 38 years (mean = 36.8, s.d. = 8.9) at the time of the interview. Informed consent was obtained from all participants prior to assessment.

Measures

Psychiatric disorders

The outcome measures of interest, as outlined in the introduction, were lifetime diagnoses of common psychiatric disorders. In order to facilitate the discussion, we will use the concepts of internalising (propensity to express distress inwards, including major depression, GAD, panic disorder, any phobia) and externalising (propensity to express distress outwards, including alcohol and drug dependence, antisocial personality disorder, conduct disorder) disorders as described by Krueger et al (Krueger, 1999; Krueger & Markon, 2001). With the exception of ‘any phobia’, all disorders were assessed using the Structured Clinical Interview for DSM–III–R (Spitzer & Williams, 1985). Diagnostic algorithms for GAD, panic disorder and alcohol dependence were modified to reflect DSM–IV criteria (American Psychiatric Association, 1994), whereas major depression, drug dependence, antisocial personality disorder and conduct disorder were based on DSM–III–R criteria (American Psychiatric Association, 1987) owing to the lack of items corresponding to DSM–IV criteria. The drug dependence diagnosis included dependence on marijuana, cocaine, opiates, hallucinogens, stimulants, sedatives or other drugs. Phobias were assessed with an adaptation of the phobic disorders section of the...
Diagnostic Interview Schedule, version III–A (Robins & Helzer, 1985), and the
diagnosis of ‘any phobia’ included agoraphobia, social, situational, animal, blood
and miscellaneous phobias. The diagnostic
algorithm for phobias has been described
in detail previously (Kendler et al., 2002).

Interviewers were carefully trained and
supervised, and had at least a master’s
degree in a mental health-related field or a
bachelor’s degree in such a field and two
years of clinical experience. Diagnoses for
conduct disorder and antisocial personality
disorder were based on self-report
questionnaires; all other diagnoses were
assessed using personal interview. Inter-
rater reliability for diagnosis (based on a
subsample of FF twins) was high (e.g. for
major depression, mean (s.d.), \( \kappa =0.96
\) (0.04)), and test-retest reliability (based on
an average interval of 4.5 weeks, range 2–8 weeks, between base and reli-
ability interview) was also acceptable for
most diagnoses (range=0.23–0.74, average
\( \kappa =0.52 \)). Finally, the comorbidity of an-
tisocial personality disorder and conduct
disorder was not examined because the
diagnosis of antisocial personality disorder
requires the onset of conduct disorder
before age 15 years. Table 1 describes the
prevalence of psychiatric disorders in our
sample.

### Personality

Neuroticism and extraversion, as concep-
tualised by Eysenck (Eysenck & Eysenck,
1975; Hirschfeld et al., 1983), have been
identified cross-culturally as major person-
ality traits by nearly all subsequent investi-
gators (Pervin, 1990). Neuroticism reflects
emotional instability, vulnerability to stress
and anxiety proneness, whereas extra-
version measures sociability and liveliness.
Novelty seeking, another personality
dimension, measures exploratory excita-
bility, impulsiveness, extravagance and
regimentation (Cloninger et al., 1991). Person-
ality measures of neuroticism and
extraversion were obtained by self-report
questionnaire in the MM/MF sample and
were part of the telephone interview in
the FF sample. Novelty seeking was ass-
sessed by self-report questionnaire only, in
both samples. Neuroticism and extraver-
sion were assessed with 12 and 8 items,
respectively, from the shortened version of
the Eysenck Personality Questionnaire –
Revised (EPQ–R; Eysenck et al., 1985;
Heath et al., 1992). Novelty seeking was
evaluated by 18 items from the abbreviated
54-item version of the Tridimensional
Personality Questionnaire (TPQ) of Clonin-
ger (Cloninger et al., 1991; Heath et al.,
1994). For statistical analyses we used
composite personality measures derived
from individual items for each dimension,
respectively.

### Missing data

Valid data on all three personality measures
and all eight psychiatric disorders were
available for the vast majority (85.6%;
\( n=6499 \)) of the sample. Missing data for
major depression, GAD, any phobia and
alcohol and drug dependence were minimal
(<0.6%). Rates of missing data for
conduct disorder and antisocial personality
were somewhat higher (approximately
7–16%) because these diagnoses were
assessed using a separate self-report
questionnaire. Rates of missing data for
the three personality measures were 2–16%,
also due primarily to lower response rates
for the self-report questionnaire. Prelimi-
nary analyses revealed no significant differ-
ces in mean levels of personality or
psychiatric diagnosis due to missing data on
other variables (results available from
the authors upon request).

