CHAPTER III

CONCEPT OF INTELLIGENCE

Introduction:

Measuring is expressing a quality or an object in quantitative form i.e. in the form of number. The main question to be answered by measurement is how much of what.

Measurement may be direct like that of length, weight, time etc. or it may be indirect like that of electricity, heat etc. In indirect measurement, the measurement of the property is done in terms of the measurement of one of its manifestations. As intelligence is an innate ability, its measurement is done indirectly in terms of its manifestation.

So the person interested in the measurement of intelligence must define intelligence precisely.

Definition

The meaning of the word "definition" as given in "Chamber's Twentieth Century Dictionary", is "description of a thing by its properties, an explanation of the exact meaning of a word, term or phrase". The scientific definition of any term must include the definition properties of the term. When the term is used in a sentence, the definition should enable a person to say precisely whether the use is correct or incorrect.

According to Sir C. Burt there are two types of definitions- nominal and real. "A nominal definition is one which states how the word will be used; a real definition is one which explains the nature of the thing to be defined".[1/]

Definition of Intelligence.

The word intelligence is as old as Aristotle who distinguished oresis- the emotional and moral functions from dia noia- the cognitive and intellectual functions". "The latter word was translated by Cicero as intelligentia (inter-within, legere to bring together, choose, discriminate)".[2/]

As P.E.Vernon points out in his presidential address delivered on April 16, 1955, at the annual conference of British Psychological Society, ".... there are said to be almost as many definitions of intelligence as there are psychologists".[3/] After the publication of Binet's tests of intelligence number of tests were published by different psychologists by defining it in different ways in terms of its many manifestations. Others also tried to define it in some other forms. To bring unanimity of opinion regarding the definition of intelligence uptil now, four symposia were arranged in England and America. But still there is no unanimity of opinion regarding its definition. Some of the definitions are given below:-

1/Burt Cyril, Mental and Scholastic Tests, Staples Press, London, 1962. pp 145.

2/Vernon P.E., Intelligence and Attainment Tests, University of London Press Ltd., London E.C.4, 1962. pp 27.

3/Cohen John, Readings in Psychology, George Allen and Unwin Ltd, London, 1964. pp 291.

1. Alfred Binet.

"Binet's Central concept of intelligence, ... involved three principal points: (1) a goal or direction to the mental process; (2) the ability to make adaptations by means of tentative solutions; (3) the ability to select, to make good judgements and to criticise any postulate or solution".[1/]

2. Stodard G.D.

"Intelligence is the ability to undertake activities that are characterised 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".[2/]

3. Thorndike E.L.

"We may then define intellect in general as the power of good responses from the point of view of truth or fact, and may separate it according as the situation is taken in gross or abstractly and also according as it is experienced directly or thought of ".[3/]

4. Terman L.M.

"An individual is intellegent in proportion as he is able to

1/Stodard G.D., The Meaning of Intelligence, Macmillan Company, New York, 1959. pp 94.

2/Ibid, pp 4.

3/Tyler Leona E., Intelligence: Some Recurring Issues, Van Nostrand Reinhold Company, New York, 1969. pp 5.

carry on abstract thinking".[1]

5. Colvin S.S.

"In a very true sense intelligence is mental adaptability to environment".[2]

6. Pinter Rudolf.

"I have always thought of intelligence as the ability of the individual to adapt himself adequately to relatively new situation in life".[3]

7. V.A.C.Henman.

"Intelligence then involves two factors- the capacity for knowledge and knowledge possessed".[4]

8. Peterson Joseph.

"Intelligence seems to be a biological mechanism by which the effects of a complexity of stimuli are brought together and given somewhat unified effect in behaviour. It is a mechanism for adjustment and control and is operated by internal as well as by external stimuli".[5]

9. Thurstone L.L.

"Intelligence as judged in every day life contains atleast

1/Ibid, pp 8.

2/Ibid, pp 11.

3/Ibid, pp 13.

