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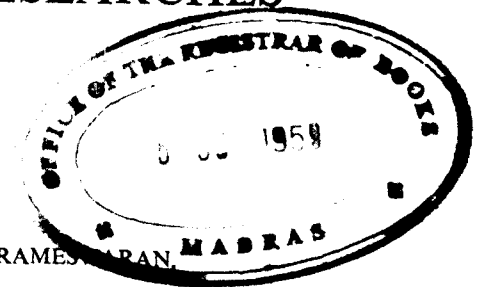
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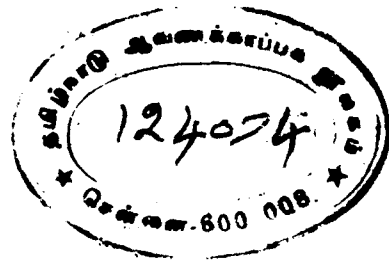
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The Gestalt Concept and Acculturation

U. R. EHRENFELS, Ph.D., (Vienna),
Professor and Head, Dept. of Anthropology,
University of Madras.

Christian Freiherr von Ehrenfels, was born hundred years ago on June 20, 1859 at Rodaun near Vienna in Austria. He created the *Gestalt* concept of modern Psychology 69 years ago in his work: *Über Gestalt-qualitäten*, the criteria for which laid the basis of the vast work done since in the field of Gestalt Psychology.

The centenary of his birth will be celebrated in a Memorial volume, edited by Dr. Weinhandl, Professor of Psychology in Graz and a Special Number of the journal of *Gesellschaft für Ganzheitsforschung* in Vienna.

Professor U. R. Ehrenfels, the only son of Christian Ehrenfels, who is teaching since ten years at the Madras University as Head of the Department of Anthropology, will be contributing to both these *compendia* and agreed to translate for our journal one of his contributions, which contains special references to our problems here in India.

The Editor

I

Introductory note

Since the *gestalt* principle (Ehrenfels—I, 1890) has been applied to Anthropology (Benedict, 1934), a varied field of its utilization has been opened for which the two "Ehrenfels criteria" (Kohler, 1947; Katz 1950: 35) are basic (Ehrenfels—II, 1952: 4; 1959/B).

The first of these two Ehrenfels criteria indicates that a *gestalt*, a structured form-unit, is something different from, and more than, the sum of its constituent single elements. The second Ehrenfels criterium is concerned with the transposable nature of structural units. They remain essentially the "same" and are as such recognisable,—even if each of its constituent elements is being replaced, by another. This is what happens for instance in the case of a melody if transposed from the major to the minor key, or in that of a geometric pattern if reproduced in dimensions, colours and materials,—different from this pattern's formerly seen execution.

The application of these two Ehrenfels criteria on anthropological problems proved fruitful. It made possible the recognition of cultures as such and that of single cultural aspects during migrations or/and in the process of acculturation, even when the constituent elements of these units have undergone complete change, in the course of these migrations. A culture phenomenon, say for, instance, *hajj*, the Muslim pilgrimage to Mecca, remains "the same" and recognisable as a *gestalt*, even if mechanization of transport, or urbanization of the stations in the journey have changed all its single features, or replaced it by altogether new ones.

The continuity of *gestalt* is retained in all such processes of culture-change and can be shown to be different from, and more than, mere semantic identity.

II

The present phase of intercultural relations is characterized by a breadth and depth of world acculturation, hitherto unknown on this planet. Its media are : technical specialization, mechanization and intensification of transport.

Is this to say that each and every single culture unit will cease to exist in what has hitherto been the multiplicity of civilizations?

This question is fundamental to *all* culture processes of the future ; also the Western. This fact deserves stress here, because it has been this western European civilization which, during the past three or four centuries, acted aggressively acculturating upon a number of other, non-European civilizations which, on their part, behaved more or less passively acculturated, during that particular period.

A typical example of this kind, which has been taken little notice of, scientifically, is the diffusion of European cold-country clothing and housing patterns over the entire globe, including the tropical belt with its basically different climatic conditions. In all these regions European dress fashions and housing models were imitated by : *firstly*, economically leading elites, *later* the white-collar workers and *now* even the working classes, regardless of the fact that what they imitated was the product of a cool, rain-snowy climate, adapted to its conditions,—not to the tropics. It scarcely needs much documentation to show the functional disadvantages, inherent in this kind of mechanic assimilation. Forms of dress and of etiquette, evolved in the conditions of cold, northern Europe are now being thoughtlessly imitated all over the broad tropical belt which stretches from India and the Pacific Islands, Mexico and Brazil to Ghana and Tanganyika. This process involves serious interference with that holistic unity of culture in all these countries, which is their psychological *gestalt*.

This is no small problem of mankind in its unity and multiplicity. Its full weight will be measured only on realizing the fact that by far the greater part of mankind lives in this very same tropical belt,—not in the cooler, arctic and sub-arctic regions—and that moreover practically all the tropical peoples have already regained political independence, or are at least on the brink of it. Complete assimilation through thoughtless imitation contradicts the very fundamentals of life conditions on which these original cultures were built up. This is no doubt a serious problem which, however, should be the concern of the World Health Organization and the World Bank, rather, than that of a treatise on our culturological problems. We are concerned with yet another question. It is this : does the experience of Gestalt Psychology permit to assume that this process of world acculturation in forms of civilizations will ever lead towards something like a super-structure, or common world-culture *gestalt*,—without thereby destroying traditional cultures and their visible manifestations in art and structural functioning? This question is basically a problem of aesthetics within that part of anthropology, which has been called *culturology* (White, 1949).

III

Which are the gestalt psychological means of ascertaining interconnections between *principles* and *manifestations* of culture?

The subconsciously affected identification of character types with visible or audible *gestalten* was the concern of the first experiments which have been analysed by applying the Ehrenfels *criteria* to *gestalt* phenomena of culture.

We will quote Kohler's two classical examples. At first a poem of Morgenstern, this quizzical philosopher who garbed much wisdom in a quiet sort of humour :

“ Die Mowen sehen alle aus,
als ob sie Emma hiessen.”
(The sea-gulls all appear to me,
as though their name was Emma).

I can very well remember from my school days how this particular identification, of which Kohler confessed that it convinced him (1947 : 224), was a source of amusement to my father Christian and my mother Emma Ehrenfels. The second identification on which Kohler experimented, is likewise concerned with seemingly incompatible entities. The nonsense words “takete” and “maluma” have been identified without hesitation with one of two abstract figures, offered as choice to different persons ; *maluma* with a curved, soft-cornered design and *takete* with another figure, composed of sharp angles and straight lines, instead of *vice versa* (Kohler, 1947 : 225, fig. 18 and 19).

This principle of internally perceived *gestalt* congruence is applicable also to considerably more complex figurations of culture. Any object of art, derived for instance from early mediaeval Europe, China, India or Aztec Mexico is easily identifiable as to its country of origin, —even by a layman of some artistic inclination and in spite of many formal similarities which these objects may have in common. This identification of each single piece with its country of origin is made possible by the application of the *gestalt* principle which, in every single culture, effects a tangible and recognizable unity of style. Such being the case, we shall not be surprised that, in a reverse process, the introduction of traditionally and climatically alien dress-and housing-styles, results in cultural disintegration. This introduction of foreign concepts is perhaps most clearly dramatized in the adoption, among tropical peoples, of the European taboo on even partial nakedness for the human body. Partial freedom of especially the upper part from burdensome and unhygienic clothing has been traditional in the style of the world's great civilizations, outside northern Europe : in India, Egypt, the Pacific Islands, Mezo-America, classical Greece and Rome. This arrangement permitted accommodation to climatic necessities, but was disturbed by the introduction, of the late-mediaeval European taboo on nakedness and even partial nakedness. The history and development of this taboo is in itself a not yet fully clarified subject for research. It has been attributed to certain puritanical trends within the Christian churches,

but also to the European invasion of the Americas, to the intensification of the Indian trade, creating the felt need, among the invaders, to symbolise with visible *insignia* their "Europeanness" as against a culturally refined, literate "heathendom."

However this may be, the disintegration following this taboo on the human form was not confined to the hygienic sphere (Elwin 1959 : 132 ff., Ehrenfels—II, 1952 : 202 ff.; 1955), but extended far beyond that into the realm of economy, social structure and the aesthetico-cultural unity (Elwin, 1959 : 128, 131 ; Ehrenfels II, 1958 ; 1959/A).

Mahatma Gandhi and Vinoba Bhave lent expression to moral resistance against this kind of cultural intervention, through their own habits and example. There can be but little doubt that the response of the masses was in no small measure due to this their practical perpetuation of arche-typal patterns, though the psychological processes, here at work, are not always overtly conscious. On the level of conscious practice, their example has in fact been followed, but little. The weighty arguments of hygienic and economico-social nature which would recommend a re-adaptation of the traditionally simple and suitable style of dress find little consideration, whilst the symbolic and so-to-say semantic aspect of their example is being formally sanctified, as in a little gypsum figure in front of which incense may be burnt, or on which flower garlands can be draped, but is otherwise pretty much out of the way, as far as daily life behaviour goes. This sort of attitude finds verbalized expression which the present author often heard when he asked his friends why they did not follow the examples, given by the Father of the Nation, or his follower, marching on foot through India?

"Ah—Gandhiji and Vinobaji—they are great saints. They can do such a thing—go about like rishis and sadhus, but we cannot. We must be *progressive* and fashionable. *What* will the foreigners say, if they see us like this?"

The last half century of first, political strife for, and later building up of, Independence has seen a tremendous upsurge in the political, economic and intellectual endeavours of India. Led by the genius and sympathetic understanding of the Prime Minister, Mr. Nehru, the artistic and traditional genius of India found official encouragement and support.

In one respect, however, the stupor which overcame India under prolonged foreign domination has not yet been fully dissolved : the popular response to that combination of functional usefulness and integration into the traditional style, which we generally call *taste* in cultural matters, or artistic feeling.