### Statistical analysis

We performed logistic regression analyses
to estimate the association of each
personality dimension with each psychiatric
disorder. Correction for the correlated
structure of our twin data was done using
generalised estimating equations (Liang &
Zeger, 1986) as implemented in the Statisti-
cal Analysis System (SAS) procedure GEN-
MOD. Multiple logistic regression analyses
were performed with all three personality
measures as independent variables. Age,
zygosity and gender were used as covari-
ates. Scores for all personality measures
were standardised to a mean of 0 and a var-
iance of 1 to facilitate the direct compar-
is of their effects on the disorder of
interest. Odds ratios with 95% confidence
intervals and their statistical significance
are reported. An odds ratio of \( >1 \) repre-
sents the increase in risk of disorder associ-
ated with each standard deviation (s.d.)
increase in the score of the personality di-
mension. An odds ratio of \( <1 \) represents
the decrease in risk associated with each
s.d. increase in personality dimension score.

In order to calculate the proportion of
comorbidity attributed to variation in
normal personality, we conducted struc-
tural equation modelling analyses using
the software program Mx (Neale et al.,
1999). As depicted in Fig. 1, the model we
used allowed us to calculate the total co-
variance (i.e. comorbidity) between the
disorders of interest. This covariance
was broken down into the covariance
attributed to personality and the residual
covariance, which represents any remaining
comorbidity after removing the covariation attributable to personality. Covariance due to personality comprised both direct and indirect effects. Direct effects are the direct effects of each personality measure on each of the two disorders. In path analyses, the contribution of personality to comorbidity can be assessed by multiplying the direct effects of a given personality variable on each of the two disorders. Indirect effects are effects of personality on disorder and comorbidity that occur through correlated personality dimensions. Because the overall correlation across personality measures was low to moderate (between neuroticism and extraversion = −0.19, neuroticism and novelty seeking = 0.04, extraversion and novelty seeking = 0.34) indirect effects of personality are ignored when calculating the contribution to covariance of each individual personality dimension (although they are included as a separate category; see Table 3 below).

The structural equation models were fitted to the raw data using maximum likelihood estimation, which allowed us to use all valid data, even if some responses or observations for a given individual are missing. Psychiatric disorders were coded as binary (1 = present, 0 = absent); thus, data were treated as ordinal, and thresholds for each disorder were estimated using z scores that corresponded to the prevalence of the given diagnosis. These thresholds were allowed to vary by gender to accommodate gender differences in the rates of psychiatric disorders. To test for significant gender differences, we constrained the thresholds to be equal for men and women and evaluated the overall fit of the model (using Akaike’s information criteria, AIC) compared with the model where thresholds were allowed to vary by gender. Models with the lowest AIC values were considered to be the best-fitting models. We also tested for gender differences in the overall pattern of covariance by constraining the parameter estimates to be the same in males and females, and comparing the pattern of covariance with a model where parameters were allowed to vary by gender. Because Mx currently lacks the capability to analyse continuous and ordinal traits simultaneously, the continuously measured personality traits were divided into categories based on the maximum number of responses possible, and thresholds corresponding to the proportions of individuals in each category were estimated. For example, scores on the neuroticism variable were in the range 0–12. Thus, we used 12 thresholds to estimate the proportion of individuals within each response category.

**RESULTS**

**Logistic regression for the effects of personality on psychiatric disorders**

Table 2 shows the odds ratios from the logistic regression analyses for each of the three personality measures. Higher scores on neuroticism significantly increased the risk for all the disorders examined. For each s.d. increase in neuroticism, the highest (130%) risk increase was for GAD and the lowest (26%) for conduct disorder. Extraversion’s impact was modest overall, with no consistent pattern across internalising and externalising disorders. Specifically, one s.d. increase in extraversion was associated with a 24% increased risk for drug dependence, with a smaller increase for GAD, alcohol dependence and major depression. Novelty seeking was most strongly associated with externalising disorders (alcohol and drug dependence, antisocial personality disorder, conduct disorder), with increase in risk ranging from 37% to 83%. Inspection of covariates revealed that internalising disorders (major depression, GAD, panic disorder and any phobia) were more prevalent in females whereas externalising disorders (alcohol and drug dependence, antisocial personality disorder, conduct disorder) were more prevalent in males (Table 1). Age was positively associated with internalising disorders (i.e. older subjects reported a higher prevalence of major depression, GAD, panic disorder and any phobia) and was negatively associated with the externalising disorders (i.e. younger subjects had higher rates of alcohol and drug dependence, antisocial personality disorder and conduct disorder). Zygosity was not associated with any of the psychiatric disorders.