4/Ibid, pp 16.

5/Ibid, pp 18.

three psychologically differentiable components: (a) the capacity to inhibit an instinctive adjustment, (b) capacity to define the inhibited instinctive adjustment in the light of imaginally experienced trial and error, (c) the volitional capacity to realize the modified instinctive adjustment into overt behaviour to the advantage of the individual as a social animal".[1]

10. Woodraw Herbert.

"Intelligence, then, is the capacity to acquire capacity".[2]

11. Wechsler D.

"Intelligence is the aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment".[3]

12. Burt Cyril.

"By intelligence I understand innate, general cognitive efficiency".[4]

13. Knight Rex.

"Intelligence is the capacity for rational constructive thinking, directed to the attainment of some end".[5]

Going through these and various other definitions, one will

1/Ibid, pp 19.

2/Ibid, pp 12

3/Downie N.M., Fundamentals of Measurements, Oxford University Press New York, 1961. pp 217.

4/Burt C. Op.Cit., pp 145.

5/Knight Rex, Intelligence and Intelligence Tests, Melhuen & Co.Ltd. London Wc 2, 1959. pp 16.

be astonished to find that "the problem 'what is intelligence' had inspired most wasted effort than almost any other problem in psychology".[1/]

But as Vernon points out "the most striking feature of these different views is not that they disagree but that all the functions listed overlap considerably, and may indeed be regarded as partial aspects of intelligence".[2/] All these are nominal definitions according to Burt's classification of definitions.

Attempts have also been made to provide real definition of intelligence. The problem has been attacked from different angles.

I. Biological Approach:

This approach has tried to interpret intelligence in terms of development of the nervous system.

Man is more intelligent than any other animal. The size of the human brain is large as compared with that of the other organisms. His brain consists of centres which are capable of producing specialised functions in cooperation with each other. These brain centres are thus capable of producing more complex behaviour. Biological approach has tried to associate this complexity of behaviour with intelligence.

Intelligence has been defined as capacity for profiting by experience, adaptation to environment, plasticity or ability to

1/Roppart David, Gill Merton M, Schafer Roy, Diagnostic Psychological Testing, International Universities Press Inc., New York 1968. pp 64.

2/Vernon P.E., Op. Cit., pp 30.

learn.

a. Phylogenetic Hierarchy:

There is a continuous evolution in the nervous system of the organism according to its place on the ladder of evolution. The difference in the structure of this nervous system is paralleled by its difference in the various mental capabilities. The phylogenetic hierarchy is determined by the increasing complexity of adaptative capabilities. Higher the animal on the evolution ladder more intelligent it is both qualitatively and quantitatively.

b. Neurological Hierarchy:

The human nervous system is divided into two classes, central nervous system and peripheral nervous system. The nerves are classified as afferent nerves and efferent nerves according to their functions. The peripheral afferent nerves and efferent nerves connect with the central nervous system at different levels. Bronson postulates a series of three main levels within the nervous system.

Level I - at brain stem

Level II - at subcortical fore brain

Level III - at Neocortex

The network of neurons, surrounding the connections in level III, are capable of making most refined sensory and motor discriminations. Lower the level of these connections lower is this capacity in the neurons surrounding them. Thus there is a hierarchy of neurons. The neurons in the higher position of this hierarchy, are

capable of doing more complex intellectual activities.

c. Ontogenetic Hierarchy:

Ontogenetic development appears to be hierarchical. Certain capabilities regularly follow certain others. The development of certain cognitive processes not only depend on the experiences due to environment but also on the maturation of hierarchically ordered neural substances. This maturation is determined by constitutional factors. The reasoning ability, the ability to transfer concrete into symbolic representations, which are identified as activities of intelligence, cannot take place unless the maturation of certain neural substance takes place.

