UPPER AND LOWER BOUNDARY ALIGNMENT OF PERSONALITY FACTORS MEASURED BY THE CHILD AND PERSONALITY QUESTIONNAIRE[1]

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INTRODUCTION

Procedures for the systematic measurement of basic personality dimensions, whether questionnaires, ratings or objective tests, generally assume that there is continuity of such dimensions through the entire life-span. It is also assumed, however, that at different maturational levels, the same materials will not be suitable in defining the identical dimensions. Consequently, it becomes necessary to develop test forms which seem appropriate to the language or other behavior levels at which measurement is to occur.

It is obviously part of an adequate test construction procedure to determine the factor structure of a given instrument for the population upon which it is to be used. But it would seem equally important to validate the premise that the factor structure determined for a given instrument is comparable over the entire age range or range of talent for which it has been constructed. Moreover, if the instrument is intended to be part of a series of instruments which are designed to measure personality structure throughout the life-span then it becomes incumbent to investigate the linkage of a particular test with other definitions of the same dimensions for adjacent age sectors.

It is the purpose of this paper to report the results of a study which investigates the factor structure of the Child Personality Questionnaire (CPQ) (Porter, Scheier and Cattell, 1965) from the point of view of comparing its factorial structure at the bottom and top of its range of application, and to examine its linkage at these points with the Early School Personality Quiz (ESPQ)

(Cattell, Karson and Nuttall, 1966) and the High School Personality Quiz (HSPQ) (Cattell, Karson and Nuttall, 1966) respectively.

Procedure

Test Administration

Forms A and B of the CPQ and Forms A and B of the ESPQ were administered to 157 third grade children in the public schools of Morgantown, West Virginia and Fort Collins, Colorado. Both forms of the CPQ and Form B of the HSPQ were administered to 182 sixth grade children from the same schools. Questionnaires were administered to all children in classrooms selected so as to provide a reasonable spread of parents' socio-economic status.[2] The forms were completed by all children in two sessions spread over two consecutive days with the CPQ always administered during the first session.

Data Analysis

Correlation matrices were computed separately for Grades 3 and 6. For grade 6, the upper boundary of the CPQ, we have a 42 x 42 matrix consisting of the 14 factor scales for the two alternate forms of the CPQ and the 14 factor scales from Form B of the HSPQ. Thirteen of the scales are assumed to be common (A, B, C, D, E, F, G, H, I, J, N, Q3, and Q4), while Factor O is represented only on the CPQ and Factor Q2 is limited to the HSPQ. The 54 x 54 correlation matrix derived from the Grade 3 data (the lower boundary of the CPQ) again contains the 14 factor scales for both CPQ forms as well as 13 factor scales for each of the alternate forms of the ESPQ. In the lower boundary study all scales are common except for Q3 which is not measured on the HSPQ.

Both correlation matrices where factored by the principal components method. Nineteen factors where extracted at the upper boundary while seventeen factors were taken to suffice at the lower boundary. The factor matrices were then rotated by the Procrustes method through the fifteen (respectively fourteen

for the lower boundary) factors as specified by the markers provided by the factor scales.

Alignment Criteria

In order to assess the goodness of factor alignment of the CPQ at the upper and lower boundaries, several characteristics of the joint factor pattern matrices (v_{fp}) must be considered. In the following analysis we shall pay attention primarily to three considerations: (1) If there is perfect alignment then any given factor scale must have a positive value significant at a specified level of confidence on the personality factor on which it is hypothesized to be aligned. (2) If the scales have been properly aligned then a given factor scale should be a better estimate of the factor on which it is hypothesized to load than for any other factor; i.e., the hypothesized loading should be the highest row value. (3) If perfect alignment has been achieved a given factor scale should be a better factor estimate than any other non-hypothesized scale; i.e., the hypothesized loading should be the highest column value.

As a consequence of the Procrustes rotation, the factor reference axes are of course located such that loadings for the hypothesized variables will be maximized. Alignment failures may therefore result in several different consequences as far as the factor pattern is concerned. If there is complete misalignment, than the scales from the instrument having maximum variance should determine the factor, and the scales from the other instrument should show zero or minimal leadings. But what of the case where the two forms estimating a given factor differ in factor structure? Here one of the forms may be aligned with the other instrument or both may be misaligned. If both instruments lack in agreement among forms then the factor will be over-determined by that form having most homogenous content and the remaining scales may align with non-hypothesized scales in the joint matrix.

