THE RELATIONSHIP BETWEEN THE FOURTH EDITION (2003) OF THE LOCUS OF CONTROL INVENTORY AND THE SIXTEEN PERSONALITY FACTOR QUESTIONNAIRE (VERSION 5)

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ABSTRACT

The principal objective of the study was to determine the relationship between the fourth edition (2003) of the Locus of Control Inventory (LCI) and version 5 of the Sixteen Personality Factor Questionnaire (16PF). After some minor changes the LCI was applied jointly with the 16PF to a sample of 3089 first-year university students. Complete records were obtained in respect of 3033 participants for the LCI, and 2798 for both the 16PF and the LCI. An iterative principal factor analysis of the LCI was done. The three-factor-structure previously found was substantiated by the analysis. Highly acceptable reliabilities were obtained. The 16PF yielded six global factors with reliabilities that ranged from 0,721 to 0,861. Canonical correlations of 0,659; 0,455 and 0,322 were obtained between the three scales of the LCI and the primary factors of the 16PF.

Key words
Locus of Control, Factor Structure, Sixteen Personality Factor Questionnaire

The third edition (1999) of the Locus of Control Inventory (LCI) produced very promising results indeed. In particular very interesting relationships with the Bar-On Emotional Quotient Inventory (Bar-On, 1997), the Sense of Coherence Scale (Antonovsky, 1993), and the Personal Orientation Inventory (Bloxom, 1972 & Knapp, 1976) were found. However, certain minor changes of the LCI proved necessary. Furthermore it was deemed desirable to determine the relationship between the LCI and the Sixteen Personality Factor Questionnaire (16PF) as the 16PF is one of the most often used instruments in South Africa.

Statement of the problem

The principal objective of the study was to determine the relationship between the LCI and the 16PF, but in order to achieve this objective the following subsidiary goals had to be met first:

- The factor-structure and metrical properties of the LCI had to be determined, and
- the factor structure and metrical properties of the 16PF (Version 5) had to be determined.

RESEARCH DESIGN

Research approach

Logically the study falls into two sections. The first section deals with the factor structure and metrical properties of the LCI and the 16PF, and the second section with the relationship between the two instruments. Section 1 will be dealt with first and then Section 2.

The planned study is quantitative in nature. Principal factor analysis and item analysis will be used in Section 1 of the study. In Section 2 a canonical correlation analysis will be done. The data will be collected by means of a cross-sectional field study.

THE FACTOR STRUCTURE AND METRICAL PROPERTIES OF THE LCI

Sample

The full complement of first-year university students at the Rand Afrikaans University was tested with the LCI and 16PF during 2003. All incomplete records were rejected. The final sample consisted of 3089 participants in respect of the 16PF and 3033 in respect of the LCI. For the sake of brevity only the bigger sample will be described here.

The sample was representative of all the faculties of the university. The ages of the students ranged from 17 to 43 years with a mean of 19,30 years and a standard deviation of 1,662 years. The various cultural groups were represented as follows: Blacks 17,8%; Coloureds 4,3%; Indians 6,2% and Whites 68,5%. As far as gender is concerned 41,5% of the sample were male and 55,3% were female. As far as language is concerned 42,6% of the sample spoke English, 26,2% of the sample spoke Afrikaans and 9,5% were fluent in both English and Afrikaans. Only 5,6% of the sample indicated an African language as their home language. Missing information accounted for 3,2% of the sample.

Measuring instrument

From the statistical analysis of the third edition (1999) of the LCI it became clear that items 11 and 17 should be included in the category of Internal Control rather than External Control and that item 11 should be reflected. Furthermore, it was clear that items 26, 62 and 78 should be revised. All these changes were made in the fourth edition (2003) of the LCI.

As the procedure that was followed in the analysis of the LCI has been fully described by Schepers (2004) only the essential results are given here.

RESULTS

The items of the LCI were intercorrelated and the eigenvalues of the unreduced intercorrelation matrix were calculated. These matrices, however, are too big for reproduction here.[1] Nineteen of the eigenvalues were greater than unity, accordingly 19 factors were extracted and rotated to simple structure by means of a Varimax rotation (Kaiser, 1961).

Next, 19 subscores were formed by adding all the items with substantial loadings on a factor, together. The 19 subscores were then intercorrelated, and the matrix of intercorrelations is given in Table 1.

Table 1 shows that the correlations of the subscores with one another vary from moderate to low and from positive to negative, suggesting several factors.

Next, the eigenvalues of the unreduced intercorrelation matrix (19 × 19) were calculated. The obtained eigenvalues are given in Table 2.

Table 2 shows that four of the eigenvalues are greater than unity, suggesting four factors (Kaiser, 1961). Accordingly four factors were extracted and rotated to simple structure by means of a Direct Oblimin rotation.

The rotated factor matrix yielded three well determined factors and a fourth factor with only two loadings that were very low. It was therefore decided to extract only three factors.

The rotated three-factor-solution is given in Table 3.

From Table 3 it is evident that all three factors are well determined with five or more high loadings. Twenty-eight items relating to Autonomy had substantial loadings on Factor I. Accordingly Factor I was interpreted as Autonomy. Twenty-nine items associated with External Control had substantial loadings on Factor II. Factor II was therefore interpreted as External Control. Thirty-one items relating to Internal Control had substantial loadings on Factor III. Factor III was therefore interpreted as Internal Control.

