CHAPTER II

THE CONCEPT OF INTELLIGENCE

While we are in the context of history it is well to consider in an organized manner, the threads of thinking concerning the nature of intelligence. According to Cyril Burt, intelligence goes back to intelligencia, a term introduced by Cicero. Spearman reported that the monarchic view of unitary thing called intelligence was popular far back as the fifteenth century.

The concise Oxford Dictionary informs us that the term intelligence means 'intellect' and understanding. Intelligence is generally guessed from the way a person appears to understand a fact or a group of facts, and the manner in which he responds to those facts.

The term intelligence is used even by a layman in everyday talks. He is not at all worried about its meaning in technical terms. The definition of intelligence has so far defeated the intelligence of psychologists. They have been trying to give a clear definition of intelligence but all do not meet on common ground. Almost every writer on the subject has put forward his own definition of intelligence and some, in the fullness of time, have even offered more than one and have not been constrained by consideration of compatibility.
The physical scientists are always busy in experimenting with new things. Every moment brings new idea for them. Every new invention in science becomes helpful in refining and redefining the knowledge of things. Same is the case with the psychologists. For hundred years or rather more, they have been trying to understand the structure of their own intelligence. The existence of individual differences amongst the people have led them to develop instruments for measuring intelligence. As stated by Freeman:

A scientific approach to measurement requires that the aspect or aspects of mental life, proposed to be measured by the instrument being designed should be stated by the test maker.

(Freeman, F.S., p.4)

This is surely a challenge to the practical psychologists. The test maker should always make it clear what his instrument will measure. For that, first of all, he should be clear about its concept. Rex Knight remarks that for the practical purpose of measuring intelligence, it may well be that full knowledge of its nature is not necessary. He believes Terman to be right who says that ' to demand that one, who would measure intelligence, should first present a complete definition of it, is quite unreasonable' (Knight, p. 5).
More than eighty percent of the people in the world believe in praying God, in one form or the other. No body has been successful in describing him exactly and specifically. Each religious faith describes God in its own way. The images of God are even carved out without ever seeing him. People say that God is like the carved images in the temple. He is just like what we describe him to be. With such confused ideas people pray him and try to understand him from times immemorial. Exactly in the same manner without any clear idea of intelligence, psychologists have started constructing the tests to measure intelligence. As they are baffled in the task of defining intelligence they have also started saying that intelligence is what the intelligence tests measure.

They say that though we cannot give a concise definition of intelligence, the results of different intelligence tests agree with each other to a considerable amount and hence, no such attempt, however modest, on the part of the test maker is necessary. Such a view is supported by Freeman, who remarks that "though psychologists started with different definitions, they emerge with tests having considerable similarity" (Freeman, F.S., p. 68). However, the same author favours a theoretical study of the concept of intelligence in the following words:
First, the student should be familiar with the thinking of psychologists in this field, as a background for his better understanding of the tests themselves. Second, it is through the interaction of the theoretical and applied that improvement and advances will be made. Third, it is possible that one or more of these theories will have increasing influence, in the future, upon test construction, testing practice and test interpretation.

(Freeman, F.S. as quoted by Bhatt C.L., p.9)

Guided by these reasons, the investigator has thought to discuss a few ideas about intelligence. It is not claimed to be an original contribution but only a modest attempt to discuss the nature of intelligence.

**Concept of Biologists**

Herbert Spencer's definition of intelligence which he used in Biology was perhaps the first attempt to explain the concept of intelligence in modern psychology. Spencer defines intelligence as "the mental adjustment of internal relations to external relations" (Spencer as cited by Desai, K. G., p.17). Afterwards the psychologists differentiated between man and animal with the help of this term. The former modified his action in the light of his past experience while the latter are endowed with only instincts.

McDougall, however contradicts this view and defines 'an intelligent action as one which seems to show that the creature has profited by prior experience of
similar situations, that it somehow brings to bear a previous experience in the guidance of its present action. Instinct is the native or inborn capacity for purposive action; intelligence is the capacity to improve upon native tendency in the light of past experience' (McDougall, p. 78).

**Doctrines of Intelligence**

Before the scientific study of understanding intelligence started, i.e. before the advent of correlations, three fundamental doctrines were put forward. These doctrines have led us to the current theories and hence would almost be indispensable for their right comprehension.

Spearman in Human Ability (1951) puts these three doctrines.

**Monarchic Doctrine of Intelligence:**

Earliest in the field came the ancient conception of a power that could be taken to provide the human mind with "universal" abstract ideas, and so to constitute the one source of genuine knowledge. Such a power was termed in Greek the 'nous'; accordingly, its actual exercise was "noesis". In Latin these words were rendered as intellectus and intelligentia. In English it came as intellect and intelligence.
According to this view a single power or ability controls all the capacities of man. There are nothing like different abilities according to this doctrine. "But if this be so and the notion of intelligence does embrace a wide, shifting and even self-contradictory range, then all attempts to measure it, would appear to become illusory" (Spearman, p. 3).

The psychologists prepare tests to measure abilities through their manifestations. In practice the function of intelligence is divisible into several units partly uncorrelated. Thus this doctrine is in contradiction to the theory and practice of current mental tests.

**Oligarchic Doctrine of Faculties and Types:**

In this second fundamental doctrine of human ability, single sovereign faculty is replaced by a small number of different ones. The outstanding faculties are Judgement, Perception, Memory, Invention, Attention, Language and Movement. These faculties are quite independent of each other, and therefore, each needs a separate measurement of its own. Spearman says, "All such faculties have had a strange fate" (Spearman, p. 4).

These faculties are highly criticised and even ridiculed. Herbert had contradicted saying, "Strength of memory is usually limited in every man to particular kinds of objects ... He who easily remembers the technical
expressions of a science that interests him has often a bad memory for the novelties of town." He winds up by complaining that: "The marvel of these things vanishes on discarding the hypothesis of mental faculties" (Herbert as quoted by Spearman, p. 4).

Anarchic Doctrine of Independent Elements:

According to this doctrine, there exists a number of primitive mental abilities highly particularised and independent of one another. According to Thorndike, "The mental sciences should at once rid themselves of the conception of the mind as a sort of machine, different parts of which sense, perceive, discriminate, imagine, remember, conceive, associate, reason about, desire, choose, form habits, attend to .... There are only the particular connections between particular mental events and others" (Thorndike as quoted by Spearman, p. 5).

Sir Godfrey Thomson's Sampling Theory is the most developed mathematical form of this non-focal view. The mental tests depend on the good team work of a group of mental abilities acting together as one unit. Intelligence is thought to be constituted of these abilities and by averaging or summing up the scores obtained in them, the general level of the organisation or intelligence can be known. "It is scarcely workable at all without some auxiliary hypothesis of averaging or of sampling which are
hard to accept" (Spearman, p. 5). Monarchic and Oligarchic views fall short of providing functional unity. This anarchic view is the little better case having to prove functional independence which is equivalent to disunity.

Spearman objects saying that no genuine averaging or sampling of anybody's abilities is made, can be made or even has really been attempted. (Spearman as quoted by Desai, K. G., p. 23).

