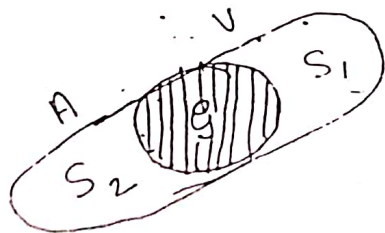


THEORIES OF INTELLIGENCE

Spearman's Two Factor Theory :-

Charles Spearman (1863-1945) announced his two-factor theory of intellectual ability in 1904. However his theory did not come into prominence until the mental testing movement had been given impetus by the development of intelligence tests. Once it had come into its own it became the basis for rival theories of intelligence formulated on the basis of mathematical analyses tests.

Spearman's basic assumption is that all mental tests require two kinds of ability, a general ability " g " + specific ability " s ". " g " or general ability is common to all intellectual tests, whereas " s " is always specific to a given task. Consequently there is one " g " but as many " s "s as there are different intellectual tasks. For the sake of simplicity let us assume that we are dealing with two tests a vocabulary test and an arithmetic test. Both tests draw upon the common general ability " g ", yet in addition each requires specialized abilities, verbal ability s_1 , + numerical ability s_2 , which are specific + independent of each other. Moreover it follows that, because the two tests require a common ability, they will be positively correlated, but the correlation will not be perfect as the specific abilities s_1 + s_2 are independent + has nothing in common. The situation can be represented graphically as follows.



dot ellipses V + A represent - vocabulary + arithmetic tests respectively. Because the tests are correlated, the ellipses overlap. The area of overlap represents g . The areas of independence represent s_1 + s_2 . Applying the same reasoning more general all intellectual tests according to Spearman, 'center' on g , since all are positively correlated. Indeed the basic evidence for the two factor theory was derived from Spearman's finding that various intellectual tests are positively correlated to a moderately high degree. By a complex process involving use of tetrad equations, Spearman was able to show mathematically that his two factor theory could account for the empirical inter relationships existing among tests.

Spearman's theory is able to explain the observed fact that the children who show ability in one intellectual area also show ability along other lines. However because specific abilities are held to be independent of g + of each other, the theory also allows for differences in their more specialized aptitudes. Such fluctuations in abilities are most marked in the case of highly specific aptitudes, such as musical or mechanical ability. Being relatively independent of g , highly specific aptitudes may ~~be~~ be well developed in persons of generally low overall ability or may be poorly developed in individuals of relatively high general intelligence.

Spearman's theory as originally formulated subsequently underwent revision in the light of further studies. He discovered that the tests of mental abilities that are highly similar correlate to a greater extent than can be accounted for on the basis of their common overlap with g . As a result he acknowledged

the possibility of group factors such as verbal ability & spatial ability. He did not however abandon his original position with regard to 'g' & 's'. The new group factors are conceived to be intermediate in scope, while 'g' remains the overall factor of greatest importance. Finally he proposed the existence of additional general factor 'p' 'o' & 'w' which stand for perseveration oscillation and will respectively. According to Spearman perseveration represents the inertia of the individual's supply of mental energy, & oscillation the extent to which it fluctuates from time to time. Finally 'w' represents will a motivational-personality factor that enters into the taking of intelligence tests.

Regarding his assumption as to the nature of 'g':

Spearman believes that 'g' is basically the ability to grasp relationships quickly & to use them effectively. Because his definition of 'g' is so broad he is able to account for the ability required to solve virtually any kind of intellectual problem. Furthermore, the amount of 'g' present to the individual remains constant regardless of the kind of task to which it is applied. Because of its mental energy nature, 'g' is not affected by educational procedures. This of course is not true of 's' since any given 's' can be greatly influenced by the educational procedures. Heredity apparently is a great factor in the amount of 'g' present in the individual. As far as Spearman is concerned, neither race nor sex is of any particular importance in terms of determining amount of 'g' present to the individual.

