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ABSTRACT

This paper concerns two features of a project on the assessment of job potential: the J-Coefficient, and the J-Scale. The J-Coefficient is a means of determining the validity of a test for a position on the basis of (1) the Beta Weights for predicting test scores from a set of elements and (2) estimates of importance of each element in the particular job. The other feature, the J-Scale, is a method in which elements of ability, knowledge, skill or personal characteristics are selected for a particular job, on the basis of their amenability to valid rating when examiners evaluate experience, training, education, etc., as well as tests. See also TM 001 164-166 for further information on the Job Element (J-Scale) method. (Author/DIG)

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Substance of Presentation on

The J-Coefficient and Job-Element Procedure as a Means of Integrating All Evidences of Ability to Meet Educational or Job Requirements

APGA Convention - April 8, 1968

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My early work with the J-Coefficient and Job-Element procedure is described in the enclosed paper by Dr. Maslow, "Summary of Paper on Job Analysis Techniques Presented at the Personnel Selection Institute, Public Personnel Association, Chicago, Illinois, October 1958." You will find additional information in Lawshe and Balma, Principles of Personnel Testing (second ed.) McGraw Hill, 1966, pages 255-257, 271, 292-293, and in additional references given there.

One feature of the Job-Element procedure is the J-Coefficient. This coefficient, as explained in the above citations, is a means of determining the validity of a test for a position on the basis of (1) the Beta weights for predicting test scores from a set of elements and (2) estimates of importance of each element in the particular job.

Another feature in the Job-Element procedure is the J-Scale, in which elements of ability, knowledge, skill or personal characteristics are selected for a particular job, on the basis of their amenability to valid rating when examiners evaluate experience, training, education, etc., as well as tests. An early application of the J-Scale method is shown in "Application of Job Element J-Scale Method to Job Analysis and Selection of Inspectors," a copy of which is enclosed. (The present J-Scale formula represents an improvement over the one shown in this paper.) The rating scale for Element 2, Ability to Learn to Make Acceptable Inspection Reports, on page 8 of this enclosure, shows how test and other evidences are used to evaluate an element.

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The purpose of my presentation at the APGA Convention was to show some of the latest work I have been doing in the Job-Element procedure which is especially appropriate when dealing with deprived groups. Although my first studies in this work had been with jobs, for this presentation I used high school data in order to show the application for scholastic counseling.

In the J-Coefficient procedure, Beta weights are determined for each of a set of elements to predict a test score. The sum of products of these Beta weights times correlations of elements with job (by definition proportional to importance of element in job) is equal to the validity coefficient when there are enough elements to completely determine test (that is, when multiple R of test score on elements is unity).

In the J-Scale procedure, when only a small number of elements are used, there are not enough elements to completely determine a test score. In this case, Betas may be divided by R, assuming that the part of the variance that is in a test, but not in the elements, is similar to the part of the variance that is in the elements.

Table 1 in the handout shows the test weights (Beta/R) for each of five elements to predict certain tests. For example, the Paper Form Board is made up of about .25 x Knowledge of mechanic's tools and machines, .20 x Interest in reading written material, .06 x Understanding mechanical devices, .24 x Education, and .66 x Trades Interest. In examining practice, several evidences are used to measure each element; however, for the purpose of this presentation, only one evidence was used for each element, as shown in Table 1.

This type of analysis is more meaningful than the usual factor analysis because it is in terms of real elements that are defined in advance in terms of the specific evidences that are most appropriate for the domain, and can actually be measured for each subject. In orthogonal factor analysis, the factors are not defined in advance of the study, and the scores of each subject on each factor can be estimated only roughly. The basic difference between elements in the Job-Element procedure and factors in orthogonal factor analysis is that the elements are expected to be related (i.e., not independent). This is an advantage, since real abilities tend to have fairly high intercorrelations. Because elements are not independent, Beta weights have to be used instead of simple correlations. Intercorrelations are sums of products of Beta weights times correlations, rather than correlations times correlations as in orthogonal factor analysis.