We also tested for interactions between gender and each of our three personality measures for each of the disorders. Out of 24 possible interactions (8 disorders × 3 interactions), only the interaction between gender and neuroticism for alcohol dependence was significant ($\beta = 0.06$, s.e. = 0.02, Wald $\chi^2 = 5.22$, $P < 0.05$). In this case, the relationship between neuroticism and alcohol dependence was stronger for females than for males. However, it should be noted that this significant interaction may be a stochastic effect. Thus, for the structural equation modelling analyses of personality and comorbidity, males and females were combined into a single sample, although thresholds corresponding to psychiatric disorder were estimated separately for males and females.

**Structural equation modelling of personality effects on comorbidity**

For ease of interpretation, the results of the structural equation modelling analyses are
depicted graphically in Fig. 2. The height of the bar represents the total phenotypic comorbidity of any two given disorders, and the differently shaded segments depict the direct covariance accounted for by each individual personality dimension, as well as any indirect effects, and the residual covariance. For example, the comorbidity (phenotypic correlation) between major depression and GAD is 0.41. Neuroticism accounts for the 0.16 of this comorbidity whereas the remaining comorbidity (0.25) was residual covariance. Extraversion, novelty seeking and indirect effects accounted for negligible (and negative) covariance. In order to facilitate the description, results from these analyses have been presented also as percentages of the total comorbidity (Table 3). Thus, in the case of comorbidity between major depression and GAD, Table 3 shows that 0.41 is total comorbidity. Neuroticism accounts for 39% of this comorbidity, with the remaining comorbidity due primarily to residual covariance (61%).

The overall pattern of results, as shown in Fig. 2 and Table 3, indicates that neuroticism accounts for the highest proportion of comorbidity within internalising disorders (20–45%, arithmetic average=31%) and between internalising and externalising disorders (19–88%, arithmetic average=36.8%). Neuroticism also explained 10–12% of the comorbidity within externalising disorders. Extraversion explained only a very small proportion of the comorbidity (−4.9 to 7.4%). Novelty seeking accounted for a negligible proportion of comorbidity within internalising disorders (−0.8 to 0.7%) and between internalising and externalising disorders (−13.2% to 5.8%); however, novelty seeking did account for 7.4–14% of the comorbidity within externalising disorders. Residual covariance (i.e. due to factors other than personality) accounted for most of the comorbidity, with an arithmetic average of 65%. Negative values in Fig. 2 and Table 3 reflect the effects of low extraversion (introversion) and low novelty seeking on comorbidity, although the majority of these effects are quite small.

Although the models where thresholds for psychiatric disorders were allowed to vary by gender consistently fit the data better than models assuming equal thresholds, there were no significant gender differences in the covariance structure (results available from the authors upon request). Thus, the pattern of comorbidity accounted for by personality was similar in males and females, despite the significant differences in the rates of psychiatric disorders.

**DISCUSSION**

**Neuroticism**

Our results suggest that normal personality dimensions of neuroticism not only contributed to individual diagnoses but also accounted for a significant part of the lifetime comorbidity of common psychiatric disorders. The most striking finding was that neuroticism, on average, accounted for 26% of the comorbidity among the disorders included in the study (range=12–88%). This finding is consistent with previous research (Clark et al, 1994; Sher & Trull, 1994, Krueger & Markon, 2001; Bienvenu et al, 2001) and suggests neuroticism as a potential general underlying vulnerability factor for psychopathology.