Results

Upper Boundary Study

The Procrustes solution appears to be a reasonable one with angular separations between factors sufficient to warrant the retention of the fourteen factor system as representing clearly operationally distinguishable as well as conceptually distinguishable dimensions. The factor inter-correlations reported in the supradiagonal portion of Table 1 are quite modest, with the highest correlation being .34 between factors F and Q2. Let us ~~now~~ therefore consider the status of factorial linkage at the upper boundary of the CPQ. All our analyses will be based upon inspection of the factor pattern matrix.

Our first criterion requires saliency of hypothesized positive factor loadings. The appropriate entries from the V_{fp} matrix have been summarized in Table 2. The full criterion (i.e. saliency of all hypothesized loadings for a given factor) is attained for factors B, F, H, I, J and Q3 or in six out of twelve of the matched factors. A more limited criterion would require that at least one of the forms for each test show the hypothesized salient loading. This latter criterion is reached by factors A, E, G and Q4. No match in terms of saliency is attained for factors C and N at the upper boundary.

Table 3 provides the information for the second matching criterion. In this instance (a considerably more demanding one that the first criterion) we insist that a match must be presented by the fact that the salient factor loading be the highest common factor loading in the respective row of the V_{fp} matrix. The criterion is fully reached for all three forms used in the upper boundary study only for factors B and I. The criterion is approximated also (i.e. criterion attained for the HSPQ and one form of the CPQ) for factor G. Of the remaining factors F, H, J and N appear overdetermined by the

CPQ but not matched by the hypothesized HSPQ scales. In this instance the matching HSPQ scales load on factors 17, Q4, 18, and Q4 respectively. Factors A and Q4 appear overdetermined by the HSPQ scale, and in this case the matching CPQ scales for A appear on factors G and I and for Q4 on factors N and Q2 respectively. Factors C, D, E and Q3 are determined by Form B of the CPQ but not matched either on the HSPQ or Form A of the CPQ.

The third and most stringent criterion specified that the salient loadings should be the highest loadings in the respective column of the V_{fp} matrix, i.e. the factor scales should be better estimators of a given factor than any non-hypothesized scale. This criterion is attained for all instruments for factors B, H, I, J and Q3 or give out of the twelve matchable factors. Partial attainment of the criterion (one form of CPQ matches HSPQ) occured in addition for factors A and G. The relevant entries from the V_{fp} matrix are reported in Table 4.

In summary, unambiguous matching of the CPQ at the upper boundary by all criteria can be reported only for factors B (intelligence) and I (Premsia). Matching on two of the criteria furthermore occurred for H, J. and Q3, and on one of the criteria only for factor F. All three criteria were attained partially for factor G, two criteria were partially reached for factor A and one criterion was partially attained for factor Q4. Complete mismatching by all criteria occured for factors C, D, E and N.

Lower Boundary Study

The factor correlations for the joint analysis of the CPQ with the ESPQ are reported in the infradiagonal portion of Table 1. Again good factor separation was obtained. The largest factor intercorrelation was between factor E and 17 (.46), but for the hypothesized factors was only .32 (between A and E).

Factor matching in terms of the minimal criterion of significant loadings for all salients was obtained (as shown in Table 5) for factors A, B, D, E, H, I and O or seven of the thirteen matchable factors. In addition, partial matching as defined by at least one form of both tests showing a significant loading for the salients was obtained for factors C, G, J, N and Q4. Only factor F failed to be matched even partially in terms of the significant salients criterion.

Table 6 summarizes the results for the lower boundary study with regard to the criterion that the hypothesized salient be the highest row value for each scale. The only scale which satisfied this criterion was that for intelligence (Factor B). A partial match with at least one form from both the CPQ and ESPQ meeting the second criterion was obtained for factors A, D, I, N and Q4. Of the remaining scales, factors C, E, F, G, H and J were overdetermined by the ESPQ, while factor O was overdetermined by the ESPQ, with no corresponding match in the other questionnaire. The nature of the misalignment cannot be defined with certainty from these data, as the highest row-value for the misaligned scale differs in each instance between the two forms of the misaligned questionnaire factor.

