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The Eysenck personality factors: psychometric structure, reliability, heritability and phenotypic and genetic correlations with psychological distress in an isolated Croatian population

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Abstract

We report the psychometric structure of a Croatian translation of the Eysenck Personality Questionnaire-Revised (short form), its correlations with psychological distress (General Health Questionnaire-30), its heritability, and personality-psychological distress genetic correlations. The setting is a large (≈ 1000), family-based sample of men and women from a Croatian island. The neuroticism and extraversion traits and the lie scale showed good psychometric characteristics. The translated psychoticism scale was unsatisfactory in this sample. There were significant additive genetic contributions to neuroticism, extraversion, and psychological distress. Psychological distress had a very high genetic correlation with neuroticism, and a moderate genetic correlation with extraversion.

Introduction

There is a growing consensus about the validity of human personality traits as important dispositions toward feelings and behaviours (Matthews, Deary, & Whiteman, 2003). Current trait models differ in details, but many can be reconciled within the Five Factor Model, which includes the traits of neuroticism, extraversion, openness, conscientiousness, and agreeableness. Here we examine the Eysenck Personality Questionnaire-Revised, short form, which includes the first two of these traits, plus psychoticism and a lie scale (Eysenck et al., 1985). An important part of the validation of any trait-based model of personality and its associated measurement instrument is to investigate its applicability to other cultures. This tends to be done in two ways: emic and etic. Emic research typically uses the lexicon of the local culture to investigate the structure and content of the personality-related terms (Saucier and Goldberg, 2001). Etic research applies personality measures devised in one culture to new cultures and asks whether they show the same psychometric structure and reliability and validity (McCrae, 2001).

A large amount of etic research has been completed on the Eysenck Personality Questionnaire. The research has been done mostly on the original 90-item EPQ. Generally, its psychometric structure has been well-reproduced in at least 34 countries (Barrett & Eysenck, 1984; Barrett et al., 1998). Here we apply the short form of the EPQ-Revised in a new setting.

There is great interest in discovering the genetic contributions to common, complex diseases (Lohmueller et al., 2003; Davey Smith et al., 2005). One such group of illnesses is states of anxiety and depression, which form a major cause of medical

consultation and a large burden of morbidity in the population. Genetic contributions are likely to be polygenic, i.e. with many genes each contributing a small effect (Hirschhorn & Daly, 2005). Moreover, a likely useful route to discovering the genetic contributions to common disorders is to examine the genetic bases of quantitative traits which act as risk factors for them (Flint & Mott, 2001). Thus, for states of low mood like anxiety and depression, the personality trait of neuroticism is a major target for investigation (Levinson, 2005; Middeldorp et al., 2005; Nash et al., 2005). The extensive review of twin and family studies conducted by Middeldorp et al (2005) concluded that the comorbidity of anxiety and major depressive disorders was in part due to genetic factors associated with the personality trait of neuroticism. A likely contributor is genetic variation influencing the serotonin transporter length polymorphism, but it has not been replicated in large studies (Willis-Owen et al., 2005). In the present study we shall examine the genetic correlation between personality traits and psychological distress.

Here we apply the Eysenck Personality Questionnaire-Revised (short form) to a new group, a large sample of Croatian people living in small islands with relatively stable communities. We examine its psychometric structure, internal consistency, sex differences, heritability, and phenotypic and genetic relationship to psychological distress.

Method

Sample

Adult subjects living in the villages of Komiza and Vis on the Croatian island of Vis were recruited in May 2003 and May 2004 for a large genetic study. They underwent a medical examination and interview, led by research teams from the Institute for Anthropological Research and the Andrija Stampar School of Public Health, Zagreb, Croatia. Informed consents, procedures and questionnaires were reviewed and approved by relevant ethics committees in Scotland and Croatia. All individuals over 18 years old and resident on the Island of Vis were invited to participate in this study. Volunteers attended an early morning clinic where fasting blood samples were collected and various physiological quantitative traits were measured. Blood samples were also collected for DNA extraction and plasma and serum samples were aliquoted and stored for future measurement of biochemical quantitative traits. They then completed a series of questionnaires relating to family and medical history as well as lifestyle and diet. As a part of the interview participants also completed the Eysenck Personality Questionniare-Revised (short form; EPQ-R) and the General Health Questionnaire 30 (GHQ). 70% of the villages' adult population took part in the study, a total of 1030 individuals (427 men, 603 women), 9 of whom have no EPQ-R or GHQ data. The mean age was 56.1 years (SD = 15.6), and ranged from 18 to 93 years. 588 individuals could be placed in 125 pedigrees (the largest of which links 134 phenotyped individuals and has a depth of six generations). This provided many related pairs to analyse, including 222 parent-child pairs and 141 sib-pairs.