According to this theory, experience is necessary but it alone is not sufficient for abstract and conceptual forms of mental activity which are the functions of intelligence. Maturation of certain neural substance is necessary.

d. Hebb's Theory:

He postulates that the premitive consciousness of the child is completely undifferentiated at the time of birth. As it goes on gaining experiences, the neurons go on grouping themselves in the association areas of the brain. These organizations or schemata are called percepts. When sufficient number of percepts are formed, further mental development takes place. These perceptual schemata organize themselves into higher order ones namely the conceptual schemata in the association areas of the brain. Once these are established, they act independent of any

particular neurons.

Moreover he has advocated two types of intelligence- Intelligence A and Intelligence B. Intelligence A is a genetic potentiality and Intelligence B is a present mental efficiency. Intelligence A represents the capacity for forming, retaining and reorganizing perceptual and conceptual schemata, where-as intelligence B represents the cognitive ability developed due to environment. Intelligence A is genetic and intelligence B is acquired. Intelligence tests measure intelligence B.

The biological approach of defining intelligence is not of much help to the person interested in the measurement of intelligence.

II. Psychological Approach:

This approach is not much concerned with the biological factors. It is concerned with the particular cognitive functions which characterise human intelligence.

Intelligence has been defined in forms of capacities or abilities, like capacity for relational constructive thinking, ability to judge, ability to grasp new relationship etc.

Though they look like disagreeing with each other, they are the partial aspects of intelligence.

As Vernom points out ".... no definition is precise enough to provide much guidance in devising intelligence tests".[1/]

1/Ibid, pp 30

III. Operational Approach:

Electricity can be measured without precisely defining electricity. The operational approach has viewed the problem of measurement of intelligence from this angle. Intelligence is defined operationally and a test of intelligence is constructed accordingly. A good test is one which enables us to make certain valid predictions about the child.

The performances on different tests based on different operational definitions show a high degree of correlation. This is due to overlapping of different abilities. This approach fails to explain why a child superior in performing one kind of mental activity should also be superior in performing other kinds of mental activity.

IV. Developmental Approach:

This approach has tried to explain the meaning and process of mental development.

Mention of the work of D.O.Hebb has already been made else where in this chapter. He has tried to explain mental development in terms of perceptual and conceptual schemata.

1. Piaget's Theory:

Similar conclusions have been drawn by J. Piaget. He advocates that the cognitive development is inherent, unalterable, evolutionary and continuous. It takes place in different phases. Each level of development finds its roots in the previous phase and continues in the following one. Each phase reflects a range of

organizational patterns. Previous ones are sensed inferior and becomes part of the new superior level. The difference in the organizational pattern creates a hierarchy of experiences and actions. Each individual has the polentiality to reach the highest level in the hierarchy, though it may not perhaps be realized.

The different phases in the hierarchy as beheld by Piaget, and their characteristics are as follows:

a) Sensory Motor Phase:- (Age 0-2 years). There is a coordination of motor activities and sensory perceptions. The individual realizes himself as a part of his own environment.

b) Perceptual Phase:- (Age 2-4 years). This is the period of transition from purely self satisfaction to more rudimentary social behaviour. Language, play & imitation are used as means of communication and socialization.

c) Phase of Intuitive Thought:- (Age 4-7 years). It is the phase of widening social interest. The individual gradually begins to react with his environment realistically. Use of language is done in the process of thinking and reasoning.

d) Phase of Concrete Operations:(Age 7-10 years). The individual is able to do mental experimentation based on perception. He tries to explore several possible solutions of a problem before adopting any one of them.

e) Phase of Formal operations:- (Age 11-15 years). He is able to think and reason beyond his own realistic world. His thinking begins to use propositions.

This developmental theory is very similar to the concept, intelligence B, proposed by Hebb. However Piaget has located five distinct phases of development and has also given their characteristics.

The influence of this theory on the movement of mental measurement is not much as it tries to describe its sequence of development.