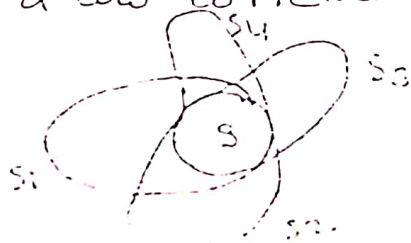
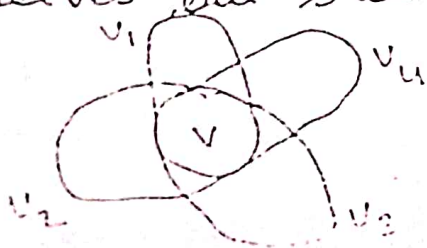
The principal contributions of Spearman are theoretical & statistical. His work became the basis for the factor-analytic techniques which expanded and refuted

~~The possibility of group~~

his theory. Still without his contributions the more sophisticated models prevalent today might have been greatly delayed. Spearman's theory of 'g' + 's's' remains a brilliant view of intellectual expression.

THURSTONE'S WEIGHTED GROUP-FACTOR THEORY:

L.L. Thurstone (1887-1955) has been identified since the early 1930's with a weighted group-factor theory of primary mental abilities. Thurstone denies the existence of 'g' and 's'. Rather he conceives of mental organization in terms of group factors of intermediate scope. However his group factors are not believed to be the result of the overlapping of highly specific abilities of narrow range. Rather such factors are revealed by correlation clusters occurring among similar tests, which in turn are drawing upon certain primary mental abilities. For example, let us assume that a group of individuals are given a large variety of tests among which are included tests of verbal, spatial, arithmetical & perceptual ability. Let each of these tests be represented by small ellipses with appropriate subscripts $v_1, v_2, v_3, s_1, s_2, s_3$ and so on. If all tests are intercorrelated, the result will be the appearance of clusters of tests that are highly correlated among themselves but show only a low correlation between clusters



Intelligence

~~Crisis~~

The area of common overlap in each cluster defines a primary mental ability (P.M.A). In one investigation, Thurstone (1935) found evidence for seven primary mental abilities.

Briefly these are

- 1) Verbal - The ability to understand & utilize verbal ideas effectively.
- 2) Number - The ability to carry out fundamental arithmetic operations of additions, subtraction, division & multiplication.
- 3) Spatial - The ability to deal with objects in space & spatial relationships as demanded in geometric problems.
- 4) Perceptual - The ability to identify objects quickly & accurately as required in reading & mapwork.
- 5) Memory - ability to learn & retain information.
- 6) Reasoning - The ability to perceive & utilize abstract relationships; to put together past experiences in the solution of new problems.
- 7) Word fluency - The ability to think of words rapidly. Word fluency may be related to personality variables as well as intellectual factors.

On the basis of his findings, Thurstone undertook the program of test construction for the development of more refined measures of P.M.A. He believed that the traditional method of rating the individual's intellectual ability by the means of a single score was wrong. Instead, the testee's standing on each of the P.M.A is reported in terms of percentiles. In this way a psychogram of

Intelligence

of the individual's pattern of abilities can be reported. Thurstone believes that, this method gives a more valid & useful appraisal of the abilities than the traditional IQ score which he feels, obscure the underlying pattern of mental aptitudes.

Finally it should be noted that Thurstone's factoranalytic techniques reveal that various tests show different "factor-loadings" or varying degree of relationship with the several correlation clusters.

Thurstone also discovered low +ve correlations among the various primary abilities, indicating the existence of a low order of general ability contrary to his denial of the existence of g . Moreover, he found that for adults the correlations among primary abilities are low, while for children the correlations are higher.

Independent confirmation of this finding has been provided by H. E. Garrett (1946) and his associates.

On the basis of these findings, Garrett has postulated a developmental theory of intelligence to the effect that, with increasing age abilities differentiate out of general abstract intelligence into relatively independent factors. He believes that the differentiation occurs as a result of both maturation & increasing specialization of interests on the young adult level. The concept of a unitary intelligence, measured by a general intelligence test appears to be valid for young children, while the concept of more specialized aptitudes or group factors measured by appropriate tests seems to be more valid for older children and adults.

