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SHORT NOTE

Psychometric properties of the Danish 16PF and EPQ

ERIK LYKKE MORTENSEN[1], JUNE MACHOVER REINISCH[2]
and STEPHANIE ANN SANDERS[2]

[1]*Copenhagen Health Services, Copenhagen, Denmark*
[2]*The Kinsey Institute for Research in Sex, Gender and Reproduction, Indiana University, Bloomington, Indiana, USA*

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A Danish translation of the Cattell's 16PF has been used in studies evaluating the effects of prenatal drug exposure. This paper reports a psychometric analysis of the 16PF and Eysenck's EPQ based on a sample of 558 young Danes. Many 16PF scales had unacceptable psychometric properties (as indicated by coefficient alpha and item—total score correlations), but more satisfactory results were obtained with the EPQ N and E scales. A factor analysis of all 16PF and EPQ scales suggested a six factor solution that roughly corresponds to the second-order factor structure obtained by Krug and Johns (1986). It is concluded that the second-order factor structure should be the basis of interpretation of the 16PF in both practical and research contexts.

Key words: Cattell 16PF, Eysenck EPQ, coefficient alpha, factor analysis.

Erik Lykke Mortensen, Institute of Preventive Medicine, Copenhagen Health Services, Kommunehospitalet, Copenhagen, Denmark

Cattell's Sixteen Personality Factor Questionnaire (16PF) has been used in research for more than forty years and has been translated into several languages (Cattell *et al.*, 1970). The questionnaire (form A) was translated into Danish in 1981–82 during the initiation phase of the Prenatal Development Project, a large-scale series of studies of the effects of prenatal drug and hormone exposure on human development (Reinisch *et al.*, 1993).

A large sample allowed us to make a detailed analysis of the psychometric properties of the questionnaire. This analysis revealed inadequate internal consistency for a number of the primary factor scales, and since the 16PF is used widely in Denmark in the area of personal selection and vocational guidance, we find it appropriate to call attention to the psychometric problems that we have observed. For comparison reasons we also report a psychometric analysis of the Eysenck Personality Questionnaire (EPQ) which has previously been compared with the 16PF (Eysenck & Eysenck, 1975).

The EPQ has become particularly interesting since Digman (1990) described the emergence of the five factor model of personality structure: Intelligence is considered one of the five dimensions, and the remaining four essentially consist of Eysenck's three factors (Extroversion [E], Neuroticism or Emotionality [N], and Psychotism [P]) with the P factor split into two factors). Thus, the EPQ scales can be used as 'markers' for relatively well-established personality factors.

Several studies have suggested that Cattell's higher order factors Extroversion and Anxiety correspond closely with Eysenck's Extroversion and Neuroticism respectively (Abdel-Khalek *et al.*, 1986; Birenbaum & Montag, 1989; Nollar *et al.*, 1987; Montag & Levin, 1990). Another second-order 16PF factor has been called 'tender-minded-vs-tough poise' and this factor may be related to the Eysenck P scale.

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METHOD

Subjects

Subjects visited the Institute of Preventive Medicine for a full-day psychological evalutation. Complete 16PFs and EPQs were obtained from a total of 558 subjects (292 females and 266 males). The mean age was 23.33 (SD 1.31) and 23.51 (SD 1.41) for female and male subjects respectively. All subjects were selected from a Copenhagen perinatal Birth cohort (Zachau-Christiansen & Ross, 1975) on the basis of their prenatal and perinatal medical records. Since it is unlikely that prenatal drug exposure affects the intercorrelations among various personality traits, it was decided to include both drug exposed and control subjects in data analyses (288 subjects were prenatally drug exposed while 270 were control subjects).

Data analysis

Since a complete WAIS testing was part of the evaluation, Cattell's factor B (intelligence) questions were not included in our 16PF version, and thus scores were only obtained for 15 personality traits.

Coefficient alpha and split-half reliability indices were calculated for all subscales of the 16PF and EPQ. Correlations between each item and the subscale total scores and the average correlation among the items of subscales were also calculated.

For factor analysis data from males and females were first analyzed separately: The matrix of intercorrelations among the fifteen 16PF scales and the 4 EPQ scales was factored by the method of principal components and rotated to a varimax criterion. Coefficients of congruence (Cattell 1978, p. 252) were calculated between the rotated factor patterns of females and males, and since they were high, a solution based on all 558 subjects is presented here. An oblique promax solution was very similar to the orthogonal solution.

