

# Phenotypic and Genetic Structure of Traits Delineating Personality Disorder

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**Background:** The evidence suggests that personality traits are hierarchically organized with more specific or lower-order traits combining to form more generalized higher-order traits. Agreement exists across studies regarding the lower-order traits that delineate personality disorder but not the higher-order traits. This study seeks to identify the higher-order structure of personality disorder by examining the phenotypic and genetic structures underlying lower-order traits.

**Methods:** Eighteen lower-order traits were assessed using the Dimensional Assessment of Personality Disorder–Basic Questionnaire in samples of 656 personality disordered patients, 939 general population subjects, and a volunteer sample of 686 twin pairs.

**Results:** Principal components analysis yielded 4 components, labeled Emotional Dysregulation, Dissocial Behavior, Inhibitedness, and Compulsivity, that were similar across the 3 samples. Multivariate genetic analyses also

yielded 4 genetic and environmental factors that were remarkably similar to the phenotypic factors. Analysis of the residual heritability of the lower-order traits when the effects of the higher-order factors were removed revealed a substantial residual heritable component for 12 of the 18 traits.

**Conclusions:** The results support the following conclusions. First, the stable structure of traits across clinical and nonclinical samples is consistent with dimensional representations of personality disorders. Second, the higher-order traits of personality disorder strongly resemble dimensions of normal personality. This implies that a dimensional classification should be compatible with normative personality. Third, the residual heritability of the lower-order traits suggests that the personality phenotypes are based on a large number of specific genetic components.

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**I** NTEREST IN dimensional models of personality disorder has increased recently because of accumulating empirical support for a dimensional approach<sup>1-3</sup> and the need for more specific constructs to investigate biological factors.<sup>4</sup> Despite this interest, to our knowledge, a consensual set of dimensions to represent personality disorder has not emerged. Instead, various structures have been proposed that include Eysenck's<sup>5,6</sup> 3-dimensional model of neuroticism, extraversion, and psychoticism, and the 5-factor approach that consists of Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness,<sup>7-9</sup> the biological model of Cloninger and colleagues<sup>10-12</sup> with 4 temperaments and 3 character types, the interpersonal circumplex in which traits are organized into a circular configuration based on 2 dimensions of affiliation and dominance,<sup>13-16</sup> and structures derived from multivariate analyses of the clinical features used to diagnose personality disorder.<sup>17-19</sup>

The evidence suggests that personality is hierarchically organized: broad higher-

order traits subdivide into more specific lower-order traits.<sup>20-22</sup> For example, Eysenck<sup>6</sup> proposed that the higher-order dimension of Neuroticism consists of the following lower-order traits: anxiety, depression, guilt feelings, low self-esteem, tense, irrational, shy, moody, emotional.

Typically 3 strategies are used to investigate the higher-order structure of personality disorder. One approach is to identify the traits underlying personality disorders by examining the covariation among diagnoses.<sup>23-28</sup> Usually between 2

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and 4 dimensions are identified which suggests that the covariation among diagnoses can be explained by a few broad dimensions. A second approach is to relate personality disorder diagnoses to structures of normal personality. The problem with this approach is that there is little consensus on the higher-order traits required for a dimensional representation of personality disorder partly because the