2. Learning Hierarchy:

Gagne has proposed a theory of mental development based on the concept of cummulative learning. According to this theory, some skills are more basic than others. The acquisition of these basic skills lead to the acquisition of more complex skills. The mental ability of any individual at a particular time is the cummulative learning done by him at that time. The elements learnt build patterns on each other which are more complex, and which generate increasing intellectual competence. The level of competence of an individual depends on the opportunities available for him to encounter with the environment. So, any individual can reach any level in the hierarchy of mental growth, if he gets adequate opportunities. However there is very little evidence to believe it. As Jenson A.R. remarks, "..... There is little satisfaction in being told that a person with I.Q. of 70 could become a Burtrand Russel if only he were taught over a period of some 100 or 200 years".[1/]

1/Jensen A.R., Hierarchical Theories of Mental Testing, Chapter VI, On Intelligence, Dockrell W.B., Editor, Methuen & Co. Ltd., London, 1970. pp 137-138.

V. Factorial Approach:

Dr. Spearman gave a number of intelligence tests to a group of individuals and calculated the coefficients of correlation between the performances on these tests. He found that there was positive correlation in every possible pair of these tests. He arranged these correlations in the descending order of their magnitude and treated the data mathematically. This mathematical procedure is known as factor analysis.

The main object of this procedure is to simplify the description of the data by decreasing the number of variables called factors. It converts the table of intercorrelations into a factor matrix. Different methods of factor analysis have been developed by Spearman, Thurstone etc.

Based on the results of factor analysis, number of theories of intelligence have been put forth, some of which are described below:-

A. Two Factor Theory:

When Spearman arranged the intercorrelations in hierarchial order, he found that, "The correlation coefficients in two colaumns tend to be in the same ratio as we go up and down the pair of coloumns".[1/] He placed these ratios in the form of tetrad differences, and found that these tetrad differences are zero, or tend to zero.

He argued that the correlation between any two intelligence tests is due to some common factor which is influencing the

1/Thomson G.H., The Factorial Analysis of Human Ability, University of London Press Ltd., London E.C.4, 1960. pp 12.

performance on these tests. This common factor, was called as 'g'.

He observed a kind of hierarchy of mental abilities. He found that, the 'g' saturation in case of tests involving complex mental activities is more than that in case of those requiring simplex mental activities.

On the basis of these findings he formulated his famous theory of two factors as:

"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 the others".[1/]

He named this fundamental element as 'g' and the specific elements as 's'. The element 'g' is found in every intellectual activity whereas the particular 's' factor is found only in that particular activity, and not found in any other intellectual activity. According to him, the 'g' factor is innate and uneducable but the 's' factor is affected by education and training. Every test has its own 'g' saturation. The saturations of 'g' factor in the tests determine the extent to which they correlate with each other. However, the saturation of 's' factor reduces the correlation between them.

Though he never called 'g' as general intelligence, he advocated that the measure of 'g' is the measure of general intelligence. According to him a single test with high 'g' saturation is enough

1/Butcher H.J., Human Intelligence- Its Nature and Assessment, Melhuen & Co. Ltd., London E.C.4, 1968. pp 45.

for testing intelligence, and the tests requiring to findout abstract relationships are the best measures of 'g'.

However he was conscious from the beginning that there might exist some intermediate factors, which may not be so universal as 'g' and not so strictly specific as 's'. He accepted the evidence showing the existence of group factors which are common in some tests, but not in all, but concluded that their existence is either small or rare.

However many psychologists like Burt, Kelley etc. considered that this theory indicates the initial degree of analysis. They consider that existences of such group factors in many intellectual activities is neither small nor rare.

Though this theory has been much critisized severely, the importance of his contribution of treating the problem statistically cannot be denied, as this problem was considered to be too complex to be analysed.

B. Multifactor Theories:

However American psychologists in general and Thorndike in particular did not agree with the views of Spearman. They put forth multifactor theories, the main theme of which is that intelligence consists of more than one factor as against Spearman's 'g' factor only.

Thurstone developed a different technique of factor analysis which helped him to formulate his theory of Primary Mental Abilities.