CATTELL'S THEORY:

Cattell extended the Thurstone technique to the analysis of intelligence. Cattell believes that his modification of the Spearman & Thurstone techniques provides evidence for two fundamental types of intelligence, both of which are underlying general order factors. These are "Crystallized intelligence" and "fluid intelligence".

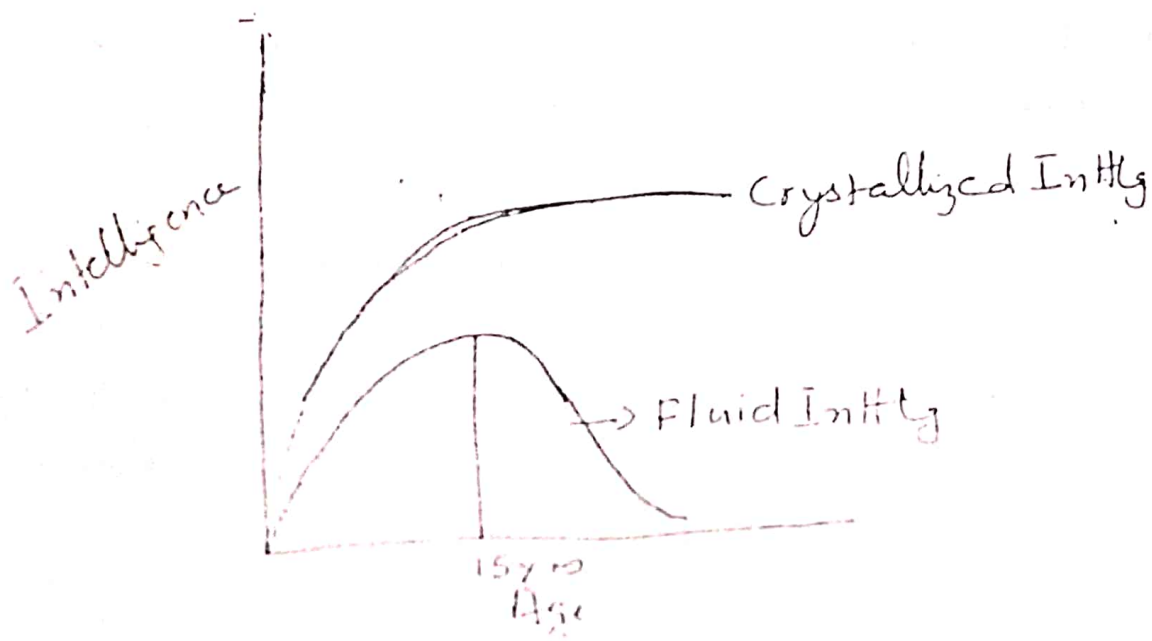
Fluid intelligence is the capacity for insight into complex relationships. In other words it is the capacity for acquiring new concepts & demonstrating general "brightness" & adaptability in novel situations. Consequently fluid intelligence is relatively independent of education, & tests that measure it minimize scholastic training & cultural factors.

Crystallized intelligence is a combination of acquired knowledge & developed intellectual skills. In Cattell's own terminology it is the "investment" of fluid intelligence in the higher level skills of the culture to which the individual is exposed.

Cattell's concept of fluid intelligence is comparable to 'g', which Spearman defined as the ability to grasp relationships quickly or more technically, to ~~educate~~ ^{educate} correlate from given elements of a relationship. Cattell believes that this type of ability is primarily related to the mass of the cortical association areas in the brain & therefore finds support in studies such as Lashley's & Hebb's, which show that impairment following brain injury is proportional to the mass of cortical association tissue destroyed. Crystallized ability on the other hand, reveals the greatest decrement in cases of injury to specific motor or sensory areas. Verbal ability for example would be seriously impaired by injuries to the ^{speech} center or Broca's area.