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## SUBJECTS AND METHODS

### SUBJECTS

Three groups of subjects were used: (1) a clinical sample of 656 patients comprising 416 women (mean  $\pm$  SD age, 33.1  $\pm$  9.0 years; age range, 17-61 years) and 240 men (mean  $\pm$  SD age, 34.9  $\pm$  8.7 years; age range, 16-64 years); (2) a general population sample of 939 subjects comprising 578 women (mean  $\pm$  SD age, 29.1  $\pm$  11.1 years; age range, 16-55 years) and 361 men (mean  $\pm$  SD age, 28.63  $\pm$  10.4 years; age range, 16-70 years); and (3) a volunteer sample of 686 twin pairs comprising 340 monozygotic (MZ) twin pairs (212 female pairs, mean  $\pm$  SD age, 31.5  $\pm$  12.4 years; and 128 male pairs, mean  $\pm$  SD age, 30.9  $\pm$  12.1 years) and 346 dizygotic (DZ) twin pairs (174 female pairs, mean age, 31.3  $\pm$  11.9 years; 76 male pairs, mean age, 30.9 years; SD, = 11.5 years; 96 male-female pairs, mean  $\pm$  SD age, 29.6  $\pm$  10.6 years). The clinical sample comprised patients with a primary diagnosis of personality disorder attending a general hospital outpatient department. Diagnoses were based on clinical interviews. All DSM-IV<sup>36</sup> personality disorders were included. Exclusion criteria were the presence of organic mental disorder, schizophrenia and related disorders, and major mood disorder. The diverse general population sample included university and hospital employees, university students, and persons from the general community.

The twin sample was recruited primarily from southwestern British Columbia through newspaper advertisements and

media stories. Zygosity was determined by a questionnaire<sup>37</sup> that is highly reliable (95%) when compared with analyses of red blood cell polymorphism<sup>38</sup> and with photographs. The twins received questionnaires through the mail, a common procedure in twin studies of psychiatric disorders.<sup>39</sup> Written informed consent was obtained from all subjects.

Volunteer twin samples typically include more MZ and female twin pairs than DZ and male pairs.<sup>40-42</sup> An excess of MZ twins did not occur in our sample, but fewer male DZ twins volunteered despite being offered specific inducements. This, and the volunteer nature of the sample, raises questions about the representativeness of the sample. We examined this possibility by comparing the twins' scores on the Dimensional Assessment of Personality Pathology Disorder-Basic Questionnaire (DAPP-BQ)<sup>43</sup> with those of the general population sample used in this study and norms based on a large general population sample. Significant differences were not obtained ( $P < .05$ ). In addition, the scores of our twin sample on standard personality inventories (eg, NEO-Personality Inventory-Revised [NEO-PI-R],<sup>44</sup> NEO-Five-Factor Inventory,<sup>44</sup> and Eysenck Personality Questionnaire-Revised<sup>45</sup>) did not differ significantly from published norms ( $P < .05$ ).

### PERSONALITY MEASURES

Personality disorder traits were assessed using the DAPP-BQ, a 290-item self-report measure consisting of 18 scales: Affective Lability, Anxiousness, Callousness, Cognitive Dysregulation, Compulsivity, Conduct Problems, Identity Problems, Insecure Attachment, Intimacy Problems, Narcissism, Oppositionality, Rejection, Restricted

structure of normal personality is still unresolved with suggestions ranging from 3<sup>6</sup> to 7<sup>29</sup> dimensions.

A third approach is to use traditional ways of investigating the structure of normal personality by extracting higher-order dimensions from a systematic sample of lower-order traits. This approach is promising because there is considerable convergence across studies regarding the lower-order traits of personality disorder despite differences in methodology.<sup>30-32</sup> Livesley and colleagues,<sup>17,18,33,34</sup> for example, extracted 15 factors in clinical and general population samples from the intercorrelations among 100 traits that were identified using a systematic literature review and clinical judgments. Similarly, Clark<sup>19,35</sup> starting primarily from DSM-III diagnostic criteria, used a conceptual sorting task and psychometric analyses to identify 15 dimensions. Conceptual and empirical comparisons of the 2 systems indicated considerable similarity.<sup>30,31</sup> Given this convergence, investigation of the structure underlying these lower-level traits may clarify the higher-order structure of personality disorder. Such an approach would also have the advantage of using traits derived from clinical concepts of personality disorder rather than analyses of normal personality.

Studies of phenotypic structure alone, however, may not resolve the structure of personality disorder. Personality phenotypes are extremely variable. Minor variations in measures and samples influence the number and contents of factors identified. Confidence in any structure

would, therefore, be increased with evidence that the phenotypic structure reflects an underlying genetic architecture. For this reason, we also report on the genetic structure underlying the lower-order traits in a twin sample.