Eysenck Personality Questionnaire-Revised (short form)

This is a self-reported questionnaire (Eysenck, Eysenck, & Barrett, 1985). It has 48 items, 12 for each of the traits of neuroticism, extraversion and psychoticism, and 12 for the lie scale. Each question has a binary response, 'yes' or 'no'. For the present study the questionnaire was translated into Croatian. It was then back-translated independently. The back-translated (English) and original English version were compared by IJD and IR (who is fluent in both Croatian and English) and two additional researchers who were not involved in the original translation of the items.

General Health Questionnaire 30

This is a 30-item, self-reported questionnaire that asks about recent psychological distress (Goldberg & Williams, 1988). Each question has four response options. It was back-translated using the same method as the EPQ-R.

Statistical analyses

Factor analysis of the EPQ-R was done using the principal factors method in the SAS statistical package. Tetrachoric correlations were used because of the binary response format of the questions. There are some missing data for EPQ-R and GHQ, and this is indicated in the numbers available for the analyses. Narrow-sense heritabilities (h^2) were calculated by a variance-components estimation method using restricted maximum-likelihood implemented in ASReml (Gilmour et al., ASReml User Guide Release 1.0, VSN International Ltd., Hemel Hempstead, UK). The statistical significance of the estimated heritability was determined by a likelihood ratio test (LRT), in which the obtained likelihood for the full model was compared to the likelihood of the nested model, in which the additive genetic variance was constrained to be zero. Twice the difference in $\log_e$ likelihoods of these models yields a test

statistic that is asymptotically distributed as a 1/2:1/2 mixture of X^2 variates, one with 0 degrees of freedom and the other with 1 degree of freedom.

Results

Four orthogonally rotated factors from the principal factor analysis of the EPQ-R are shown in Table 1. The items associated with the neuroticism and extraversion traits and lie factors all have high loadings on the expected factors, with almost no substantial cross-loadings on the other factors. The exception is the psychoticism factor. Fewer than half of its items have large (> 0.50) loadings on the expected factor, and seven of the 12 items have their highest loadings on non-psychoticism factors. The Cronbach alpha (internal consistency) coefficients were as follows: neuroticism = 0.82; extraversion = 0.78; psychoticism = 0.26; and lie = 0.78. Therefore, the psychometric analyses show that the neuroticism, extraversion and lie scales perform well in this sample, but not the psychoticism scale.

There were relatively large sex differences in neuroticism (Cohen's $d = 0.49$) and GHQ (Cohen's $d = 0.45$), with women scoring higher (Table 2). Men scored slightly higher on extraversion (Cohen's $d = 0.17$). Women scored higher on the lie scale (Cohen's $d = 0.37$). Age correlated strongly positively with the lie scale and less so with neuroticism and GHQ, and had a modest negative correlation with extraversion (Table 2).

The GHQ had a Cronbach alpha of 0.92. The GHQ total score had a strong positive correlation with neuroticism, a modest negative correlation with extraversion, and a near-to-zero correlation with the lie scale (Table 2). There was a modest negative association in this sample between neuroticism and extraversion ($r = -0.27$, $p < .001$). Therefore, to check that this was not the source of the correlation between extraversion and GHQ a partial correlation analysis was conducted. The partial

correlation between extraversion and GHQ was $r_{E\text{-}GHQ.N} = -0.22$ (N = 957, $p < 0.001$). In a linear regression model of GHQ, neuroticism and extraversion contributed significant independent variance to GHQ: 30% and 3.3%, respectively (both $p < 0.001$). When the regression analysis was repeated for each sex separately, the results were very similar.