1. Theory of Primary Mental Abilities.

Thurstone believed that some abilities which facilitate some mental activities to a great extent have no effect on some others. So he also gave number of tests to the same group of individuals. He carried out factor analysis according to the procedure he had developed and identified the following seven factors influencing the intellectual activities:-

S - Spatial ability

P - Perceptual speed

N - Numerical ability

V - Verbal meaning

M - Memory

W - Verbal fluency

I or R - Inductive reasoning

He called these activities as primary abilities. As these factors are independent of each other, the tests constructed to measure these abilities should not at all correlate with each other. If at all they do so, due to experimental errors, the correlations between them should be insignificant. He believed, in his earlier studies, that he had analysed the abilities without assuming the concept of general intelligence.

But in the latter studies he observed that the residuals in some of the matrices were too large to be neglected. So he performed a second order analysis of the factors and called this second order factor as 'G'. He considered this second order factor

agreeing with Spearman's 'g'. According to him the primary abilities are media for the expression of intellect and second order factors are the parameters of its primary abilities. If the primary abilities are considered as sense organs, the second order factors are those which influence the activities of these organs.

So he indirectly accepted the existence of 'g'. Moreover, though he called these as primary mental abilities, there was nothing primary in them in neurological or psychological sense.

2. Sampling Theory.

Thomson formulated the sampling theory which assumes the concept of bonds of mind. Though the exact nature of these bonds are not known, they are thought of as some thing associated with the neurons or nerve cells of the brain. They are innumerable in number and are capable of organising themselves in patterns. The simplest patterns are instinctive whereas complex ones are acquired. Thinking process is accompanied by the excitation of these patterns. Intelligence is associated with the number of, and complexity of these patterns, which the brain can make.

The explanation given by this theory for the Zero tetrad difference is that "each test calls upon a sample of the bonds which the mind can form and that some of these bonds are common to two tests and cause their correlation"[1/], and that "the laws of probability alone will cause a tendency to zero tetrad differences among correlation coefficients"[2/].

1/Thomson G.H., Op. cit., pp 309.

2/Ibid, pp 311.

This theory assumes that each ability is composed of some of the bonds and may differ in their richness. Richness according to this theory corresponds to communality according to two factor theory i.e. some abilities need many bonds and others may need few of them. The factor 'g' measures the whole number of bonds and the common factors indicate the degree of structure among them.

Thus this theory gives an alternate explanation for the zero tetrad difference. It neither asserts nor rejects the existence of the general ability.

3. Three Facet Theory.

Guilford has formulated this theory on the following assumptions:-

a. Intelligence consists of number of abilities which are independent of each other.

b. Though they are sufficiently distinct to be recognised, they resemble each other in certain ways and hence they can be classified.

c. The basic abilities may vary according to the following three aspects which he names as facets:-

   1. Basic psychological processes involved
   2. The kind of content or material used
   3. The forms that given information takes in the course of the process.

He has proposed a three dimentional model for the structure of intelligence. These dimensions represent operations, content,

and products respectively. The five operations proposed by him are,

a. Cognition - discovery, rediscovery or recognition.

b. Memory - retention of what is cognized.

c. Divergent Production - thinking in different directions, sometimes searching, sometimes seeking variety.

d. Convergent Production - Leading the information to one right answer or to a recognise best or conventional answer.

e. Evaluation - Reaching decisions as goodness, correctness, suitability or adequacy of what is known, remembered and produced in productive thinking.

The four types of material or content are:-

a. Figural - material perceived through the senses, like size, form, colour etc.

b. Symbolic - consisting of letters, digits and other conventional signs.

c. Semantic - in the form of verbal meanings or ideas for which no examples are necessary.

d. Behavioural - This has been added on a purely theoretical basis to represent the general area sometimes called "social intelligence".

The six products proposed are:-

a. Units	c. Relations	e. Transformations
b. classes	d. Systems	f. Implications.