The analyses we report sought to answer 4 questions: (1) Is the higher-order structure of traits similar in personality disordered and general population samples? Evidence of similar structure in samples differing with respect to the presence of personality disorder is strong evidence for a dimensional model.<sup>5</sup> (2) What is the relationship between the higher-order structure of personality disorder emerging from analyses of lower-order traits and descriptions of normal personality? (3) Does phenotypic structure reflect an underlying genetic architecture? (4) Is the hierarchy based on a few general genetic factors that explain the variance in lower-level traits, or does each lower-order trait also have its own unique genetic etiology?

## RESULTS

### PHENOTYPIC STRUCTURE OF TRAITS

Principal components analyses of the clinical, general population, and twin data yielded 4 eigenvalues greater than unity in each case that accounted for 66.7%, 68.8%, and 68.9% of the total variance in the clinical, general population, and twin samples, respectively (**Table 1**).

Expression, Self-harm, Social Avoidance, Stimulus Seeking, Submissiveness, and Suspiciousness. A social desirability scale is included. Note that the Self-harm scale was not included in the analyses because low item-endorsement rates in general population subjects led to highly skewed distributions. The DAPP-BQ has satisfactory psychometric properties; internal consistency (coefficient  $\alpha$ ) ranges from 0.83 to 0.94, and test-retest reliability over a 3-week period ranges from 0.81 to 0.9331. Similar values for coefficient  $\alpha$  were obtained in this study.

#### STATISTICAL ANALYSES

We evaluated the higher-order phenotypic structure of the DAPP-BQ scales in the clinical and general population samples by conducting separate principal components analyses with oblimin rotation criteria. A similar analysis was conducted on the twin sample by randomly selecting 1 twin from each pair. Decisions on the number of factors to retain for rotation and inspection were based on the eigenvalues greater than unity rule, a scree plot, the simple structure properties of the rotated solution, and Lautenschlager's<sup>46</sup> criteria. Factors derived from the 2 samples were compared by computing factor congruency coefficients.<sup>47</sup>

The genetic structure underlying the DAPP-BQ scales was evaluated using multivariate genetic analysis of the twin data. Previously we used univariate genetic analyses to decompose the variance in each trait into genetic and environmental components to show that DAPP-BQ scales have a substantial heritable component.<sup>48,49</sup> In this study, we used a similar method to that described by Heath et al<sup>50</sup> to compute the genetic and environmental correlations between traits

using a triangular factor analysis or "Cholesky decomposition"<sup>51</sup> computed using the method of maximum likelihood contained in the LISREL 8 program.<sup>52,53</sup> This procedure teases apart genetic and environmental components in a manner that is comparable to using samples of twins reared apart and together. Only additive genetic and nonshared environmental components were specified because previous analyses showed that these 2 factors accounted for the variance in the DAPP-BQ scales.<sup>48,49</sup> Genetic and environmental correlations can be factor analyzed to evaluate the genetic and environmental structures underlying a set of traits.<sup>54,55</sup> The matrices of genetic and environmental correlations were separately subjected to principal components analysis with oblimin rotation. Principal components analyses of genetic and environmental matrices yield similar results to other factor-extraction methods.<sup>54</sup>

To examine the heritability of specific variance in the lower-order traits, standard biometrical model-fitting methods<sup>51</sup> were used to estimate the heritability of the specific variance of each DAPP-BQ scale. The specific variance of each scale was computed by regressing the common variance from each scale and computing a standardized residual score.<sup>56</sup> The common variance was represented by the 4 higher-order factor scores estimated from the oblimin-rotated principal component analysis of the DAPP-BQ scales.