All the above doctrines have failed as they have omitted to determine ranges of functional unity. By such range we mean the sphere within which the ability at issue tends to vary concurrently from one person to another. By discarding all these views for the reasons just discussed Spearman found a solution as he says, by putting forward a new eclectic theory which includes something of all of them. Spearman has also formulated the principles of noegogenesis to form the basis of intelligence tests.

The Principles of Noegeneses

Spearman challenged common sense and common terminology to compete with his theories. To understand Spearman's theory of intelligence and intelligence tests we must first examine his three famous 'noegenetic' Principles of Cognition as propounded in his Nature of
Intelligence and Principles of Cognition. Intelligence being primarily a cognitive function besides anything else, cognition attracted Spearman's attention and he evolved these principles. Since they deal with intellectual processes, they are described as 'noetic' but because they are also concerned with the generation of new items of experience from those which are already given, they are called noegenetic principles. These principles can be spelt out as follows:

1. Apprehension of experience - 'Any lived experience tends to evoke immediately a knowing of its characters and experiencer'.

2. Education of Relations - 'The mentally presenting of any two or more characters (simple or complex) tends to evoke immediately a knowing of relations between them'.

3. Education of correlates - 'The presenting of any character together with any relation tends to evoke immediately a knowing of the correlative character.'

(Spearman as quoted by Heim, p. 13)

The value of a test of intelligence depends on how far it is able to call into play these noegenetic principles. No doubt many other processes such as memory, perception imagery etc. are involved in the tests. The
cognitive processes form the core part of the tests and hence these three Principles of Noogenesis have been an unique contribution to the theory of intelligence tests. In addition to his statement that the word 'intelligence' covers the three noegenetic principles in their manifestations, Spearman often implies that the three principles in all their manifestations cover 'intelligence'. To understand this well, we must consider his use of 'g' i.e. his two factor theory which will be discussed later in this chapter.

Definitions of Intelligence

Psychologists have been generous to a fault with their definitions of intelligence. Almost every writer on the subject has forwarded his own definition and some, in the fullness of time, have even offered more than one - and have not always been constrained by considerations of compatibility. It is well to insist upon the fact that the meaning of general intelligence has had a gradual growth and that we did not start with a clear definition of general intelligence set up by some psychologists. We may say rather that the psychologist borrowed from everyday life a vague term implying allround ability and knowledge, and in the process of trying to measure this trait he has been and still is attempting to define it more sharply and endow it with a stricter scientific connotation.
A wide variety of definitions, expressing diverse views on the nature of intelligence, have been given by psychologists. General interest in such definitions has been aroused since the famous symposium, organised by the Journal of Educational Psychology in 1921. The editor invited seventeen psychologists to take part in a symposium. They were asked to write brief answers to the following two questions:

1. What I conceive "intelligence" to be, and by what means it can best be measured by group tests.

2. What are the crucial "next steps" in research?

Numerous voices were heard in response to these questions. The outcomes were far from the agreement. As Spearman puts it, "intelligence became a mere vocal sound, a word with so many meanings and finally it had none" (Spearman, as quoted by Guilford, p. 12).

F. N. Freeman (1939, 1940) classifies the responses of the psychologists as organic, i.e. those which characterise intelligence as a characteristic of organic constitution, social i.e. those which emphasise its dependence upon symbols and cultural concepts, and behavioristic i.e. those which define it in terms of performance on a given test (Freeman, F. N. as quoted by Mursell, p. 78).
F. S. Freeman classifies them in the following three groups:

(1) One group places the emphasis upon adjustment or adaptation of the individual to his total environment.
(2) Second type of definitions state that intelligence is the ability to learn.
(3) Others have defined intelligence as the ability to carry on abstract thinking.

(Freeman, F.S., p. 150)

However, even when he does it, he holds that the categories are not and cannot be mutually exclusive.

Rudolph Pintner groups these responses of the psychologists as (1) Biological (2) Educational (3) Faculty and (4) Empirical (Pintner, as quoted by Mursell, p. 78).

Biological:

In this type of definitions the emphasis is upon the adjustment or adaptation of the organism to its environment or to certain aspects of its environment. The more intelligent organism can adjust to a greater number of environmental changes. Higher organism has got greater adaptability and greater intelligence.

Stern: "Intelligence is a general capacity of an individual consciously to adjust his thinking to new
requirements. It is general mental adaptability to new problems and conditions of life."

Wells: "Intelligence means precisely the property of so recombining our behaviour - patterns as to act better in novel situations."

Peterson: "Intelligence seems to be a biological mechanism by which the effects of a complexity of stimuli are brought together and given a somewhat unified effect in behaviour."

Woodworth: "To be intelligent, a test subject has to see the point of the problem now set to him, and to adapt what he has learned to this novel situations."

Edward: "Capacity for variability or versatility of response."

From all the above definitions it is clear that they conceive of general intelligence as including behaviour that leads to better and better adaptation, not only in man but even in animal kingdom.

Educational:

This kind of definitions put stress on learning ability.

Buckingham: "Intelligence is the ability to learn."
Colvin: "An individual possesses intelligence in so far as he has learned, or can learn, to adjust himself to his environment."

Henmon: "Intelligence is the capacity for knowledge and the knowledge possessed."

The knowledge possessed is not ordinarily included in intelligence by most writers. The individual is intelligent, who learns quickly and easily. Who finds learning difficult is lacking in intelligence. The biological point of view and this educational point go parallel and has no contradiction as all learning may be regarded as adjustment or adaptation to various situations.

Faculty:

Here intelligence is described in terms of faculty or capacity. It is not functional but structural in nature.

Binet: "Intelligence is judgement or common sense."

Terman: "An individual is intelligent in proportion as he is able to carry on abstract thinking."

Woodrow: "Intelligence is an acquiring capacity. It is capacity to acquire capacity."

Haagerty: "It is a practical concept connoting a group of complex mental processes traditionally defined in systematic
psychologies as sensation, perception, association, memory, imagination, discrimination, judgement and reasoning ...

For the most part I would exclude from the concept, emotions, instincts, will, activities and so called character traits."

**Empirical:**

In this type of definitions, the emphasis is on the practical results of intelligence. It may be called behaviouristic as they pay attention to the behaviour value of intelligent response.

**Thorndike:** "We may then define intellect in general as the power of good responses from the point of view of truth or fact."

**Ballard:** "The relative general efficiency of minds measured under similar conditions of knowledge, interest and habituation."

**Pintner:** "Intelligence is merely an evaluation of the efficiency of a reaction or a group of reactions under specific circumstances."

There are other definitions of intelligence which can hardly be classified under any of the above categories.

**Thurstone:** "Intelligence is the capacity to live a trial-and-error existence with alternatives that are as yet only
incomplete conduct."

Freeman: "Psychologically, degrees of intelligence seem to depend on the facility with which the subject matter of experience can be organised into new patterns. This arrangement of thought material is what characterizes particularly the higher mental processes."

Binet: "Intelligence involves (1) the tendency to take and maintain a definite direction (2) the capacity to make adaptations for the purpose of attaining a desired end and (3) the power of self criticism."