Cattell also presents evidence to show that fluid + crystallized intelligence undergo a different course of development over the trajectory of life. Between infancy + age 15 the two types of intelligence show identical growth, curves with rapid negative acceleration. However at age 15 the curves diverge - with that for ^{crystallized} crystallized intelligence remaining virtually unchanged or perhaps rising a little + that for fluid intelligence showing a steady and relatively steep decline. This finding can account for the well known difficulty that the older persons experience in mastering new materials or facts that are contrary to prior + well entrenched knowledge. At the same time knowledge + judgement - based on past experience (crystallized intelligence) hold up well.

Finally, the concept of fluid intelligence that is measured independently of culture + education would seem to lend itself to helping resolve the nature nurture controversy - that is the degree to which intelligence is dependent upon heredity versus environment.



GUILFORD'S THEORY :

A radically different factor theory of intelligence has been proposed by J. P. Guilford (~~Guilford~~) who denies the existence of 'general factor' 'g' or even the possibility that intelligence can be reduced to a few factors. Instead he proposes that there are 120 unique intellectual abilities.

One of the dimensions of intelligence according to Guilford is 'content' of which there are four basic varieties. —

1- figural (2) symbolic (3) semantic (4) behavioral.

Figural content refers to the utilization of pictures or images:

Symbolic content is largely mediated through numbers & letters.

Semantic content through verbal meaning and Behavioral content by interpreting another's behavior (social intelligence).

The second broad dimension of intelligence is operations, or what is done with content. This involves five categories:

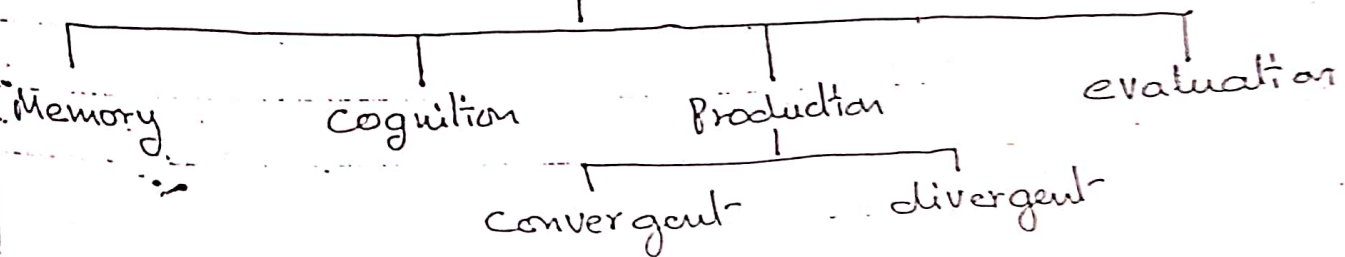
(1) cognition (2) memory (3) convergent production (4) divergent production and evaluation.

Cognition refers to awareness of the meaning of words or concepts, Memory refers to the ability to retain information.

Convergent production is the ability to come to a valid or logical conclusion on the basis of given pieces of information, Divergent production is essentially creativity.

Evaluation is judging wisely in behaving.

Intellect.



The third broad dimension of intelligence is 'Products' or the results of operation on content.

There are six kinds of products: (1) units (2) classes (3) relations (4) systems (5) transformations (6) implications.

Units are single products such as a word or number.

Classes refers to a class of units such as noun, a species;

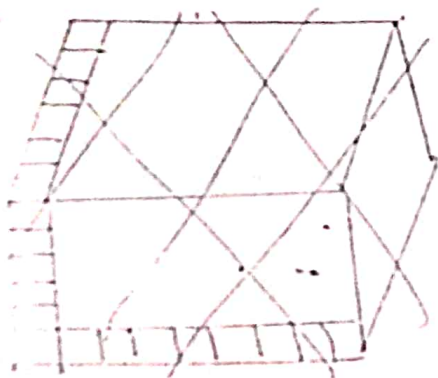
Relations are relationships between units such as similarities or differences; Systems refers to plans or systems for

action; Transformation involves a change & Implications involves making a prediction/anticipation - when one item of information suggests another.

Since there are 4 contents, 6 products + 5 operations the resulting combinations involve a total of 120 ($4 \times 6 \times 5$).