TABLE 1
MATRIX OF THE INTERCORRELATIONS OF THE SUBTESTS OF THE LOCUS OF CONTROL INVENTORY (2003)

Variable	Subtest 1	Subtest 2	Subtest 3	Subtest 4	Subtest 5	Subtest 6	Subtest 7	Subtest 8	Subtest 9
Subtest 1	1,000								
Subtest 2	0,433	1,000							
Subtest 3	-0,099	-0,147	1,000						
Subtest 4	-0,166	-0,229	0,438	1,000					
Subtest 5	0,378	0,496	-0,046	0,101	1,000				
Subtest 6	-0,218	-0,272	0,321	-0,482	-0,151	1,000			
Subtest 7	0,373	0,342	-0,108	-0,220	0,223	-0,172	1,000		
Subtest 8	0,440	0,578	-0,175	-0,206	0,420	-0,368	0,262	1,000	
Subtest 9	0,436	0,175	0,045	0,111	0,240	-0,025	0,136	0,183	1,000
Subtest 10	0,299	0,467	-0,110	-0,156	0,481	-0,193	0,162	0,384	0,200
Subtest 11	-0,092	-0,322	0,318	0,450	-0,223	0,449	-0,130	-0,334	0,073
Subtest 12	0,506	0,358	-0,077	-0,150	0,288	-0,156	0,277	0,267	0,238
Subtest 13	0,334	0,185	-0,039	-0,019	0,126	-0,048	0,126	0,212	0,191
Subtest 14	-0,118	-0,189	0,132	0,319	-0,083	0,216	0,129	-0,152	0,016
Subtest 15	0,157	0,285	-0,330	-0,404	0,140	-0,453	-0,169	0,275	-0,039
Subtest 16	0,341	0,379	-0,143	-0,238	0,261	-0,252	0,281	0,343	0,127
Subtest 17	0,125	0,275	0,030	-0,063	0,207	-0,103	0,117	0,229	0,095
Subtest 18	0,102	0,137	0,018	-0,023	0,164	-0,047	0,052	0,128	0,071
Subtest 19	0,367	0,308	-0,039	-0,054	0,283	-0,110	0,194	0,307	0,225

Note. N = 3033

	Subtest 10	Subtest 11	Subtest 12	Subtest 13	Subtest 14	Subtest 15	Subtest 16	Subtest 17	Subtest 18	Subtest 19
Subtest 1										
Subtest 2										
Subtest 3										
Subtest 4										
Subtest 5										
Subtest 6										
Subtest 7										
Subtest 8										
Subtest 9										
Subtest 10	1,000									
Subtest 11	-0,260	1,000								
Subtest 12	0,245	-0,095	1,000							
Subtest 13	0,158	0,028	0,181	1,000						
Subtest 14	-0,087	0,169	-0,050	-0,056	1,000					
Subtest 15	0,207	-0,373	0,126	0,064	-0,201	1,000				
Subtest 16	0,257	-0,173	0,217	0,199	-0,168	0,215	1,000			
Subtest 17	0,219	-0,111	0,167	0,020	-0,027	0,035	0,086	1,000		
Subtest 18	0,067	-0,066	0,057	0,047	0,030	0,059	0,077	0,068	1,000	
Subtest 19	0,240	-0,100	0,223	0,177	-0,106	0,086	0,149	0,064	0,088	1,000

1) Available from the author on request.

TABLE 2
EIGENVALUES OF UNREDUCED INTERCORRELATION MATRIX (19 × 19)

Root	Eigenvalue
1	4,802
2	2,252
3	1,249
4	1,002
5	0,938
6	0,918
7	0,866
8	0,824
9	0,760
10	0,729
11	0,691
12	0,650
13	0,610
14	0,586
15	0,496
16	0,481
17	0,422
18	0,383
19	0,343
Trace	19,000

From the intercorrelations of the factors given in Table 3 it is clear that External Control and Internal Control are essentially uncorrelated. Internal Control is substantially ($r = 0{,}521$; $p < 0{,}001$) correlated with Autonomy, and External Control is moderately negatively correlated with Autonomy ($r = -0{,}324$; $p < 0{,}001$).

Next, three scales were formed, corresponding to the factors obtained. To ascertain whether any of the items needed to be reflected, the principal axis of each of the scales were determined. All the reflections made on logical grounds were confirmed. Following this the three scales were subjected to item analysis.

The means and standard deviations of the item statistics in respect of Scale I (Autonomy) are shown in Table 4.

Table 4 shows that the mean of the item means is 5,318, which is above average, judged on a seven-point scale. The mean of the item-total correlations is 0,486, which indicates a high internal consistency of the items in the scale. This is supported by the Cronbach alpha reliability coefficient of 0,881. No items were rejected.

The means and standard deviations of the item statistics in respect of Scale II (External Control) are given in Table 5.