These definitions extend from 1914 to 1940 and with repeated appearance of the same points. The biological and the educational points of view are not very different. The faculty point of view lays stress on different abilities used in making the adaptations and adjustments and learnings while the empirical point of view calls our attention to the result of the responses of the organism.

All attempts to define intelligence as a single entity have thus far failed. As we can see from the above discussion, different psychologists give different definitions and hence diversity of opinion makes it impossible to give a single definition of intelligence and say that this is what psychologists think intelligence
is. We can say that the prevailing impression is not one of contradiction but of vagueness. It is true that there are differences in emphasis, but on the whole it would not seem very difficult to reconcile these various formulations.

Attributes of Intelligence

Intelligence has certain properties and we call them 'attributes'. Intelligence is manifested in different situations and so these attributes can be divided into different types. Attributes are distinguished into four kinds by Thorndike as - (a) Level (b) Range (c) Area (d) Speed.

**Level:**

This refers to the degree of difficulty of task that can be solved. If we arrange different tasks according to their levels of difficulty, the highest step of this ladder shows the level or altitude of intelligence. Enumeration, description and interpretation are some of the important aspects of altitudes or levels which are aspects of intellect which can never measure it alone.

**Range:**

It refers to the number of tasks at any given degree of difficulty that we can solve. We cannot measure
altitude without range or width.

**Area:**

Area may be thought of as the total number of situations at each level to which the individual is able to respond. It is very highly correlated with altitude. This is not considered important as one cannot hope to measure by means of tests the total area of any one's intelligence. This will only help us in understanding the concept of intelligence.

**Speed:**

This is the rapidity with which we can respond to situations. It has positive correlation with altitude.

The intelligence ratings based on any test is necessarily a mixture of all the attributes as practically they cannot be separated. Some attributes are given more importance and other less in different tests. Sometimes speed is given more importance while sometimes the range and level. Thorndike's $AVD$ emphasizes altitude and pays practically no attention to speed.

**Three Kinds of Intelligence**

Intelligence is thought to be constituted of different kinds and hence psychologists are of the opinion that they should be distinguished. Thorndike has suggested
a three-fold division into (a) Abstract (b) Concrete and (3) Social.

**Abstract:**

This is the ability to respond to symbols of various sorts, such as words, numbers, letters and the like. We can consider verbal tests as tests of abstract intelligence. At the highest levels, abstract intelligence is seen in the reactions of the student and philosopher dealing with the relations of things symbolized in words or numbers or mathematical formulae.

**Concrete:**

Here we test the ability to respond to things themselves. It is the ability to comprehend actual concrete situations and react adequately to them. This kind of intelligence is best measured by means of performance tests.

**Social:**

It is also called ability to understand and deal with persons. It does not include the feelings or emotions aroused in us by other people, but merely our ability to understand others and to react in such a way towards them that the ends desired should be attained.
This is merely a convenient scheme of classification of intelligence. It can also be divided as verbal and non-verbal intelligence or in some other way. Abstract intelligence is measured by most of our present day group-verbal tests. Concrete intelligence is measured by performance tests and to some extent by tests involving pictures rather than words. As Freeman observes, even tests that present the subject with things rather than with ideas and symbols are not devoid of demands upon ability to conceptualize and make abstractions although testees need not necessarily state these in the form of language and number (Freeman, F. S., p.70).

Comprehensive Definitions of Intelligence

Psychologists have so far failed to give a compact definition of intelligence. Hence they have started to describe it in a comprehensive way rather than define it in a compact form. These attempts have resulted in reducing the differences but not in removing them completely. Such comprehensive definitions are given by Wechsler, Stoddard, Boynton and Thorndike. Those by the first two are discussed at length in the following paragraphs.
Wechsler’s Definition:

Wechsler writes in the preface to the fourth edition of his work, published in 1958, that his views on the nature of intelligence have not changed radically but that he has become increasingly convinced that intelligence is most usefully interpreted as an aspect of the total personality (Wechsler, 2, p. vii).

He defines it as "the aggregate or global capacity of the individual to act purposefully, to think rationally and to deal effectively with his environment" (Wechsler, 2, p.7). This cannot be compared with those already presented. It will be easily noticed that this definition encompassed the other three. Learning ability is not mentioned; it is surely implied. The words aggregate and global indicate that an individual's intelligence is revealed by his behaviour as a whole. The word purposefully signifies that intelligence involves behaviour towards a goal, which may be more or less immediate; The inclusion of the phrases, "to act purposefully" and "to deal effectively" specifies that 'drive' or 'incentive' enter into intelligent behaviour. Wechsler clearly emphsizes these aspects by supporting Alexander's findings, which include a reference to such non-intellective aspects" (Wechsler, 1, p.14). The inclusion of "drive", "incentive" and the like as aspects
of intelligence is of doubtful validity. Their inclusion would confuse the issue, the testing instrument, and the results obtained. Nevertheless, a single testing device that attempts to combine the measurement of intellectual with nonintellectual traits without providing for differentiation between the two would not succeed adequately in either respect" (Freeman, F.S., p. 152). Freeman further clarifies his point by adding that we should not ignore "drive", "incentive", "interest" etc. in assessing the individual's intelligence (Freeman, F. S., p.152).

Wechsler too seems to have been quite conscious about this. In the preface to the 1958 edition of his works, he writes:

I look upon intelligence ... as a resultant of interacting abilities - non-intellective included. The problem confronting psychologists today is how these abilities interact to give the resultant effect we call intelligence. At this writing it seems clear that factorial analysis alone is not the answer. Probably a new statistic involving field theory and non-linear differential equations will be required. In the meantime, I remain a reformed but unchastened Spearmanite.

(Wechsler, 2, p. vii)

The present investigator agrees with Wechsler in all other matters except in including non-intellective factors in intelligence. Freeman has rightly said that there are other tests like those of personality for
measuring these non-intellective traits. The writer is also of the opinion that their inclusion would confuse the issue, the testing instrument and the results obtained. These non-intellective factors are essential to motivate the children to put their best. Hence, the test material should be interesting and the administration procedure of the test should be planned and standardized. But she does not think that non-intellective traits can possibly be measured, as aspects of intelligence with the help of a usual intelligence scale.

**Stoddard's Definition:**

"Intelligence is the ability to undertake activities that are characterized by (1) difficulty (2) complexity (3) abstractness (4) economy (5) adaptiveness to a goal (6) social value and (7) the emergence of originals, and to maintain such activities under conditions that demand a concentration of energy and a resistance to emotional forces."

(Stoddard, p.4)

It can be noted that this definition does not only include the aspects mentioned in Wechsler's definition but also adds to it. Stoddard undertakes to discuss each of the attributes. Degree or level of difficulty is implied in all definitions but his contribution is in insisting on distinguishing between true differences in degree of difficulty and differences
that only seem to exist, as between two or more test items. Difficulty means the ability to perform high level intellectual tasks like higher mathematics. It does not mean ability to define unusual words. To him it is a function of the percent passing, a function of 'population'. Stoddard remarks that "it would be a strange world if seven-year-olds were more able than seventeen-year-olds" (Stoddard, p. 5).

