PART 1. INTRODUCTION
CHAPTER I

PSYCHOLOGICAL TESTS IN PERSONNEL SELECTION

Introduction

Studies of individual differences created an awareness of the need to device psychological tests to measure the characteristics of mental make up. The greatest impetus to this awareness came from Charles Darwin who showed that the "survival of the fittest" maxim which applied to plants and lower animals could well apply to human beings. If differences in survival rate result in slow changes in the species of a lower animal over many generations, individual differences in humans may slowly lead to changes in the average characteristics of the entire human species. It was soon realized that there was no end to ways people differed from one another in physical as well as mental characteristics. But psychologists were more interested in a study of individual differences in mental characteristics in general and in intellectual characteristics in particular.

The major problem with research on individual intellectual differences has been whether the cognitive domain of an individual is made up of a single general factor, popularly known as intelligence or g, or a conglomeration of several important, independently varying factors, popularly known as abilities. In other words, is intelligence a general, all pervasive factor or is it composed of several unitary and independent
abilities? The problem has not yet been resolved completely although the consensus of opinion is in favour of the latter notion. Meanwhile numerous psychological tests have been developed to measure the intellectual capacity of the human being. In fact, the development of tests has generally far outrun an understanding of the basic nature of intelligence. However, both the researches on the theoretical understanding of intellectual capacity and the development of psychological tests to measure this capacity have progressed along side the above two notions.

Notions On Intelligence

Unifocal view

A scientific study of intelligence was initiated by two leading psychologists, Charles Spearman (1904) and Alfred Binet (1905), although historically Francis Galton in England and James McKeen Cattell in USA started their work shortly before the turn of the century. Both Galton and Cattell were imbued with the Darwinian spirit prevailing then, and had perceived the significance of individual differences in mental and physical characteristics of human beings. They accepted that even moral and intellectual features of men were dependent upon physical ones and, therefore, developed tests to measure sensory thresholds, and simple psychomotor abilities such as strength of handgrip, reaction time, perception of pitch, judgement of weight, etc. Galton (1869) gave the first glimpse of the notion of the general mental capacity when he criticized the prevailing faculty theory and argued that in practical and intellectual
pursuits, we have to recognize a general ability over and above some more specialized aptitudes (Burt, 1970). He has further shown, chiefly, by examining pedigrees, that this general ability is to a large extent hereditary, or at least innate. Cattell did not spell out the nature of intellectual capacity. He administered his tests to several college students (1890, 1896). Cattell's tests for prediction of college grades were poorly related both to each other and to the practical criteria of intellectual functioning such as educational achievement (Sharp, 1898-1899, Wissler, 1901, Gilbert, 1897). The poor performance of the Cattell's tests, however, proved to be the starting point for the conceptualization of intelligence.

In 1904 Spearman argued that poor intercorrelations among tests were primarily due to the unreliability of the separate measures. When errors of measurement were taken into account, he found that these tests had substantial common variance which was almost perfectly correlated with the common element in estimates of intelligence obtained from school grades and teachers' ratings (Spearman, 1904). The correlation matrices showed for the first time that by rearranging the order of the tests along the edge of the matrix he could always get a "hierarchy." That is to say, the correlation coefficients would decrease in size uniformly from above downwards and from left to right. He showed that the existence of a hierarchy tested by the tetrad differences criterion lead one to think that every ability can be divided into two contributions: A general mental ability (labeled g) which it shares with all other abilities, and
an ability absolutely specific to that performance (labeled s) (Spearman, 1914 and 1927). This is Spearman's famous two-factor theory of g and s. This marked the beginning of conceptualization of intelligence and controversies on this topic. "The two-factor theory has had to face later modifications, but for 25 years it was a tower of strength in the form of a clear cut, methodological, testable reference theory ..." (Cattell, 1971, p. 19).

Binet was commissioned in 1904 to devise a procedure for segregating slow learners in the schools of Paris. His innovations led to the construction of the famous Binet Scale of general intelligence, which is the first known systematic realization of a standardized test of intelligence. It has dominated the conceptualization and measurement of this variable ever since (Binet and Simon, 1916).

What were Binet's views about intelligence as a theoretical concept? Did he hold the multifocal concept of intelligence or unifocal? Preferring complex tests and often remarking on the great complexity of intelligence, Binet seems to reject the monarchic nature of intelligence. He even says that our specialized mental tests can only analyze a single faculty (Binet, 1909). But in adapting a single score for his test he not only shows the unifocal view, but as Guilford (1967) says appears to be inconsistent also. Spearman also described it as "inconceivably illogical" (Spearman, 1927, p. 24). Guilford while explaining Binet's inconsistency says, "It is obvious that Binet did not carry his conception of independent
Multifocal Notion of Intelligence

Although Binet did not spell out clearly the oligarchic nature of intelligence, he certainly sowed the seed of this school of thought. After the initial work of Spearman and Binet evidence challenging the notion that a single underlying factor of general ability could account for intercorrelations among all mental tests accumulated from many directions, such as intraindividual differences in abilities, the low intercorrelations of many tests with I.Q. test scores, and the differential intellectual symptoms found associated with brain injuries and brain insults of other origin (Guilford, 1967).

Thorndike (1927), not convinced of g, believed that a random set of tests will reveal several massive group factors, e.g., verbal, mathematical, dexterity, rather than a single general factor, which are so broad that they might be called distinct g's or varieties of intelligence. Thorndike grouped these g's into social intelligence, concrete intelligence, and abstract intelligence.