TABLE 3
ROTATED FACTOR MATRIX (DIRECT OBLIMIN)

Variables	K	Factor I	Factor II	Factor III	h^2_i
Subtest 5: Items 2,5,22,23,24,25,29,67	8	0,650	0,051	+0,096	0,476
Subtest 2: Items 3,30,44,46,70,73*,74,81,82,83	10	0,632	-0,161	+0,140	0,610
Subtest 10: Items 14,15*,28	3	0,594	-0,051	+0,027	0,393
Subtest 8: Items 1*,13,62,66,68	5	0,498	-0,213	+0,169	0,491
Subtest 17: Item 64	1	0,373	0,036	-0,034	0,120
Subtest 18: Item 16	1	0,181	0,016	+0,023	0,036
Subtest 4: Items 4,9,45,47,50,51,57,58,65,80,84	11	0,105	0,790	-0,022	0,586
Subtest 6: Items 20,43,52,53,56,88	6	-0,073	0,638	-0,025	0,451
Subtest 15: Items 38,39	2	0,080	0,576	-0,016	0,364
Subtest 3: Items 12,34,35,36,41,79	6	0,089	0,554	-0,011	0,284
Subtest 11: Items 21,71,72	3	-0,321	0,551	+0,238	0,452
Subtest 14: Item 77	1	0,014	0,337	-0,068	0,122
Subtest 1: Items 6,7,10,27,32,37,42,48,49,61,63,75,76,78,85,87	16	-0,041	-0,099	+0,895	0,802
Subtest 9: Items 18,19,26,31	4	0,085	0,197	+0,473	0,268
Subtest 12: Items 55,59	2	0,104	-0,072	+0,465	0,300
Subtest 13: Items 60,86	2	-0,011	0,004	+0,394	0,151
Subtest 7: Items 8,33,40,54	4	0,065	-0,192	+0,346	0,215
Subtest 19: Item 69	1	0,209	0,001	+0,308	0,205
Subtest 16: Items 11*,17	2	0,159	-0,241	+0,264	0,244
Number of items per factor	88	28	29	31	

Note. Factor III has been reflected

INTERCORRELATIONS OF FACTORS

Variables	Autonomy	External control	Internal control
Factor I	1,000	-0,324	+0,521
Factor II	-0,324	1,000	-0,174
Factor III	+0,521	-0,174	1,000

Note. Factor III has been reflected
Factor I = Autonomy
Factor II = External control
Factor III = Internal control

TABLE 4
MEANS AND STANDARD DEVIATIONS OF THE ITEM STATISTICS IN RESPECT OF SCALE I OF THE LCI: AUTONOMY

	Mean of items $\overline{X}_g$	Standard deviation of items (S_g)	Item-test correlations (r_{gx})	Index of reliability of items ($r_{gx}s_g$)
Mean	5,318	1,247	0,486	0,598
SD	0,432	0,203	0,081	0,098

Cronbach alpha = 0,881
Mean of test = 148,900
Standard deviation = 16,726
Number of items = 28
N = 3033

Note. Items 1, 15 and 73 have been reflected

TABLE 5
MEANS AND STANDARD DEVIATIONS OF THE ITEM STATISTICS IN RESPECT OF SCALE II OF THE LCI: EXTERNAL CONTROL

	Mean of items $\overline{X}_g$	Standard deviation of items (S_g)	Item-test correlations (r_{gx})	Index of reliability of items ($r_{gx}s_g$)
Mean	3,376	1,530	0,484	0,740
SD	0,723	0,126	0,075	0,123

Cronbach alpha = 0,881
Mean of test = 97,912
Standard deviation = 21,461
Number of items = 29
N = 3033

Note. No items have been reflected

Table 5 indicates that the mean of the item means is 3,376, which is below average, judged on a seven-point scale. The mean of the item-total correlations is 0,484, which indicates a high internal consistency of the items in the scale. This is supported by a Cronbach alpha reliability coefficient of 0,881. No items were rejected.

The means and standard deviations of the item statistics in respect of Scale III (Internal Control) are given in Table 6.

TABLE 6
MEANS AND STANDARD DEVIATIONS OF THE ITEM STATISTICS IN RESPECT OF SCALE III OF THE LCI: INTERNAL CONTROL

	Mean of items $\overline{X}_g$	Standard deviation of items (S_g)	Item-test correlations (r_{gx})	Index of reliability of items ($r_{gx}s_g$)
Mean	5,939	1,101	0,428	0,465
SD	0,301	0,174	0,063	0,068

Cronbach alpha = 0,852
Mean of test = 184,115
Standard deviation = 14,392
Number of items = 31
N = 3033

Note. Item 11 has been reflected

From Table 6 it can be seen that the mean of the item means is 5,939, which is above average judged on a seven-point scale. The mean of the item-total correlations is 0,428, which indicates a high internal consistency of the items in the scale. This is supported by a Cronbach alpha reliability coefficient of 0,852. No items were rejected.

By virtue of the positive findings of the analysis, it was decided to prepare a set of norms for the 2003 edition of the LCI.

In the preparation of the norms the same sample as was used in the factor analysis of the LCI, was used. Complete records in respect of 3033 students were available. The standard scores in respect of Autonomy, External Control and Internal Control are given in Tables 7, 8 and 9 respectively.