Coming to complexity, Stoddard clarifies that complexity refers to the breadth or area of intelligence. According to this attribute of intelligence, the individual who is able to deal successfully with several kinds of tasks, at a given level of difficulty, is more intelligent. This does not mean the addition of different types of tasks. Complexity refers to the ability to hold together many considerations in a unitary effort, such as manifests itself in any high level skill, or in complex research (Mursell, p. 81). Commenting on the relation between complexity and difficulty, Stoddard remarks that they are related in the sense that high accomplishment is pyramidal in structure (Stoddard, p.10).

The third attribute abstractness is of utmost importance to the minds of psychologists. It is essential for all high level mental operations. Hence, for Stoddard it "lies at the heart of intelligence as defined" (Stoddard, p.15).
All the above three characteristics, have to do with mental organisation and can no doubt be qualified to some extent by existing psychometric techniques.

Stoddard finds economy a better word than speed, for it means moving towards a goal or performing a task without irrelevences. Acceptance of "economy" as an attribute of intelligence means that tests would impose time limits that should differentiate among individuals in respect to their rates of performance of tasks and solutions of problems at given levels of difficulty, and degrees of complexity (Freeman, F.S., p.153). Sherman says, "Speed becomes an important element in adult behaviour although it is not unimportant in children" (Sherman, p. 22). The present investigator has given due importance to this attribute. The maximum time limit is fixed for each item and also time bonuses are given for quicker children.

Adaptiveness is the differentiating quality of intelligent person. This attribute means that intelligent action is directed towards a goal or purpose. The more comprehensive goal will require more intelligent action.

"The inclusion of 'social value' as an attribute of intelligence is of doubtful validity" (Freeman, F.S., p. 154). It is nearly ethical or moral or a matter of subjective evaluation.
"Concentration of energy and resistance to emotional forces" are non-intellective aspects and subject to the same objection as Wechsler's "drive" and "incentive".

"The emergence of originals" refers to the ability to create something new. The persons with this attribute are at the superior end of the distribution of intelligence. The current tests of intelligence have little opportunity to measure this attribute. Stoddard believes that at present the tests of intelligence do not satisfactorily discern and rate an individual's intellectual originality.

Nature and Nurture

If one wishes to improve the human race one must know which is the influential factor, nature or nurture, on the child's development. Maturation is largely determined by heredity and learning is largely determined by one's environment. The problem is an academic one. If abilities and other traits of persons differ because of heredity, then to improve the race we should carefully select the parents of the generations to come. If personalities are made what they are under environmental pressures then we can ignore the stock from which the next generations come and devote our efforts towards improving the milieu within which children develop and
improving the means of educating them.

There is no direct knowledge regarding the inheritance of human mental traits. Direct investigation of this problem is difficult or rather impossible. Whether the ability described above is innate or acquired, or both, and if both to what extent, is a problem of considerable dispute among psychologists. The American psychologists give more importance to training, nurture and environment whereas the British psychologists being more conservative in traditions, frequently tend to err in favour of nature or heredity.

The mental endowment being very complex, it is very difficult to view it clearly. Environment includes pre-natal as well as post-natal influences. Hence it is very complex. However, investigations are carried on and consequently many important results have been obtained. Burt writes:

In my view the confusion that still befogs this bewildering controversy has arisen largely because both the believers in mental inheritance and sceptics still cling to a theory of heredity that is hopelessly out of date. Most of the psychologists who have supported a hereditarian theory have adopted the old Darwinian notion which supposed that heredity meant 'the principle that like begets like'.

(Burt, 2, p. 7)
Such notions are not applicable in current democratic societies; they are neither tenable in view of further biological researches. The Watsonian school no longer believes in inherited capacity. They say that "All have equal chances at birth" (Watson as quoted by Burt, 4, p. 167). All are created equal not in political view, but in all mental capacities. The dunces and geniuses are not born but made, according to this extreme environmentalists.

Some psychologists believe that development of a child depends upon his hereditary characters. One cannot turn out to be a scientist, if he is born with poor mental endowment. Mursell also believes in such limit set by heredity. According to him, the point is not to adjudicate a partisan competition between heredity and environment but to discover what influences are prepotent, how much change they can produce and why (Mursell, pp. 374 & 377).

The psychologists who do not so exaggerate the dispute become practical and concentrate their attention on measured intelligence. The fact that mental traits and abilities are within certain limits constant also suggests that heredity as the connection between the inheritance of mental traits and their constancy, is not certain. Cobb's argument is that continuation in school and school
performance are closely related with intelligence as revealed by tests. Limits no doubt there are, but the idea of a hard-and-fast ceiling is a great oversimplification.

Burt on the contrary deduces with confidence an over-all figure for the relative influences of nature and nurture. According to him "child's genetic constitution accounts for approximately 77 per cent of the individual variation rather less if the tests are merely group tests of a purely verbal type" (Burt as cited by Bhatt, p. 23).

Bhatia while discussing the nature of intelligence quotes Kohs' viewpoint about nature and nurture. Kohs believes that the person's synthetic or analytical ability depends upon his heredity character. In his own words "It seems evident that if one is born with good mental endowment his brain will 'synthesize' to a degree and in a manner impossible to one whose mental endowment is poor" (Kohs as quoted by Bhatia, p. 11).

Guilford says, "On the whole, it appears that differences in intelligence are determined by differences in environment. Although there are evidences that heredity influences many other traits of personality to a greater extent these traits are dependent upon social factors. Significant changes in personality can be brought about in spite of heredity" (Guilford, 2, p. 86).
Cf Spearman developed the hypothesis that g is a function of heredity, whereas the s factor represents the acquisition of specific learning and experiences" (Fruchter, p. 8).

From the above discussion it is evident that there is no settlement between nature and nurture controversies going on and yet both the test maker and user has to keep in mind the view points of both the sides while constructing the tests and interpreting the test results. Intelligence exists in the environment and it should be measured in its natural settings.

Analysis of Human Ability

The discussion so far done, is purely meant to understand the human ability in its functional character that is, how it operates. It is also necessary to study the structural pattern of it. Different psychologists have studied it in their own ways and have concluded and put forth their views in the form of theories. This is just like the blind people trying to understand the shape of an elephant. They touched the different parts of the elephant's body and described the elephant in their own ways. The psychologists have been talking about intelligence in the same way and describing it as they find it to be.
They have made the analysis in an effort to determine its underlying factors. This analysis is carried out to know the elements, or components of intelligence, not only for better theoretical understanding of this complex process but also to learn what might be the implication for the design and construction of mental tests. The procedure adopted can, in general, be described as an extension of the correlational techniques. The large number of separate tests, more or less diverse in character, are given to an adequate sampling of the population. The results are intercorrelated; the coefficients of correlation, thus obtained are subjected to various statistical analysis in an effort to discover the extent of common ground between them and their degree of independence.

These statistical methods are known as factor analysis. The results obtained will depend upon the data fed for calculations and the interpretations of experts. These different results however need not invalidate the use of well standardized psychological tests. An attempt will be made to think over different theories put forth by different psychologists.