But the greatest jolt to the monarchic view of intelligence came from Thurstone, a talented and inventive engineer turned psychologist who...
devised the new mathematico-statistical tool of multiple factor analysis, to discover how many group factors could account for test intercorrelations (Thurstone, 1931; and 1947), although factor-analysis began in psychology with Spearman and Pearson and was carried forward by Burt, Kelley, Hotelling, and Thompson. Thurstone found seven or eight quite distinct psychologically interpretable factors which he referred to as primary mental abilities, such as verbal, numerical, spatial, perceptual, inductive reasoning, deductive reasoning, and associative memory. (Thurstone, 1938).

The further pursuit of primary abilities following Thurstone's method was undertaken by many investigators. (Adkins, 1952; Alexander, 1935; Brodhent, 1965; Carroll, 1941; Fleishman, 1954; Kelley, 1954; and Rimoldi, 1951). The most outstanding work in this area which not only enriched but also clarified the nature of primaries has been conducted by Guilford and his co-workers (Guilford, Christenson, et. al. 1954a; Guilford Christenson, Frick, and Merrifield, 1961; Hoepfner, et. al. 1964; Peterson, 1963; and Guilford and Zimmerman, 1948). Over the years the list of primaries increased considerably. Kelley (1928) discovered seven factors, Thurston eight, Shartle (Staff, 1945) 11, and Guilford first 28 and then as many as 120. The discovery of the several primary mental abilities by Thurstone exploded the unifocal view, although Spearman and his followers had lately started realizing such a possibility. Cattell writes, "For a moment it threatened to replace general intelligence and I.Q. by a quite
different structural picture in which about a dozen primary abilities were salient concepts ... it was treated as a psychological earthquake ... I.Q. was no longer a useful concept". (Cattell, 1971, pp. 24-25).

Rapprochment Between Unifocal and Multifocal Notions

However, after considerable controversy a rapprochment between the general factor and the multiple factor theories of intelligence seemed possible in "Second-order factors". Thurstone not only proved the existence of several distinct primary abilities but also showed that a single general ability can be considered to lie further back in a sense as a source of these primaries. It was hoped that when first order primary abilities were again factor-analyzed through the multiple factor analysis, a single general factor, similar to g, would be found. Cattell (1941) pointed out such a possibility and Thurstone fully concurred with it. However, most of the subsequent analyses of intercorrelations among first order factors obtained more than one second order factor. Since more than one second order factor appeared, it was asked to which one of them should be called as a second order g. Thurstone suggested that one of them, perhaps the inductive factor, might correspond to Spearman's g.

Second order factors are criticized on several grounds. Vernon argues that g is not uniquely determinable but is conditioned by tests put into the matrix. Guilford objects that g is not general since many intellectual tests ultimately found that do not positively correlate together.
Third, the demarcation of $g$ depends on the degree of obliqueness of the primaries, which constantly alters with the population or sample and introduce lack of uniqueness in a second sense. And last, more than one second order factor exists among primaries. Guilford asks: "... which one of them is $g$, or is any of them? It may well be that none is common to all first-order factors, and hence to all tests ... (it) cannot represent any stable psychological concept. One could go on to third - and higher order factor levels, until only one factor emerged, but the same objections would still apply, even if a single factor were finally reached" (Guilford, 1968, p. 219). In the second order factors, Cattell's theory of fluid and crystallized intelligence is most well known and needs to be mentioned.

Cattell's Theory of Fluid and Crystallized Intelligence

Regarding the last criticism against second order factors, Cattell says: "... existing preliminary second order factorings show not one, but three or four, second order factors among primaries, is more significant and opens the door to a new theoretical development" (Cattell, 1957, p. 875). Cattell does not argue for one general ability, like Spearman, but for several general abilities. Of these, two called fluid intelligence ($G_f$) and crystallized intelligence ($G_c$) are of major importance. Crystallized intelligence is more highly involved in cognitive tasks in which skilled habits have become crystallized as the result of earlier learning. Crystallized general mental ability shows itself heavily in such primary
abilities as verbal factor, V; numerical ability, N; reasoning, R or I; mechanical information and skill, MK; and experimental judgement. Crystallized intelligence reaches its maximum level during 25 to 30 years of age. It is less variable in cultures, and local rather than generalized brain damage affects it more.

Fluid intelligence, on the other hand, is involved more in tasks which require adaptation to new situations where crystallized skills, resulting from prior learning, are of no great advantage. It is largely innately determined and depends more on general physiological efficiency. It reaches a maximum early (14 years) and declines after about 20 years of age. General brain damage will have more pronounced effect on fluid intelligence. It appears in exercises, such as series, classifications, analogies, and topology. It is more highly correlated with the speed of learning in a new area (Cattell, 1957; Cattell, 1963; and Cattell, 1971).

Cattell's theory is similar to Spearman's theory. Spearman argued for single innate general factor whereas Cattell talks about two factors. Spearman factor analyzed the test scores whereas Cattell factor analyzed the primary factors. Like fluid and crystallized intelligence three other famous dualities in this area often confused with fluid and crystallized intelligence are: (1) Distinction between "verbal" and "numerical-quantitative" ability score, (2) Guilford's convergent V, divergent thinking abilities, and (3) Vernon's (and sometimes Burt's) distinction of verbal educational (V: ed) V, practical mechanical (M:k factor) general
ability. Cattell emphasizes that his factors of fluid and crystallized intelligence are different from the other dual factors (Cattell, 1971). However, the similarities among them are shown subsequently.