The fit-of each model was assessed with (1) likelihood ratio  $\chi^2$ ; (2) the principle of parsimony; and (3) Akaike's<sup>57</sup> Information Criterion. The best-fitting model was the one that did not significantly increase  $\chi^2$  values, accounted for the variance with the fewest number of parameters, and yielded the smallest negative value of Akaike's Information Criterion.

The scree plot and Lautenschlager's criteria<sup>46</sup> also suggested a 4-factor solution. The eigenvalues were 6.80, 2.31, 1.59, and 1.28 for the clinical sample, 7.47, 2.34, 1.49, and 1.27 for the general population sample, and 6.51, 2.27, 1.62, and 1.30 for the twin sample. Examination of the data using common factor analysis and other rotations yielded similar results. The loadings from the 3 matrices were remarkably similar; congruence coefficients ranged from 0.94 to 0.99 (**Table 2**).

The first factor appears to represent unstable and reactive tendencies, dissatisfaction with the self and life experiences, and interpersonal problems. Given the saliency of Anxiousness and Affective Lability, the component was labeled "Emotional Dysregulation."

The second factor, labeled "Dissocial," was marked by Rejection (interpersonal hostility and judgmental attitudes), Callousness, Stimulus Seeking (sensation seeking, impulsivity, and recklessness), and Conduct Problems. Those scoring highly on this factor probably lack regard for others and see them as objects to be exploited for personal gain.

The third factor, labeled "Inhibition," was defined by Intimacy Problems and Restricted Expression (restricted expression of affects and difficulty sharing information) in all 3 samples, and Identity Problems in the general population sample. Those with high scores on this factor are probably inhibited and derive little enjoyment from intimate relationships, including sexual re-

lationships. The fourth factor, marked by Compulsivity and negatively by Oppositionality (oppositional behavior and passivity) was labeled "Compulsivity."

#### GENOTYPIC STRUCTURE OF TRAITS

**Table 3** reports the oblimin-rotated principal components analysis of the matrix of genetic correlations among the 18 basic traits. Multiple criteria indicated that a 4-factor solution accounting for 76% of the variance was optimal. The first 4 eigenvalues were 7.43, 2.58, 1.69, and 1.22. Comparison with the results of the phenotypic analyses yielded congruence coefficients ranging from 0.95 to 0.98 (**Table 4**).

Table 3 also reports a similar analysis of the matrix of environmental correlations. Again, a 4-factor solution accounting for 62.8% of the variance was optimal with the first 4 eigenvalues being 5.61, 1.98, 1.61, and 1.47. Table 4 gives the congruence coefficients computed between the environmental, genetic, and phenotypic factors based on the twin data.

#### RESIDUAL HERITABILITY OF THE LOWER-ORDER TRAITS

**Table 5** shows the twin correlations and heritability estimates for the residual trait scores following removal of the effects of the 4 higher-order components. The MZ

**Table 1. Oblimin-Rotated Principal Component Factor Loadings\* of the DAPP-BQ Dimensions Correlations of Subjects From the UBC Twin Project (N = 686), the General Population (N = 939), and Patients (N = 656)†**

Dimension	Clinical Sample				General Population				UBC Twin Project			
	1	2	3	4	1	2	3	4	1	2	3	4
Submissiveness	0.85				0.84				0.84			
Cognitive dysregulation	0.64				0.75				0.70			
Identity problems	0.81				0.74				0.75			
Affective lability	0.64				0.78				0.73			
Stimulus seeking		0.76				0.67				0.70		
Compulsivity				0.93				0.88				0.88
Restricted expression			0.75				0.74				0.75	
Callousness		0.81				0.74			0.78			
Oppositionality	0.64			-0.47	0.69			-0.40	0.68			-0.45
Intimacy problems			0.85				0.86				0.88	
Rejection		0.78				0.82			0.79			
Anxiousness	0.86				0.89				0.90			
Conduct problems		0.74				0.76			0.61			
Suspiciousness	0.50				0.41	0.46			0.42			
Social avoidance	0.76				0.69				0.71			
Narcissism		0.41			0.60				0.49	0.43		
Insecure attachment	0.70		-0.44		0.81				0.70			

\*Only factor loadings greater than or equal to 0.4 are given.