Since J-Coefficients are sums of products of Betas and r's, the geometric form for an element involves two axes, with Betas to predict tests on one axis and correlations with tests on the other axis. Chart 1 shows the geometric form for one element--Knowledge of mechanic's tools and machines. (The J-Coefficient formula is the generalized formula for elements or factors, regardless of whether the elements are independent or not. In orthogonal factor analysis, r's and Betas are equal because factors have zero intercorrelations, and so there is no distinction between r's and Betas.)

J-Coefficients can be calculated between two tests by summing the products of Beta times r on the elements. These J-Coefficients represent that part of the test intercorrelations that is related to the elements. (Actually these are two J-Coefficients, one for Beta of Test A times r of Test B, and one for Beta of Test B times r of Test A. A single coefficient can then be achieved by taking the geometric mean of the two.)

Table 2 shows the J-Coefficient (computed from the Beta weights shown in Table 1 and the correlations of the tests with the elements). The correlation between J-Coefficients and actual intercorrelations of the tests is .994.* The greatest discrepancy is for intercorrelation of Stenquist 1 and Stenquist 2, because these tests include a common factor that is not in the elements and therefore would not affect the J-Coefficient. The common factor probably has to do with the fact that the same author produced both tests for a very similar purpose, so that these two tests have in common some very specific test variance.

Since the element weights are Betas, and since pupils have been given actual ratings in each element, "synthetic" test scores can be obtained by applying the Beta/R weight to standardized element ratings. Table 3 shows the synthetic test scores and the actual test scores on the Otis. The formula for this synthetic test score is given in Table 4. For some pupils, the synthetic test score and the actual Otis score are quite close; for example, the synthetic score for pupil No. 1 is 33, and the actual score is 32. (See note on page 4.)

On the other hand, for some pupils the synthetic score is higher. For example, pupil No. 19 gets a synthetic score of 40, and an actual score of 29. Since the synthetic score is based on abilities, it is likely to be more representative of academic grade than the Otis score if the pupil has difficulty taking tests. In the case of this particular pupil, where the synthetic score was 40, while the actual Otis score was only 29, the academic high school grade was 4.0, very high. There were a number of pupils, on the other hand, like pupil No. 21, who have higher Otis scores than synthetic scores. These pupils were usually a year or more younger than the class and probably had not had an opportunity to demonstrate ability on elements such as in Table 1, but were able to demonstrate potential in the actual Otis test. Thus, pupil No. 21 who got 45 on the actual Otis and only 28 on the synthetic test, also got 4.0 in academic grade.

In civil service practice, it would probably be necessary to count the higher of the two scores--the synthetic score or the actual score. For counseling purposes information available to the counselor could be used to indicate to him which score is more meaningful in an individual case.

*when all intercorrelations are included: r_{12} r_{13} ..... and r_{21} r_{31} etc. In the tablem, r's that would be under the diagonal of a matrix are not given.

A final aspect mentioned in the presentation was the use of a J-Coefficient analysis in determining elements present in a test but not in a job situation. Often, such an element may discriminate against certain racial or social groups, and it is useful to be able to put the statistical microscope over a test to eliminate certain unnecessary elements. One example cited was an arithmetic test where the test included content obviously requiring memory, but where memory as measured in the test had no Beta weight on memory required by jobs. By decreasing the content of memory from the arithmetic test, a test was developed which can "pass" applicants from deprived groups who can take an apprentice training course but who could not pass the original arithmetic test.

It is emphasized that the data used for the presentation were selected because they were available to illustrate a procedure. In practice, it would be necessary to use the most appropriate elements for any particular situation.

Note: Before calculating synthetic scores, elements with negative weights for an ability test are eliminated for that test, and Beta weights are recomputed, since logically abilities should be additive positively in any test. Thus, Element 1 was eliminated before synthetic scores were computed for the Otis test.

Tables to Accompany Presentation on the J-Coefficient and Job Element Procedure as a Means of Integrating All Evidences of Ability to Meet Educational or Job Requirements (In Symposium on Extending Test Validity for Vocational Counseling: Non-Traditional Research Approaches)

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Table 1

Test Weights (Beta/R)

(Based on data for Jordan Junior High School pupils reported in Paterson, D. G., Elliott, R. M., Anderson, L. D., Toops, H. A., and Heidbreder, Edna. (1930) Minneapolis mechanical ability tests. Univ. of Minn. Press.)