Structural Models of Intelligence

We are left at this point with an unhappy choice at the theoretical level between a theory of general intelligence inadequate to account for observed data and a theory of multiple abilities which offers an unorganized collection of miscellaneous skills increasing in number every year. Pursuing a coherent theory of intellectual functioning, it soon became clear that some mode of organizing the separate abilities will have to be found that will take into account the varying amounts of interrelationships they display and provide a framework for individual assessment. This pursuit resulted in two types of models. With the British who insist on g factor, the models have been hierarchical (Burt, 1949; Vernon, 1960). In the U.S. where Thurstone’s multiple-factor models have prevailed and no g factor is found, except on rare occasions, the morphological type of model has been proposed (Guilford, 1959).

Guilford’s Structure of Intellect Model

The most illuminating work on this subject in recent years is that of Guilford (Guilford, 1959, 1967). He collected massive data on factors of human intellect and developed a classification scheme or taxonomy for these factors. On the basis of more than two decades of analytical
research on factors, in which he found no evidence for general ability or g, he proposed a box-like morphological model which classifies intellectual traits along three broad dimensions, and their various subdivisions (Figure 1.1).

**Operations:** Major kinds of intellectual activities or processes done by the organism including cognition, memory, divergent production, convergent production, and evaluation.

**Contents:** The nature of the material or information on which operations are performed including figural, symbolic, semantic (e.g., words), and behavioral (information about other person's behavior, attitudes, needs, etc.)

**Products:** The basic form in which information is processed by the respondent. Products are classified into units, classes, relations, systems, transformations, and implications.

The descriptive parameters of Guilford's structure of intellect form a cube of $4 \times 5 \times 6 = 120$ cells, each of which represents at least one hypothetical mental ability, i.e., an independent source of variance among individuals. Some cells may contain more than one factor also. But many of these cells are still hypothetical, awaiting the construction of special tests capable of measuring the hypothetical abilities that are defined by the various possible combinations (120 in all) of the parameters of the model. Guilford and his associates have identified 98 of the anticipated factors (Guilford and Hoepfner, 1971). The remaining unfilled cells provide a plan for further research. Figure 1.1 gives the names and letter symbols for each dimension. The location
Fig. 1.1: Guilford's Structure of Intellect Model. (Guilford, 1967, p.63)
of a factor in the structure of the intellect model is indicated by a three-letter symbol of operation, content, and product, in that order. The well-known factor of verbal comprehension, for example, corresponds to cognition of semantic units (COM) and is best measured by a vocabulary test. It is not possible to describe every known factor here. More information regarding the factors is available in Guilford and Hoepfner, 1971; Guilford, 1967; and Christensen and Guilford, 1963.

Hierarchical Models

Guilford's model leads to an appallingly large number of separate factors and says nothing about possible relations between them. Alternate models for the organization of factors have been proposed by several British psychologists, including Burt (1949), and Vernon (1960), and Humphreys (1962) in U.S.A.

Burt's Model

Burt's model is like an inverted tree (Figure 1.2)

Burt makes a first major dichotomy between intellectual characteristics or g and practical characteristics. Among the practical abilities he places the psychomotor abilities and aptitudes for dealing with space and mechanical matters. He identified "relations" at the highest level, "associations" at the second level, "perception" at the third, and "sensation" at the fourth. Burt has fitted various group factors at the various levels in his model.
Fig. 1.2: Burt's Hierarchical Model of Mental Abilities. (Burt, 1949, p. 103)

Fig. 1.5: Vernon's Hierarchical Model of Mental Abilities. (Vernon, 1960, p.22)
Vernon's Model

Vernon (1960) makes a beginning like Burt (Figure 1.3). At the top of the hierarchy, he places Spearman's g factor. At the next level are two broad group factors corresponding to verbal-educational (V;ed) and to practical mechanical (K;m) aptitudes, respectively. Factor V;ed subdivides into verbal and numerical abilities and factor K;m into space and psychomotor abilities. Further analysis can identify narrower subfactors. At the lowest level of the hierarchy are the specific factors.

Jensen's Two Level Theory of Mental Abilities

Jensen (1969, 1970) felt that literature on social class differences in intelligence cannot be systematized without positing at least two dimensions. One dimension is the culture loading dimension defined by the theoretical extremes of complete heritability ($h^2 = 1$), in which there is no environmental variance in test scores, and at the other extreme of zero heritability in which all variance is attributable to environmental factors. The other is the complexity dimension, going from simple associative learning to complex conceptual learning (Figure 1.4).

Level I ability is essentially the capacity to receive or register stimuli, store them, and later recognize or recall them with a high degree of fidelity. Level II ability is characterized by transformation and manipulation of stimulus prior to making the response. Digit span and
LEVEL II
ABSTRACT PROBLEM SOLVING
CONCEPTUAL LEARNING

Progressive Matrices
Stanford-Binet

h² = 1
"culture free"

Arithmetic Test
Spelling Test

h² = 0
"culture loaded"

Serial Learning
Digit Span

ASSOCIATIVE LEARNING
LEVEL I

Fig. 1.4: Jensen's Two-level Model of Mental Abilities. (Jensen, 1970, p. 154).