What about the criterion of salients being the best estimates of the factors as defined in the factor space common to the two questionnaires? This criterion is attained at the lower boundary for factors A, B, D and O. Partial attainment of the criterion in terms of matching for at least one form of each questionnaire furthermore occurred for factors J, N and Q4. Table 6 summarizes data for this matching criterion and indicates the nature of the mismatches which again fail to be consistent across the two forms of the CPQ.

Conclusions

The results of the present study suggest that caution is in order for the researcher who wishes to rely upon the IPAT questionnaire series from ESQP through CPQ to the HSPQ as a linked system of factor scales if developmental comparisons are required. Table 8 provides an integrated summary for the status of each of the factor scales of the CPQ interms of its linkage at both lower and upper boundary. Although only Factor B (intelligence) is completely and unambigously linked at both lower and upper boundaries, substantial evidence for linkage at both boundaries is also provided for Factors A (Affectothymia), I (Premsia) and J (Coasthenia). In addition, firm linkage appears at the lower boundary for factors D (Excitability) and N (Shrewdness), and at the upper boundary there is some evidence for possible linkage for G (super-ego strength), H (Parmia) and Q3 (high self sentiment). Investigators concerned with developmental studies requiring use of cross-instrument analysis may at this time need to limit their comparison to the above mentioned factors. At our present state of knowledge even this limited convergence across instruments is quite encouraging. Nevertheless, future efforts at test revision will need to concern itself not only with the clear identification of factor structure within age-limited questionnaires, but will also need to select items so as to miximize cross-instrument linkage.

References

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Footnotes

[1]The authors are indebted to Dr. Naomi B. Patterson who supervised the Fort Collins data collection and to Inge Ahammer and Barbara Stone who assisted in the data analysis.

[2]The CPQ study was conducted with samples who participated in a larger study of school achievement. More detailed demographic, ability and achievement data on these Ss have been reported elsewhere (Schaie, 1967), (Ahammer & Schaie, 1970).

TABLE 1

Factor Intercorrelations in the

Upper Boundary Study Above Diagonal

Lower Boundary Study Above Diagonal

	A	B	C	D	E	F	G	H	I	J	N	O	Q2	Q3 (15)	Q4	16	17	18	19
A	-	11	-14	15	00	-02	16	-17	-08	09	08	12	-19	-23	05	-08	-12	28	12
B	-14	-	01	10	07	00	-22	16	02	17	-06	13	-12	-16	12	-25	08	25	06
C	12	-18	-	-10	19	-04	-32	00	08	-09	-03	07	02	-06	17	-05	-03	-01	08
D	06	16	-03	-	05	-07	-10	00	11	-07	-15	-07	00	-01	-11	00	20	18	00
E	32	-11	02	-18	-	-09	05	06	11	-07	-03	11	-02	07	-01	-09	09	06	-05
F	-01	12	-19	16	07	-	15	04	11	19	-06	21	34	-12	07	12	-04	09	-10
G	-10	17	-31	23	-13	04	-	-05	-13	23	04	08	-04	18	-02	-01	-19	01	14
H	-04	-02	-18	24	-06	12	-10	-	10	04	24	17	-15	-02	14	-02	07	05	-03
I	-19	14	04	-21	22	10	03	-11	-	07	33	-22	13	-03	16	02	03	11	-09
J	-06	09	00	-04	25	14	-28	27	-13	-	-24	-18	17	-08	01	-01	-11	08	02
N	-02	25	16	08	-07	-11	00	-07	19	-13	-	12	14	21	15	-11	00	02	05
O	-21	13	24	-08	00	06	-28	12	31	12	07	-	02	-01	-14	-09	17	-10	-02
Q_2	04	02	-06	16	03	04	-13	05	-17	09	-07	15	-	05	30	-15	08	-02	-02
Q_3(15)	08	07	22	08	-16	-21	23	-01	20	-09	02	-06	-20	-	-05	07	-05	-02	-26
Q_4	-18	-15	02	-20	13	14	09	06	22	-05	-32	07	31	-07	-	-19	-01	09	09
16	01	21	-02	-10	-11	-03	-22	-01	20	-15	08	07	12	01	-16	-	15	-13	19
17	12	-03	-13	-05	46	29	-02	25	-06	06	-22	-06	-21	-13	12	-26	-	04	-3
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	07