It was just this predominant sensitivity of the Indian mind which gave rise to such a glorious wealth of artistic creativeness and achievements at which we now can only marvel, on our pilgrimages to Barhut and Sanchi, to Amaravati and Elephanta, to Mahabalipuram and Khajurao, to Ellora and Ajanta and the uncounted treasures of similar truly great art, dotted all over this great country !

But where are its modern counterparts? Where is anything, comparable to this past glory, creative and formed in our days? Where is originality? Where the expression of the Indian genius of today?

The desire for art and visible representation of beauty is not dead in India. The crowds queueing in front of the cinema boxes are witnessing this fact. But how is this thirst quenched? Is it art, is it original, or Indian, in the good sense of the word, what they get there?

This somewhat rhetoric question is not to say that films cannot be true art at all. There were one or two Indian films, produced by amateur photographers and actors in Bengal. Their works met with enthusiastic responses on the part of the Prime Minister, Mr. Nehru and also abroad. But in Madras and other cities of India, they were shown to three quarter empty cinema houses. The masses of India did not respond.

In private households, interior decoration and living style are thoughtless imitations of the West in which sometimes truly good pieces of art, South Indian bronzes, or wood-carvings, are mixed up with the most tasteless products of mechanized toy industries,—almost like a delicious orchid, put into the same flower vase with paper flowers of the most ludicrous type.

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This perversion of beauty and style is neither the inevitable product of mechanization, as its absence in contemporary Japan shows,—much less something inherently Indian, as its absence in pre-British India can well illustrate.

What is missing in India of today, is a sense for the *gestalt* in Indian culture,—that unit of aesthetic configuration, which in the example used at the beginning of this paper, enables us to determine the country of origin for an art object, by its mere stylistic affinity to a known concept of a culture—rather, than by any definable marks, signs or techniques.

The appreciation of "Indianness" in art has vanished with the disappearance of the truly Indian style of dress. It has been destroyed by the acceptance of the European taboo on nakedness, and on even the partial sight of the human body.

"001

IV

Do these observations imply unmitigated pessimism for the future of aesthetic aspects in the growing culture of Free India and *mutatis mutandis*, of all other tropical civilizations?

To many this may appear to be so, but from the *gestalt*-psychological viewpoint, it does not seem imperative to take such an extreme stand. The attempt has been made, at the beginning of this paper, to show that even a fairly great amount of culture change need not necessarily destroy the culture features involved, *as long* that is, as its *gestalt* principle remains recognizably intact, as such and consequently

does not get disrupted. Two examples, quoted in this connection, can illustrate our point: *hajj*, the Muslim pilgrimage and forms of cold-country clothing in tropical regions. In the case of the first of the two examples, *hajj*, whole sets of constituent elements have been shown exchangeable (transport, urbanization, etc.) without thereby destroying the *gestalt* quality of the pilgrimage as such, and therefore also not its religious meaning and significance. The other example which has been discussed, concerned the introduction of cold-country clothing-forms which, by their very nature, are contradictory to the basic principle or inner *gestalt* of dress requirements in tropical regions. In the first instance the substitution of single elements left the basic *gestalt* of the pilgrimage untouched. In the second case, the change affected the fundamental structure, the unifying form-principle of traditional clothing styles. The ensuing loss of *gestalt* found therefore expression in a proportionate aesthetic atrophy.

The application of theoretically acquired knowledge about the working of the *gestalt* principle, can no doubt also be gainfully applied to the solution of practical problems which made their appearance for the first time in human history, when the unprecedented global acculturation trends of this century began to sweep over the surface of this planet.

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Correlation of Tests of Psychomotor Ability with Intelligence and Non-motor Tests.

G. JAYALAKSHMI
University of Madras

Intelligence and non-motor tests.

The presence of non-motor factors in primary motor tests has been a subject of interest for many factorial studies. Some studies have revealed the presence of non-motor factors like Spatial Relations, Mechanical experience, perceptual speed, etc., in motor tests while other investigations have failed to reveal the presence of any such non-motor factors in motor performance. However, there was not much opportunity, with the exception of the U.S. Air Force programme of research in the perceptual motor skill testing during World War II, to identify the non-motor factors in motor tasks performance, since few batteries included both kinds of tests. Factor studies, as well as experimental ones, have indicated that success in "complex motor" activities may depend upon non-motor as well as motor factors. In this section we will discuss the correlations obtained between simple psychomotor abilities studied and other abilities like general intelligence and mechanical comprehension.

Tests of mechanical comprehension and general intelligence were administered along with a battery of psychomotor tests, which included the following tests: (1) Tapping, (2) Steadiness, (3) Finger dexterity, (4) Aiming, (5) Manual dexterity, to a group of 46 Engineering Students and 42 Arts Students (Ref. 5).

Mechanical Comprehension tests

To measure mechanical ability, the Mechanical Reasoning and the Space Relations Tests were selected from the differential Aptitude Test Battery published by Bennett, Seashore and Wesman. This test is designed to measure the capacity of an individual to understand various types of physical and mechanical relationships. Most of the problems are so presented as to require understanding of the principles involved rather than rote learning.

The Space Relations Test consists of 40 items which measure the ability of an individual to visualise a constructed object from a picture or a pattern and the ability to imagine how an object would appear if rotated in various ways.

The Mechanical Reasoning Test consists of items pictorially presented of a mechanical situation together with a simply worded question. This test is intended to measure the ability of an individual to understand the operation of various physical principles from an examination of 68 drawings or schematic diagrams.

These two tests were administered as group tests wherever possible. Directions for each test are in the test booklets themselves. The time limit allowed for each test is 30 minutes. The scoring method as given in the manual was followed.

General intelligence test

In this investigation only performance tests of intelligence were used. The intelligence tests were administered not to measure the IQ but for studying the correlation of this mental ability with other abilities.

Alexander's Pass a long Test, Koh's Block Design Test and Cox's Cube Construction Test were administered and scored following the instructions given in the manual. Cube analysis and Number Series Tests were also included in the battery.

Reliability of the tests used

The Reliability of the Mechanical Comprehension Test and Space Relations Test were found out using the Kuder-Richardson formula of rational equivalence. The formula reads as:

$$r_{11} = \frac{n\sigma^2_t - M(n - M)}{\sigma^2_t - (n - 1)}$$

Where r_{11} reliability of whole test
 n number of items in the test
 σ^2_t SD of the test scores
 M the mean of the test scores.

The Reliability Coefficient obtained for the Mechanical Reasoning test is equal to +.853 and +.877 for the Engineering and Arts groups respectively and that for the Space Relations test is equal to +.948 and +.959 for the Engineering and Arts groups respectively. All the Reliability-coefficients are quite high and significant.

Experimental findings

The correlations between the psychomotor tests and other tests are shown for the Engineering and Arts groups separately in the following tables:

Table showing the correlations between the psychomotor tests and other tests of intelligence and mechanical comprehension for the Engineering group

General Intelligence and Mechanical comprehension tests	Psychomotor tests					
	Aiming	Tapping	Steadiness	Finger dexterity	Minnesota placing	Minnesota turning
Mechanical Reasoning ..	— .25	.42	.029	.159	.074	.228
Space Relations ..	— .044	.159	.164	.088	.168	.179
Alexander's Battery ..	— .037	.246	.041	.174	.084	.149
Cube Analysis ..	— .118	.296	.061	.111	.087	.039
Number Series Completion ..	— .087	.237	.004	.039	.13	.091

Table showing the correlations between the psycho-motor tests and other tests of intelligence and mechanical comprehension for the Arts Group

General Intelligence and mechanical comprehension tests	Psychomotor tests					
	Aiming	Tapping	Steadiness	Finger dexterity	Minnesota placing	Minnesota turning
Mechanical Reasoning ..	-.213	.475	.190	-.049	.295	.301
Space Relations	-.019	.107	.054	-.181	-.006	.256
Alexander's Battery ..	-.172	.393	.146	.383	.034	.365
Cube Analysis	-.162	.081	.035	-.135	-.241	.008
Number Series Completion	-.042	.289	-.132	-.314	-.027	-.021

Taking the aiming test we find that it does not correlate significantly with any of the intelligence or mechanical comprehension tests. All the five correlations are negative but none significant in the case of the Engineering group. In the Arts group also the correlations are insignificant and negative except for the positive correlations with the Space Relations test and Cube Analysis test but this is also very insignificant.

Next, we find that the Tapping Test correlates positively with all the intelligence and mechanical comprehension tests, in both the Engineering and Arts groups. In both the Engineering and Arts groups the correlation between the Tapping test and Mechanical Reasoning test is positive and significant at 1% level itself. The other significant positive correlation of the tapping test in the Arts group is with the Alexander's battery of tests (at 1% level) and number series test (at 5% level). In the Engineering group the correlation between Tapping test and Cube Analysis test is positive and significant at 5% level. All the other correlations are positive but not significant.

In the case of the Steadiness test, we find that the correlations are all insignificant. The correlation ranges from $-.132$ to $+.19$ in the Arts group and from $-.004$ to $+.16$ in the Engineering group.

The Finger Dexterity test correlates negatively with all the tests except Alexander's Battery of tests in the Arts group. The correlation between Finger Dexterity test and Number Series test is negative and significant (at 5% level) equal to $-.314$. The correlation between finger dexterity test and Alexander's Battery of tests is positive and significant at (5% level) equal to $+.383$, in the case of the Arts group whereas this correlation is positive but not significant in the case of the Engineering group.

The Finger Dexterity test correlates negatively with all the tests except Alexander's Battery of tests in the Arts group. The correlation between Finger Dexterity test and Number Series test is negative and significant (at 5% level) equal to $-.314$, in the case of the Arts group whereas this correlation is positive but not significant in the case of the Engineering group.