RESULTS AND DISCUSSION

Scale structure

Table 1 shows coefficients alpha and split-half reliability index for all subscales. For the 16PF the range of coefficient alpha is from 0.14 to 0.81, and for both reliability indexes the Table shows a surprisingly large number of scales with unacceptably low reliability.

Coefficient alpha is influenced by the number of items in a scale (Green *et al.*, 1977), and therefore as an index of item homogenity Table 1 also shows the mean intercorrelations among the items in each scale. For 9 of the 15 Cattell scales the average item-intercorrelation is 0.10 or less, and this of course explains the low alpha coefficients and the fact that for these scales a number of items have very low or indeed sometimes negative correlation with the scale total score.

Eysenck's two classic scales (E and N) have higher coefficient alpha than any of Cattell's scales, and by the psychometric criteria used here only Cattell's H scale appears to be of the same quality as the two Eysenck scales. However, both coefficient alpha and the mean item intercorrelation show problems with the P scale.

Some of the estimates of the 16PF reliabilities are unacceptable by any standard and so are items that correlate less than 0.10 with scale total scores. Cattell (1978, p. 289) has suggested that coefficients of internal homogeneity should not be too high, since this may indicate that the items in a scale measure a very narrow—and therefore psychologically uninteresting—trait. This may be true to some extent, but the question can also be raised whether it is meaningful to calculate total scores from items that on the average correlate 0.04 or less. Furthermore, Table 1 indicates that split-half estimates of reliability are also unacceptably low for several scales, and Saville and Blinkhorn (1981) found coefficient alpha to be very close to 16PF alternate forms correlations in British samples. The pattern of alpha coefficients in Table 1 is in fact similar to the patterns observed in this and other studies of the

Table 1. *Internal structure of personality factors*

	Cattell factor	Alpha coef.	Split-half	Mean cor.	Items with item-total correlation <0.10
1.	A: Warmth	0.31	0.29	0.04	3, 27, 101, 151, 176
3.	C: Stability	0.59	0.55	0.11	104
4.	E: Dominance	0.59	0.62	0.11	31, 81
5.	F: Impulsivity	0.60	0.63	0.10	8
6.	G: Conformity	0.49	0.51	0.09	9, 159
7.	H: Boldness	0.81	0.82	0.26	—
8	I: Sensitivity	0.54	0.57	0.11	37
9.	L: Suspiciousness	0.27	0.37	0.04	64, 113, 139, 164
10.	M: Imagination	0.22	0.19	0.02	15, 39, 65, 91, 115, 116, 140, 165, 166
11.	N: Shrewdness	0.14	0.19	0.02	17, 42, 66, 67, 92, 117, 167
12.	O: Insecurity	0.64	0.61	0.13	119, 144
13.	Q1: Radicalism	0.35	0.27	0.05	20, 21, 45, 170
14.	Q2: Self-sufficient	0.40	0.48	0.06	22, 47, 72, 121
15.	Q3: Self-discipline	0.44	0.48	0.08	73
16.	Q4: Tension	0.73	0.67	0.18	—
	Eysenck factor	Alpha coef.	Split-half	Mean cor.	Item-total correlation < 0.10
1.	E: Extroversion	0.84	0.84	0.21	—
2.	N: Neuroticism	0.87	0.86	0.23	—
3.	P: Psychoticism	0.51	0.62	0.04	2, 55, 59, 78, 85, 88, 93
4.	L: Lie-scale	0.74	0.77	0.12	—

16PF (Barrett & Kline, 1982; Matthews, 1989), and consequently it is also unlikely that our results are a translation artefact.

Given the alpha coefficients in Table 1 it should be no surprise that an item factor analysis of the 16PF demonstrated very little correspondence to Cattell's scales (this analysis is not presented here).

Factor analysis

Only four factors had eigenvalues greater than one, but Cattell's (1966) scree test suggested interpreting six factors. Table 2 presents the six-factor solution rotated to a varimax criterion for the total sample and coefficients of congruence for the female and male solutions. This factor structure will be compared with the results of Krug and Johns (1986) who analyzed the second-order structure of the 16PF in a very large sample (N = 17381).