G

V

N

Q

T

Candidate 3
Candidate 4
Candidate 5

Fig. 1.6: Scores Expressed in Percentile Rank
semantic generalization and concept formation are the examples of levels I and II abilities, respectively. Spearman's g corresponds to level II ability. Performance on culture fair tests such as Raven's Progressive Matrices also depends heavily on level II ability. Jensen maintains that Cattell's theory of fluid and crystallised intelligence cuts across level I and II. Thus, the two systems are orthogonal. He further claims that levels I and II abilities are largely genetically conditioned. Jensen says: "Level I and level II are viewed as broad categories of abilities which may be further fractionated by factor analysis or related methods. Level I and level II are ways of conceptualizing two broad sources of variance in host of mental tests" (Jensen, 1970, p. 158).

Jensen's theory has not escaped criticism. Vernon has questioned the importance and generality of level I performance, suggesting that it was quite specific to certain types of tasks. If level I ability is made up of registration, storage, and retrieval capacities, recent experimental research indicates that it does involve some "elaboration, transformation or manipulation of the output" (Miller, 1956; Bower, 1972; and Underwood, 1972). Recognition or recall with a high degree of fidelity does not necessarily imply an absence of transformation of input (Wickens, 1972). In a recent article Lawson and Jarman (1977) have shown from experimental and factor analytic studies how recent research on memory do not match with Jensen's conception of level I.
Other Theories

Apart from the theories mentioned above, Jenson (1970) gives an excellent account of other hierarchical theories of mental abilities, such as Gagne's theory of cumulative learning (Gagne, 1968), the phylogenetic hierarchical theories, and ontogenetic hierarchical theories.

Synthesis of Theories of Intelligence

This is the brief history of ideas on intelligence and on the organization of intellectual abilities. Although there are two major schools of thought on the topic, each accepts other's stance. Guilford somewhat accepts the hierarchical models, but refuses to accept the concept of $g$ and advocates a morphological model. Burt, a member of the school advocating the concept of $g$, shows how Guilford's factors largely correspond to his levels of hierarchy and feels that it should not "be difficult to reconcile the morphological scheme with the hierarchical" (Burt, 1970, p. 17). According to Burt, Guilford's operational factors largely correspond to his 'formal factors' (perception, memory, imagination, comprehension, etc.). Guilford's content factors correspond still more closely to Burt's content factors (verbal, numerical, spatial, etc.). Finally, with little adjustment, Guilford's product factors can be paralleled with Burt's hierarchical group factors, ranging from the highly specific or "narrow" group factors to the extremely broad group factors. According to Vernon also "there is really much less contradiction between the Burt-Vernon hierarchical conception of abilities, and the Thurstonian
multiple factor conception" (Vernon, 1970, p. 102). Vernon feels that innumerable mental skills can be further classified and subclassified. Thurstone, Guilford, and their followers prefer to start with separate types of abilities, but admit that second order or more general factors running through them (Vernon, 1970).

Among second-order factors, Cattell's theory of Fluid (Gf) and Crystallized (Gc) intelligence, and Hebb's (1948) well-known distinction between intelligence A, representing potential, and intelligence B, representing realized intelligence, has many similarities, although Cattellian concepts are preferred to Hebbian concepts because the principle concepts in Cattell's theory have specifiable and measurable behaviour referents, whereas in Hebb's theory intelligence A does not refer to measurable behaviour but to neurological potential. Jensen's two level theory of mental abilities is also not in conflict with Cattell's theory, but both are complementary schemata for describing mental test data. Regarding Cattell's Gc - Gf theory, Humphreys (1967) has pointed out that in many respects it is congruent with the hierarchical group factor theories put forth by investigators such as Burt (1955) and Vernon (1960). Vernon's work, for example, draws a distinction between a broad "abstract" verbal-numerical-educational factor (V:ed), having properties similar to Gc and an equally broad "practical" mechanical-spatial-physical factor (k:m) which is somewhat similar to Gf. In short, among second order factors also, theories are relatively less contradictory.
What is the implication of the various theories for the applied psychologist? It must be accepted that intelligence "is an undifferentiated, monolithic ability, unstructured, and completely measurable by means of a single score, is dead or dying" (Guilford, 1968, p. 215). Whether one believes in the hierarchical models or morphological model, it is agreed that intelligence is composed of several factors, whether general group factors or primary mental abilities. For the applied psychologists it will be worthwhile to deal with the broader, more intensive, and more hardy factors with good construct validity, in the sense of useful correlations with external criteria - not merely internal consistency - so that they can be applied to decision making (Vernon, 1970). One may not completely agree with Guilford's long list of factors but one should not have difficulty in agreeing with Thurstone's Primary Mental Ability Factors. The development of various multiple aptitude batteries for applied uses indeed show that applied psychologists have agreed upon Thurstsonian conception of mental make up.

Cultural Differences in Abilities

Our present knowledge about the factorial structure of abilities is based almost entirely on data gathered from English speaking children in the West. The degree to which factors found and confirmed in one culture will found also in markedly different cultures is not known. We will discuss certain relevant points regarding this issue here, and dwell upon this in Chapter 4.
From the cross-cultural studies summarized by Anastasi (1958), Klineberg (1935), Cattell (1971) and others, among factors that can produce differences in the factorial structure of abilities are the linguistic system, heredity, environmental demand, and the mode of life.