The Multiple-Factor Theory:

In this theory as the name indicates intelligence is said to be constituted of a multitude of separate
factors or elements, each one being a minute element of ability. This theory was propounded by Thorndike and is called representing extremity in the interpretation of mental structure. The positive correlation between performance on two mental tasks is ascribed to common elements involved in the acts. Hence, in Thorndike's view, the concept of general intelligence is not tenable. But Thorndike himself admits that in constructing a mental test his "atomistic" theory is of less practical significance than the conception that many of the specifics operate together in any situation demanding intelligence. This is illustrated by his scale, known as CAVD test. Thorndike does not claim that four sets of items encompass the entire range of abstract intelligence, it represents only certain parts.

The Two-Factor Theory:

At the same time that Binet and Simon were working in France on the first practical mental test, a psychologist in England, Charles Spearman, was working from a different standpoint. Spearman hypothesized a general factor of intelligence, which he called the 'g' factor. The 'g' factor was thought of at that time as being a kind of "mental energy". Unlike Binet, Spearman undertook extensive investigations to determine whether or not there is only one common factor of intelligence.
It was in 1904 that Spearman published his correlations between sensory tests and estimates of intelligence which showed that: 'all branches of intellectual activity have in common one fundamental function (or group of functions) whereas the remaining or specific elements of the activity seem in every case to be wholly different from that in all others'.

(Vernon, 2, p. 12)

Spearman was one of the first to attack the factor problem. He observed that tests of abilities tend to have positive intercorrelations. These correlations when arranged properly showed a hierarchical order and that was so, because each test contained only one general factor 'g' common to all and one specific factor.

To understand this the following hypothetical illustration of intercorrelations between four tests can be taken.

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<td>1</td>
<td>-</td>
<td>$r_{12}$</td>
<td>$r_{13}$</td>
<td>$r_{14}$</td>
</tr>
<tr>
<td>2</td>
<td>$r_{21}$</td>
<td>-</td>
<td>$r_{23}$</td>
<td>$r_{24}$</td>
</tr>
<tr>
<td>3</td>
<td>$r_{31}$</td>
<td>$r_{32}$</td>
<td>-</td>
<td>$r_{34}$</td>
</tr>
<tr>
<td>4</td>
<td>$r_{41}$</td>
<td>$r_{42}$</td>
<td>$r_{43}$</td>
<td>-</td>
</tr>
</tbody>
</table>
Spearman found that for columns 1 and 2 we can have the equation \( r_{31} - r_{41} \) or \( r_{31}r_{42} = r_{32}r_{41} \).

Similarly other equations also can be obtained. Another way of expressing this equation is: \( r_{31}r_{42} - r_{32}r_{41} = 0 \).

This is known as Spearman's famous tetrad equation. Divergence of this difference from zero, within the limits of sampling error are tolerated. Spearman and others found a considerable number of ability tests whose correlations satisfied proportionality criterion. These correlations could be accounted for by a single factor. It was called 'g' the general intellectual factor. Spearman's two-factor theory postulated that every test which satisfies the criterion of proportionality contains two factors, 'g' and 's'. His 'g' factor is general factor common to all intellectual tests. The 's' factor is specific to each test and represents that portion of reliable variance of a test which does not correlate with other tests.
TABLE 2: TABULAR REPRESENTATION OF SPEARMAN'S TWO-FACTOR THEORY

<table>
<thead>
<tr>
<th>Test</th>
<th>Factors</th>
<th>g</th>
<th>S₁</th>
<th>S₂</th>
<th>S₃</th>
<th>S₄</th>
<th>S₅</th>
<th>S₆</th>
<th>h²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>.7</td>
<td>.714</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.49</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>.5</td>
<td>.866</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.25</td>
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<tr>
<td>3</td>
<td></td>
<td>.3</td>
<td>.954</td>
<td></td>
<td></td>
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<td></td>
<td>.09</td>
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<td>4</td>
<td></td>
<td>.8</td>
<td>.600</td>
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<td>.4</td>
<td>.917</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>.16</td>
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<tr>
<td>6</td>
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<td>.5</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.25</td>
</tr>
</tbody>
</table>

(Fruchter, p. 8)

The same correlation is represented diagramatically in the following way:

Figure 1: Schematic representation of Spearman's two-factor theory for six tests

(Fruchter, p. 8)
The numbers in the portions of the ovals not included in the circle are the loadings of tests on their specific factors, while the numbers in the portions of the ovals outside the circle are the loadings of tests on their 'g' factor. Each of these loadings in circle if squared gives the proportion of the variance on the general factor. The total variance can be represented by the following equation:

\[ g_j^2 + s_j^2 = 1.00 \]

Where \( g \) stands for loading on general factor of test named \( J \); and \( S \) stands for specific factor loading.

The overlapping variances for one common factor in three tests can be pictured as follows:

Figure 2: The Overlapping Variances for one common factor in three tests

The three tests overlap in only one area, the cross-hatched section which is labelled 'g'. Each test
then has a portion of its area which is specific. It does not overlap with the other tests outside the 'g' area. Psychologists are working on the assumption that all forms of mental activity have something in common. The tests to measure the diverse activities as defining words, solving arithmetical problems etc. are regarded as being measures to a greater or lesser degree of general intelligence. It was believed that an individual's level of general intelligence would emerge. Therefore, psychologists were justified in adding up the test items correctly passed in the several types of activities and deriving a single total score to represent an individual's general intelligence level. "The two-factor theory provides a logical basis also, for devising satisfactory tests of g" (Verhon, 2, p.13).

The Practical Implications of the Two-Factor Theory:
Tests which are based on this theory will be saturated with the general factor, so that the testee's level and quality of 'g' will be measured and effects of specific character will be cancelled out. For this, a careful selection of items, significantly correlated with each other, should be done. Such a test will yield an index that reflects the caliber of a particular mentality working as a whole.

And further, as Wechsler puts it, "Spearman's
demonstration of the existence of at least one pervasive factor in all performances requiring intellectual ability remains one of the great diversities of psychology" (Wechsler, 1, p. 9).

Criticism against the Two-Factor Theory: Some of Spearman's statistical techniques were strongly criticised by Thomson and he argued that the two-factor theory was a possible, but not a necessary inference from the statistical results (Brown and Thomson as quoted by Vernon, 2, p.14).

The two-factor theory, as we have seen is based on the tetrad equation where tetrad difference is thought to be zero and sometimes allowance is made for sampling errors, though some of them still show an appreciable magnitude.

While discussing the statistical background of the two-factor theory Fruchter writes:

Spearman's technique is now largely of historical interest, but it should be added that Spearman has had a strong influence on British factor analysts, and they and their followers usually look first for a general factor in any table of intercorrelations.

(Fruchter, p. 8)

Fruchter seems to be one of the opponents of Spearman. The charge against Spearman is that he and his proponents were always keen to find out 'g' factor and
never analysed the results objectively. The tetrad results were not always found to be equal to zero and the difference though big enough was considered due to sampling error. This was quite improper and absurd as well. Many cases were found out by factorists in which no 'g' factor was found to be common to all tests. Some groups were found having common factor loadings and hence as a result the group factor theory was proposed. The dispute between the Spearmanites and the group factorists continued for a pretty long period.