Passing on to the Minnesota Placing test we find that it does not correlate significantly with any of the tests. Its correlation with the Cube Analysis and Number Series test is negative and insignificant in both the groups. In the Arts group the correlation between the Minnesota Placing test and Mechanical Reasoning test is equal to .295, which falls just short of the .304 required for it to be significant at 5% level, whereas the value of this correlation in the Engineering group is equal to $-.074$.

Lastly, the Minnesota Turning test correlates positively with all the tests except the Number Series test in both the groups. The correlation of .301 with the Mechanical Reasoning test and that of .365 with Alexander's Battery of performance tests in the Arts group are significant whereas no other correlation is significant.

It is interesting to note that the correlation obtained between the Minnesota Turning test and other tests of Intelligence and Mechanical Comprehension, is higher than that found between the Minnesota Placing and other tests of Intelligence and Mechanical Comprehension.

Now studying the correlations from the point of view of the Intelligence and Mechanical Comprehension tests, we find that the Mechanical Reasoning test correlates positively with all the tests of psychomotor abilities in both the groups except the Aiming test and Finger Dexterity test in the case of the Arts group and in the Engineering group with the Aiming test and Minnesota Placing test. Similarly the Space Relations test correlates positively though insignificantly with all the tests of psychomotor abilities except the Finger Dexterity test in both the groups.

As already pointed out we find that Alexander's Battery of tests correlate positively with all the psychomotor ability tests except the Aiming test in both the groups. Similarly the Cube Analysis test also correlates positively though insignificantly with all the psychomotor tests except the Minnesota Placing test in both the groups and with the Finger Dexterity test in the Arts group alone and the Aiming test in the Engineering group.

It is interesting to note that the number series test differs from the other tests. The number series test correlates negatively though insignificantly with all the tests of psychomotor ability except the Tapping test. In other words, we find that all the tests of Mechanical comprehension and intelligence with the exception of the number series test, correlate positively though insignificantly, with most of the psychomotor tests.

Here again, a thorough study of factorial analysis will help us to identify the presence of non-motor factors in simple psychomotor tests.

From the results given above, we find that the correlation between the tests of psychomotor abilities and tests of other abilities is very low and insignificant. In other words, individual tests of psychomotor ability have very low and insignificant correlation with other individual tests of intelligence and mechanical comprehension.

Now, to find out whether there is any correlation between the psychomotor ability in general, with the other abilities, correlation was worked out between the composite scores of psychomotor tests, intelligence tests and mechanical comprehension tests. Composite scores were obtained by averaging the T scores. Thus the average T Scores of Mechanical Reasoning test and Space Relations test gives the composite score for mechanical comprehension. The average T scores of Alexander's Battery of tests, Cube Analysis test, and Number Series test, give the composite score for general intelligence.

Similarly for the composite score of the psychomotor ability, the average T Scores of the Aiming test, Tapping test, Steadiness test, Finger Dexterity test, Minnesota placing test and Minnesota Turning tests were worked out.

The correlations obtained between these three abilities are shown in the following tables :

Table showing the inter-correlations between the composite scores of the several intelligence tests, Mechanical Comprehension tests and Psychomotor tests.

A. Engineering Group				
	G.I.		M.C.	P.A.
G.I.	...	...	.585	.026
M.C.	...	...		.239
P.A.	...	...	...	...

B. Arts Group				
	G.I.		M.C.	P.A.
G.I.	...	...	.645	.084
M.C.	...	...		.285
P.A.	...	...		

Where, G.I.—Composite scores of general Intelligence tests.
M.C.—Composite scores of Mechanical Comprehension tests.
P.A.—Composite scores of Psychomotor Ability tests.

From a study of the above tables we find that the correlation between the psychomotor ability and general intelligence is positive but very insignificant equal to .026 and .084 in the case of the Engineering and Arts groups. The correlation between psychomotor ability and mechanical comprehension is higher than that obtained between the psychomotor ability and general intelligence. The correlation between the psychomotor ability and mechanical comprehension is equal to .285 and .239 in the case of the Arts and Engineering groups respectively. We find that the correlation between general intelligence and mechanical comprehension is equal to .585 and .645 in the Engineering and Arts groups respectively, and both these correlations are positive and significant. We also find that this correlation between the general intelligence and Mechanical comprehension is higher in the case of the Arts group than that found in the case of the Engineering group.

The first-order partial correlations between the correlations of the composite scores are shown in the following table.

Table showing the first-order partial correlations between the composite scores of the three abilities tested, for both the Engineering and Arts groups

First-order partial correlations		Engineering group	Arts group
$r_{12.3}$	...	.597	.651
$r_{13.2}$	...	.145	.137
$r_{23.1}$	...	.277	.304

Where,

- 1 = General Intelligence.
- 2 = Mechanical Comprehension.
- 3 = General Psychomotor Ability.

From a study of the table above we find that, with general intelligence held constant the correlation between the psychomotor ability and Mechanical comprehension becomes equal to .277 and .304 in the Engineering and Arts groups respectively. We find that these values are approximately the same as when intelligence is not held constant (.239 and .285 in the Engineering and Arts group respectively). It would seem that for the groups tested, the correlation between mechanical comprehension and general psychomotor ability is relatively independent of intelligence as measured by the present battery of tests.

Similarly, for the correlation between mechanical comprehension and general intelligence, with psychomotor ability held constant, the values of the correlations do not differ much. The value of the r with the psychomotor ability held constant is equal to .597 and .651 in the Engineering and Arts groups and with the psychomotor ability not held constant, the values of the r are equal to .585 and .645 for the Engineering and Arts groups respectively. So, here again, we find that the correla-

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tion between general intelligence and mechanical comprehension is independent of psychomotor ability.

On the other hand the correlations between general intelligence and psychomotor ability changes when the mechanical comprehension is held constant. The correlation between the general intelligence and psychomotor ability is equal to .026 and .084 in the Engineering and Arts groups respectively, when the mechanical comprehension factor is not held constant. When the mechanical comprehension is held constant, these correlations become negative equal to $-.145$ and $-.137$ in the Engineering and Arts groups. This reveals the fact that what little correlation there is between general intelligence and Psychomotor ability is due to the Mechanical Comprehension and its high correlation with General Intelligence.

Conclusion

The correlation between the various independent tests of Psychomotor ability and other tests of general intelligence and Mechanical Comprehension was found to be very low and insignificant. But the general Psychomotor ability was found to correlate moderately with the mechanical comprehension, as shown by the positive correlations obtained between the composite scores of these two abilities. The correlation between composite scores of Psychomotor ability and those of general intelligence was found to be very insignificant. In other words, the general Psychomotor ability correlates with the Mechanical Comprehension higher than it does with general intelligence. The correlation between general Psychomotor ability and Mechanical Comprehension seems to be independent of the factor of general intelligence, whereas the correlation between Psychomotor ability, and general intelligence seems to depend on the factor of Mechanical Comprehension.

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Is "Stenquist Mechanical Assembly Test" a Test of Mechanical 'Ability' or Mechanical 'Aptitude'?

RAMANATH KUNDU

Calcutta University

Introduction

With the rapid development of the science of psychology many new terms have been introduced in the literature of mental measurement. As interest in the field of 'psychological testing' becomes increasingly widespread, it is perhaps expected that misconceptions about some related terms would appear. This has specially happened about the terms—aptitude, ability, achievement, and such other terms. It has also been observed that psychologists differ in entitling a test which intends to measure some innate or acquired mental quality. A particular test has been named an aptitude test by one investigator but another test which is similar to the previous one has been called as an ability test by another investigator. This controversy of terminology becomes very noticeable when a particular test is used in different situations by different investigators. But as the time rolls on and with the progress of research such controversy is expected to be eliminated or minimized.

The present writer and his colleagues had to face difficulty in conducting various testing programmes with a battery of tests which included the Mechanical Assembly Test of Stenquist. The question arose—whether the Stenquist Mechanical Assembly test measures mechanical ability or it measures mechanical aptitude. It has been found that the test is recognized as an Assembly test of general mechanical ability, but there are investigators who have successfully used the test as a measure of mechanical aptitude. So what the test actually measures, is a controversial point. The present paper reports a study which has been designed to clear this point of controversy.

Concept of ability and aptitude

Various definitions of ability and aptitude have been put forward by different investigators like—Bingham, Warren, Freeman, Tiffin and many others. But since it is not the purpose of the present investigation to review all those definitions, we like to present the definition of English and English (3) only as we have accepted their definition for our practical purposes. According to them "ability implies that the task can be performed now, if the necessary external circumstances are present; no further training is needed. Aptitude (which formerly carried implications of innateness) has now been specialized in technical writing to refer to the fact that the individual can be brought by a specialized amount of training to a specified level of ability, either general or special, but usually the latter." So

aptitude, in their opinion, is the "capacity to acquire proficiency with a given amount of training, formal or informal." Thus for all practical purposes, we have assumed some sort of difference between the two terms—ability and aptitude and wish not to dwell further in the domain of terminology. We now propose to discuss the available concepts of mechanical aptitude and ability. We shall use the term mechanical ability or mechanical aptitude according as the different authors have used them.

Earlier studies concerning the nature of mechanical aptitude and ability

It is an established fact that besides intelligence there are certain special aptitudes in persons, of which mechanical aptitude is one. This aptitude manifests itself in behaviour. It may be presumed that a successful mechanical engineer possesses, in addition to his other qualifications, an aptitude in dealing with tools and implements; this may be described as mechanical aptitude. It is more concerned with manual activity, motor activity, etc., than the intelligent activities. Cox wrote in his doctorate dissertation, concerning the use of the term 'aptitude,' "Since the term 'ability' must obviously extend its meaning to cover any kind of performance whatever, it would seem desirable to continue its employment in this wide sense, and to use the term 'aptitude' when only the innate character of the 'ability' is intended. Employing the terms in this way, we should say that a person actually able to carry out 'mechanical' work has mechanical ability, while one who has the appropriate innate mental constitution for acquiring this ability (whether he has actually done so or not) may be said to possess mechanical aptitude" (5). According to Mursell (6) "Mechanical aptitude refers to a higher level of organization than manual aptitude. It involves not merely dexterity, but the ability to understand and solve problems involving mechanical relationships and arrangement, such as those which occur in the adjustment, repair, and assembly of machinery." Freeman (4) is of opinion that the capacity designated by the term mechanical aptitude "is a combination of sensory and motor capacities....., plus perception of spatial relations, the capacity to acquire information about mechanical matters, and the capacity to comprehend mechanical relationships. Thus tests of mechanical aptitude are designed to measure capacity and performance on a higher level of organization than are those of sensory motor capacity and dexterity."