Attempts have been made to eliminate the effect of linguistic system by administering non-verbal tests. But it cannot be assumed that non-verbal tests measure the same functions as verbal tests. For example, a spatial analogies test is not merely a non-verbal version of verbal analogies test. Spatial analogies test might be loaded with spatial visualization and numerical abilities. Factorial analyses have revealed that even in tests like the Progressive Matrices non-verbal factors contribute greatly to variations in test scores (Anastasi, 1976; Das, 1963; and Dolke, 1976). Jahoda (1956) and Scott (1950) indicate that in going to another culture, it is not enough simply to substitute non-verbal for verbal test. Vernon says: "non-verbal and spatial test materials are as much subject to cultural influences as are verbal materials" (Vernon, 1970, p. 115). Actually, evidence suggesting that non-language tests may be more culturally loaded than language tests is accumulating (Jensen, 1968; Orter, 1972; and Vernon, 1969).

Heredity vs. environment is a perennial tussle in psychology. Within recent years, interest has been revived in behavior genetics with Jensen's work (1969). Jensen and others (Loehlin, Lindzey and Spuhler, 1975) have computed heritability index and attributed most of the
variation in the intelligence test scores to heredity or genetic factors. However, the greatest antithesis to the genetic approach has been provided by McV Hunt (1969), Kagan (1969), et. al. Hunt claims that experience and learning plays a major part in determining the human intellectual level. He assembled an impressive array of experimental evidence against the idea that intelligence is fixed, immutable, largely innate, and relatively impervious to variations in experience. Several studies have shown that environmental factors, such as urban versus rural background (McNamar, 1942), environmental deprivation (Harlow and Harlow, 1962), orphanage life (Yarrow, 1961), stimulation and encouragement (Fowler, 1962), etc., profoundly affect the development of intelligence and other abilities.

Vernon in his book *Intelligence and Cultural Environment* (1969) has emphatically shown that although one cannot deny completely the existence of innate differences in potential ability, it has little practical importance, and indeed admittedly cultural environment largely affect the development of intelligence and other abilities.

Regarding the effect of environmental demands on intelligence the question is: do specific demands lead to specialized factors? For instance, do members of a society which lean strongly on authority and tradition develop reasoning abilities which are organized differently? Similarly, does the pattern of relationship between people lead to subtle skills of interpersonal perception or memory? "In some areas a different language must be used in speaking to a superior than in speaking to a subordinate. Does there emerge in such a society a set of correlated performances
related to these role shifts? In short, we know that our tests are to some degree culture bound, but we do not know how general are our factors" (Guthrie, 1963, p. 459).

Cross cultural and factorial studies of ability patterns and of possible cultural and environmental influences have been conducted for such widely divergent cultural groups as Chinese Americans, South American-Americans, Filipinos, Ugandans and Cangoles, educated to high levels through English as foreign language. There are findings which suggest primary mental abilities conforming closely to Thurstonian type of constructs, with verbal ability unique to their indigenous languages. Two such studies which show the generality of primary mental abilities across the cultures using individuals from non-western cultures are of special interest here. Vandenberg (1959) factor analyzed scores on 35 tests for a group of Chinese students in U.S. Universities. He found five factors: Spatial, verbal, number, memory, and perceptual speed which closely approximated those of Thurstone. He concluded that cultural influences play a role in the formation of abilities, but that "several potentialities exist in the adult human neuro-physiological organization that are independent of the particular kind of cultural, linguistic, and educational background of the subjects tested." Guthrie (1963) administered 50 tests, some in the Philippine Tagalog dialect, to 314 Philippine College students, and extracted 22 factors. His findings correspond to Vandenberg's.

Proceeding discussion leads to the conclusion with which most researchers
agree, that intelligence and other abilities are the function of the interaction between heredity and environment. However, one may surmise that although cultural environment affects the development of these abilities, certain abilities, probably the Thurstonian type of primary mental abilities, which are by and large culture free and, therefore, can appear in any culture. This discussion is particularly relevant to our investigation because it shows the need for testing the generality of factors in our culture measured by a test developed in different culture.

Individual Differences in Abilities and Psychological Tests

The discovery of several primary mental abilities gradually had an impact on the methods used for measuring intelligence. When the multiple aptitude test batteries were developed in the 1940s, testing movement took a significant turn. Psychologists began to describe an individual's intellectual status in terms of a profile of scores on several abilities rather than by a single index such as I.Q. Another reason for an interest in the multiple aptitude testing was that the activities of psychologists diversified into vocational counselling and in selecting personnel for business, industry, government, and military forces. With multiple aptitude batteries, both inter and intra individual differences could be assessed simultaneously.

Most of the work on test development, however, proceeded on Thurstone's line rather than Guilford's. It must be conceded that the Guilford's model is useful for analyzing test content, but for focusing attention
on neglected areas such as reasoning and fluency, it is extremely cumber-
some. McNemar (1964) called the model 'scatter brained', and lately
Eysenck (1967) has observed that if this is the best model currently avai-
liable then something has gone very wrong indeed. The stable and predicti-
vely useful factors of the Primary Mental Ability type make for a realistic
approach for test development. A first well known battery of this type -
Chicago Primary Mental Abilities Test - was developed by Thurstone himself.
This battery was published in 1941. It was a direct outcome of Thurstone's
pioneering research on the identification of the primary mental abilities
(1946-1958). Other well known batteries to follow were the Differential
Aptitude Test developed by Bennett, Seashore and Wesman (1974), Aptitude
classification test by Flanagan (1959), the Holzinger-Crowder Unifactor
Test by Holzinger and Crowder (1955), and General Aptitude Test Battery
developed by the United States Employment Service (U.S. Department of
Labour, 1970a).