†Largest twin study factor intercorrelation = 0.32 between factors 1 and 2; accounted variance: 1, 38.3%; 2, 13.4%; 3, 9.5%; and 4, 7.6%. Largest general population sample factor intercorrelation = 0.31 between factors 1 and 2 and 0.27 between factors 1 and 3; accounted variance: 1, 41.3%; 2, 13.4%; 3, 8.9%; and 4, 7.6%. Largest clinical sample factor intercorrelation = 0.36 between factors 1 and 2; and 0.17 between factors 1 and 3; accounted variance: 1, 41.3%; 2, 13.4%; 3, 9.2%; and 4, 7.5%. DAPP-BQ indicates Dimensional Assessment of Personality Pathology–Basic Questionnaire; UBC, University of British Columbia, Vancouver.

**Table 2. Factor Congruency: Clinical, General Population, and Twin Factors**

Sample	Factors			
	1	2	3	4
Clinical and general population sample	0.97	0.99	0.97	0.94
Clinical and twin sample	0.98	0.99	0.97	0.95
General population and twin sample	0.99	0.98	0.99	0.98

twin correlations were higher than the DZ twin correlations for all 18 traits. Twelve of the basic traits showed substantial residual heritability that ranged from 0.26 for Intimacy Problems to 0.49 for Conduct Problems.

#### COMMENT

The 4-factor structure obtained was remarkably similar across samples, thus providing further evidence that the phenotypic traits of personality disorder are continuously variable. The large first component, labeled Emotional Dysregulation, initially appears to be the typical general factor identified in any analysis of psychopathology. Alternative analyses and rotations were not successful in decomposing this factor into smaller units. Consequently, we believe that the factor represents an important aspect of the organization of personality disorder for several reasons. First, the factor does not seem to be an artifact arising from overlapping scale content because considerable care was taken during scale development to eliminate items that correlated highly with scales other than their own. Second, the component is almost identical in clinical and nonclinical samples, which suggests that it is a general dimension of personality.

Third, a general factor is consistent with the organized nature of personality. Since the components of personality are parts of an integrated system, disturbance in one component is likely to affect the whole system. This would be reflected in a general factor of personality pathology such as Emotional Dysregulation.

Emotional Dysregulation resembles Neuroticism and the concept of Harm Avoidance described by Cloninger et al<sup>10-12</sup> that is closely related phenotypically and genetically to Eysenck's Neuroticism.<sup>50</sup> The major difference between the constructs is that Emotional Dysregulation is more extensive than Neuroticism. Identity Problems, Cognitive Dysregulation (schizotypal cognition and cognitive disorganization under stress), Insecure Attachment, Oppositionality, Suspiciousness, and Narcissism are not represented in measures of Neuroticism. These differences are not surprising because the components of Neuroticism were largely derived rationally to describe normal personality whereas Emotional Dysregulation was derived empirically from clinical concepts. Emotional Dysregulation also differs from NEO-PI-R Neuroticism in that it does not include Impulsivity. This trait factors with sensation seeking and recklessness to define the DAPP-BQ Stimulus-Seeking scale which loads on the "Dissocial" component.

Emotional Dysregulation also resembles the DSM-IV borderline personality disorder. As with Neuroticism, however, Emotional Dysregulation is more pervasive than borderline personality disorder; Submissiveness, Social Avoidance, Oppositionality, Narcissism, and Suspiciousness are not included in the DSM-IV criteria set. The breadth of this factor helps to explain the extensive overlap of borderline personality disorder with other personality disorders.<sup>58</sup> It also suggests that the DSM-IV criteria set is inappropriately circumscribed to differentiate

**Table 3. Oblimin-Rotated Principal Component Factor Loadings\* of the Additive Genetic and Nonshared Environmental Correlations†**

