

**FACTOR STUDY OF AN APTITUDE TEST BATTERY
USED FOR DIFFERENTIAL PREDICTION**

S. CHATTERJI AND MANJULA MUKERJEE
Indian Statistical Institute, Calcutta.

Under our present educational system at the end of the delta class the students are to be allocated to a specific course of training viz., Science, Humanities, Commerce etc. This decision is of crucial importance for them because if they want to change their field of study in future they have to start again from the very beginning.

The task of matching one's aptitudes and interests with the vocation that he may pursue, is a difficult one. But in our country the students are generally forced to accept the decision made by others on the basis of (a) past school examination marks + (b) parents' decision. Experience shows that though both of these are helpful, yet there is the need for some objective method by which one can have a better knowledge of the potential ability of the child. To serve this purpose, a battery of aptitude tests suitable for students reading in class VIII was constructed and developed.² The Differential Aptitude Test Battery of the Psychological Corporation was not used as it had been developed and standardised under foreign conditions, hence was considered not suitable for Indian students.

The present study describes the results of factorizing the matrix of intercorrelations among the tests of this battery.

Description of the tests used in the battery:

(a) English knowledge and Comprehension (EK-I, EK-II, EK-III). There were three parts in this test dealing with spelling of words, detecting errors in sentences and comprehension of written English. These parts were separately timed.

(b) *Clerical Aptitude* : (CA-I, CA-II) : There were two parts in this test viz., Matching and Coding and both were speed tests.

(c) *Abstract Reasoning* (A.R) : In each item of this test there was a sequence of figures which were related to each other in some way. The task was to choose one alternative answer from among the four suggested alternatives given which would logically follow the sequence.

(d) *Verbal Reasoning* (V.R) : The items were designed to measure verbal intelligence and several types of verbal reasoning items were used in separate blocks.

(e) *Mathematics knowledge and Aptitude* (M.K) : The items of the test covered all the topics included in the Mathematics syllabus for class VIII and in addition several items involving numerical reasoning were also included.

(f) *Scientific knowledge and Aptitude* (S.A) : The items in this test covered the general science

course taught at the class VIII level and the test also included some items which could be answered on the basis of day to day observation. It mainly measured general knowledge in the field of science.

(g) Mechanical Comprehension (M.C): Several types of items were included in this test dealing with space relations, understanding of mechanical principles etc.

The sample of students: The battery of tests was administered on a sample of 386 girls and 656 boys reading in class VIII, in 12 different Higher Secondary Bengali Medium Schools of Calcutta. These 12 schools were selected at random from a list of schools stratified on the basis of sex and performance of the students of the school in the Higher Secondary Examination.

Analysis of the data:

Intercorrelations among the tests were separately calculated for the boy's and girl's groups under the expectation that there might exist some difference between the two groups. The obtained values are presented in Table 1 and Table 2 along with the odd-even reliabilities of the tests.

For the girl's group all the correlations are significantly different from zero, but for the boy's group, there are some values which are not so (critical value is .088 at the 5% level).

Next, the significance of the differences between the corresponding pairs of intercorrelations are tested by using Fisher's z transformation, and as two sets of values are significantly different for some of the cases, factor

analysis is done separately for the two groups.

The intercorrelation matrices are subjected to Thurstone's method of centroid or multiple factor analysis³, because it is observed from a study of the relevant literature that the centroid method is the most popular one and involves less computational work and at the same time, yields consistent and psychologically meaningful factors.

Results: The centroid factor loadings obtained for the two groups are presented in Tables 3 and 4 along with the communalities and specific and error factor variances.

In order to determine when to stop extraction of factors the three criteria discussed by Frutcher (1) are obtained and the results are presented in table 5.

It is apparent from this table that according to Humphrey's rule and as well as Coomb's criterion it would be possible to extract at most three independent factors but according to Tucker's Phi no definite indication is obtainable. However, for both the groups, three factors are extracted.