Bingham (1) has drawn a clear distinction between an aptitude for solving mechanical problems and an aptitude for acquiring manual skills. The same material may serve the purpose of a mechanical aptitude test and manual aptitude test. The material consists of parts of a mechanical object which can be properly assembled, such as the parts of an electric lamp socket. A man, who has never done it before, may be asked to fit the parts together so that the device may work. The activities that are required to assemble the parts properly is called by him as mechanical aptitude. Now if the man is shown how to assemble the lamp socket most easily and quickly, and then asked to do it rapidly, his success in this case is a symptom not of mechanical aptitude, but of manual aptitude.

The assumption of mechanical aptitude as a real entity is specially stressed by recent correlation investigators and by factor-analysis of human abilities. Some investigators suggested that there is a single common factor—mechanical ability—common to all kinds of manipulative operations, but there are also others who are of opinion that the existence of a distinctive common factor is doubtful.

Stenquist (8) is of opinion that there is a single central factor known as mechanical ability. The individual possessing a high degree of this common factor is likely to succeed in any or all mechanical operations. He applied two intelligence (assembly type) tests and two mechanical (picture type) tests on several hundred boys of a New York City Public School. The fact that mechanical tests inter-correlated on an average, between 0.6 and 0.7, led Stenquist to conclude that "on the whole, any one of the four tests affords an important indication of a general ability that may for convenience be called mechanical aptitude—general in the sense that it does not pertain to any special trade, and mechanical, as is more or less obvious from its nature" (9).

Some of Stenquist's findings and conclusions are confirmed in an investigation by Cox (2). He applied a series of tests not involving manipulation but requiring the solution of mechanical problems embodied in mechanical models, diagrams, etc. The obtained test results of his investigation point out the existence of a central factor appearing in any operation in which the subject is called upon to deal mentally with mechanical movements. According to him, this central factor 'm' appearing almost in conjunction with 'g' and forming part of what has been called "mechanical ability." He is of opinion that concrete mechanical ability can be resolved into (1) the general factor 'g,' (2) the characteristic group factor 'm', and (3) one or more factors specific to the mechanical task in question.

Murphy (7) is of opinion that various kinds of mechanical ability tests, indicate that existence of common factor (in mechanical work) is doubtful. She found on analysing a battery of eighteen tests which included Copying, Tracing and Tapping from MacQuarrie, and Substitution and Checking tests from Army Alpha, that "a special relations factor and a eye-hand co-ordination factor would account for all their inter-correlations". According to Vernon (10), Murphy's conclusion may be true for MacQuarrie tests, but it cannot be accepted for all kinds of mechanical tests, as she did not include tests in her investigation, that do involve comprehension or assembling of actual mechanisms. He agreed that a large portion of what is commonly called mechanical ability actually consists of k; mechanical information according to him, constitutes a distinctive factor of mechanical aptitude.

There are also others who have made important contributions in understanding the nature of mechanical aptitude and the relationship of this factor with other factors. But to review all the works is not the main subject-matter of our present study. We have discussed some of the important contributions and shall now turn our attention to the present study.

The present study

Mechanical aptitude test as devised by Stenquist consists of two parts, one of which is an assembly test of General Mechanical Ability. The Series I of the assembly test has been taken into consideration for our present study.

To make the test less time-consuming, which is highly essential for application on industrial personnel, a short form of the test has been thought of by the Applied Psychology Section of Calcutta University. As such a preliminary investigation has been carried out to determine the split-half reliability of the test. The test was split into odd and even items. The reliability coefficient determined in this way was found to be sufficient for accepting the odd 5-items or even 5-items as a representative test of the original one. For the sake of convenience, we have taken into consideration the odd 5-items of the test. Thus a short form of 5-items of the test has been designed with the following models :

- Model A : Cupboard catch
- Model C : Paper clip
- Model E : Bicycle bell
- Model G : Wire bottle stopper
- Model I : Lock

Now this mechanical test and the Group Pass-along test, designed by late Dr. G. Bose for measuring performance type of intelligence, have been administered on two groups of individuals—Group A and Group B. Group A consisted of 82 industrial personnel of a manufacturing concern having trades like—fitter, machinist, moulder, welder, etc. They were selected by the management of the concern by written tests and interview. They then underwent three years of apprenticeship period for theoretical and practical training and were then employed by the management as skilled workers in different trades. The aforementioned two tests were administered on them, after two years of work in the same plant, as a group test. Each group consisted of approximately 20 individuals.

Group B consisted of 78 individuals who were selected by psychological and other tests for employment as apprentices in the same manufacturing concern. The battery of selection tests included Mechanical assembly test of odd 5-items and the Group Pass-along test. The data were collected in the same way as stated in case of Group A.

All possible care was taken to keep the variable factors which affect test score constant. The two tests were administered on two groups of individuals by the same two senior students of psychology under the direct supervision of the writer and the test scores were determined by them also. All environmental factors were also controlled. The educational background, nationality, sex (male), age, etc., were practically identical for the two groups. It was assumed that the two groups were parallel on mechanical aptitude at the initial stage, i.e., before employment.

It is evident from the above stated facts that at the time of testing of the individuals of Group A, they have already acquired some proficiency in dealing with mechanical objects and mechanical manipulation in course of their three years of training in apprenticeship course and two years of working in the different trades. On the other hand, the individuals of Group B did not have any such acquired-trait, as they had no previous training in the mechanical line and appeared in the psychological examination in order to be selected for apprenticeship training. Thus as regards fundamental training in the mechanical line the two groups differed.

Results and discussion

The test scores of the Mechanical Assembly test and Group Pass-along test of the two groups of individuals were subjected to statistical treatment. Means and standard deviations were determined for each group and for each test separately. Standard errors of means were calculated and the 't' test was applied to determine the significant difference between means of Mechanical Assembly test scores of Group A and Group B and between two means of Pass-along test results for those groups. All these statistics are given in Table I.

TABLE I
Means and other statistics in the comparison of Group A and Group B

Statistic	Mechanical Assembly test		Group Pass-along test	
	Group A	Group B	Group A	Group B
N	82.	78.	82.	78.
M	34.5	27.7	29.6	28.
σ	6.7	9.9	5.1	6.2
σM	.744	1.125	.566	.704
σdM	1.36		.9	
D_M	6.8		1.6	
t	4.98		1.78	
Conclusion	Significant at 1% level		Insignificant	

The means and standard deviations of the Mechanical Assembly test for two groups of individuals were found to have a wide difference, but in case of the Pass-along test the two means and standard deviations did not differ to such an extent. Consequently the t-ratio for the Mechanical Assembly test was found to be significant at 1% level while that of Pass-along test score was found to be insignificant.

The higher mean score of Mechanical Assembly test for Group A is possibly due to the fact that the individuals of this group have already acquired some training in mechanical work and so they have performed the task of assembling the mechanical parts in a better way than the individuals of Group B—those who had no such training. As the level of performance type of intelligence (as it is revealed by Pass-along test) of the two groups of individuals did not differ significantly, it can be said that the difference of the two means of the Mechanical Assembly test is possibly not due to intelligence.

Standard deviation of the Mechanical Assembly test of Group B was found to be higher in comparison with that of Group A. It indicates that the individuals of Group B, so far as mechanical ability or aptitude is concerned, are more variable than those of Group A. This higher spread of Group B is also expected, as they do not possess any specific training in mechanical work. The Mechanical Assembly test, in this case, probably measures some kind of innate mechanical capacity of the tested individuals. But the same test is perhaps measuring some acquired mechanical capacity in case of the individuals of Group A. This is evident from the higher mean but lower standard deviation than the corresponding results in Group B. Thus we can say that the Mechanical Assembly test measures more of ability than aptitude in case of Group A and the reverse is true in case of Group B, i.e., measures more of aptitude than ability.

Correlations between the scores of the two tests, Mechanical Assembly test and Pass-along test, were determined separately for Group A and Group B. In case of Group A it was found to be .096 and for Group B it was —.076. These two coefficients of correlation, however, were found to differ significantly from zero. So there is no relation between the scores of the Mechanical Assembly test and Group Pass-along test in either of the two groups. This also proves that difference in scores of the Mechanical Assembly test between two groups of individuals is not due to intelligence.

Conclusions

It has been found from the present study that the Stenquist Mechanical Assembly test may measure both ability and aptitude. When the test is applied on individuals having previous training in the mechanical line, it will measure more of ability than aptitude. But if the test is administered on individuals having no training in the mechanical line, the test will measure more of aptitude than ability. Thus, so far as the present study is concerned, it may be concluded that the test measures both the ability and aptitude. Hence it will not be unwise to call the test a mechanical ability test or mechanical aptitude test according as the group on whom the test is being applied. Therefore, our conclusion is the same as that of English and English (3), who opined that "since all measurement is necessarily of present performance, an aptitude test is merely one form of ability test. It is a measure of present characteristics that has been found to be predictive of capacity to learn.....But

the distinction remains : ability is present, and actual aptitude is potential, though the same test measures both."