	Genetic Factors				Environmental Factors			
	1	2	3	4	1	2	3	4
Submissiveness	0.91				0.76			
Cognitive dysregulation	0.66				0.70			
Identity problems	0.84				0.68			
Affective lability	0.69				0.70			
Stimulus seeking		0.61				0.81		
Compulsivity				0.93				0.85
Restricted expression	0.45		0.67				0.78	
Callousness		0.88				0.66		
Oppositionality	0.74				0.54			
Intimacy problems			0.93				0.75	
Rejection		0.82				0.65		
Anxiousness	0.96				0.86			
Conduct problems		0.75				0.69		
Suspiciousness	0.61			0.45	0.45			
Social avoidance	0.76				0.69			
Narcissism	0.60				0.47	0.45		
Insecure attachment	0.64				0.69			

\*Only factor loadings greater or equal to 0.4 are given.

†Largest genetic factor intercorrelation = 0.38 between factors 1 and 2, and 0.16 between factors 1 and 3; accounted variance: 1, 43.7%; 2, 15.2%; 3, 9.9%; and 4, 7.2%. Largest environmental factor intercorrelation = 0.16 between factors 1 and 2, and 0.16 between factors 1 and 3; accounted variance: 1, 33.0%; 2, 11.7%; 3, 9.4%; and 4, 8.7%. Largest phenotypic factor intercorrelation = 0.36 between factors 1 and 2; and 0.19 between factors 1 and 3; accounted variance: 1, 38.3%; 2, 13.4%; 3, 9.5%; and 4, 7.6%.

the disorder from other putatively distinct diagnoses. Support for this contention is also provided by studies showing that patients with borderline personality disorder score highly on neuroticism and its facets.<sup>59,60</sup> Emotional Dysregulation is similar to Kernberg's<sup>61</sup> concept of borderline personality organization—a diagnosis that includes several DSM-IV personality diagnoses—and to Linehan's<sup>62</sup> description of borderline personality disorder in terms of emotional, interpersonal, behavioral, cognitive, and self dysregulation. Thus, studies of normal and disordered personality traits, analyses of diagnostic overlap, and clinical observation converge on the importance of a general factor of personality pathology organized around affective traits.

Dissocial behavior resembles the negative pole of agreeableness in the 5-factor approach. The strongest resemblance, however, is with Eysenck's Psychoticism dimension,<sup>6</sup> the Impulsive-Sensation Seeking factor of Zuckerman et al,<sup>63,64</sup> and Hare's<sup>65</sup> description of psychopathy. The major difference with Psychoticism is that the latter does not include Sensation Seeking. Like Zuckerman and his colleagues, we found that impulsivity was associated with sensation seeking and antisocial traits rather than extraversion.<sup>63,64</sup>

Inhibition shows some correspondence to introversion-extraversion although it is more specific. Extraversion as described by Eysenck combines sociability and impulsivity—features that load on different factors in our analyses. Inhibition is, however, consistent with Kagan's<sup>66</sup> concept of the inhibited temperament. Finally, Compulsivity resembles the Conscientiousness domain of the 5-factor approach.

The major discrepancy between our results and the 5-factor approach is the failure to identify a component resembling Openness to Experience. The DAPP-BQ has little content related to Openness because it is based on

**Table 4. Factor Congruency: Genetic, Environmental, and Phenotypic Factors**

Sample	Factors			
	1	2	3	4
Genetic and environmental	0.94	0.90	0.95	0.86
Genetic and phenotypic	0.97	0.97	0.98	0.95
Environmental and phenotypic	0.99	0.96	0.99	0.96

the clinical literature. Examination of this literature yielded few items related to openness. Presumably, clinicians do not find these traits helpful in understanding personality disorder. Other investigators have also failed to find such a factor.<sup>63,67</sup> Moreover, the nature of the domain is open to dispute.<sup>68</sup> Costa and McCrae<sup>44</sup> named it Openness to Experience drawing on ideas from existential psychology whereas others have emphasized the cognitive nature of the domain and its relationship to culture.<sup>69</sup>