Spearman says, "We want to see what opposition the theory has encountered. Certainly the criticisms have been extensive and emphatic.... For in reply the proponents of the theory did not require that group factors should be absent altogether." (Spearman, p.16).

We can see the compromising attitude of Spearman in the above statements. The Spearmanites are found coming somewhat nearer to group factorists. Later on he remarks, "The opponents of the theory appear to have changed their ground" (Spearman, p.17).

Kelley concludes that "all of his data, as well as, the data of many other workers, point to a multiple-factor hypothesis rather than to a single-factor hypothesis" (Kelley as quoted by Pintner, p. 68).
Holzinger's Bi-factor Theory

More recently Spearman and his adherents have realized that those tests which do not satisfy the criterion of proportionality and which Spearman has termed "disturbers" may be retained in the correlation matrix if it is recognized that some of the tests may have a factor in common, in addition to the general factor that is not common to all of the tests. These factors, common to groups of tests, are termed group factors. Holzinger's bi-factor method, which is a variation of Spearman's two-factor method, obtains a general and one or more group factors. The bi-factor theory may be represented schematically, as in Figure 3.

Figure 3: Schematic representation of Holzinger's bi-factor theory

(Fruchter, p. 10)
Table 3 gives the same information in tabular form.

TABLE 3 : TABULAR REPRESENTATION OF HOLZINGER'S BI-FACTOR THEORY

<table>
<thead>
<tr>
<th>Test</th>
<th>g</th>
<th>C1</th>
<th>C2</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
<th>h²</th>
</tr>
</thead>
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<td>.3</td>
<td></td>
<td>.742</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.73</td>
</tr>
</tbody>
</table>

(Fromcher, p. 10)

Group-Factor Theory

The statistical analysis gained much more importance and factorists carried on the laborious work of factor analysing the test results. It was found by the psychologists like Thurstone that each and every test had not necessarily a common factor 'g'. It was found by him that some factors were common to two or more tests. So he propounded his group factor theory. "The analysis and interpretations of Thurstone and others led them to the conclusion that certain mental operations have in common a primary factor that gives them psychological and functional unity and that differentiates them from other mental operations. These
Thurstone's work resulted in the construction of a set of measures called tests of primary mental abilities. Each test has its own primary factor, giving the group a functional unity and cohesiveness. Each of these factors is said to be relatively independent of the others. He administered a large variety of test material to college students and to high school students and carried on factor analysis. As a result he found out six primary factors emerging clearly enough for identification and use in test design and construction. Though primary mental abilities were originally said to be functionally independent, actually it was found that they are positively and significantly intercorrelated. This means that primary mental abilities are not sufficient factors at work in the mental activities required by tests. Thurstone, therefore, concluded that in addition to the primary abilities, there is a second order general factor.

Thurstones also stated in their earlier test manual that "If further studies of the primary mental abilities should reveal this general factor it may sustain Spearman's intellective factor" (Thurstones as quoted by Freeman, F.S., p. 165).

The above conjecture is further supported by an
attempt to represent in a tabular form, the theories of mental abilities (Freeman, F. S., p. 173).

**TABLE 4: TABULAR REPRESENTATION OF THEORIES OF MENTAL ABILITY**

(A) THE TWO-FACTOR PATTERN

<table>
<thead>
<tr>
<th>Test</th>
<th>General Factor</th>
<th>Specific Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>X</td>
<td>$S_1$</td>
</tr>
<tr>
<td>2</td>
<td>X</td>
<td>$S_2$</td>
</tr>
<tr>
<td>3</td>
<td>X</td>
<td>$S_3$</td>
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<tr>
<td>4</td>
<td>X</td>
<td>$S_4$</td>
</tr>
<tr>
<td>5</td>
<td>X</td>
<td>$S_5$</td>
</tr>
<tr>
<td>6</td>
<td>X</td>
<td>$S_6$</td>
</tr>
</tbody>
</table>

(B) THE GROUP-FACTOR PATTERN

<table>
<thead>
<tr>
<th>Test</th>
<th>Group Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>1</td>
<td>X</td>
</tr>
<tr>
<td>2</td>
<td>X</td>
</tr>
<tr>
<td>3</td>
<td>X</td>
</tr>
<tr>
<td>4</td>
<td>X</td>
</tr>
<tr>
<td>5</td>
<td>X</td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>
From the above tables representation of different factors in different theories is visualised quite easily. In the two-factor theory the general factor is found in all the tests while there is a specific factor for each test. These specific factors are designated as $S_1, S_2, S_3,$ ...etc. In the group-factor theory there are different group tests which have a common factor. When both these theories are combined there are a general factor, group factors and specific factors.

**Sampling Theory**

This theory was propounded by G.H. Thomson who was also the criticiser of the two-factor theory. According to his views coefficient of correlation is determined by the number of common independent factors utilized by the tests. He says, "Each test calls upon a 'Sample of bonds'
which the mind can form and that some of these bonds are common to two tests and cause their correlation" (Thomson, 1, p. 45). By this he tries to explain the zero tetrad, indicated by Spearman.

All these theories require that a scale measuring general mental ability should pool a variety of tests that differ in content and mental processes. In the two-factor theory subtests are required to have high correlation with each other. While in the sampling theory the subtests are required to have a low correlation with each other but high correlations with the criterion of validity.

The sampling theory, as Thomson has emphatically stated, is not a rival of the theory of two factors. He believes each activity to be a sample of many factors and calls his theory to be atomistic. Thomson goes to the extent of saying that the two theories become identical if perfect hierarchical order among correlation coefficients is a fact. Sampling theory does not deny general ability, though Thomson differs in the description of it by saying that the general abilities possessed by different individuals would not be identical in nature (Brown and Thomson, pp. 189, 194 - 197).

Thomson believes that the appearance of a general factor and specific factors is a chance. He also thinks that zero tetrad is no reality but only a tendency. He
further adds that the hierarchical order is also the most probable one expected on sampling theory.

Thomson concludes the controversy by reference to the fact pointed out by Mackie that simultaneous belief in "bonds" and "specifics" is absurd psychologically and hence, we must either give up the factors of the two-factor theory or the bonds of the sampling theory as realities. We cannot keep both as realities though we may employ either mathematically (Thomson, 1, p. 53).

Consensus of the Various Theories:

As has been already discussed, Spearman and Thurstone have arrived at a general factor as well as the group factors and the specifics. The point of dispute is only the matter of emphasis and interpretation.

The Spearman's Two-Factor Theory now recognizes that some group factors should be posited to explain test findings; but emphasis is upon the 'g' factor. Perhaps the Spearman theory may now be renamed 'The General Factor-Group Factor Theory', and the other might be renamed 'The Group Factor-General Factor Theory'. The narrowing of differences between the two theories represents significant scientific progress.