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Certain Aspects of Work Curves

R. RATH

Utkal University

A. Introduction

"Whether it is due to fatigue, refractoriness, interference from mental association, or external disturbance, speed, habits, preservation, from the sense of a just perceived error,—attention fluctuates" (1). With the best of intention it cannot be stopped. Then the question arises—why does it fluctuate and how. Different investigators have devised different techniques to answer this question. The tests used have ranged from those involving the mere use of sense to pure mental work. Broadly speaking there are those of absolute threshold, rivalry, differential threshold, reaction-time, judgment of time intervals in supraliminal tasks such as addition, dotting, cancellation, etc. When the results are plotted we get work curves. These work curves appear so complex, so erratic and indeterminate that we get completely baffled when we attempt to read any system into them. Of course, this is not a new experience in the field of science. Hundreds of scientists have the same difficulty before they decipher any system in the apparent chaotic mass of things and behaviours of natural phenomena.

In the beginning there were divergent opinions in this field. Some admitted that there were rhythmic periodicities in the work curves while others refuted it. Those who had seen the signs of regular rhythms, had interpreted them as arithmetic. But it was Dr. Philpott was completely departed from this traditional view and introduced an entirely new conception in the work curves. He found the evidence that there were definite rhythms and these rhythms were geometric.

Subsequently many other interesting findings follow. Fluctuations are characterised by apparent cycles of geometric duration or period. These cycles can be demonstrated by several methods. The simplest is that of smoothing. Whole duration smoothings make the curves completely smooth, while part duration smoothings make them loop rhythmically. If output averages are calculated for half durations of a given dominant cycle the resulting curve loops of groups of two points—a crest followed by a trough. Likewise one-third and one-quarter duration smoothings loop by threes and fours respectively. Dr. Philpott (1) found that these fall into five major groups of families as follows :—

I	II	III	IV	V
1.49	1.70	1.94	2.42	3.02
1.50		2.00	2.53	
1.50		2.09	2.70	

The interesting question arises here—why so few standard measures? Clearly the curves must belong to a fairly well-defined system. They are obviously not chance determined. Fluctuations are law abiding. If they are random, and if the trough and crest sequences are haphazard then a grand total of several hundred individual curves will cancel all the troughs and crests and produce a smooth or heavily damped curves. But such grand total curves fluctuate widely. This shows that their ups and downs are manifestations of underlying fluctuations of law abiding nature. "Moreover, the laws involved must have been working to a 'master time table,' to times of chronoscopic accuracy, now rising into crests, now dropping into troughs according to a master scheme or system binding on them all" (1).

Measures of similarity in respect of cycle length and phase are attempted by the method of shapes. If a curve showing a perfectly simple cycle is cut into successive sections of one period each, it follows that all the pieces so obtained will be similar in outline, each covering a completely crest-trough unit. If these sections are added together, an average shape is obtained. End-points should come in corresponding places from curves containing the L.C.M. cycles, if the fundamental assumptions with regard to consistency of phase and cycle lengths are correct.

When working in logarithms, the pulses of any one cycle are made to appear of constant length throughout. All the logs of the ratios tend to be whole number multiples of 0.0016, which is termed *p*. So dividing throughout by this unit all cycle lengths can be expressed as natural numbers. For example the ratio 1.94 cycle being 0.2°80 on the log scale can be expressed as 180*p* or of log period 180. These have been used as measures. Such log period measurements express relationships. The analogy with the problem of combining proportions in the early days of the atomic theory is obvious.

The most obvious measures analysing inter trough distances are of L.C.M. (repeat or beat) cycles. Such L.C.M. cycles will be of length corresponding with highly factorisable numbers. If there are many elementary cycles in a curve, it will show signs of quite a number of associated or interlacing cycles all subsidiary to the main, or complete repeat cycle.

To start with let us take an imaginary case. Let waves of period 3, 4 and 5 be present in a curve all three starting from a common trough at the time $T_0 = 0$. Within the first 60 units of the curve the three elementary waves will interact to set up a complex cycle of changes that is completed and starts afresh at $t = 60$. The three waves will interact by pairs to give L.C.M. measures of 12, 15 and 20 units period respectively. The system is summarised as follows :—

Repeat Cycles		Trough times									
12 = 3 × 4	... 012	24	36	48	60	72	84	108	120		
15 = 3 × 5	... 0	15	30	45	60	75	90	105	120		
20 = 4 × 5	... 0	20	40		60		80	100	120		
60 = 3 × 4 × 5	... 0				60				120		(2)

The general hypothesis assumes that changes must be by multiples of a unit. If this system holds, it follows that even if individual and specific differences do exist, it will be difficult to measure them, simply because they must take place by definite amounts.

The only possible hypothesis would seem to be that of a pool of general purposes mechanism, each with its characteristic oscillation, emergence of any particular mechanism being determined by factors other than those of the task, the subject and like factors, these working in such a way that emergence seems to be chance determined. But if we have a grand total of quite a sufficient number of curves we expect a lot of them to appear.

But on this assumption some L.C.M. cycles are more probable than others. Such cycles will be of length corresponding with the highly factorisable numbers. So from a relatively large pool of possible elementary cycles only a small number of major cycles need emerge. For example let the 'pool' consist of all the possible waves with periods that are whole numbered multiples of p , namely, waves $1p$, $2p$, $3p$, $4p$, up to np . Let t_0 be taken as zero and let the scale of log time graduated from that point with p as unit. Then it enables us to calculate from a given time value just how many waves and just which waves of the hypothetical pool could conceivably be there in a trough.

By hypothesis, all waves trough at T_0 . Hence at a point $12p$ distance there from we could conceivably find waves $1p$, $2p$, $3p$, $4p$, $6p$, $12p$ sharing a trough, those and no others. At point $13p$, on the log scale we could find waves $1p$ and $13p$ sharing a trough and p no others. So by calculating the factors of the natural numbers an ideal theoretical curve can be obtained. It affords a record of relative probability. And if an empirical grand total curve correlates highly with such a curve then our general hypothesis is verified. Using the numbers from 1 to 400 it is shown that the major log cycle lengths are actually scattered much as are the most highly factorisable numbers in the natural scale. Some of these probabilities are extremely large, a fact which explains why so few ratios were found in practice.

B. Hypotheses

After this brief introduction let us come to the hypotheses to be proved and the experimental results.

- (a) Work curves are periodic and this periodicity is geometric.
- (b) There seem to be very few ratios and the period seems to be constant.
- (c) In so far as the Theoretical curve correlates significantly with the Empirical curves there is positive evidence in favour of geometricity.
- (d) Work curves resemble one another, *i.e.*, there is a standard form or outline when a large number of curves are combined to give a strong total curve whereas weak curves vary widely.
- (e) There are no observable individual differences either in the tasks involved or in persons working, *i.e.*, the curves for different tasks and produced by different persons at different times and places do resemble in their trough and crest placings.

C. Materials

For demonstrating the geometricity and the dominant ratios the writer analyses 320 curves from a single individual arranged in 8 groups. They are tolerably strong to show the grand total patterns of L.C.M. periods. From the hypothesis the weak curves which consist of only few records are all divergent and dissimilar in outline, because they may draw only a few waves from the pool of all possible wave lengths. Of course, the grand total curves which may consist of hundreds of curves will not vary very much, as they gradually approach the ideal curve of all possible waves from the general pool.

In demonstrating the similarity between the curves the writer uses some of the results of another research student who has got them from different individuals. One of them has also got another set of 320 curves from a single individual. All the curves are of 20 minutes length and derived from supraliminal tasks of addition, subtraction, multiplication and division. Some of the curves are also mixed ones of all these tasks in the same sitting.

D. Experimental Evidences

(a) Smoothing

The curves are smoothed by geometric intervals. Centering at different points on the time scale the curves have been smoothed by different logarithmic time intervals, such as $90p$, $63p$, $60p$ and $36p$ were $p = 0.0016$. These intervals are used because they are the part duration of the major ratios found in the previous researches.

The arrangement is, if the curves are geometric they will loop rhythmically when smoothed by geometric intervals. For example if a curve is of ratio 2.00 and we smooth by whole duration intervals of that ratio then it will give a line cleared of waves. But if we smooth by half or one-third or one-fourth of duration it will loop rhythmically by twos or threes or fours respectively, *i.e.*, the troughs will appear at every two, three or four points as the case may be. If it is not geometric the troughs will be irregularly distributed.

Results—

90p Interval Smoothing

Looping		Ratio	Frequencies
2, 4, 8	...	1.94	14
		1.94 ² etc.	
3 and 6	...	2.70	...
		2.70 ²	37
10	...	...	9

63p Interval Smoothing

	Looping	Ratio	Frequencies
3	...	2.00	40
6	...	2.00 ²	...
4	...	2.53 ²	39
8	...	2.53	...
5	...	...	28

60p Interval Smoothing

	Looping	Ratio	Frequencies
3	...	1.94	...
6	...	1.94 ²	48
9	...	1.94 ²	...
4	...	2.40	29
8	...	2.40 ²	...
5	...	3.02	10

36p Interval Smoothing

	Looping	Ratio	Frequencies
2	...	1.30	14
4	...	1.30 ²	...
5	...	1.94	16
7	...	2.63	...
14	...	2.53 ²	36
21	...	2.53 ²	...

Thus the most frequent ratios may be arranged in groups like this :—

1.94	2.40	} 3.02 (not very common).
2.00	2.53	
	2.70	

Conclusions

(i) Out of so many curves there are only very few ratios which are also to be found in previous researches. This is really very astonishing.

(ii) The curves seem to be geometric. When smoothed according to geometric intervals they loop rhythmically.

(b) Shapes

After demonstrating the geometricity and the common ratios by smoothing the writer also demonstrates the same thing as well as the constancy of phase by the method of shapes.

The argument is very simple. If similars are treated similarly they will give similar results and this will be true in the matter of 'shapes.' If the curve is periodic similarity will have to be in respect of both period and phase.