TABLE 2

Common Factor Loadings on Hypothesized Factors
for the Factor Scales in the Upper Boundary Study

Factor	Child Personality Quiz		High School Personality Quiz
	Form A	Form B	Form B
A	.26*	.14	.71*
B	.66*	.92*	.64*
C	.12	.73*	.07
D	.06	.82*	.10
E	.09	.68*	.15*
F	.36*	.44*	.18*
G	.71*	.02	.75*
H	.73*	.47*	.29*
I	.74*	.63*	.46*
J	.68*	.36*	.17*
N	.67*	.71*	-.01
O	.51*	.69*	-
Q2	-	-	.35*
Q3	.22*	.86*	.59*
Q4	.43*	-.02	.48*

*Factor loading on hypothesized factor has positive value significant at 5% level of conficence.

TABLE 3

Highest Common Factor Loadings for

Variables in the Upper Boundary Study

Factor Scales	Factors		
	Child Personality Quiz		High School Personality Quiz
	Form A	Form B	Form B
A	I (.48)	G (.20)	A (.71)*
B	B (.66)*	B (.92)*	B (.64)*
C	18 (-.30)	C (.73)*	Q4 (-.57)
D	J (.61)	D (.82)*	F (.52)
E	I (-.48)	E (.68)*	F (.44)
F	F (.36)*	F (.44)*	17 (-.32)
G	G (.71)*	18 (-.48)	G (.75)*
H	H (.73)*	H (.47)*	Q4 (-.62)
I	I (.74)*	I (.63)*	I (.46)*
J	J (.68)*	J (.36)*	18 (.44)
N	N (.67)*	N (.71)*	Q4 (.38)
O	O (.51)*	O (.69)*	-
Q2	-	-	Q2 (.35)*
Q3	Q2 (.92)	Q3 (.86)*	19 (-.79)
Q4	N (.54)	Q2 (-.49)	Q4 (.48)*

*Highest factor loading matches hypothesized factor pattern.

TABLE 4

Best Factor Loading Estimates of

Hypothesized Factors in the Upper Boundary Study

Factors	Factor Scales: Child Personality Quiz Form A	Child Personality Quiz Form B	High School Personality Quiz Form B
A	G (.58)	A (.14)*	A (.71)*
B	B (.66)*	B (.92)*	B (.64)*
C	N (.15)	C (.73)*	J (.31)
D	I (.16)	D (.82)*	I (-.20)
E	C (.24)	E (.68)*	F (.16)
F	F (.36)*	F (.44)*	D (.52)
G	G (.71)*	A (.20)	G (.75)*
H	H (.73)*	H (.47)*	H (.29)*
I	I (.74)*	I (.63)*	I (.46)*
J	J (.68)*	J (.36)*	J (.17)*
N	N (.67)*	N (.71)*	Q3 (-.18)
O	O (.51)*	O (.69)*	Q3 (.17)
Q2	Q3 (.92)	H (.31)	Q2 (.35)*
Q3	Q3 (.22)*	Q3 (.86)*	Q3 (.59)*
Q4	Q4 (.43)8	J (-.34)	C (-.57)
16	J (-.38)	I (.39)	Q4 (.15)
17	D (-.34)	B (.25)	F (-.32)
18	C (-.30)	G (-.48)	J (.44)
19	Q3 (.15)	Q3 (.23)	G (.96) Q3 (-.79)

*Best estimate of factor matches hypothesized factor pattern.

TABLE 5

Common Factor Loadings on Hypothesized Factors for the Factor Scales in the Lower Boundary Study

Factor	Child Personality Quiz		Early School Personality Quiz	
	Form A	Form B	Form A	Form B
A	.41*	.18*	.22*	.40*
B	.61*	.59*	.83*	.86*
C	.16*	-.08	.45*	.84*
D	.41*	.54*	.45*	.37*
E	.35*	.19*	.89*	.91*
F	.09	.07	.74*	.70*
G	.39*	.05	.49*	.23*
H	.35*	.19*	.34*	.80*
I	.35*	.24*	.52*	.38*
J	.23*	.04	.61*	.69*
N	.61*	.32*	.08	.40*
O	.81*	.49*	.26*	.30*
Q3	.40*	.62*	-	-
Q4	.12	.83*	.62*	.64*

*Factor loading on hypothesized factor has positive value significant at 5% level of confidence.