Element	Paper Form Board	Minn. Spat.	Stenquist Pic. 1	Stenquist Pic. 2	Minn. Assem.	Otis Ment. A.	Mechan. Inf. Test
Knowledge of mechanic's tools and machines (Evidence--Quality of shop work)	2467	4930	3538	6461	7309	-2418	0889
Interest in reading written material (Evidence--Literary interest blank)	1955	0653	-4059	0748	-1040	2264	0606
Understanding mechanical devices (Evidence--Reported experience in mechanical operations)	0586	0483	5427	3021	4011	1196	3502
Education (Evidence--Academic grades)	2442	0399	1191	4716	-1656	7486	6568
Trades Interest (Evidence--Trades interest blank)	6571	5932	3491	-2062	2034	5069	3080

Chart 1

Element 1 - Knowledge of mechanic's tools and machines

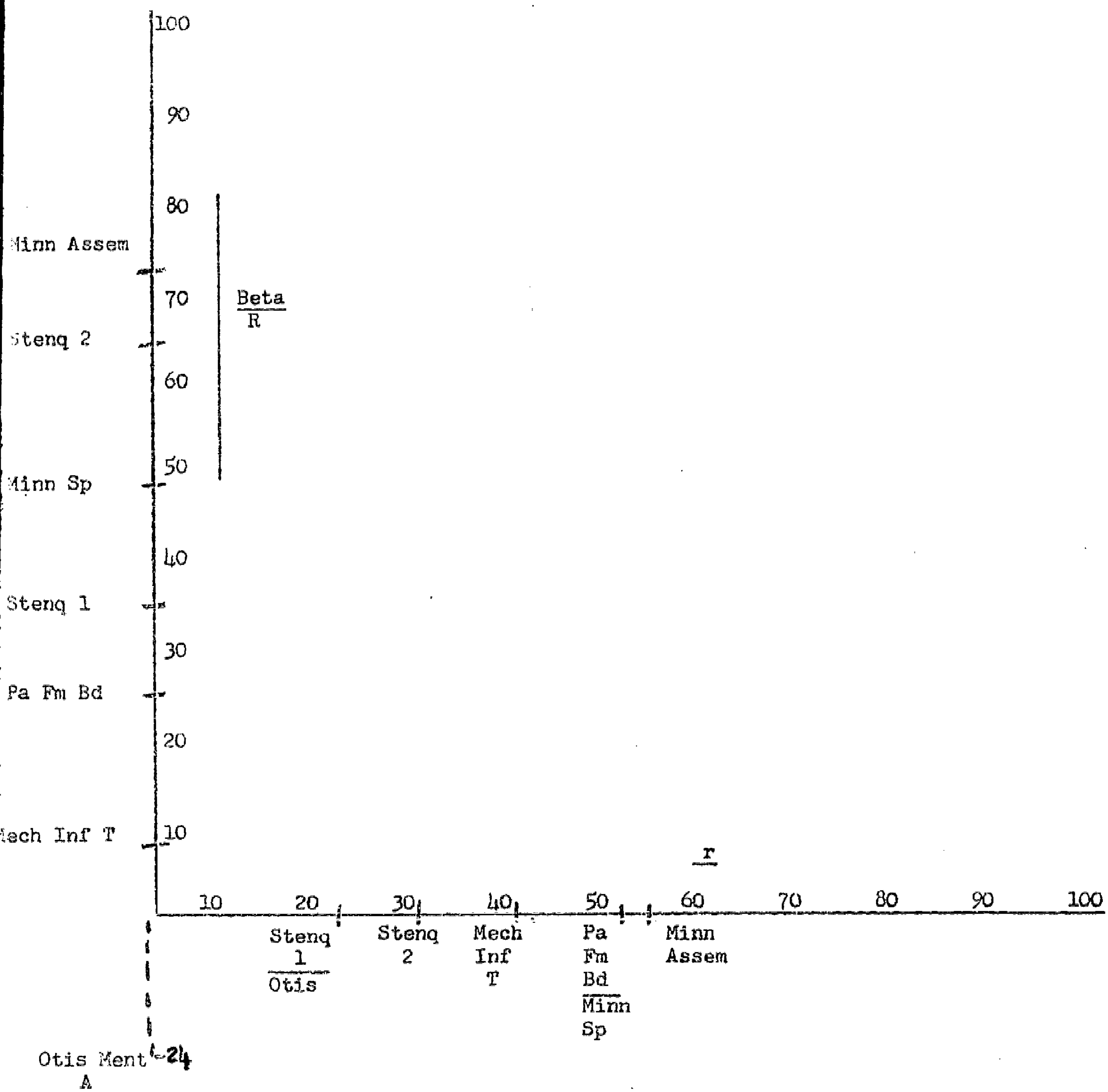

Table 2

J-Coefficients Compared With Actual Test Intercorrelations

Tests	J-Coefficient	Actual Correlation
Pa. Fm. Bd.		
Mech. Inf.	58	57
Minn Sp	63	63
Stenq 1	33	37
Stenq 2	36	30
Minn Assem	48	49
Otis	54	56
Mech. Inf.		
Minn Sp	48	40
Stenq 1	33	35
Stenq 2	43	34
Minn Assem	41	35
Otis	58	68
Minn. Spat		
Stenq 1	36	42
Stenq 2	33	39
Minn Assem	54	56
Otis	40	23
Stenq 1		
Stenq 2	23	54
Minn Ass	42	46
Otis	20	11
Stenq 2		
Minn Assem	35	40
Otis	32	21
Minn Assem		
Otis	22	13

Correlation between J-Coefficients and actual correlation coefficients = .994

Table 3

Synthetic Otis Raw Score Compared to Actual Score