(Freeman, F. S., p. 168)

Vernon is also of the same opinion while concluding the discussion on the theories of intelligence; he remarks, "The discussion consisted of (1) general factor (2) an unlimited number of narrow specific factors and (3) very few broad group factors" (Vernon, 2, p. 18).
From this, one can see that he also believes in the presence of general factor, specific factors and group factors.

Anastasi's views about this are as follows:

The field of trait organisation remained a centre of controversy during the decades of the twenties and thirties. Gradually, however, a definite rapprochement was apparent in the reformulation of the original theories. Adherents of the two-factor theory came to recognize the fact that narrower group factors were repeatedly identified and multiple factorists extended their methodology and theoretical formulations to admit a general factor under certain conditions. Today, the major differences between the various theories of trait organisation appear to be a matter of emphasis. It is now generally agreed that behaviour can be described in terms of general, group, and specific factors.

(Anastasi, 2, p. 125)

Types of Models

Uptil now an attempt was being made to discuss the different viewpoints put forth by different psychologists at different times. Any serious investigator, in basic science or in technology, finds a good frame of reference very helpful. The one which is close to a scientific theory is most useful to the investigator of some particular domain such as intelligence.

A good frame of reference for an investigator's responses has three important specifications that is, it should be systematic, comprehensive and it should be
empirically based. From the words 'it should be systematic', we can understand natural phenomena because there are regularities in nature and hence possibilities of principles and scientific laws which provide a shorthand type of apprehending information.

To achieve further simplification, model building becomes possible. Model building is theory construction. It is observed that in the adults, the thinking in terms of abstract dimensions becomes more or less natural. These are dimentional models which are most widely applied in mathematics and the physical sciences. "Inhelder and Piaget point out that there is growth of conceptions of what they call 'seriation'. By 'seriation' they mean the arrangement of items of information in linear order, each item related to next in line in the same manner, i.e. larger than, harder than, or more beautiful than" (Guilford, 3, . . ., p. 47).

The second type of model is hierarchical models in which there is a parallel development in the recognition of classes and of classes within classes. This type of models are common in biology and in psychology to some extent. It will be seen that this type of model has been strongly advocated for an encompassing theory of intellectual abilities. To this mathematically set principles also apply very readily.
The third type of model is named as morphological by Stronomer Zwicky. Basically this classification is a cross classification of phenomena in interesting categories rather than in categories within categories. The well known example of this type is the chemist's periodic table in which the chemical elements are arranged in rows and columns, each row and each column representing a different category. It is also known as 'logical matrix'. The use of this type of model in psychology is advocated by Guilford. A fourth type of model is known as operational type of model useful to conceive events in terms of interconnected series of transmission of information.

In the present section, two types of models, hierarchical model as well as morphological model will be discussed in detail.

**Hierarchical Models of Factors**:

What has been described above as hierarchical model comprises two different types and these are known as (1) Vernon model (2) Burt model.

**Vernon model**: This is diagramatically presented by Vernon himself (Vernon, 2, p. 22) as shown below in Fig. 4.
The British psychologists have always tried to prove the importance of 'g' factor. During such trials, in eight analyses, 'g' was found to cover more than twice as much variance as all group factors combined. The tables of results showed the characteristic of mental structure, namely hierarchy. Under 'g' are two major factors, (1) V:ed, for verbal-numerical-educational and (2) k:m, practical-mechanical-spatial-physical. That is after the removal of 'g', tests tend to fall into two main groups. The verbal-numerical-educational on one hand and the practical-mechanical-spatial-physical on the other hand. The former, V:ed subdivides into verbal and numerical, while the latter, k:m subdivides three ways, into space ability, manual ability and mechanical information, only
if the analysis is sufficiently detailed. Beyond these are specific factors, each of very narrow scope and considered by Vernon to be of a great importance. Many of what Burt recognizes as small group factors belong to this category.

Burt Model: This model as presented by Guilford (Guilford, 3, p. 58) is shown below in Fig. 5.

![Burt's Conception of an idealized hierarchical model](image)

Figure 5: Burt's Conception of an idealized hierarchical model

Burt model consists of an ideal hierarchy with successive dichotomies, each subdivision of a higher factor to give two immediately lower. The various levels
of bifurcation he identified as 'relations' at the highest level, 'association' at the second level, 'Perception' at the third and 'Sensation' at the fourth. Many subcategories contain more than two factors and hence Burt had to depart from strict dichotomization. At association level, for example, he recognized a division into memory with a general retentiveness, under which are group factors of visual, auditory, kinesthetic, and verbal memory factors, and productive association, with a general factor of inventiveness, under which are group factors of fluency and originality. These examples will give the general picture of Burt's hierarchical model.

Evaluation of Hierarchical Models:

We have seen the evidence against the idea of a 'g' factor, which is a key concept of the hierarchical models of Burt and Vernon. It can still be argued that it is the fact that where 'g' is demanded and found, it is not an invariant variable but changes almost with every battery of tests that is analysed. This is particularly true when the first centroid factor is taken to be 'g'. If we change the battery, the location of the centroid will change even when the axis is rotated from this dimension to locate 'g'. It is difficult to see how its location can be invariant from one analysis to another.
Morphological Model:

In this type of model there is a cross classification of phenomena in different categories. These categories have no connection with each other except that they belong to the same phenomena. The structure-of-intellect model is the good example of this type of models.

The Structure-of-intellect Model (SOI): Guilford gives his consideration of propounding his new model, the structure-of-intellect model which can be seen in his own words;

Several facts based upon experiences in factor analysis of intellectual tests in the United States had cast doubt upon the applicability of a hierarchical structure. Almost no one reported finding a 'g' factor; in fact the tendency has been for each factor to be limited to small number of tests in any analysis.

(Guilford, 3, p. 60)

The second consideration he gave was as follows:

The absence of a 'g' factor and the apparently comparable generality of all the factors do not give support to a hierarchical conception of their intercorrelations.

(Guilford, 3, p. 61)

These considerations were very important according to him. He thought that many factors have obviously parallel properties. While giving example, he
says, "If one collects a half-dozen verbal factors in one set and an appropriate collection of a half dozen non-verbal factors in another, it is clear that the factors in the two sets can be paired off in a meaningful manner. The psychological operation is the same in each pair, only the content of the test item is different (Guilford, 3, p. 61).

**Overview of the Model**: The model is a three way classification of intellectual abilities designed to encompass and organize intellectual aptitude factors. The three dimensions of the model represent the operation, content and product of a given kind of intellectual act. Each factor hypothesized or accounted for by the model is uniquely located and defined by specifying a category on each of the three dimensions. The three categories that specify each factor are coded in terms of triagram symbol specifying the operation, content and product respectively for the factor. For example, reading clock-wise GFU stands for Cognition of a Figural Units.

Complete characterization of an intellectual ability is achieved in terms of the possible subclass differentiation on each of the three major dimensions. 'Operations' is differentiated in five ways: Memory, Cognition, Evaluation, Divergent production, and Convergent production. 'Contents' is differentiated by four subclasses: Figural, Symbolic, Semantic and Behavioural.
'Products' is differentiated by six subcategories: Units, Classes, Relations, Systems, Transformation and Implications.