The EPQ N scale and three Cattell scales have very high loadings on the first factor which can be described as a general adjustment factor. A person scoring low on this factor is neurotic, emotionally unstable, apprehensive, and tense, and this factor clearly confirms the importance of the 'Negative Affectivity' factor of Watson and Clark (1984). Krug & Johns found six scales with loadings high on an Anxiety factor, and these six scales all have loadings higher than 0.30 on our first factor.

The second factor in Table 2 roughly correspond to Krug & Johns "Independence" factor with high loadings on Dominance (Assertiveness) and Radicalism and moderate loadings on Suspiciousness and Imagination (the high loading on Shrewdness is the most striking difference in our data).

Table 2. *Varimax rotated factor matrix*

		Factor					
	16PF Scale	1	2	3	4	5	6
1.	A: Warmth	−0.05	−0.26	−0.51	0.27	−0.24	0.36
3:	C: Stability	0.81	0.04	−0.18	0.01	−0.06	0.02
4.	E: Dominance	0.10	0.63	−0.48	−0.20	0.02	−0.16
5.	F: Impulsivity	0.10	0.34	−0.71	0.04	−0.14	−0.22
6.	G: Conformity	0.03	−0.08	0.04	−0.25	−0.02	0.83
7.	H: Boldness	0.32	0.16	−0.82	−0.01	−0.08	0.02
8.	I: Sensitivity	−0.27	−0.15	−0.10	0.77	0.04	−0.05
9.	L: Suspiciousness	−0.49	0.42	−0.27	−0.19	0.20	−0.09
10.	M: Imagination	0.24	0.39	0.14	0.65	−0.15	−0.12
11.	N: Shrewdness	−0.03	−0.58	0.16	−0.14	0.17	0.21
12.	O: Insecurity	−0.82	−0.05	0.23	0.07	0.04	−0.01
13.	Q1: Radicalism	0.11	0.79	−0.08	0.01	−0.01	−0.08
14.	Q2: Self-sufficient	−0.11	−0.03	0.19	−0.10	0.84	−0.08
15.	Q3: Self-discipline	0.47	−0.05	0.11	−0.19	0.11	0.60
16.	Q4: Tension	−0.86	−0.11	0.07	−0.01	−0.02	−0.14
	EPQ Scale						
1.	E: Extroversion	0.25	0.13	−0.84	−0.04	−0.08	−0.08
2.	N: Neuroticism	−0.80	−0.10	0.23	0.11	−0.02	−0.02
3.	P: Psychoticism	0.01	0.34	−0.03	−0.22	0.09	−0.60
4.	L: Lie-scale	0.18	−0.25	0.12	0.22	0.50	0.47
Coefficient of congruence		0.97	0.85	0.96	0.93	0.84	0.91

The EPQ E scale and three Cattell scales have very high loadings on the third factor which can be described as a general Extroversion factor. A high E person in the 16PF is described as an Outgoing, Impulsive (Happy-go-lucky) and Bold (Venturesome), and this obviously corresponds to Krug & John's Extroversion factor.

Factor four is mainly defined by the Tough-minded-vs-Tender-minded (Sensitivity) and the Practical-vs-Imaginative dimensions. The factor clearly corresponds to the "Tough Poise" second-order factor that has been found repeatedly in the 16PF. One pole of the factor corresponds to a Tough-minded and Practical (perhaps Cynical) attitude to life, and it may be significant that the Eysenck P scale has moderate loading on the factor.

Factor five may be unique to the Danish sample. It is defined by the high loadings on the Self-sufficiency factor and the Eysenck L scale.

Eysenck's P and L scales have high loadings on the sixth factor in Table 2. The negative loading on the P factor fits the picture of the high P person as an Unconform (not conscientious) and undisciplined person. The factor clearly corresponds to Krug & Johns' "Control" factor and Digman's "Conscienciousness/Will" factor.

CONCLUSION

The study of the internal structure of the 16PF indicates unacceptably low reliability for most primary factor scales, and consequently interpretation of these scales cannot be recom-

mended for practical use in situations where important decisions about people are made on the basis of test results. Our study confirms the usefulness of Eysenck's E and N scales, but also suggests serious problems with the P scale.

In spite of the serious scale structure problems factor analysis revealed five of the six second-order factors that Krug & Johns obtained and that have been demonstrated in several 16PF studies. Thus, the obtained factor pattern appears to be very robust, and it seems clearly related to the five factor model of personality. Consequently, it is recommended that the second-order factor pattern should be the basis of 16PF interpretation in both practical and research contexts.

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