**Extraversion**

Although extraversion was significantly, albeit weakly, associated with four of the eight psychiatric disorders in the logistic regressions, it explained very small proportions of comorbidity. This pattern of weak
### Table 2: Association of personality measures and common psychiatric disorders

<table>
<thead>
<tr>
<th>Personality dimension</th>
<th>Major depression</th>
<th>Generalised Anxiety disorder</th>
<th>Panic disorder</th>
<th>Any phobia</th>
<th>Alcohol dependence</th>
<th>Any drug dependence</th>
<th>Antisocial personality disorder</th>
<th>Conduct disorder</th>
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<tr>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Neuroticism</td>
<td>1.95***</td>
<td>2.30***</td>
<td>1.93***</td>
<td>1.62***</td>
<td>1.57***</td>
<td>1.64***</td>
<td>1.44***</td>
<td>1.26***</td>
</tr>
<tr>
<td></td>
<td>(1.85–2.06)</td>
<td>(2.01–2.63)</td>
<td>(1.61–2.31)</td>
<td>(1.54–1.71)</td>
<td>(1.47–1.67)</td>
<td>(1.50–1.79)</td>
<td>(1.26–1.65)</td>
<td>(1.15–1.38)</td>
</tr>
<tr>
<td>Extraversion</td>
<td>1.07*</td>
<td>1.21*</td>
<td>0.95</td>
<td>1.18***</td>
<td>1.24**</td>
<td>1.28**</td>
<td>0.92</td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>(1.01–1.13)</td>
<td>(1.01–1.45)</td>
<td>(0.77–1.18)</td>
<td>(1.09–1.26)</td>
<td>(0.87–1.04)</td>
<td>(0.77–1.09)</td>
<td>(0.83–1.04)</td>
<td></td>
</tr>
<tr>
<td>Novelty seeking</td>
<td>1.14***</td>
<td>0.92</td>
<td>1.10</td>
<td>1.37***</td>
<td>1.58***</td>
<td>1.83***</td>
<td>1.39***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.09–1.22)</td>
<td>(0.76–1.10)</td>
<td>(0.88–1.36)</td>
<td>(1.03–1.16)</td>
<td>(1.03–1.76)</td>
<td>(1.57–2.13)</td>
<td>(1.26–1.54)</td>
<td></td>
</tr>
</tbody>
</table>

Values are odds ratios, with 95% confidence intervals in parentheses; *P < 0.05, **P < 0.01, ***P < 0.001.

### Table 3: Covariance between personality measures and comorbid psychiatric disorders, represented as percentage of total covariance ($r_{tot}$)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Major depression</th>
<th>Generalised anxiety disorder</th>
<th>Panic disorder</th>
<th>Any phobia</th>
<th>Alcohol dependence</th>
<th>Any drug dependence</th>
<th>Antisocial personality disorder</th>
<th>Conduct disorder</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generalised anxiety disorder</td>
<td>0.41</td>
<td>39.0</td>
<td>0.9</td>
<td>0.8</td>
<td>63.1</td>
<td>0</td>
<td>0.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Panic disorder</td>
<td>0.49</td>
<td>20.9</td>
<td>0.1</td>
<td>0.7</td>
<td>79.1</td>
<td>0</td>
<td>0.49</td>
<td>21.9</td>
</tr>
<tr>
<td>Any phobia</td>
<td>0.30</td>
<td>39.1</td>
<td>0.1</td>
<td>0.7</td>
<td>66.2</td>
<td>0</td>
<td>0.30</td>
<td>44.9</td>
</tr>
<tr>
<td>Alcohol dependence</td>
<td>0.34</td>
<td>30.6</td>
<td>0.8</td>
<td>2.8</td>
<td>65.9</td>
<td>0</td>
<td>0.34</td>
<td>88.1</td>
</tr>
<tr>
<td>Any drug dependence</td>
<td>0.40</td>
<td>26.0</td>
<td>0.8</td>
<td>3.0</td>
<td>70.2</td>
<td>0</td>
<td>0.40</td>
<td>61.2</td>
</tr>
<tr>
<td>Antisocial personality disorder</td>
<td>0.29</td>
<td>23.9</td>
<td>0.3</td>
<td>5.8</td>
<td>67.4</td>
<td>3.2</td>
<td>0.19</td>
<td>39.5</td>
</tr>
<tr>
<td>Conduct disorder</td>
<td>0.19</td>
<td>26.3</td>
<td>0.6</td>
<td>5.4</td>
<td>65.4</td>
<td>3.5</td>
<td>0.09</td>
<td>56.9</td>
</tr>
</tbody>
</table>

N, neuroticism; E, extraversion; NS, novelty seeking; $r_{tot}$, residual covariance; IND, indirect covariance.
effects of extraversion on psychiatric disorders and comorbidity is inconsistent with previous research (Sher & Trull, 1994) and probably stems from the restrictive definition of our extraversion scale, which only reflects sociability. Eysenck revised the extraversion scale in the EPQ–R and items that measured impulsivity were largely moved to the psychoticism scale (Nyborg, 1997).