Psychological Tests and Personnel Selection

Since World War II psychological tests are being employed by different
establishments including schools, industrial organizations, the military,
the clinic, etc. However, they are most widely used in educational and
vocational guidance and for personnel selection and classification. We
are concerned with the latter use of psychological tests.
Need For Proper Selection of Manpower

The management of any industrial organization has to serve and satisfy three bosses, viz; the investor, the customer, and the labour force or workers. Each of these makes definite demands on the management. The investor demands returns for his investment as dividends and interests which are paid from profits. The customers expect products of good quality at reasonable lower prices. The more he is satisfied with the goods sold to him the higher the probability that he will continue buying from the company. The demands of the labour force have recently become very strong due to the emergence of unions. The labour demands higher wages and better amenities. Unless the employee is convinced that he is being fairly paid in cash and kind, he will not feel committed to his job and this may affect his efficiency and output. This is only a very generalized and simplified analysis of the demands on an industry and the management's main problem is to satisfy these masters without affecting the others.

The management thus faces a real problem and the logical solution is to achieve more production within the same costs thereby increasing sales. Thus, given the technology and raw materials, the labour must work at their maximum efficiency to produce more and better goods. This solution can be attained by selection and placement of personnel who have the necessary aptitudes and skills for their jobs. Thus, the management has to improve the selection methods and build a sound personnel
policy that will ensure judicious selection and manpower utilization.
The thrust of the argument is on selection and placement so that maximum
use made of available manpower.

The advantages of careful and systematic selection and placement cannot
be overemphasized. Most managements will agree that careful selection
and placement can prevent inefficiency, low production, high labour
turnover, breaches of discipline, and unnecessary waste of human power.
A systematic selection and placement generates higher motivation
(Gallerman, 1968), and better mental health (Hersberg, et.al, 1957;
Cameron, 1951). They also ensures, to a considerable extent, that each
person will use his abilities, motivation, and temperaments in the best
possible way for him, and society will be able to make the best possible
use of its total manpower resources.

Round Peg in Round Hole

The entire discussion ultimately boils down to the problem of "fitting
the round peg in the round hole". Individuals differ not only in physical
characteristics such as sex, height, weight and colour of the eyes but
also in their mental characteristics such as intelligence, temperament,
scholastic aptitude etc. The measurement of individual differences is
essential for proper selection of personnel because different jobs need
different kinds and quantum of physical and mental abilities and tempe­
raments and individuals differ in the possession of these abilities and
temperaments. The purpose of every psychological test is to measure
these differences among individuals so that a person can be assigned appropriate job. One must assure as Dunnette says: "That right people move into the right jobs at the right times under the right circumstances" (Dunnette, 1966, p. VII).

Scientific Selection Procedure

Wise personnel decisions are possible through the application of scientific principles in the recruitment, selection, and placement of employees at various levels in the organization. A given selection procedure should obviously begin long before the day of the interview. Application of scientific principles in the total selection procedure involve several stages, starting from a departmental requisition, through the adoption of selection criteria to the actual appointment of a candidate. The entire procedure, in general, may be seen as a series of steps in three distinct phases (Figure 1.5).

Phase 1

Position description;
Job specification;
Internal search; and
Appointment of panel

Phase 2

Advertisement;
Screening;
Shortlisting; and
Interview letter
Steps in Selection Procedure

Preliminary Preparations
  i) Position Description
  ii) Job Specification
  iii) Internal Search
  iv) Appointment of Panel

Advertisement

Application Blank

Satisfactory Data

Psychological Tests

1. Identification Data - Age, education, training, area of living etc.
2. Family Background
3. Professional Information (previous work etc.)

Satisfactory Data

Group Discussion

1. Intelligence
2. Personality
3. Aptitudes
4. Knowledge, etc.

Satisfactory Data

Interview

1. Leadership Qualities
2.Originality
3. Attitude Toward others
4. Manners, etc.

Satisfactory Data

Medical Test

1. Any Discrepancy in Application Blank
2. Observation of Individual
3. Personnel Data, etc.

Selection

1. Physical Fitness
2. General Health, Stamina

Training → Placement

Rejection

Fig. 1.5

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Phase 3

This phase deals with the various first hand testing situations to be employed by the selection panel. To achieve maximum "interview" of a candidate, interviewer must create maximum opportunities for the candidate to reveal the desired qualities. A conducive psychological atmosphere must be created in the interest of the individual and the organization. The candidate must go back with a degree of satisfaction, even if not selected. At least two corollaries to the rule above would be:

(a) devotion of more time to get maximum information on the candidate, and
(b) adoption of a several testing situations to contribute to an overall rating. Whatever be the tools, the total testing programme must measure achievement, abilities, and personality traits. The choice of tools and, particularly, the relative weightage to be given to measures must be decided before testing. These will depend greatly on - Phase I of the selection schedule.

Two Major Tasks

The procedure described above may differ from one organization to another and from one situation to another situation. However, there are two tasks common to any selection procedure. First is to find means of differentiating between people in terms of abilities, temperaments, interests, etc., and the second is to discover what abilities and temperamental qualities are required for success in a given job. Unless the individual's abilities are matched with the requirements of the job,
the individual is unlikely to produce his best. How do we know what are
the inputs in terms of abilities, temperaments, and knowledge for success
in any job? How do we find out who fulfill these requirements? The
first question can be answered by a systematic job analysis and the
second question can be answered by a systematic measurement and evaluation
of the qualities of the individual, through objective and standardized
psychological tests. Ghiselly and Brown put it: "A knowledge of job and
worker is a fundamental prerequisite for an intelligent attack upon all
personal problems in any organization whether large or small, public or
private" (1948, p. 23).