TABLE 7
TRANSFORMATION OF RAW SCORES TO STANDARD SCORES IN RESPECT OF THE LCI: AUTONOMY

Raw score	Stanines	Raw score	Stens
0 to 119	1	0 to 114	1
120 to 127	2	115 to 123	2
128 to 136	3	124 to 132	3
137 to 145	4	133 to 140	4
146 to 153	5	141 to 149	5
154 to 161	6	150 to 157	6
162 to 169	7	158 to 165	7
170 to 177	8	166 to 173	8
178 to 194	9	174 to 180	9
		181 to 194	10

TABLE 8
TRANSFORMATION OF RAW SCORES TO STANDARD SCORES IN RESPECT OF THE LCI: EXTERNAL CONTROL

Raw score	Stanines	Raw score	Stens
0 to 61	1	0 to 56	1
62 to 72	2	57 to 66	2
73 to 82	6	67 to 77	3
83 to 94	4	78 to 88	4
95 to 104	5	89 to 99	5
105 to 115	6	100 to 109	6
116 to 125	7	110 to 120	7
126 to 136	8	121 to 130	8
137 to 170	9	131 to 141	9
		142 to 170	10

TABLE 9
TRANSFORMATION OF RAW SCORES TO STANDARD SCORES IN RESPECT OF THE LCI: INTERNAL CONTROL

Raw score	Stanines	Raw score	Stens
0 to 157	1	0 to 153	1
158 to 165	2	154 to 161	2
166 to 173	3	162 to 169	3
174 to 181	4	170 to 177	4
182 to 188	5	178 to 184	5
189 to 195	6	185 to 192	6
196 to 201	7	193 to 198	7
202 to 207	8	199 to 204	8
208 to 217	9	205 to 209	9
		210 to 217	10

THE FACTOR STRUCTURE AND METRICAL PROPERTIES OF THE 16PF (VERSION 5)

Sample
Essentially the same sample as was used in the analysis of the LCI, was used with the 16PF. Complete records were available in respect of 3089 participants.

Measuring instrument
The Sixteen Personality Factor Questionnaire (Fifth Edition) was adapted for use in South Africa by the local distributors of the test (Jopie van Rooyen & Partners SA (Pty) Ltd.) in collaboration with the Institute for Personality and Ability Testing, Champaign, Illinois. Particular attention was paid to language issues, because many American idiomatic expressions are unfamiliar in South Africa.

As the 16PF is widely used in South Africa and an appropriate administrator's manual is available it will not be described here in detail (Cattell, Cattell & Cattell, 1993; Russell & Karol, 1994).

The procedure that was followed in the analysis of the 16PF differs from that used with the LCI in as much as the scoring of the 16 primary factors were taken as given. Only the essential results are given here.

RESULTS (SECTION 1)

To start off the 16 primary factors were intercorrelated. The matrix of intercorrelations of the factors is given in Table 10.

Next, the eigenvalues of the unreduced intercorrelation matrix were computed. The eigenvalues are given in Table 11.

From Table 11 it can be seen that six of the eigenvalues are greater than unity suggesting six factors according to Kaiser's criterion (1961). Accordingly six factors were extracted and rotated to simple structure by means of a Direct Oblimin rotation. The rotated factor matrix is given in Table 12.

Table 12 shows that five of the global factors are reasonably well determined with three or more moderate to high loadings. Factor 5 has only two moderate loadings.

TABLE 10
MATRIX OF INTERCORRELATIONS OF THE PRIMARY FACTORS OF THE 16PF

Correlation	Warmth (A)	Reasoning (B)	Emotional Stability (C)	Dominance (E)	Liveliness (F)	Rule-consciousness (G)	Social Boldness (H)	Sensitivity (I)	Vigilance (L)
Warmth (A)	1,000	-0,116	0,089	0,094	0,314	0,096	0,319	0,448	-0,028
Reasoning (B)	-0,116	1,000	0,074	0,021	0,113	-0,011	-0,004	-0,047	-0,056
Emotional Stability (C)	0,089	0,074	1,000	0,236	0,206	0,140	0,393	-0,113	-0,227
Dominance (E)	0,094	0,021	0,236	1,000	0,197	0,033	0,413	-0,054	0,084
Liveliness (F)	0,314	0,113	0,206	0,197	1,000	-0,202	0,446	0,062	-0,050
Rule-consciousness (G)	0,096	-0,011	0,140	0,033	-0,202	1,000	-0,021	0,044	-0,064
Social Boldness (H)	0,319	-0,004	0,393	0,413	0,446	-0,021	1,000	0,038	-0,102
Sensitivity (I)	0,448	-0,047	-0,113	-0,054	0,062	0,044	0,038	1,000	0,017
Vigilance (L)	-0,028	-0,056	-0,227	0,084	-0,050	-0,064	-0,102	0,017	1,000
Abstractedness (M)	-0,023	0,034	-0,325	-0,071	0,073	-0,291	-0,104	0,162	0,173
Privateness (N)	-0,342	0,041	-0,195	-0,134	-0,243	0,004	-0,419	-0,082	0,253
Apprehension (O)	0,123	-0,037	-0,523	-0,218	-0,091	0,072	-0,308	0,233	0,195
Openness to Change (Q1)	0,143	0,017	0,129	0,218	0,154	-0,074	0,243	0,118	0,000
Self-reliance (Q2)	-0,388	0,038	-0,264	-0,115	-0,472	0,036	-0,379	-0,019	0,160
Perfectionism (Q3)	-0,022	-0,105	0,056	0,116	-0,228	0,414	-0,038	-0,003	0,067
Tension (Q4)	-0,132	0,073	-0,310	0,152	0,032	-0,184	-0,087	0,019	0,236