If a curve showing a perfectly simple wave form is cut into successive sections of one period length each it follows that all the places so obtained will be similar in outline, each covering a complete crest trough unit. If these sections are added together an average shape or section is obtained. The main problem in respect to any given 'shape' is the portion of its deepest trough. Suppose the above shape is constructed on a seven unit base and the deepest trough comes at point 3 on the base line. If now we deal with a number of other curves and if they all have a deepest point at 3 in their shape then to that extent they can be said to be similar to one another. The argument is that if the different curves are not similar to each other, that is, there is no similarity in phase or wave length, then this frequency will show a chance distribution of trough points. But if the original curves are similar the frequencies will cluster on certain points more than a chance distribution would necessitate.

Results

		Points							X2	Level of significance
		1	2	3	4	5	6	7		
(3) Warburton	...	...	2	5	6	6	2	7	14	...
(1) Philpott	...	...	...	4	4½	1½	...	...	1	16.95
(4) Rath	...	...	1	3	2	2	...	...	4	...
Total	...	2	12	12½	9½	2	7	19	22.57	.001

The above table shows that the curves of the three researches are very similar to each other. When Rath's shapes are added to that of Warburton and Philpott the odds against chance are raised very significantly from 1 in 100 to 1 in 1,000. This also lends support to the general theory of constancy of phase and period in curves of fluctuation of attention, no matter who the subject or subjects. In other words shapes are based on curves containing geometric cycles belonging to the standard system.

(c) *Analysis of Variance*

Argument—A typical table of results may be envisaged as 320 columns and 4 rows. At the head of the columns we enter the times, 5, 10, 15 . . . seconds. In each column are four entries per row, indicating the amounts of work done in the four work curves covered by the table.

In other words, figures per row represent the output for each task entered against time and columns correspondingly show output value in the successive 5 seconds intervals. Now if there is a perfect wave system in all the curves the variance between the columns should be significant. This follows because we expect that some columns will contain mainly trough values and others mainly crest values. In other words the average output per column will sometimes be high and sometimes low and significantly so. That is, the variance of totals per column will be higher than expected by chance. This will be shown by our analysis in that the appropriate F ratio will be significant. On the other hand of course, if trough and crest placings are just a matter of chance then the total per column will hardly vary one from the other and the F ratio will be insignificant.

The second argument has to do with the Pool theory. This implies that there is a pool of many possible waves. For each experiment the subject takes as it were a random handful of waves from the pool. In such case the individual cases will differ widely. But as more and more samples are taken from the pool, grand total curves will become similar to one another. Moreover the larger the number of the single curves there are in the grand total, the more closely will it approach a standard end-product. If this hypothesis is correct then F ratio between the grand totals containing 160 curves each will be greater than those of curves containing 40—42 curves each.

Lastly the grand total curves of the writer are compared with those of Akil who has also used 320 curves from one individual.

CERTAIN ASPECTS OF WORK CURVES

The F ratio are given in the following table :—

Nature of curves	F ratios empirical	F ratios expected 1% level	Level of significance
4 curves of one kind of work—each containing 42 pieces.	1.45	1.30	Significant at 1% level
4 curves of mixed work of different tasks—each containing 4w pieces.	1.60	1.30	Do.
2 grand total curves each containing 168 curves.	2.85	1.39	Do.
Rath's and Akil's (s) curves, of one kind of tasks—each 168 curves.	2.85	1.39	Do.
Rath's and Akil's mixed type of work curves—each 168 curves.	1.72	1.39	Do.

The results definitely prove that the trough and crest sequences of the different curves from the same individual as well as from different individuals are not completely random and due to chance, but rather have a definite resemblance in crest and trough placings. When the grand total curves are compared the F values increase considerably. This warrants the conclusion that the stronger the curves, the greater is the resemblance. Thus the pool theory is verified again.

(d) *Correlation*

The argument behind this is very simple. A correlation coefficient is a measurement of agreement between two sets of variables.

If there is perfect agreement between two given curves in respect of their crest and trough placings then the correlation will be positive, and round about plus 1.00. If there is a relation just opposite to this, that is, crests in one coming at the same time as troughs in the other the correlation will be towards $r = -1.00$. If there is no relation whatsoever between them the correlation will be somewhere near 0.00.

Here the straight curves involving only one kind of task and the mixed grand total curves consisting different tasks will be inter-correlated. The theoretical curve will also be correlated with the above grand total curves. The theoretical curve is presumably an approximation to the ideal grand total result. By definition it gives the likelihood or probability of a trough occurring at a given point. For if as many as (say) 20 different waves could conceivably be given—a trough at time x , i.e., if X has 20 factors, then we are more likely to find a trough there—than at time Y if that number is prime.

Then the curves of the writer are also correlated with those of Akil because of the same reasons given above. The results are as follows :—

	Straight				Mixed	Theoretical
St.	...	...	...	...	·251	·168
Mixed	...	...	...	...	...	·389
Theoretical (5)	...	...	...	...	...	...
Akil's straight	...	...	...	} ·353	}	
Rath's straight	...	...	...			
Akil's mixed	...	...	...	} ·255	}	
Rath's mixed	...	...	...			

Here the correlation should be about ·181 to be significant at ·01 level. All the correlations except the one between the straight (Rath's) and theoretical are quite significant. The latter is significant at ·05 level. Some of them are very highly significant. The following conclusions can be drawn from this :

- (1) Curves irrespective of differences in tasks and persons involved are similar in nature, not only in trough and crest placings but also in phase.
- (2) So far as they correlate significantly with the theoretical curve of probability the waves are of general purpose and nature. Thereby the theory of a pool of all possible waves is proved. This is strengthened by the evidence that the stronger the empirical curves, the greater is the approximation to the standard end-product, which is represented by the theoretical curve.

E. Conclusion

Thus all the hypotheses stated in the beginning are verified.

The findings of this research as well as the general conclusions arrived at by different writers in this field do not seem to have any great promise in Applied Psychology. But it has tremendous theoretical possibilities which may closely link Psycho-physical organisms to physics and chemistry. In the psychological field, the behaviour of the organism appears to be so very indeterminate that many psychologists resent the encroachment of the physical and chemical concepts which are strictly scientific and logical. There is no doubt that the manifestations of the psycho-physical organisms are indeterminate and mostly unpredictable. But such

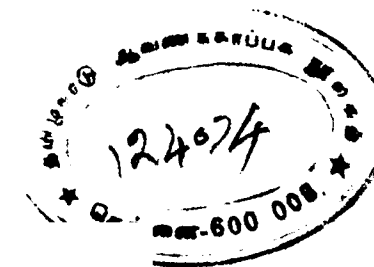
was the case with the other sciences at the beginning. To a layman the changes in weather appear to be completely erratic and indeterminate but the achievements of the weather experts will show that it is not so. They can predict a good deal about it. Similarly our main conclusions in this field may serve as fundamental groundings on which the future edifice of a grand synthesis of all the sciences may be built.

Our conclusions regarding the constancy of 'waves', the 'pool' of general purposes, nature, the absence of individual differences either in tasks or persons involved, etc., may just serve as hints for the guidance to the vast uncharted stretches of the psycho-physical world. Our universal p which seems to enter every kind of task and person employed, at all sorts of places and times, as well as of ages and sexes, may have some connection or parallel with the ' h ' of Quantum Physics. We do not know. In the words of Arthur Eddington(6) "an addition to knowledge is won at the expense of an addition to ignorance. It is hard to empty the well of truth with a leaky bucket."

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An Empirical Investigation of Job Analysis Reliability, Methods and Results

K. N. SHARMA AND P. N. KALRA

Indian Statistical Institute

Introduction

In order to select suitable workers for jobs, maintain fitness at work, develop a satisfactory training programme, eliminate unnecessary fatigue, reduce the rate of accidents, have a satisfactory job evaluation system, proper transfer and promotion of employees and full utilization of manpower in an industrial concern, objective information about the personnel is essential. The information should cover occupational activities and responsibilities, duties of workers and supervisory staff, working conditions and hazards that affect the efficiency of the workers and other supplementary information which may be required for job performance and job evaluation (10, 13). This information can be obtained in a comprehensive and objective manner by means of "job analysis."

Job analysis has been defined in different ways but the central idea in all the definitions is that job analysis is a scientific study of all the facts about a job revealing its content and modifying factors (13). For clear understanding it would be worthwhile to include two widely accepted definitions: Ralph C. David says, "A job analysis is an investigation and analysis of work assignment, and the conditions surrounding it, to determine its requirements from an organizational standpoint..... It is used by the personnel department to procure information regarding the job and the worker that will facilitate employment, promotion, transfer, and training" (9).

Job analysis has been defined by the Organization for European Economic Co-operation (10), "as a method of: (i) Breaking down facts about a job to determine its essential component features and the qualities required of the worker to perform it, and (ii) recording such facts in a convenient and usable way." It includes the contributions of both the employer, *i.e.*, tools, materials, pay and general working situations as well as the employee, *i.e.*, skill, intellectual capacity, previous experience and personal qualities (2).

It may be of interest to trace the development of the concept of job analysis. The early Time Study men were called "job analysts" by some industrial engineers. While referring to job study the Taylor group used the term "Time Study" and the Gilbreth group used "Motion Study." From 1909 to 1912 a job study included job classifying, job rating, hiring, transferring and promotion, *i.e.*, personnel functions. This trend was developed by E. O. Griffenhagen for the municipal service at the Commonwealth Edison Company, Chicago, and carried to similar

companies and government offices employing large clerical forces. In 1914 Harry A. Hopf classified clerical positions in banks and insurance offices. During World War I there was a rapid growth in the personnel movement and "job analysis" became one of its important activities. In 1920 the National Personnel Association defined job analysis as "a process which results in establishing the component elements of a job and ascertaining the human qualifications necessary for its successful performance." After 1922 every manufacturing company large enough to afford a personal staff was using job analysis as its main source of data for personnel work. Personnel department functions may be said to have grown up during 1922-29. During the period 1931-37 job analysis became fundamental and because it had also contributed to better classification, it served as the basis of systematic job evaluation. Since then it has been widely used in industrial concerns in America and Europe (9).