Code No.	Lit. Int. x 1.4652	Son's Mech. Op. x .0897	Acad. Gr. x 11.6952	Int. Anal. x 1.0212	Synthetic Otis Score (-15.1092)	Actual Score on Otis
1	3.0	21.0	3.5	1.0	33.1245	32
3	7.0	9.0	3.9	-11.0	30.3326	35
4	2.0	0	3.1	0	24.08	26
7	3.0	15.0	3.6	-4.0	28.6498	22
8	1.0	4.0	2.5	0	15.9528	19
9	4.0	2.0	2.5	-5.0	15.0630	23
11	4.0	1.0	2.9	0	24.7574	21
14	4.0	15.0	3.6	-3.0	31.1362	44
15	3.0	26.0	2.8	-5.0	19.2592	28
17	4.0	11.0	4.2	-9.0	31.6673	33
18	3.0	18.0	3.0	1.0	27.0078	26
19	5.0	20.0	4.0	-1.0	39.77	29
21	3.0	18.0	4.0	-9.0	28.4910	45
23	4.0	14.0	3.0	-2.0	25.0506	28
25	2.0	1.0	2.2	-1.0	12.6191	15
26	3.0	12.0	3.1	-3.0	23.5543	18
27	1.0	10.0	3.5	-5.0	23.0802	35
29	4.0	12.0	3.6	-2.0	31.8883	33
30	2.0	10.0	3.4	-6.0	22.3547	17
31	5.0	15.0	2.3	-2.0	18.4189	16
32	7.0	32.0	4.0	-6.0	38.6712	39
33	4.0	9.0	3.5	5.0	37.59[illegible]	27
35	1.0	22.0	3.5	-6.0	23.1[illegible]	27
40	2.0	11.0	2.7	1.0	21.4061	19
42	4.0	2.0	2.9	-2.0	22.8047	19
43	6.0	0	3.4	-2.0	31.4033	46
45	2.0	9.0	3.4	0	28.3922	36

Table 4

Formula for Synthetic Score, Otis

	Literary Interest	Son's Mech. Op.	Acad. Gr.	Int. Anal.
W = Beta for / R positive elements only	.2311	.0829	.6966	.4055
(S. D. Otis)	(9.066)	(9.066)	(9.066)	(9.066)
S. D. element	1.43	8.38	.54	3.60
K = S.D. Otis / S. D. Element	6.340	1.082	16.789	2.5183
W.K. = corrected weight	1.4652	.0897	11.6952	1.0212
Mean	3.45	11.54	3.30	-2.61

Mean Otis = 26.82

Correction for Mean = Mean Otis - Σ WK Mean = - 15.1092