Note. N = 3089

	Abstractedness (M)	Privateness (N)	Apprehension (O)	Openness to Change (Q1)	Self-reliance (Q2)	Perfectionism (Q3)	Tension (Q4)
	-0,023	-0,342	0,123	0,143	-0,388	-0,022	-0,132
	0,034	0,041	-0,037	0,017	0,038	-0,105	0,073
	-0,325	-0,195	-0,523	0,129	-0,264	0,056	-0,310
	-0,071	-0,134	-0,218	0,218	-0,115	0,116	0,152
	0,073	-0,243	-0,091	0,154	-0,472	-0,228	0,032
	-0,291	0,004	0,072	-0,074	0,036	0,414	-0,184
	-0,104	-0,419	-0,308	0,243	-0,379	-0,038	-0,087
	0,162	-0,082	0,233	0,118	-0,019	-0,003	0,019
	0,173	0,253	0,195	0,000	0,160	0,067	0,236
	1,000	0,061	0,224	0,271	0,165	-0,306	0,109
	0,061	1,000	0,108	-0,141	0,349	0,098	0,160
	0,224	0,108	1,000	-0,075	0,100	0,111	0,209
	0,271	-0,141	-0,075	1,000	-0,092	-0,084	-0,184
	0,165	0,349	0,100	-0,092	1,000	0,139	0,148
	-0,306	0,098	0,111	-0,084	0,139	1,000	-0,009
	0,109	0,160	0,209	-0,184	0,148	0,009	1,000

Root	Eigenvalue	% of variance	Cumulative %
1	3,159	19,743	19,743
2	2,104	13,148	32,891
3	1,718	10,740	43,631
4	1,415	8,844	52,475
5	1,203	7,520	59,995
6	1,020	6,375	66,370
7	0,836	5,226	71,596
8	0,787	4,918	76,514
9	0,640	4,000	80,513
10	0,549	3,434	83,947
11	0,532	3,327	87,274
12	0,463	2,897	90,171
13	0,426	2,665	92,836
14	0,394	2,460	95,296
15	0,379	2,369	97,665
16	0,374	2,335	100,000
Trace	16,000		

Factor 1 has high loadings on Liveliness (0,901) and Group-orientation (0,492), and a low loading on Warmth (0,344). It thus relates to enthusiasm, spontaneity and attention seeking, particularly in social situations.

Factor 2 has substantial loadings on Perfectionism (0,671), Rule-consciousness (0,600) and Groundedness (0,349). Persons

scoring high on Factor 2 are thus perfectionistic in whatever they do, they strictly observe cultural standards of right and wrong and are practically minded in what they do.

Factor 3 has high to moderate loadings on Dominance (0,709), Social Boldness (0,570), Self-assuredness (0,490) and Reactivity (-0,402). Persons scoring high on Factor 3 tend to exert their will over others, they are forceful and tend to initiate social contacts. They are not shy in the face of new social settings, are self-assured and react to life experiences.

Factor 4 has high to moderate loadings on Tension (0,731), Emotional Stability (0,453), Vigilance (0,396) and Self-assuredness (0,371). Persons scoring high on Factor 4 are characterised by high nervous tension, they take life in their stride and manage events in a balanced, adaptive way, they are vigilant about others' motives, and are not troubled about their sense of adequacy.

Factor 5 has moderate loadings on Abstractedness (0,580) and Openness to Change (0,571). Persons scoring high on this factor are more orientated to internal mental processes and ideas than to practicalities. They are constantly looking for ways to improve things and enjoy experimenting.

Factor 6 has high to moderate loadings on Warmth (0,684), Sensitivity (0,443) and Forthrightness (0,350). Persons scoring high on this factor are warmly involved with people, and they rely on empathy and sensitivity in their dealing with others. They readily talk to others about themselves.

The communalities of Factor B (Reasoning) and Factor L (Vigilance) are very low, indicating that these two factors have little in common with the other primary factors.

TABLE 12
ROTATED FACTOR MATRIX OF SIXTEEN PERSONALITY FACTOR QUESIONNAIRE (DIRECT OBLIMIN ROATAION)

Variables	Factor 1	Factor 2*	Factor 3*	Factor 4	Factor 5	Factor 6*	h_j^2
Factor A: Warmth	**0,344**	0,066	0,016	-0,032	0,057	**0,684**	0,700
Factor B: Reasoning	0,110	0,027	-0,013	0,004	0,028	-0,208	0,050**
Factor C*: Emotional Stability	0,148	0,154	**0,402**	**-0,453**	-0,038	-0,155	0,559
Factor E : Dominance	0,048	0,125	**0,709**	0,289	0,125	0,003	0,544
Factor F : Liveliness	**0,901**	-0,070	0,024	0,087	0,054	-0,137	0,830
Factor G : Rule-consciousness	-0,010	**0,600**	-0,039	-0,159	-0,039	0,064	0,409
Factor H : Social Boldness	0,290	-0,043	**0,570**	-0,055	0,050	0,180	0,585
Factor I : Sensitivity	0,080	0,037	-0,131	0,069	0,190	**0,443**	0,294*
Factor L : Vigilance	-0,034	0,074	0,008	**0,396**	0,137	-0,044	0,202**
Factor M : Abstractedness	-0,065	**-0,349**	-0,168	0,155	**0,580**	0,008	0,604
Factor N : Privateness	-0,163	0,147	-0,221	0,198	0,044	**-0,350**	0,333*
Factor O*: Apprehension	0,112	0,164	**-0,490**	**0,371**	0,085	0,240	0,537
Factor Q1: Openness to Change	0,016	-0,028	0,224	-0,168	**0,571**	0,044	0,400
Factor Q2*: Self-reliance	**-0,492**	0,069	-0,088	0,158	0,152	-0,195	0,435
Factor Q3: Perfectionism	-0,062	**0,671**	0,082	0,096	-0,058	-0,006	0,498
Factor Q4: Tension	0,017	-0,139	0,129	**0,731**	-0,198	-0,020	0,518