### Novelty seeking

High novelty seeking increased the risk for externalising disorders significantly (Table 2) when these disorders were examined individually. Novelty seeking also accounted for the largest proportion of comorbidity between externalising disorders (7–14%, arithmetic average = 11.9%). Not surprisingly, novelty seeking was unrelated to the comorbidity within internalising disorders and, for the most part, between internalising and externalising disorders. However, somewhat surprisingly, the contribution of neuroticism to the comorbidity within externalising disorders was comparable with the effects of novelty seeking.

These results further support the existence of broader, underlying dimensions of core psychopathological processes. Neuroticism appears to be a robust underlying dimension not only for the comorbidity within internalising disorders but also between internalising and externalising disorders and within externalising disorders. This leads us to reconsider the issue of psychiatric classification and an age-old question of splitting neurosis (Tyrer, 1985). Our previous research has indicated that the comorbidity between major depression and GAD and, to some extent, between major depression and alcohol dependence largely results from common genetic factors (Kendler et al., 1992, 1993a) with notable gender differences (Prescott et al., 2000). In a previous report, we also found that over 50% of the genetic liability for major depression was shared with neuroticism (Kendler et al., 1993b). Thus, the possibility of common genetic liability between personality and comorbid disorders appears to be a reasonable hypothesis and will be the subject of future investigation.

### Limitations

The results of this study should be interpreted in the context of four potential methodological limitations.

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**CLINICAL IMPLICATIONS**

- Comorbidity among psychiatric disorders is a common and consistently reported finding.
- The normal personality dimension of neuroticism appears to be a broad vulnerability factor for the comorbid psychiatric disorders.
- Novelty seeking is modestly important for the comorbidity between externalising disorders only.

**LIMITATIONS**

- The normal personality dimensions used were from two different scales.
- The cross-sectional nature of the data used has a potential to confound state, trait and scar effects.
- The sample was limited to Caucasian individuals so the results might not be generalisable to other ethnic groups.

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(First received 5 August 2003, final revision 30 September 2004, accepted 8 October 2004)

First, we used scales of neuroticism and extraversion from the EPQ–R and novelty seeking from the TPQ. Although neuroticism and extraversion represent widely accepted higher dimensions of personality, there is no agreement about the lower-order dimensions among different personality researchers. Moreover, some would argue that these two scales provide an incomplete description of the structure of heritable personality differences (Heath et al., 1994). How much more of the covariation among disorders would have been explained if we used the complete EPQ–R (neuroticism, extraversion, psychoticism and lie scale) or the complete TPQ (novelty seeking, harm avoidance and reward dependence) is speculative. Similarly, although interrater agreement for diagnosis was high, test-retest reliability for some of the lower-prevalence disorders (i.e., GAD, panic disorder and antisocial personality disorder) was low (0.23–0.42). This lower reliability may have increased the variance due to random errors of measurement, lowering the strength of associations of comorbidity with personality.

Second, the cross-sectional nature of the data made it difficult to establish causality and had a potential to confound state, trait and scar effects. However, the use of lifetime diagnosis provided some assurance that the confounding effects were likely to be minimal.

Third, because of some relatively young individuals in our sample, the risk period for certain psychiatric disorders was not over. As a result, true prevalence may be underestimated in the present sample, with concomitant effects on covariance.

Fourth, the sample was limited to Caucasian individuals so the results may not be generalisable to other ethnic groups.

**ACKNOWLEDGEMENTS**

Supported by National Institutes of Health (NIH) grants T32/MH-20030, MH-40828, MH/AA/DA-49492, DA-11287 and AA-09095. The authors thank Dr Steve Aggen for his help in statistical analysis. We
also acknowledge the contribution of the Virginia Twin Registry, now part of the Mid-Atlantic Twin Registry (MATR), to the ascertainment of subjects for this study. The MATR, directed by Drs L. Corey and L. Eaves, has received support from the National Institutes of Health, the Carman Trust and the W. M. Keck, John Templeton and Robert Wood Johnson Foundations.

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