So he suggests that there are 120 (5x4x6) possible types of abilities. He and his associates engaged themselves in constructing 120 types of tests to measure these 120 abilities and their work has almost reached completion. His theory appears to give systematic and scientific classification of abilities.

However this theory is criticised by the veteran British psychologist Vernon saying that his factors are too narrow and specific. There is much overlapping of these abilities.

C. Hierarchical Theory:

Hierarchy is a classification in graded subdivisions. A body of knowledge is classified in successively subordinate grades according to a particular critarion. The types of hierarchies proposed in case of intelligence by different psychologists are as given below:-

a. Learning hierarchy
b. Neurological hierarchy
c. Phylogenetic hierarchy
d. Ontogenetic hierarchy
e. Factor hierarchy

The first four hierarchical theories have already been discussed elsewhere in this chapter.

Factor Hierarchy.

Factor analysis techniques lead the psychologists to formulate theories regarding the structure of intelligence.

C. Burt proposed a theory which advocates a hierarchy of the

factors, which is an attempt to reconcile between the two factor theory and the multifactor theory.

According to him the four factors likely to be found in any cognitive ability are general, group, specific and error. When the influence of Spearman's 'g' factor on a variety of performances are taken into account, there remain still factors like verbal ability and spatial ability, common to a large group of performances. Within these groups it is possible to find smaller groups which have also something common in them. This procedure of extracting factors may be continued until a stage is reached when there is nothing common in the given two groups. These are specific to that particular performance. The specific factor can further be divided into true variation and erroneous variation.

So in this hierarchy the 'g' factor suggested by Spearman is at the top. At the second level, there are two major group factors namely V:ed (Verbal educational) and K:m (practical mechanical). The major group factors can further be subdivided into minor group factors. This division can be continued until the lowest level of hierarchy consisting of specific factors is reached.

This model is generally still followed by the British psychologists. However Vernon warns that this model should be treated as general approximation. The details are vague because, firstly, they are not fully known and secondly, they vary according to circumstances. This theory recognises that the factor pattern depends on selection of tasks and people. In some tests V:ed may appear

as one factor. However if a large number of tests asking for Verbal factor are taken and analysis are carried out, this pattern may split up into two clearly distinguishable factors namely verbal and educational. Similarly they can further be split up into factors in the lower level of the hierarchy.

This theory is able to account for the numerous abilities that have been labelled and also for the conflicting findings. Moreover it helps to identify different kinds of factors and the tests based on them, so that one can easily decide whether that test can serve a particular purpose of assessment and prediction.

Conclusion.

From the discussion so far, we may conclude as follows:-

1. Intelligence is an innate ability which is a quality of the nervous system. This ability enables an individual to acquire, break-up, and reorganise habits, percepts, concepts and any other schemata.
2. This is general and undifferentiated at the time of birth and as the individual grows up this tends to become more and more specific.
3. Mental growth is cummulative. Thus, those who have large stock of above mentioned schemata, are able to build more complex schemata.

No theory, discussed so far, has escaped severe criticism. None of them is capable of explaining the nature or structure of intelligence fully. The factorial approach has tried to give the

mathematical model of the structure of intelligence, based on the results of factor analysis. These results are different because different procedures, which are not mathematically incorrect, are adopted for factor analysis.

Factors may be thought of as convenient generalizations. So it is possible to think of more than one model formed due to these factors. Under these circumstances the question will not be, which model is better, but it will be, which model is more useful in a particular context.

Persons like Burt, Vernon, Butcher, Dockrell etc. feel that if the question is a broad one, like- whether the individual will succeed in courses like arts, science, etc. the hierarchical order is more suitable and if the question is very specific, like- whether the individual will do well as a research scholar in a particular branch of a discipline, multifactor and multidimensional model would be more useful.

This test is designed for the children studying in standards VIII to X and that too for guidance purposes, where the problem is to be tackled in a very general way. Hence the hierarchical model illustrated by Vernon has been used as the basis for the construction of this test.

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