FACTOR CORRELATION MATRIX (16PF)

Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Factor 1	1,000	-0,220	0,296	-0,156	0,075	0,179
Factor 2*	-0,220	1,000	0,025	0,003	-0,115	0,127
Factor 3*	0,296	0,025	1,000	-0,233	-0,034	-0,028
Factpr 4	-0,156	0,003	-0,233	1,000	0,151	-0,072
Factor 5	0,075	-0,115	-0,034	0,151	1,000	0,094
Factor 6*	0,179	0,127	-0,028	-0,072	0,094	1,000

Note. Kaiser-Meyer-Olkin Measure of Sampling Adequacy = 0,704
*Factors 2, 3 and 6 have been reflected
*Factors C, O and Q2 have been reflected

The intercorrelations between the global factors are also given in Table 12. From this matrix it is clear that the mutual intercorrelations between the factors are very low. The global factors are therefore essentially independent of one another.

To determine the metrical properties of the 16PF the reliabilities of the 16 primary factors were determined with the aid of Cronbach alpha. The obtained alpha coefficients are given in Table 13.

TABLE 13
RELIABILITIES OF THE PRIMARY FACTORS OF THE 16PF (VERSION 5)

Primary factors	Cronbach Alpha
FACTOR A: WARMTH	0,686
FACTOR B: REASONING	0,559
FACTOR C: EMOTIONAL STABILITY	0,701
FACTOR E: DOMINANCE	0,616
FACTOR F: LIVELINESS	0,705
FACTOR G: RULE-CONSCIOUSNESS	0,651
FACTOR H: SOCIAL BOLDNESS	0,858
FACTOR I: SENSITIVITY	0,758
FACTOR L: VIGILANCE	0,466
FACTOR M: ABSTRACTEDNESS	0,697
FACTOR N: PRIVATENESS	0,724
FACTOR O: APPREHENSION	0,687
FACTOR Q1: OPENNESS TO CHANGE	0,593
FACTOR Q2: SELF-RELIANCE	0,707
FACTOR Q3: PERFECTIONISM	0,693
FACTOR Q4: TENSION	0,714

From Table 13 it can be seen that the alpha coefficients range from 0,466 to 0,858. The reliabilities in respect of Vigilance, Reasoning and Openness to Change are less than 0,600.

To estimate the reliabilities of the global factors, composites were formed by combining all the primary factors with substantial loadings on a particular factor. The average reliability of the components and the average intercorrelation of the components are given in Table 14.

TABLE 14
RELIABILITY OF THE VARIOUS COMPOSITE SCORES OF THE 16PF

Composite	Average reliability of components	Average inter-correlation of the components	Reliability of the components	K
	$\bar{\rho}_{gg}$	$\bar{\rho}_{gh}$	$\rho_{xx'}$	
1 Liveliness	0,6993	0,3913	0,831	3
2 Perfectionism	0,6803	0,3370	0,809	3
3 Dominance	0,7155	0,3485	0,861	4
4 Tension	0,6420	0,2833	0,807	4
5 Abstractedness	0,6450	0,2710	0,721	2
6 Warmth	0,7227	0,2907	0,825	3

The following formula developed by Schepers (1992, p.63) was used to estimate the reliabilities of the global factors:

$$\rho_{xx'} = \frac{\bar{\rho}_{gg'} + (K-1)\bar{\rho}_{gh}}{1 + (K-1)\bar{\rho}_{gh}} \text{, where}$$

ρ_{xx} = reliability of composite

$\bar{\rho}_{gg'}$ = average reliability of components

$\bar{\rho}_{gh}$ = average intercorrelation of components

K = number of components

Table 14 shows that the reliabilities of the global factors (composites) vary from 0,721 to 0,861. All the reliabilities except that of Abstractedness are greater than 0,800.

Next, the relationship between the LCI and 16PF was determined.

METHOD (SECTION 2)

THE RELATIONSHIP BETWEEN THE LCI AND THE 16PF

Sample
As was mentioned earlier the LCI and 16PF were applied to a sample of 3089 first-year university students. Complete records in respect of both instruments were obtained for 2798 participants.

Statistical analysis
To determine the relationship between the LCI and the 16PF a canonical correlation analysis was done (Cliff, 1987, p.442; Tabachnick & Fidell, 1983). The obtained canonical variates were rotated to simple structure by means of a target rotation (Browne, 1972a, 1972b, 1993).

RESULTS (SECTION 2)

As a first step in the analysis, the canonical correlations of the primary factors of the 16PF (IV's) with the three scales of the LCI (DV's) were computed. For the sake of completeness all the primary factors of the 16PF (Version 5) were included, knowing that the loadings in respect of Reasoning, Vigilance and Openness to Change would be depressed. Bartlett's (1950, 1951) test of significance was used to determine the number of significant canonical correlations, and is given in Table 15.