**Figure 6**: The structure of intellect model, with three parameters

The cube as shown in Fig. 6 is simply a visual aid to conceptualizing the three-way classification and is convenient for depicting the intellectual abilities as delineated by multivariate analysis of measured performance. The structure of intellect implies nothing beyond this conceptualization. Neither should any implication be drawn from the fact that there is a conventional order used in naming the various abilities.

**Categories in the Structure of Intellect**: It is already discussed in the overview of the model that there are three different categories in the structure of intellect.
Content Category: There is nothing to tie the three sets together except the fact that they are recognized as all being in the general category of intellectual abilities, nor is there a more general factor that would tie together the members of a set of factors. Three distinct parallel content categories were recognized and called by the terms figural, symbolic, and semantic. The kind of content called by the term behavioural was added to take care of the kind of information involved in cognition and in other operations pertaining to the behaviour of other people.

Operation Category: The intellectual factors were classified according to the supposed kind of operations involved. There were recognized perceptual factors, memory factors and reasoning factors. New investigations in 1950 pertained to creative thinking abilities, planning abilities, problem solving abilities, and judgement or evaluation abilities. In addition to memory and evaluation, other categories were added. Thus two operation categories, divergent production and convergent production were adopted and cognition was the fifth category accepted in operation category.

Product Category: The third way of looking at abilities and classifying them came to view slowly. It came about because of the need for taking into account the parallels that appeared across both the content and
operation categories. That is, if we take a set of factors having in common one of the content properties, say semantic, and also one of the operation categories, say cognition, we have a set of semantic cognition abilities, not just one.

There is a biological relation behind the order of the categories along each dimension. As there is relation of symbols between figural and semantic, symbolic category is placed between them. Symbols are basically figural but take on symbolic functions. As for operations, cognition is basic to all other kinds; hence it appears first. If no cognition, no memory; if no memory, no production. For the things produced come largely from memory storage. If neither cognition nor production, then no evaluation. Units are regarded as basic hence they appear at the top. The unique character of transformation would be a reason for putting them last, since it involves one item of information becoming something else.

The conception of the structure of intellect model as a frame of reference for the intellectual abilities has served the heuristic function of generating hypothesis regarding new factors of intelligence. Additional factors were found in the literature and were readily given logical places within the model. The position of any factor in the model, is determined by its unique properties, its operation, its content, and its product.
The position of the factors in SOI model becomes a guide line in the construction of tests. Thus it has served well its purpose of guiding research. Its conception can add considerable new meaning and significance to old and new psychological findings by other methods.

Relation to other Theories: The SOI model has some features common with other theories and models. Spearman's "fundaments" are SOI units, his relations are also SOI relations. Spearman's concept of "education of relations" is equivalent to the cognition of relations. Spearman thought two major operations characteristic of \(g\); however, the SOI model presents four distinct abilities for educing or cognizing relations, one for each kind of content, figural, symbolic, semantic and behavioural. Spearman recognized relations along the line of different kinds of information even including "psychological relation" which is rather clearly equivalent to the SOI concept of behavioural relations.

Spearman's conception of "education of correlates" belong in the SOI category of convergent production.

The typical test for the relations category with the convergent production operation fits exactly Spearman's paradigm for education of correlates. These comparisons show the narrowness of Spearman's psychological
conception of 'g'. If education of relations and correlates taken together are accepted as the sine-qua-non of 'g', then 'g' embraces only 8 of 120 intellectual abilities represented in the SOI model.

Vernon's first major bifurcation, between v:ed and k:m major group factors, is in a way parallel to the distinction between semantic and figural categories of information. His k:m factor is much broader than the SOI figural category. His further bifurcation under v:ed between verbal and numerical is parallel to the SOI distinction between semantic and symbolic information. There is no provision for behavioural information in his structure and he has nothing to suggest about operations or products, except incidentally in his further breakdowns.

Burt's first major bifurcation is so much like Vernon's that much the same parallel applies between this part of his hierarchy and SOI categories. Many of the same factors are identifiable but their arrangements in his system have little in common with interrelationships of factors in terms of placement in the SOI model.

The Present Experiment

In the foregoing discussion the investigator has tried to give different definitions of intelligence given by the psychologists of the nineteenth and the twentieth century. All of them have tried to explain the structure
of intelligence in their own ways. The definition of intelligence has so far defeated the intelligence of psychologists.

Any scientific approach to measurement requires that "the aspect to be measured by the instrument should be stated by the test maker." So, the test maker should make clear what will be measured by the instrument. Thus the understanding of the concept of intelligence becomes necessary.

Different Doctrines of Intelligence were put forward in the beginning to give some idea about the concept of intelligence. Monarchic doctrine is in contradiction to the theory and practice of current mental tests. In the Oligarchic Doctrine of Faculties and types the single faculty is replaced by a small number of different ones. These are highly criticised and even ridiculed. According to the Anarchic Doctrine of Independent Elements there exists a number of primitive mental abilities highly particularised and independent of one another. The mental tests depend on the good teamwork of a group of mental abilities acting together as one unit and Intelligence is thought to be constituted of these abilities hence this theory is of no more use.

Intelligence has certain properties which are known as attributes. Intelligence is manifested in different
situations so these attributes are divided into different types. The level or altitude of intelligence, Range, Area and Speed are different altitudes. The intelligence ratings are based on all these attributes. In the present tests they all are given due consideration. Some are given more importance and other less in different tests. In some tests speed is given more importance while in some range and level.

Intelligence is also thought to be constituted of different kinds like abstract, concrete and social. These tests mainly measure the concrete intelligence. As Freeman observes, "even tests which present the things rather than ideas are not devoid of demands upon ability to conceptualize and make abstractions" and to that much extent these tests measure abstract intelligence also.

Different theories have been put forward about the structure of intelligence. According to the Multiple factor theory intelligence is said to be constituted of a multitude of separate factors. Thorndike himself admits that in constructing a mental test his "atomistic" theory is of less practical significance. The two-factor theory was given by Spearman as a result of study of correlations between sensory tests and estimates of intelligence. Spearman's two-factor theory forms the core part of the whole discussion on the structure of intelligence.
According to him 'g' is the centre of energy which controls the activities of human mind. If the various test results are analysed the tests are found correlating with each other. This is due to the common mental functions measured by these tests. There is some common mental endowment which is found in most of the mental performances. This is 'g' according to Spearman and more over there are specific factors which are different in different tests. His principles of Noegenesis has also helped the test makers a lot.

Apart from all the controversies raised against the Spearman's two-factor theory, it has no doubt the key position amongst all the theories. The tests based on this theory will be saturated with 'g'. This theory has guided the vetern test makers to a great proportion.

The present tests are designed on this theory as the investigator believes in this theory. She has tried to develope performance tests which are rich in 'g' factor. It is a well known fact that the performance tests are having low 'g' factor loadings. There are some tests like Kohs' Block Design test which are well-known for their 'g' saturation and hence such tests were selected. The results of the factor analysis to be discussed in detail in Chapter 7 stand testimony to the fact that the present battery shows fairly high 'g' saturation.