Our data clearly show that the phenotypic structure of personality disorder traits closely reflects the underlying genetic architecture. A striking finding is the substantial residual heritability of many traits. This observation has implications for etiology, research on the molecular genetics of personality disorder, and classification. Genetics studies have tended to concentrate on the broad dimensions of neuroticism and extraversion. The high heritability of these traits has prompted the suggestion that the heritability of lower-order traits merely reflects the fact that they are components of these more general traits.<sup>70</sup> The finding of substantial residual heritability of many lower-order traits challenges this explanation. The genetic structure of personality appears to involve multiple specific predispositions and a few general factors. This conclusion is consistent with multivar-

**Table 5. Twin Correlations and Heritability Estimates of the Residualized DAPP-BQ Dimension Scores\***

DAPP Dimensions	Model-Fitting Statistics ( $\chi^2$ )†					Parameter $\pm$ SD Estimates		
	$r_{MZ}$	$r_{DZ}$	ACE	AE	CE	$h \pm SE_h$	$c \pm SE_c$	$e \pm SE^e$
Submissiveness	0.31	0.19	5.74	<u>5.76</u>	10.80	0.58 $\pm$ 0.04		0.82 $\pm$ 0.03
Cognitive dysregulation	0.32	0.25	0.03	2.50	<u>1.29</u>		0.53 $\pm$ 0.04	0.84 $\pm$ 0.02
Identity problems	0.39	0.23	2.04	<u>3.23</u>	8.52	0.63 $\pm$ 0.04		0.78 $\pm$ 0.03
Affective lability	0.41	0.12	7.09	<u>7.09</u>	24.26	0.62 $\pm$ 0.04		0.78 $\pm$ 0.03
Stimulus seeking	0.33	0.32	0.00	9.42	<u>0.00</u>		0.57 $\pm$ 0.03	0.82 $\pm$ 0.03
Compulsivity	0.30	0.23	0.81	2.83	<u>1.95</u>		0.52 $\pm$ 0.04	0.86 $\pm$ 0.02
Restricted expression	0.40	0.13	1.80	<u>1.80</u>	16.12	0.62 $\pm$ 0.03		0.79 $\pm$ 0.04
Callousness	0.42	0.22	0.95	<u>0.97</u>	10.51	0.56 $\pm$ 0.04		0.82 $\pm$ 0.03
Oppositionality	0.32	0.24	0.43	2.40	<u>1.96</u>		0.52 $\pm$ 0.04	0.85 $\pm$ 0.02
Intimacy problems	0.30	0.01	5.14	<u>5.14</u>	15.47	0.51 $\pm$ 0.04		0.80 $\pm$ 0.03
Rejection	0.36	0.19	4.67	<u>4.71</u>	10.87	0.60 $\pm$ 0.04		0.60 $\pm$ 0.03
Anxiousness	0.28	0.22	0.75	<u>3.27</u>	<u>1.16</u>		0.50 $\pm$ 0.04	0.84 $\pm$ 0.02
Conduct problems	0.46	0.31	3.20	<u>4.25</u>	13.11	0.70 $\pm$ 0.04		0.71 $\pm$ 0.03
Suspiciousness	0.29	0.21	2.42	<u>2.99</u>	5.14	0.57 $\pm$ 0.04		0.82 $\pm$ 0.03
Social avoidance	0.39	0.17	1.36	<u>1.36</u>	13.86	0.62 $\pm$ 0.04		0.78 $\pm$ 0.03
Narcissism	0.44	0.19	1.25	<u>1.25</u>	15.68	0.66 $\pm$ 0.04		0.75 $\pm$ 0.03
Insecure attachment	0.44	0.21	0.68	<u>0.68</u>	15.00	0.66 $\pm$ 0.04		0.74 $\pm$ 0.03