TABLE 15
STATISTICAL SIGNIFICANCE OF CANONICAL CORRELATIONS: BARTLETT'S TEST IN RESPECT OF LCI AND 16PF

Eigenvalues	Canonical corre-lations	Eigenvalue removed	Significance of remaining eigenvalues			
			χ^2	df	p	Lambda prime
0,434523	0,659184	0	2541,687	48	0,000001	0,401728
0,207303	0,455305	1	952,856	30	0,000001	0,710424
0,103789	0,322163	2	305,398	14	<0,000001	0,896211

Note. N = 2798

From Table 15 it is clear that there are three significant canonical correlations. Accordingly three canonical variates together with their associated canonical correlations, were computed. The complete analysis is given in Table 16.

	Correlations of original measures with canonical variates		
	Variate 1	Variate 2	Variate 3
Independent variables			
PF 1: Warmth (A)	0,001	-0,096	**0,367**
PF 2: Reasoning (B)	0,097	-0,169	-0,318
PF 3: Emotional Stability (C)	**0,656**	**-0,337**	-0,168
PF 4: Dominance (E)	**0,677**	**0,386**	0,157
PF 5: Liveliness (F)	0,108	**0,399**	0,023
PF 6: Rule-consciousness (G)	0,154	**-0,544**	**0,503**
PF 7: Social Boldness (H)	**0,611**	0,226	0,081
PF 8: Sensitivity (I)	-0,116	**-0,334**	**0,319**
PF 9: Vigilance (L)	-0,161	**0,386**	**0,355**
PF 10: Abstractedness (M)	-0,124	**0,410**	-0,114
PF 11: Privateness (N)	-0,248	0,003	-0,018
PF 12: Apprehension (O)	**-0,545**	0,155	**0,524**
PF 13: Openness to Change (Q1)	**0,538**	0,134	0,003
PF 14: Self-reliance Q2)	-0,053	-0,009	0,046
PF 15: Perfectionism (Q3)	0,179	-0,266	**0,654**
PF 16 : Tension (Q4)	-0,218	**0,304**	0,034
Average % variance accounted for	13,073%	9,009%	9,348%	Total: 31,430%
Average % redundancy	5,681%	1,868%	0,970%	Total: 8,518%
Dependent variables			
LCI 1 : Autonomy	**0,933**	0,162	**0,320**
LCI 2 : External Control	**-0,569**	**0,790**	0,229
LCI 3 : Internal Control	**0,357**	-0,299	**0,885**
Average % variance accounted for	44,077%	24,664%	31,259%	Total: 100,00%
Average % redundancy	19,153%	5,113%	3,244%	Total: 27,510%
Canonical Correlations	0,659	0,455	0,322

Note. N = 2798

Variates 1,2 and 3 have been reflected

Table 16 shows that the first canonical variate yielded a canonical correlation of 0,659 (p < 0,000001), the second a canonical correlation of 0,455 (p < 0,000001) and the third a canonical correlation of 0,322 (p < 0,000001).

From an interpretive point of view it is normally very difficult to identify the components underlying the canonical structure matrix as it resembles an unrotated factor matrix. Rotation to simple structure is therefore necessary. In this regard Cliff (1987, p. 456) states that the structure correlations between the observed variables and the canonical variates "can be transformed by the rotational methods of factor analysis, although the same transformation must be applied to the structure correlations of both batteries". Target rotation would seem to be ideal for this purpose (Browne, 1972a, 1972b).

From a theory testing point of view target rotation is more appropriate than the usual rotations to simple structure such as Varimax, Promax, Direct Oblimin, Quartimax, Quartimin, and other procedures. With target rotation the common factor structure of two batteries of tests can be specified on theoretical grounds.

It was therefore decided to rotate the canonical structure correlations to simple structure by means of a Tarrot rotation (Browne, 1993). A target matrix was specified for this purpose. It is based on attribution theory and social learning theory (Heider,

1958; Rotter, 1966) as well as on recent empirical studies of the 16PF (Hofer & Eber, 2002, pp. 397-404). The target matrix is given in Table 17, and the rotated matrix in Table 18.

TABLE 17
Target matrix for tarrot rotation

	Factor 1	Factor 2	Factor 3
A	0,000	0,000	0,000
B	0,000	**9,000**	0,000
C	**9,000**	**9,000**	0,000
E	**9,000**	0,000	0,000
F	0,000	0,000	0,000
G	0,000	0,000	**9,000**
H	**9,000**	0,000	0,000
I	0,000	0,000	0,000
L	0,000	**9,000**	0,000
M	0,000	0,000	**9,000**
N	0,000	0,000	0,000
O	**9,000**	**9,000**	0,000
Q1	**9,000**	0,000	0,000
Q2	0,000	0,000	0,000
Q3	0,000	0,000	**9,000**
Q4	0,000	**9,000**	0,000
LOC1	**9,000**	0,000	0,000
LOC2	0,000	**9,000**	0,000
LOC3	**9,000**	0,000	**9,000**

Oblique rotation to a partially specified target

TABLE 18
Tarrot rotation of canonical correlation factor loadings (16PF & LCI)