The job analysis method has become an essential part of industrial management and if followed properly, it can assist in increasing industrial productivity. Before we go into the discussion of the methods by which job analysis is done and the tools which are essential for this method, it will be appropriate to mention the job information needed. The basic job analysis formula consists of four steps *i.e.*, (i) What the worker does, (ii) How he does it, (iii) Why he does it, and (iv) What is involved in doing it (10). If this formula is used efficiently and carefully, many difficulties that are encountered in actual performance of a job, in establishing a job analysis programme can be solved. This formula emphasizes the need for the specification of the required job information. Information regarding job duties, performance requirements, working conditions and other relevant data is needed while preparing a job analysis programme. Every activity of a worker should be included in job duties and it should be kept in mind that the activity of the worker is specifically mentioned in the way the worker actually does it and not in the way it should or may be done. Performance requirements such as responsibility—supervisory as well as non-supervisory; job knowledge; mental application, *e.g.*, mental alertness, attention, concentration and planning; dexterity and accuracy and physical requirements should be clearly mentioned. Working conditions and hazards that affect the efficiency of the worker and the additional relevant data, *e.g.*, identification data, experience and training necessary for a particular job etc., should be gathered beforehand. (8, 9, 10)

The job analysis tools used to obtain this information are (10, 13): Job Specification, Employment Interview, Job Description, Job Variables, Job Families, Job Inventory and Occupational Classification System.

Industrial psychologists, industrial engineers and industrial executives have stated that job analysis is a method by which many important problems can be solved, leading to increased productivity, due to full utilization of manpower. This programme has been widely accepted and at present almost all the large indus-

trial concerns in foreign countries have employed trained job-analysts who are working quite successfully, but it is a matter of surprise that the literature does not reveal any scientific investigations establishing the reliability of the job analysis programme. The existing literature describes the theoretical approach and applicability of the programme, giving the background knowledge and the methods which are applied, and the specification of the fields in which the programme can successfully be carried out. This, however, is all theoretical and no statistical data are available to demonstrate the reliability of the programme.

Purpose of the study

This investigation had three objectives.

(A) To find out the reliability of the job analysis method under the following four headings :

- (i) Repeat Reliability, *i.e.*, reliability of the analysis done by the same individual on the same job at two different times.
- (ii) Inter-Analyst Reliability, *i.e.*, reliability of the analysis done on the same job by two different individuals.
- (iii) To find out differences, if any, in the reliability for different sets of characteristics, *i.e.*, physical, mental and personality.
- (iv) To see if reliability increases with practice in job analysis.

(B) To find out whether the time and money spent in carrying out the combined Analysis and Description Method are justified and if Analysis alone is not sufficient.

(C) To formulate a method for determining and studying the relative weight of physical, mental and personality requirements for different classes of jobs.

Methods

The following methods were employed for analysing the jobs :

- (1) *Analysis Method* : In this method the analyst rates the required characteristics on a rating scale, on the basis of his 'On-the-Spot' observation of the job.
- (2) *Description Method* : In this method the ratings are done on the basis of detailed description of the job given to him. He is not required to go and observe the job 'On-the-Spot.'
- (3) *Combined Description and Analysis Method* : This is a combination of the above two methods, where both the description and analysis are done by the same analyst on the basis of his 'On-the-Spot' study of the job. This method is most widely used.

A job analysis pro forma prepared in the Psychometric Unit of the Indian Statistical Institute was used. Physical, mental, and personality requirements were rated on a four point scale, as follows :

- A—The characteristic is required or true to a great extent.
- B—The characteristic is required or true to some extent.
- C—The characteristic is required or true to a little extent.
- D—The characteristic is neither required nor true.

The following characteristics are rated :

- (i) *Physical* : height, weight, muscular strength, eye-hand co-ordination, foot-eye-hand co-ordination, ability to move fingers rapidly and accurately, ability to move hands and arms, ability to move foot and leg, walking, jumping, running, crawling, climbing, standing, talking, throwing, pushing, pulling, accuracy of vision, accuracy of hearing, accuracy of taste, accuracy of smell, ability to discriminate colours, and accuracy of touch.
- (ii) *Mental* : ability to perceive form of objects, ability to perceive spatial relationship, ability to perceive speed of moving objects, ability to perceive mechanical relationship, ability to estimate size of objects, ability to estimate quality, ability to estimate quantity, ability to learn quickly, memory for details, memory for verbal directions, memory for written directions, ability to do logical reasoning, ability to make general discrimination, skill in oral expression, skill in written expression, accuracy in grammar, accurate spelling and vocabulary, skill in quick reading, accuracy in arithmetical computation, and ability to supervise others' work.
- (iii) *Personality* : persistence in repetitive work, carefulness, ability to work under hazards, ability to win co-operation and sympathy of others in work, concentration of mind, ability to behave gently with others, self-confidence, ability to understand the real causes of a failure, and ability to maintain good relationship with people outside the department.

The following seven jobs were analysed :—

Sl. No.	Job	Brief Description
1.	Turning	... Turning out various mechanical parts on a Lathe Machine driven by electricity.
2.	Monocasting	... A job in the Printing Press, in which letters are composed from molten lead metal.

- | | | | |
|----|----------------------|-----|---|
| 3. | Sorting | ... | An operational job on I.B.M. and Hollerith machines involving the sorting of punched cards in serial or any other order. |
| 4. | Tabulating | ... | Copying and tabulating data from punched cards using I.B.M. and Hollerith machines. |
| 5. | Calculating punch | ... | Various types of arithmetic calculations are done on punched cards using I.B.M. and Hollerith machines. |
| 6. | Assistant (Clerical) | ... | A typical clerical assistant in an office, doing correspondence, maintaining files, records, etc. |
| 7. | Computation | ... | Hand and electric Computing Machines (Facit) are used for doing various types of calculations and applying formulae to data supplied. |

The data obtained for the above 7 jobs were analysed for purposes (a) and (c), i.e., reliability and weightage, and data from three jobs, Nos. 1, 2, and 4 above were analysed for purpose (b), i.e., effectiveness of the various methods. All jobs were analysed by two analysts working independently, and each analyst repeated his analysis after an interval of time, to ensure independence between the first and the second analysis. The jobs were analysed in the same sequence.

Repeat reliability was found by computing the product moment correlation between the first and the second ratings of each analyst separately for each of the 7 jobs, and then taking the mean of the correlations to obtain a single index of reliability. Fisher's Z transformation was used to average the correlations. Inter-analyst reliability was found by computing the product-moment correlation between the ratings of the two analysts for all the 7 jobs and the mean of the correlations was similarly found. The correlations were computed and averaged separately for physical requirements, mental requirements and personality requirements.

The effectiveness of various methods was studied by having three identical jobs analysed by the three different methods. Each method was applied by two analysts. The methods are noted below with their abbreviations.

- | | | | |
|----|--|-----|----|
| 1. | Combined Analysis and Description Method | ... | AD |
| 2. | Analysis Method | ... | A |
| 3. | Description Method | ... | D |

In this way each job was analysed by 6 individuals. Inter-correlations between the ratings done by three different methods were computed according to the following design, separately for each job and set of characteristics.

		AD & A Rater		AD & D Rater		D & A Rater	
		I	II	I	II	I	II
Rater	I	r_1	r_2	r_1	r_2	r_1	r_2
	II	r_3	r_4	r_3	r_4	r_3	r_4

The mean of r_1 , r_2 , r_3 and r_4 was taken as an index of inter-correlation between two methods for one job. These indices were further averaged and an overall index of inter-correlation between two methods was obtained separately for physical, mental and personality characteristics. All averaging was done by the z transformation (6). These were compared and the differences were tested for statistical significance by the method given by Hotelling (14), the formula for which is explained below :

Let X = rating done by method A.

Y = rating done by method D.

Z = rating done by method AD.

then significance of difference between r_{XZ} and r_{YZ} is calculated by

$$t = (r_{XZ} - r_{YZ}) \sqrt{\frac{(N-3)(1+r_{XY})}{2(1-r_{XY}^2 - r_{XZ}^2 - r_{YZ}^2 + 2r_{XY}r_{XZ}r_{YZ})}}$$

t having "student's" distribution with N-3 degrees of freedom.

For purposes of assigning weights, the 7 jobs were divided into three classes representing mechanical, clerical, and computational (using I.B.M. and Hollerith machines). Those characteristics which received ratings AA, AB, BA, BB, considering both first and repeat ratings, were regarded as important. The number of such important characteristics was counted for physical, mental, and personality requirements. The mean of the numbers of important characteristics as rated by two analysts for each class of jobs, was taken as the weight for that group. The relative weight was found by percentages, equating the total of the three sets of requirements for each group to 100.

Results

The values of r representing repeat reliability are given separately for each job and set of requirements in Table 1, each analyst being listed separately. The corresponding values of z are also given, making apparent the process of finding the mean correlation at the bottom of the Table.

TABLE 1
Repeat Reliability

Characteristics			Physical N = 24		Mental N = 20		Personality N = 9	
Sl. No.	Jobs	Rater	r	Z	r	Z	r	Z
1.	Turning :	1	.86**	1.29	.84**	1.22	.62	.73
		2	.88**	1.38	.76**	1.00	.88**	1.38
2.	Casting :	1	.69**	.85	.52*	.58	.71*	.89
		2	.88**	1.38	.69**	.85	.76*	1.00
3.	Sorting :	1	.90**	1.47	.70**	.87	.94**	1.74
		2	.94**	1.74	.62**	.73	.92**	1.59
4.	Tabulation	1	.86**	1.29	.77**	1.02	.84**	1.22
		2	.81**	1.13	.88**	1.38	.94**	1.74
5.	Calculating punch	1	.82**	1.16	.86**	1.29	.96**	1.95
		2	.85**	1.26	.73**	.93	.90**	1.47
6.	Assistants (clerical)	1	.79**	1.07	.85**	1.26	.83**	1.19
		2	.84**	1.22	.95**	1.83	.95**	1.83
7.	Computa- tion.	1	.99**	2.65	.93**	1.66	.97**	2.09
		2	.86**	1.29	.85**	1.26	1.00**	5.00
Total				19.18	15.88		23.82	
Mean Z				1.37	1.13		1.70	
Mean r			.88**	.81**		.94**		
*p < .05								
**p < .01								

Table 2 gives the values of inter-analyst reliability separately for each job and set of characteristics and also the mean correlation for each set of characteristics separately.