The proportion of variance contributed by additive genetic effects was significant for all traits except psychoticism, as follows: neuroticism = 0.24; extraversion = 0.41; and GHQ = 0.18 (Table 3). A household effect was fitted but was non significant for all three measures. For neuroticism (EPQ-R-N), the variance component attributable to additive genetic effects became non-significant after adjustment for GHQ, suggesting that these two measures are influenced by shared genes. On the other hand, for extraversion the additive variance component is still highly significant even after adjustment for GHQ or neuroticism, suggesting a non-shared genetic contribution. In agreement with this observation, when a bivariate analysis was performed, there was a very high genetic correlation between neuroticism and GHQ, $r = 0.91$, and modest genetic correlations between extraversion and GHQ, $r = -0.40$, and between neuroticism end extraversion, $r = -0.41$ (Table 4).

Discussion

The neuroticism and extraversion scales had good psychometric characteristics, but not the psychoticism scale, which was not used further here. Sex differences and associations with age were as expected for neuroticism and extraversion. Indeed, despite the translation of the items, even the means and SDs were similar to the UK values for neuroticism and extraversion (Eysenck, Eysenck, & Barrett, 1985). The additive genetic contributions to these traits were within the range of those found in the literature (Matthews, Deary, & Whiteman, 2003). The genetic correlation between neuroticism and psychological distress measured using the GHQ was very high.

The heritability estimates found here are congruent with other estimates for extraversion and neuroticism (Bouchard, 2004). Family-based studies provide an upper limit for the heritability since they include a component in the resemblance between relatives which is due to shared environment. The latter can only be readily estimated in adoption studies or twins reared apart (McGue. & Bouchard, 1998; Stoolmiller, 1999). The high genetic correlation between neuroticism and psychological distress was in close agreement with the review of data from other cultures where it is found that neuroticism has a high genetic correlation with anxiety and depression (Middeldorp et al., 2005).

The trait of neuroticism is the most-studied risk factor for anxiety and depression. In this sample we found that extraversion added significant additional variance to psychological distress. The correlations between GHQ and neuroticism and extraversion here are similar to those in a large UK sample (Stewart et al., 2005). In addition to extraversion's being a replicated associate of psychological distress,

independent of neuroticism, it was found here to have a genetic correlation with GHQ. Therefore, genetic studies of psychological distress should focus on extraversion in addition to neuroticism as a risk factor.

There are some reasons why the psychoticism items might not have performed well here. First, the distribution of responses was suboptimal. For half of the items, one of the two responses received fewer than 10% endorsements: Q6 = 7%; Q10 = 2%; Q18 = 4.6%; Q22 = 8.1%; Q26 = 7.2%; and Q39 = 3.6%. Second, some of the psychoticism questions were inappropriate. For example, one of the questions is about insurance, and there was no insurance in Croatia at that time.

The study of isolate populations aims to take advantage of increased genetic and environmental homogeneity compared with predominantly urban populations. This can facilitate gene mapping but has the potential disadvantages of reducing the diversity of genetic influences and increasing the extent of shared environmental influences, which may be particularly important for personality traits. Despite this, the heritability estimates for the neuroticism and extraversion EPQ-R components are remarkably similar to those published from more diverse populations. This suggests that the potential disadvantages of using isolates in behavioural research are small.

In summary, the present study provides evidence that the EPQ-R neuroticism and extraversion scales, and the GHQ, are useful in this Croatian island setting. Furthermore, there are novel data on the heritability of personality and psychological distress, and on the genetic correlation between the two.

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Table 1

Principal factors analysis of the items in the Eysenck Personality Questionnaire-Revised. Loadings shown in bold apply to those items that were intended act as factor indicators on the EPQ-R.

Item number*	Designated trait in the EPQ-R	Factor 1	Factor 2	Factor 3	Factor 4
1	N	**.77**	-.07	-.08	-.16
2	P	.57	-.08	-.07	**.13**
3	E	-.02	-.01	**.74**	.02
4	L	-.03	**-.51**	.14	.12
5	N	**.66**	.10	-.18	.23
6	P	.13	.00	-.07	**.86**
7	E	.01	-.05	**.75**	-.19
8	L	.12	**.71**	.06	.09
9	N	**.56**	.28	.06	-.03
10	P	.17	.33	.12	**.73**
11	E	-.07	-.07	**.66**	.22
12	L	.07	**.60**	.01	.01
13	N	**.53**	.04	-.12	.10
14	P	.21	.29	.08	**-.22**
15	E	-.34	-.06	**.68**	-.02
16	L	.06	**-.57**	.08	-.01
17	N	**.73**	-.05	-.11	-.13
18	P	.02	-.49	.05	**.16**
9	E	.14	-.12	**.50**	-.02
20	L	-.10	**.78**	.09	.06