Variables	Factor 1	Factor 2*	Factor 3
Independent variables			
Factor A : Warmth	0,022	-0,119	**0,361**
Factor B : Reasoning	-0,042	+0,332	-0,181
Factor C : Emotional Stability	0,406	+0,630	0,056
Factor E : Dominance	**0,795**	-0,055	-0,029
Factor F : Liveliness	0,272	-0,256	-0,181
Factor G : Rule-consciousness	-0,012	+0,215	**0,718**
Factor H : Social Boldness	**0,651**	+0,070	-0,020
Factor I : Sensitivity	-0,193	+0,029	**0,436**
Factor L : Vigilance	0,085	**-0,538**	0,101
Factor M : Abstractedness	0,045	-0,296	-0,307
Factor N : Privateness	-0,223	-0,107	-0,032
Factor O : Apprehension	0,329	**-0,627**	0,346
Factor Q1 : Openness to Change	**-0,535**	+0,142	-0,043
Factor Q2 : Self-reliance	-0,042	-0,041	0,044
Factor Q3 : Perfectionism	0,153	-0,054	**0,712**
Factor Q4 : Tension	-0,055	**-0,338**	-0,140
Dependent variables			
LCI 1: Autonomy	**0,952**	+0,142	0,236
LCI 2: External Control	-0,125	**-0,954**	-0,230
LCI 3: Internal Control	**0,470**	-0,288	**0,778**

Note. Square root of average squared deviation = 0,175438
*Factor 2 has been reflected

FACTOR CORRELATION MATRIX

	Factor 1	Factor 2*	Factor 3
Factor 1	1,000	-0,004	0,030
Factor 2	-0,004	1,000	-0,043
Factor 3	0,030	-0,043	1,000

On theoretical grounds it was expected that persons who are high on Autonomy would be forceful, assertive, socially bold, open to change, emotionally stable and self-assured. Factor 1 of the target matrix was accordingly specified to have loadings on the above-mentioned attributes. Internal Control was included because it is well known that Autonomy and Internal Control are positively correlated.

On theoretical grounds it was expected that persons who are high on External Control would be emotionally unstable, apprehensive, suspicious, tense and concrete in their thinking (Schepers & Gropp, 2005). Factor 2 of the target matrix was accordingly specified to have high loadings on these variables.

On theoretical grounds it was expected that persons who are high on Internal Control would be rule-conscious, dutiful, perfectionistic, well organised and practical. Factor 3 of the target matrix was therefore specified to have high loadings on these variables.

Table 18 shows that Factors 1 and 2 fit the target matrix very well. Factor 3 has three additional loadings, viz. in respect of Sensitivity, Warmth and Apprehension. The loading on Apprehension (0,346) is low and does not fit in with the rest of the picture.

Furthermore, from Table 18 it can be seen that the three factors are virtually uncorrelated with one another.

Overall, the rotated canonical variate matrix gave a very good fit with the specified target matrix. The square root of the average squared deviation was 0,175. The obtained factors can therefore be interpreted with confidence.

Factor 1 can be interpreted as Ascendancy coupled with social boldness and autonomy: Persons who are high on this factor are well balanced individuals, they tend to be forceful, socially bold, open to change, and confident that they can overcome problems on their own.Factor 2 can be interpreted as Emotional Stability. Persons who are high on this factor are emotionally stable, self-assured, trusting and relaxed. They normally have low scores on External Control.

Factor 3 can be interpreted as Rule-consciousness: Persons who are high on this factor are rule-conscious, dutiful, perfectionistic, well organised and practical. They normally have quite high scores on Internal Control.

DISCUSSION

THE FACTOR STRUCTURE AND METRICAL PROPERTIES OF THE LCI AND 16PF

The factor analysis of the LCI substantiated the three-factor-structure previously found by de Bruin (2004), Schepers (2004), and Schepers and Gropp (2005). The obtained factors were interpreted as Autonomy, External Control and Internal Control.

Cronbach alpha coefficients of 0,881; 0,881 and 0,852 were obtained for Autonomy, External Control and Internal Control respectively. No items were rejected.

Conversion tables for transforming the raw scores of the three scales to standard scores were prepared in respect of a sample of 3033 participants.

The factor analysis of the 16PF produced six global factors. Five of the six factors were well determined and one was a doublet. The reliabilities of the primary factors ranged from 0,466 to 0,858. Three of the primary factors had reliabilities less than 0,600. It is therefore clear that a number of items of Factors B, L and Q1 of the 16PF will have to be revised or replaced with better ones.

The reliabilities of the global factors are more promising. The reliabilities of the composites range from 0,721 to 0,861. Only one of the coefficients is less than 0,800. It is therefore clear that more weight should be attached to the global factors than to the primary factors.

The obtained global factors were identified as follows:
Factor 1: Liveliness
Factor 2: Perfectionism
Factor 3: Dominance
Factor 4: Tension
Factor 5: Abstractedness
Factor 6: Warmth

THE RELATIONSHIP BETWEEN THE LCI AND THE 16PF

From the canonical correlation analysis three significant canonical correlations were obtained. To interpret the loadings of the canonical variates a target rotation was done.

The first factor had high loadings on Autonomy, Dominance, Social Boldness, Openness to Change, Emotional Stability, and Internal Control. It was therefore interpreted as Ascendancy coupled with Social Boldness and Autonomy.

The second factor had high loadings on External Control (negative), Emotional Stability, Self-assurance, Trust, and Relaxedness. It was therefore interpreted as Emotional stability. It needs to be stressed that this factor is associated with low scores on External Control.

The third factor had high loadings on Rule-consciousness, Internal Control, Perfectionism and Sensitivity. It was therefore interpreted as Rule-consciousness.

From the foregoing it is clear that the LCI (2003) is now ready for use on a large scale. Additional norms should be prepared for a variety of groups. The 16PF (Version 5) needs to be revised thoroughly.

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