TABLE 2
Inter-Rater Reliability

Job	Characteristics					
	Physical N = 24		Mental N = 20		Personality N = 9	
	r	Z	r	Z	r	Z
1. Turning ...	.74**	.95	.71*	.89	.63	.74
2. Monocasting ...	.66**	.79	.32	.33	.57	.65
3. Sorting ...	.53**	.59	.18	.18	.72*	.91
4. Tabulation ...	.49*	.54	.41	.44	.69*	.85
5. Calculating Punch ...	.53**	.59	.57**	.65	.68*	.83
6. Assistant (clerical) ...	.78**	1.05	.85**	1.26	.91**	1.53
7. Computation ...	.92**	1.59	.40	.42	.91**	1.53
Total ...		6.10		4.17		6.85
Mean Z ...		.87		.60		.98
Mean r ...	.70**		.54*		.75*	
						**p < .01
						*p < .05

In Table 3 the jobs are listed in the order in which they were analysed and the progress of reliability can be seen for the three sets of requirements.

TABLE 3
Showing the Improvement in Reliability of Job Analysis with Practice

Jobs	Turn- ing (1)	Cast- ing (2)	Sort- ing (3)	Tabu- lation (4)	Calcu- lating Punch (5)	Assis- tant (6)	Com- puting (7)
Physical (N = 24)...	.87**	.81**	.92**	.84**	.89**	.81**	.96**
Mental (N = 20) ...	.80**	.62**	.66**	.83**	.80**	.91**	.90**
Personality (N = 9)	.78*	.74*	.93**	.90**	.94**	.91**	.99**
				**p < .01			
					*p < .05		

Table 4 (A, B and C) present respectively for physical, mental and personality requirements, the mean values of inter-correlations between the three different methods, giving the inter-correlations separately for each job.

TABLE 4

A. Mean Correlations and Z values for Physical Characteristics
N = 24

Methods	Jobs	A and AD		D and AD		A and D	
		Z	r	Z	r	Z	r
Turning ...	...	.9300	.73**	.80	.67**	.76	.64**
Monocasting ...	...	.9550	.74**	.6175	.55**	.8125	.67**
Tabulation ...	...	1.0325	.77**	.72	.62**	.87	.70**
Mean ...	...	.97	.75**	.71	.61**	.81	.67**

B. Mean Correlations and Z Values for Mental Characteristics
N = 20

Methods	Jobs	A and AD		D and AD		A and D	
		Z	r	Z	r	Z	r
Turning ...	...	.5375	.49*	.675	.59**	.2700	.26
Monocasting ...	...	.4925	.45*	.335	.33	.5125	.47*
Tabulation ...	...	.4425	.41	.505	.46*	.2250	.22
Mean ...	...	.49	.45*	.50	.46*	.34	.33

C. Mean Correlations and Z Values for Personality Characteristics
N = 9

Methods	Jobs	A and AD		D and AD		A and D	
		Z	r	Z	r	Z	r
Turning ...	...	.9025	.72*	.4325	.40	1.1350	.81**
Monocasting ...	...	1.0275	.77*	.98	.75*	2.1350	.97**
Tabulation ...	...	.37	.35	.785	.65	.7375	.63
Mean ...	...	.77	.65	.73	.62	1.34	.87**

*p < .01

**p < .05

In Table 5, the differences of inter-correlations between A and AD, D and AD are given separately for each job, along with their respective degrees of freedom and t values. Their level of significance is also indicated.

TABLE 5

Tests of Significance for differences between Inter-correlations for Three different methods

Characteristics	df	difference in r between A and AD and D and AD	t	levels of significance
Physical ...	21	.14	1.22	20%
Mental ...	17	.01	.03	Not significant
Personality ...	6	.03	.17	Not significant

Weights and relative weights for physical, mental and personality characteristics for three different classes of jobs are given in Tables 6 and 7 respectively. The classification is as follows :

Class	Jobs included
Mechanical ...	Turning and Monocasting
Clerical ...	Assistant (clerical) and computation.
Computational (I.B.M. and Hollerith machines) ...	Sorting, Tabulating and Calculating.

TABLE 6

Weights of Different Characteristics for the classes of jobs

Characteristics	Physical	Mental	Personality
Mechanical ...	4.5	5.25	3.5
Machine calculation ...	3.83	4.00	3.17
Clerical ...	2.75	6.	3.75

TABLE 7

Relative weights of Different Characteristics for 3 Classes of Jobs

Characteristics	Physical	Mental	Personality
Mechanical ...	33.96	39.62	26.42
Machine calculation ...	34.82	34.36	28.82
Clerical ...	22.	48.00	30.

Discussion

A perusal of the Tables on reliability reveals that job analysis by the combined analysis and description method, shows high repeat reliability and is, therefore, yielding consistent results. The tables also show that if at least two persons analyse the jobs independently, high reliability is not only obtained but objectivity is also achieved. This is more marked in the case of mental characteristics. It is seen that ratings done on physical and personality characteristics have higher reliability than those on the mental characteristics. Need for greater care in the rating of mental characteristics is thus indicated. The improvement in reliability observed with more practice points to the importance of employing only trained and experienced men for job analysis.

On the basis of our findings we recommend the job analysis method as a safe and reliable method for use in practical situations. Although such detailed analysis as has been done here may not be warranted for reasons of time and economy, it is yet desirable that the ratings done by one analyst should be checked, at least in a sample of cases, by another analyst making the same ratings independently of the first. This will ensure both reliability and objectivity of the data.

Comparing the three different methods of Job Analysis, it is seen from Table 5 that the differences of the inter-correlations between A and AD and D and AD are not statistically significant when tested by Hotelling's formula. From this we may conclude that analysis and description are contributing almost equally to the combined method, and with such results dependence upon analysis alone or description alone may not be advisable. In the case of mental characteristics, the inter-correlations between A and D are quite low, while their inter-correlations with AD are almost equal, a fact which adds to the importance of using both sources of information in arriving at the final analysis.

Some interesting facts emerge from the study of Tables 6 and 7, which are contrary to general expectation. For example, mechanical jobs do not get the highest weights for physical requirements, and mental requirements are found to be more important. In the case of computational jobs, using I.B.M. and Hollerith machines, physical requirements are found to be as important as the mental ones. Personality requirements are found to be almost equally important for all jobs. This brings home the importance of scientifically studying the jobs rather than depending upon common sense notions. The method developed for finding the weights may be usefully employed in other studies.

Summary

Job analysis is the basic tool of Industrial Psychology and scientific Factory and Business Management. It is widely used for a number of purposes, such as selection and training of personnel, job classification, and job evaluation. The basis of this concept is the job analysis formula which involves four steps, i.e., (i) 'What the worker does', (ii) 'How he does it', (iii) 'Why he does it', and (iv) 'What

is involved in doing it'. Job analysis can be done by three different methods, namely 'Analysis Method', 'Description Method' and 'Combined Analysis and Description Method'. The third method is widely used, although it involves more time and money.

An investigation which was carried out in order to test the reliability of the job analysis and all the three methods has been reported. Reliability of job analysis has been tested under four headings, namely, Repeat Reliability, Inter-Analysis Reliability, differences in reliability for different sets of characteristics and progress on reliability with practice. Repeat reliability and Inter-Analyst reliability have been found to be high. Ratings on physical characteristics and personality characteristics are seen to be more reliable than those on the mental ones. An increase in reliability has been observed with practice in job analysis.

It has been shown that analysis and description contribute almost equally to the combined analysis and description, indicating that the time and money spent in carrying out the Combined Method are justified.

A method has been formulated for determining the relative weights of physical, mental, and personality characteristics for various classes of jobs.

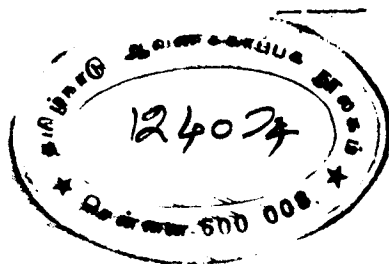
Acknowledgments

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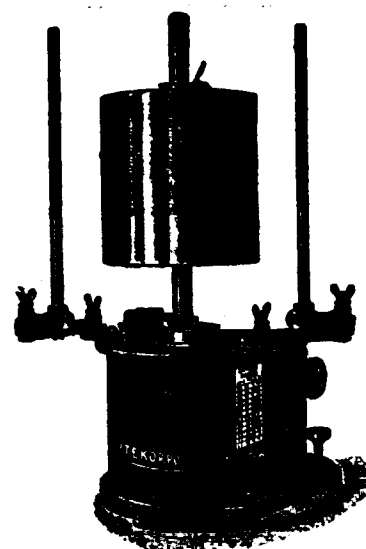
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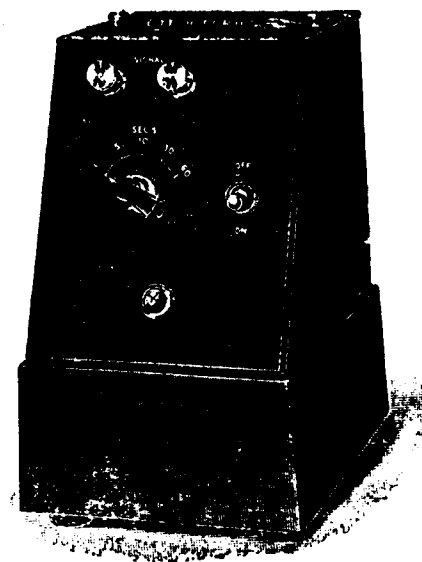
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