21	N	**.76**	-.03	-.00	-.06
22	P	.31	.24	.12	**-.30**
23	E	-.06	.01	**.66**	.10
24	L	-.15	**.74**	.08	-.02
25	N	**.69**	-.18	-.19	.18
26	P	-.28	-.03	.52	**.41**
27	E	.31	-.15	**-.73**	.03
28	P	.24	.06	-.00	**.54**
29	L	-.01	**.79**	.09	.08
30	N	**.85**	-.02	-.03	.03
31	P	.25	-.09	.12	.12
32	E	-.26	-.05	**.64**	**.59**
33	L	.03	**.65**	.05	-.06
34	N	**.59**	-.16	-.08	.28
35	P	.02	-.07	.05	**.23**
36	E	.01	.20	**.60**	.03
37	L	-.03	**.72**	.18	.05
38	N	**.75**	.06	-.12	-.07
39	P	.44	.17	.07	**-.10**
40	L	-.09	**.88**	.06	.02
41	E	.34	-.19	**-.58**	.15
42	N	**.68**	-.05	-.38	-.03
43	P	.03	-.32	.01	**.32**
44	E	.04	.02	**.71**	-.04
45	L	-.03	**-.62**	.04	.02
46	N	**.49**	.03	-.13	.17
47	L	.05	**.60**	-.00	-.01

48	E	-.24	.23	**.63**	.16

Note. *The numbers attached to the items are the numbers given by Eysenck, Eysenck and Barrett (1985, p. 29), where the full content of each item in English is available.

Table 2

Sex differences and correlations with age and GHQ for the EPQ-R traits of neuroticism and extraversion and the lie scale.

Trait or GHQ	Male[a]	Female[b]	t for sex difference	Correlation with age[c]	Correlation with GHQ[d]
Neuroticism	4.4 (3.2)	6.0 (3.3)	-7.5*	0.18*	0.54*
Extraversion	8.5 (2.6)	8.0 (2.8)	2.6*	-0.23*	-0.23*
Lie	8.0 (3.0)	9.0 (2.5)	-5.9*	0.50*	0.01
GHQ	55.4 (10.1)	60.3 (11.9)	-6.9*	0.17*	-

Note. * $p < .01$. [a]N = 408 to 422. [b]N = 575 to 596. [c]N = 983 to 1000. [d]N = 978 to 995.

Table 3

Additive genetic contributions to EPQ-R neuroticism and extraversion, and GHQ.

Trait or GHQ	Covariates	Mean effect of covariate (SE)	Additive genetic heritability (SE)	p-value for LRT
Neuroticism Mean=5.38	Age Sex*	0.04 (0.007) 1.57 (0.21)	0.24 (0.11)	0.02
Extraversion Mean=8.21	Age Sex	-0.04 (0.005) -0.42 (0.17)	0.41 (0.10)	<0.00001
GHQ (log_n) Mean=4.05	Age sex	0.002 (0.0003)) 0.08 (0.01)	0.18 (0.10)	0.04
Neuroticism	Age Sex GHQ (ln)		0.118 (0.115)	0.15
Extraversion	Age Sex GQH (ln) EPQ-R-N		0.39 (0.11)	0.0001

Note. * sex effect given as female versus male.

Table 4

Bivariate genetic analysis of EPQ-R (neuroticism, extraversion) and GHQ.

Trait	Covariates	Genetic correlation (SE)	Phenotypic correlation (SE)
GHQ (ln) and neuroticism	Age, sex	0.91 (0.26)	0.52 (0.02)
GHQ (ln) and extraversion	Age, sex	-0.37 (0.26)	-0.27 (0.03)
Extraversion and neuroticism	Age, sex	-0.41 (0.24)	-0.22 (0.03)
GHQ (ln) and extraversion	Age, sex, neuroticism	-0.23 (0.45)	-0.19 (0.03)