\*ACE indicates model specifying additive genetic, shared environmental, and nonshared environmental components; AE, model specifying additive genetic and nonshared environmental components; CE, model specifying shared environmental and nonshared environmental components; E, model specifying a nonshared environmental component only; h, additive genetic loading; c, shared environmental loading; e, nonshared environmental loading. The parameter estimates h, c, and e must be squared ( $h^2$ ,  $c^2$ , and  $e^2$ ) to yield the proportion of the variance attributable to each component. DAPP-BQ indicates Dimensional Assessment of Personality Pathology–Basic Questionnaire; MZ, monozygotic; and DZ, dizygotic.

†Underlined values indicate the best-fitting models.

iate genetic analyses of extraversion scales that found substantial specific heritability,<sup>71</sup> and with similar analyses of extraversion and impulsivity.<sup>40</sup> It is also consistent with suggestions by evolutionary psychologists that the mental apparatus includes highly specific mental mechanisms that evolved to solve specific tasks.<sup>72,73</sup>

Our results have several implications for classifying personality disorder. First, they support the inclusion of a dimensional representation of personality traits in the classification of personality disorder. The stability of factor structure across clinical and nonclinical samples supports this conclusion. Similarly, the suggestion that multiple distinct genetic factors shape the phenotype means that discrete categories are unlikely to occur. Second, the higher-order level can probably be represented parsimoniously by 3 patterns: Emotional Dysregulation Disorder, Dissocial Disorder, and Inhibited Disorder. The compulsivity component is less pervasive and seems to be less dysfunctional than the other patterns.<sup>74</sup> The lower-order trait of Compulsivity appears to be distinct from other traits both genetically and phenotypically and hence it emerges as a separate factor in the higher-order analyses. This does not mean, however, that it should be included as a higher pattern in a dimensional classification of personality disorder traits. Instead, it could be placed at the lower-order level along with similar specific traits that are clinically important, such as Suspiciousness, Oppositionality, and Narcissism. This suggestion is similar to proposals that personality disorders include conditions that differ in severity.<sup>75</sup> However, the 3 higher-order patterns are concentrations of traits in a multidimensional space that can co-occur and that they are not mutually exclusive patterns.

Third, these results also indicate that the hierarchical structure of personality disorder traits is not simply

one in which each superordinate trait is subdivided into several lower-order traits because these traits are only partly explained by their superordinate trait. Moreover, some specific traits are unrelated to higher-order patterns. This suggests that both levels of the trait hierarchy are required for a comprehensive account of personality for clinical and research purposes. For some purposes such as epidemiological studies, higher-order descriptions are appropriate. For research on etiology, however, the lower-order traits will be required to provide more detailed information. Similarly, clinical intervention is usually organized around specific clusters of behaviors rather than broader traits or diagnoses.<sup>76</sup>

Several limitations to this study should be noted. First, the use of a single self-report measure raises the question of whether these results would generalize across other measurement methods. A related issue is the value of self-report measures of personality disorder traits. The DAPP-BQ has satisfactory psychometric properties. Moreover, it shows satisfactory levels of agreement with an interview that assesses the same traits, with correlations ranging from 0.56 for callousness to 0.75 for oppositionality.<sup>42</sup> Nevertheless, different findings may result from using different instruments although it should be noted that agreement among structured interviews is also limited.<sup>77</sup>

Second, the multivariate statistical procedures involved decisions regarding methods of analysis and number of factors to retain for rotation and extraction. These decisions are often arbitrary, although in this case the solutions were fairly obvious and different methods of analysis and rotation yielded substantially similar findings. Third, bias may arise because we used a volunteer twin sample rather than a representative population-based sample. It was also obtained from a limited geographical area. However, the mean scores on the DAPP-BQ and other measures not reported

are similar to general population norms. Moreover, factor analysis of the twin data yielded a structure that was remarkably similar to that obtained from the other samples suggesting that our twins are fairly typical.

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