TABLE 6

Highest Common Factor Loadings for

Variables in the Lower Boundary Study

Factor Scales	Factors			
	Child Personality Quiz		Early School Personality Quiz	
	Form A	Form B	Form A	Form B
A	A (.41)*	16 (-.35)	E (-.36)	A (.40)*
B	B (.61)*	B (.59)*	B (.83)*	B (.86)*
C	17 (.44)	D (-.48)	C (.45)*	C (.84)*
D	D (.41)*	D (.54)*	D (.45)*	Q4 (.39)
E	G (.39)	C (-.39)	E (.89)*	E (.91)*
F	N (.49)	E (.31)	F (.74)*	F (.70)*
G	16 (-.43)	17 (.43)	G (.49)*	Q4 (-.37)
H	Q3 (.39)	A (-.50)	H (.34)*	H (.80)*
I	I (.35)*	16 (.40)	I (.52)*	I (.38)*
J	H (.48)	N (.31)	J (.61)*	J (.69)*
N	N (.61)*	I (-.53)	17 (-.59)	N (.40)*
O	O (.81)*	O (.49)*	17 (-.40)	G (-.39)
Q3	Q3 (.40)*	Q3 (.62)*	-	-
Q4	G (-.37)	Q4 (.83)*	Q4 (.62)*	Q4 (.64)*

*Highest factor loading matches hypothesized factor pattern.

TABLE 7

Best Factor Loading Estimates of Hypothesized Factors in the Lower Boundary Study

Factors	Factor Scales			
	Child Personality Quiz		Early School Personality Quiz	
	Form A	Form B	Form A	Form B
A	A (.41)*	A (.18)*	A (.22)*	A (.40)*
B	B (.61)*	B (.59)*	B (.83)*	B (.86)*
C	J (-.41)	E (-.39)	C (.45)*	C (.84)*
D	D (.41)*	D (.54)*	D (.45)*	D (.37)*
E	C (.39)	Q3 (-.37)	E (.89)*	E (.91)*
F	H (.35)	J (.30)	F (.74)*	F (.70)*
G	B (.44)	B (.36)	G (.49)*	J (-.41)
H	J (.48)	F(-.35)	H (.34)*	H (.80)*
I	G (-.36)	N (-.53)	I (.52)*	I (.38)*
J	J (.23)*	O (.30)	J (.61)*	J (.69)*
N	N (.61)*	N (.32)*	A (-.35)	N (.40)*
O	O (.81)*	O (.49)*	O (.26)*	O (.30)*
Q3	Q3 (.40)*	Q3 (.62)*	O (.28)	B (.40)
Q4	F (-.35)	Q4 (.83)*	Q4 (.62)*	Q4 (.64)*
15	B (.43)	B (.59)	D (.35)	F (-.52)
16	G (-.43)	C (.37)	O (.23)	I (-.28)
17	F (-.46)	Q3 (-.50)	N (-.59)	Q4 (-.24)

* Best estimate of factor matches hypothesized factor pattern

TABLE 8

Summary of Results of

Upper and Lower Boundary Alignments

	Upper			Lower		
	C1	C2	C3	C1	C2	C3
A	MA		MB	M	MA	M
B	M	M	M	M	M	M
C				MA		
D				M	M	M
E				M		
F	M	C	C			
G	MA	MA	MA	MA		
H	M	C	M	M		
I	M	M	M	M	MA	
J	M	C	M	MA		MA
N	C	C	C	M	MA	M
O	C*	C*	C*	M	C	M
Q3	M		M	C*	C*	C*
Q4	MA			MB	MB	MB

M = Acceptable Match

MA = Form A only matches boundary test

MB = Form B only matches boundary test

C = Forms A & B both load as hypothesized but do not match boundary test.

* = A match cannot be obtained because no boundary test exists.