1. Job Analysis: Most people agree on the importance and use of job
analysis in selection, placement and related activities. Viteles says:
"The first step in fitting men to jobs and in maintaining fitness at work,
is to make a comprehensive study of occupational activities and require­
ments" (1932, p. 142).

Job analysis is the scientific study of the various components of a job.
It involves a determination of the duties and conditions of work and the
qualifications a worker should have for successful performance. The
results of job analysis are set down in the job specifications or descrip­
tion which provides a basis for matching individuals with jobs, by
specifying the personal characteristics that are conducive to job
success. In the words of Dunnette and Kiechler: "Job analysis is the
discovery of employees behaviour necessary for successful job perfor­
We need not go into the methods for establishing job requirements. Various authors, particularly Tiffin and McCormick (1966), have given a very good account of these methods.

2. **Assessment of Individual's Qualities**: The second step in assessing the suitability of the candidate involves systematic assessment of his qualifications and inherent qualities. Two most widely used methods in these situations are the personal interview and psychological tests. We will have a brief mention of the interview method before proceeding to the description of psychological tests.

a. **Interview Method**: Although interview ranks first among selection methodologies, its present status and usefulness leaves much to be desired. Its effectiveness is generally accepted on purely a priori grounds.

Problems with the interview method range from its conduct, the skill involved in interviewing, and sources of biases to the evaluation of the interview for its reliability and validity. The various aspects of the interview method and its problems are discussed extensively by Bingham and Moore (1959), Kahn and Cannell (1957), and Maccoby and Maccoby (1954).

b. **Psychological Tests**: Although psychological testing ranks second only to the interview it ranks first for its value in the selection procedure. Modern business and industrial organizations are increasingly using psychological tests for various purposes such as, selection and place-
ment, transfer and promotion, determining the training needs of employees, evaluating effectiveness of training programmes, and employee counselling.

"A psychological test is essentially an objective and standardized measure of a sample of behaviour" (Anastasi, 1976, p. 23). Apart from objectivity and standardization, other important properties of psychological tests are reliability, validity, and norms. There are many good books available which contain the information about various psychological tests and their psychometric properties (Anastasi, 1976, Freeman, 1962; Cronbach, 1960).

Multiple Aptitude Batteries in Selection and Placement

Multiple aptitude batteries have an advantage over other unitary measures of ability because multiple aptitude batteries assess both the inter and intra individual differences simultaneously.

How do multiple aptitude batteries measure inter and intra individual variation and how is the measurement of these differences important for selection and placement?

Most of general text books on industrial and personnel psychology often use the expression "selection and placement" almost synonymously, but they are not synonyms. Selection is simply choosing one applicant who appears to have the best chances of success in the job among many. Placement is the assignment of workers to positions to which they are
best suited according to their strengths and weaknesses.

Suppose there is a vacancy for a clerk in the front office of a textile mill and five candidates have applied. Let us suppose that we know the aptitude requirements and the minimum score required on each aptitude for this job. This job needs general intelligence (G), verbal aptitude (V), clerical aptitude (Q) and numerical aptitude (N). A general intelligence test giving an overall score on intelligence will not serve our purpose. We need to know candidates' aptitude scores on other aptitudes.

Let us suppose, we administered a multiple aptitude battery on these candidates and obtained the following scores in percentiles.

<table>
<thead>
<tr>
<th>Candidates</th>
<th>Aptitude Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G   V   N   Q  T*</td>
</tr>
<tr>
<td>1</td>
<td>65  24  43  24  36</td>
</tr>
<tr>
<td>2</td>
<td>50  60  41  60  39</td>
</tr>
<tr>
<td>3</td>
<td>65  26  72  58  28</td>
</tr>
<tr>
<td>4</td>
<td>65  73  25  55  70</td>
</tr>
<tr>
<td>5</td>
<td>65  40  91  41  30</td>
</tr>
</tbody>
</table>

* T - typing skill

Let us also assume that we are using the multiple cut-off method of norms where a minimum percentile requirements for this job are 50 on G, 60 on V, 40 on N, and 60 on Q. Candidate 2 is the only person who passes on all the aptitudes required and he is selected. The multiple aptitude battery could assess the candidates standing on all the aptitudes required. This is a case of simple selection.
If we use a standard scale of measurement for each aptitude, we might find that a given person is about average in height, weight, and intelligence, but stronger than most others in spatial aptitude and weaker than most in clerical aptitude. The strength and weaknesses of a person can be expressed in relation to others, and in relation to other traits within the same person. Guion says: "The 50th percentile in a distribution of measures indicates an average amount of the trait being measured, in terms of interpersonal differences. The 50th percentile might indicate the strong point, however, of an individual who tends on most other dimensions to score at about the 15th percentile, or a serious weakness for the individual who typically scores on ability test at the 90th percentile or better. Legend is full of mathematicians who could not spell, inventive geniuses who flunked out of school, and beautiful but dumb blondes. Each person has some strong points and some weaknesses" (Guion, 1965, p. 10). These intra-individual variations have tremendous implications for placement purpose.