These three factors are rotated orthogonally into a satisfactory approximation for simple structures. The rotated factor loadings are presented in table 6. The Communality and Error Variances are not presented as they would be same to those in tables 3 and 4.

Discussion:

Comparison of the obtained factor loadings for the boy's and

Table I. showing Intercorrelations among the tests and the odd-even reliabilities (Boys's group : N=636).

Tests	EK I	EK II	EK III	CA I	CA II	AR	VR	MK	SA	MC
English Spelling (EK-I)	—	.25	.42	.33	.14	.24	.26	.26	.25	.25
English Usage (EK-II)	.25	—	.31	.18	.03	.16	.26	.24	.30	.24
English Comprehension (EK-III)	.42	.31	—	.29	.13	.41	.42	.35	.38	.38
Matching (CA-I)	.33	.18	.29	—	.43	.30	.32	.24	.17	.31
Coding (CA-II)	.14	.03	.13	.43	—	.16	.11	.11	.07	.20
Abstract Reasoning (AR)	.24	.16	.41	.30	.16	—	.41	.40	.33	.44
Verbal Reasoning (VR)	.26	.26	.42	.32	.11	.41	—	.45	.37	.48
Math. Knowledge & Aptitude (MK)	.26	.24	.35	.24	.11	.40	.45	—	.37	.42
Scientific Knowledge & Aptitude (SA)	.25	.30	.38	.17	.07	.33	.37	.37	—	.42
Mechanical Comprehension (MC)	.25	.24	.38	.31	.20	.44	.48	.42	.42	—
Reliability (odd-even)	.89	.77	.70	.75	.57	.88	.82	.71	.71	.77

Table 2. *showing Intercorrelations among the tests and odd-even reliabilities (Girl's group : N=366)*

Tests	EK I	EK II	EK III	CA I	CA II	AR	VR	MK	SA	MC
English Spelling (EK I)	—	.31	.40	.37	.24	.20	.32	.32	.32	.22
English Usage (EK II)	.31	—	.33	.27	.17	.18	.28	.34	.32	.25
English Comprehension (EK III)	.40	.33	—	.36	.29	.38	.42	.43	.53	.41
Matching (CA I)	.37	.27	.36	—	.64	.30	.35	.41	.31	.36
Coding (CA II)	.24	.17	.29	.64	—	.27	.24	.34	.15	.29
Abstract Reasoning (AR)	.20	.18	.38	.30	.27	—	.49	.43	.35	.45
Verbal Reasoning (VR)	.32	.28	.42	.35	.24	.49	—	.48	.46	.46
Math. Knowledge & Aptitude (MK)	.32	.34	.43	.41	.34	.43	.48	—	.55	.48
Scientific Knowledge & Aptitude (SA)	.32	.32	.53	.31	.15	.35	.46	.55	—	.49
Mechanical Comprehension (MC)	.22	.25	.41	.36	.29	.45	.46	.48	.49	—
Reliability (odd-even)	.79	.60	.70	.87	.88	.83	.80	.75	.67	.66

Table 3. showing the centroid factor matrix for the boy's group

Tests	factor loadings →	Factor I	Factor II	Factor III	Communnality	Specific factor variance	Error variance
EK-I		.511	-.131	-.284	.359	.531	.11
EK-II		.414	.091	-.265	.250	.520	.23
EK-III		.644	.079	-.209	.465	.235	.30
CA-I		.546	-.450	.147	.525	.225	.25
CA-II		.330	-.465	.208	.368	.202	.43
AR		.597	.124	.196	.410	.470	.12
VR		.644	.212	.149	.482	.338	.18
MK		.602	.193	.109	.412	.298	.29
SA		.567	.279	-.100	.409	.301	.29
MC		.663	.159	.183	.498	.272	.23