Figure 1.6, shows the scores on a multiple aptitude battery of candidates 3, 4 and 5 scoring 65 on the general intelligence in the above cited example. (Fig. 1.6, on page 16)

Candidate 3 does better on numerical and clerical aptitudes but not so well on verbal aptitude and typing skill. Candidate 4 does better on verbal aptitude and typing skill but performs badly on numerical aptitude. Candidate 5 is very good on numerical aptitude and equal to others on
clerical aptitude but poor on verbal aptitude and typing skill. If all these candidates are hired it might be well to place 3 as accounts department clerk, 4 as a typist, and 5 as an investigator in the statistics department.

The placement can be still more systematic and correct if we already have selection norms for other occupations, as in this example, we had it for an office clerk. Table 1.1 shows the selection norms for accounts clerk, typist and statistical investigator.

Table 1.1 : Selection Norms for Three Jobs

<table>
<thead>
<tr>
<th>Job</th>
<th>G</th>
<th>V</th>
<th>N</th>
<th>Q</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounts Clerk</td>
<td>50</td>
<td>--</td>
<td>65</td>
<td>55</td>
<td>--</td>
</tr>
<tr>
<td>Typist</td>
<td>--</td>
<td>65</td>
<td>--</td>
<td>50</td>
<td>65</td>
</tr>
<tr>
<td>Investigator in Statistics</td>
<td>60</td>
<td>40</td>
<td>75</td>
<td>40</td>
<td>--</td>
</tr>
</tbody>
</table>

These are the multiple cut-off norms in which the candidate has to reach to the minimum qualifying scores laid down for each aptitude. Candidate 3 qualify for the job of an accounts clerk, Candidate 4 for typist and Candidate 5 for an investigator in the statistics department.

Thus multiple aptitude batteries can assess the inter and intra-individual differences systematically and properly. Unfortunately, most industrial and business organizations in our country, concentrate more on selection without caring for placement in their employment procedures. "Such a one track approach in employment policy is hardly the road to maximum
Advantages of Psychological Tests in Industry

Tests have been proved useful in increasing job proficiency, selecting better trainees, reducing labour turnover, increasing the quality of applicants, and increasing the flexibility of job assignments. Some studies in each area are Stemberg, 1948; Flanagan, 1947; DuBois, 1947; Doppelt and Bennett, 1953; Wilson, 1952; Levine, 1957; and Barker, 1960.

From the cost benefit point of view also tests have edge over other selection methods. Since most of the tests can be administered to a group, a great deal of information about several candidates can be obtained in a relatively short time.

The specific advantages of using tests in selection are:

Productivity, qualitatively and quantitatively is increased.
Training time and costs are reduced.
Lateness and absenteeism are minimized since employees like their work better.
Screening and recruiting time is shortened.
Maintenance costs are decreased.
Waste is reduced.
Accidents are lessened because people are more skilled, they are faster and better trained for their work.

Is the Picture Rosy?

To meet the growing demands of psychological tests in various fields, the number of tests - good, bad and indifferent - increased rapidly
over the years. As a result, tests of all kinds have either been misused and misinterpreted, and there has been a mounting unrest regarding the use of tests. Examples of criticisms are Hoffman's *The Tyranny of Testing* (1967), Blacks, *They shall not Pass* (1963), Gross's *The Brain Watchers* (1962), and Whyte's, *The Organization Man* (1956). However, to counter this sudden and somewhat irrational attack, thoughtful analyses of the contributions and limitations of tests have also proliferated. (Carter et al. 1965; Dunnette, 1964; Dyer, 1961; Ebel, 1966).

All said and done it must be remembered that psychological tests are not panacea to selection problems nor are they infallible. They sometimes give misleading information because two kinds of risks are involved in any selection procedure: a) Selecting persons who will not perform well on the job; and, b) rejecting candidates who might have done well on the jobs. Balancing the two is difficult and depends upon the level of validity of the tests. The prediction of a candidate's potential performance can be accurate if the validity of the test is perfect. However, in the test selection research one hardly gets such a high validity. Therefore, some error is bound to remain in the selection procedure. However, if the validity of test is fairly high, the chances of getting suitable candidate are greater.

One other common abuse of psychological tests is the use of foreign tests without their suitable adaptation and "local" norms. This is very common in India. A number of companies are using some tests of intelli-
gence as a part of their selection procedure and interpret their scores arbitrarily and subjectively. This would give wrong results.

Other danger in testing are overpromotion of tests by many psychological testing organizations who employ immature professionals or pseudopsychologists, incompetence of testers, using tests without ample reason, etc. However, the picture is fairly satisfactory. Tests users today are more competent than earlier. There is also a check on test users by many employers. Moreover many test publishing houses maintain certain norms for the purchase and use of their tests. The American Psychological Association (1953) has published ethical standards of psychologists to prevent the misuse of psychological tests. When all test developers and publishers follow these recommendations carefully, test users will be safe.

This thesis concerns one of the most popular multiple aptitude test batteries, the General Aptitude Test Battery (GATB) which has been developed on the Thurstone's line of thinking about the organization of mental traits. The need for such a selection battery has long been felt in our industrial and business world.

A long term project was undertaken by the investigator with the approval and encouragement of the U.S. Department of Labour, Employment and Training Administration on the adaptation and standardization of the GATB. The detailed description of the GATB is given in Chapter 2. The specific objectives of the investigation and the plan of work are presented in Chapter 3.