Table 4 showing the centroid factor matrix for the girl's group

Tests	factor loadings →	Factor I	Factor II	Factor III	Communnality	Specific factor variance	Error variance
EK-I		.511	-.183	-.251	.358	.432	.21
EK-II		.484	-.054	-.274	.312	.288	.40
EK-III		.674	.058	-.186	.492	.208	.30
CA-I		.655	-.452	.212	.678	.192	.13
CA-II		.536	-.432	.296	.562	.318	.12
AR		.581	.241	.275	.471	.399	.13
VR		.654	.214	.084	.481	.319	.20
MK		.711	.125	-.029	.522	.228	.25
SA		.664	.333	-.251	.615	.055	.33
MC		.647	.245	.149	.501	.159	.34

the girl's groups shows that more or less similar patterns of factor loadings have been obtained for the two groups and this is expected as the corresponding intercorrelation matrices are not poles apart.

The difference between two sets of factor loadings is maximum for the Scientific Know-

ledge and Aptitude tests followed by Mathematics Knowledge and Aptitude, Abstract Reasoning and Coding for factors I and III. For factor II the maximum difference is observed for English Usage (e.g EK-II). In general the communalities are higher for the girl's group for all the tests. It can be seen from table 6

Table 5 showing the criteria for sufficient common factors for the boy's and the girl's groups

Factors	Groups →	BOY'S			GIRL'S		
		Tucker's Phi	Humphrey's Rule	Coomb's Criterion	Tucker's Phi	Humphrey's Rule	Coomb's Criterion
I		.201	.427	20	.181	.448	24
II		.688	.111	14	.645	.195	15
III		.567	.075	24	.510	.081	18
IV		.589	.034	27	.621	.040	30
Criterion value		.818	.062	31 ± 5	.818	.101	31 ± 5

Table 6. Showing the factor loadings after orthogonal rotation for the Boy's and the Girl's groups

Tests	Group Factors	BOY'S			GIRL'S		
		Factor I	Factor II	Factor III	Factor I	Factor II	Factor III
EK I		.493	.339	-.021	.450	.394	.000
EK II		.491	.097	-.001	.491	.266	.000
EK III		.630	.208	.156	.625	.251	.196
CA I		.170	.645	.283	.199	.699	.389
CA II		-.031	.562	.227	.072	.627	.404
AR		.392	.147	.484	.368	.046	.578
VR		.486	.088	.488	.518	.103	.449
MK		.469	.087	.430	.591	.208	.361
SA		.478	-.006	.425	.756	.001	.206
MC		.463	.144	.514	.491	.072	.504

that all the tests have considerable amount of loadings on factor I except the two tests viz, Matching (CA-I) and Coding (CA-II), both of which are speed tests. This factor may be identified as general ability or scholastic aptitude. Factor II has high loadings only for the tests of Matching and Coding and hence it can be identified as speed factor. Test of English

spelling (EK-I) is a bit speeded and hence it has moderately high loading on this factor. For the boy's group the last five tests have high loadings on factor III while tests of English spelling (EK-I) and English usage (EK-II) have almost zero loadings on this factor. For the girl's group Matching (CA-I), Coding (CA-II) and Scientific Knowledge and Aptitude have

only moderately high loadings on factor III, whereas for tests of English Spelling, Usage and Comprehension, the obtained loadings are of a lower order. Factor III can be identified as the reasoning ability factor because the maximum loadings are for the tests of Verbal Reasoning, Abstract Reasoning and Mechanical Comprehension. A high value for Mechanical Comprehension test may be due to the fact that the test concerned measures mechanical reasoning to a considerable extent.

REFERENCES

1. Frutcher, B. *Introduction to Factor analysis*. D. Van Nostrand Co. N. Y. pp. 77-83.
2. Mukerjee, M. *Construction and standardization of a differential Aptitude test Battery*. An unpublished dissertation submitted to the University of Calcutta. Department of Psychology 1965
3. Thurstone, L. L., *Multiple Factor Analysis*. Chicago University Press, Chicago 1947.