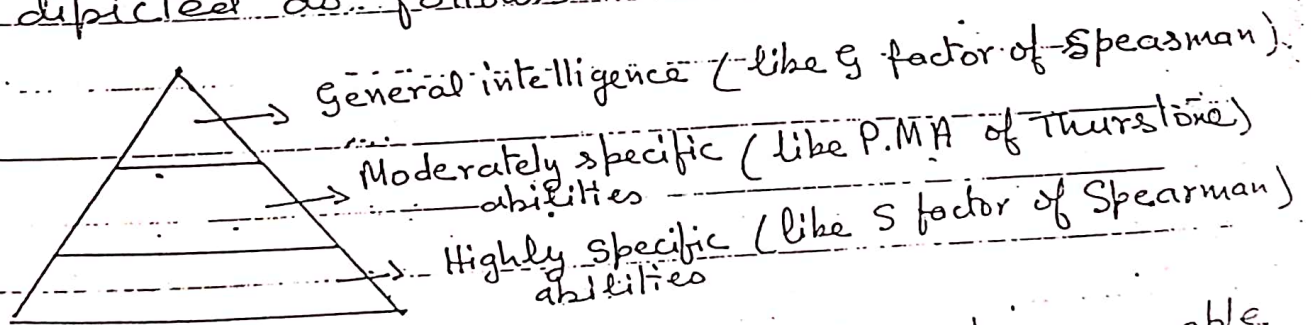
A task such as giving the definition of a word in a vocabulary test would involve cognition of units with semantic content. Doing the famous ball & field problem on the Binet test (the child is asked to plan a search for a lost ball in a large field) draws on abilities for figural content, systems, & evaluation.

Guilford's theory has the advantage of breadth & can better account for creativity than traditional theories. However - from a practical point of view it would appear difficult to measure so many different combinations of mental contents & functions.



HIERARCHICAL THEORY : . . .

There seems to be some truth in both 'g' factor theory & that theories that propose multiple factors. There are some ability factors that are relatively independent of one another but we do find some significant correlations among the factors, indicating that they share some sort of general intelligence factor. Consequently some ~~for~~ ^{example} ~~version~~ ^{version}, Eysenck etc have proposed that elements of 'g' factor theory & multifactor theory can be combined together to form a Hierarchical theory. In such a theory intelligence is pictured as a Pyramid. At the top of pyramid is general intelligence which shows up in virtually all kinds of intellectual activity. Underneath it are several moderate specific ability factors like Thurstone P.M.A. At bottom of the pyramid are larger number of highly specific abilities similar to Spearman's S factors - abilities that may come to play on one particular task. The ~~hier~~ hierarchical theory thus conceives intelligence to be multilayered pyramid - which can be depicted as follows -



This theory - is at present most reasonable acceptable of all content theories as it combines best elements of both Two and Multifactor theories.

APTITUDE AND ITS MEASUREMENT

'Aptitude' is defined in Warren's Dictionary as "a condition or set of characteristics regarded as symptomatic of an individual's ability to acquire with training some (usually specified) knowledge, skill or set of responses, such as ability to speak a language, to produce music etc."

From this definition it becomes clear that—

- (i) Aptitudes can either be acquired or be inborn.
- (ii) Aptitudes are indicative of future potentialities.
- (iii) Aptitude implies fitness or suitability for the activities in question.

APTITUDE and MEASUREMENT

Freeman (1962) has defined aptitude test as one "designed to measure a person's potential ability in an activity of a specialized kind & within a restricted range."

Achievement refers to what a person has acquired or achieved after training or specific instruction has been imparted. Hence achievement tests are primarily designed to measure the effect of specific program of instruction or training (Anastasi 1968).

APTITUDE TESTING.

The concept of aptitude carries with it certain assumptions. These assumptions permeate both research

research and practice in aptitude testing. The assumptions are - (A) An individual's potentialities are not equally strong, i.e. one can learn to do certain things more easily & better than other things & can develop greater interest & satisfaction in some kinds of activities than in others.

(B) Individuals differ one from other in their potentialities.
(C) Many of these differences are relatively stable - i.e. they tend to persist. Any changes which subsequently take place in an individual's potentialities occur within limits imposed by his present constitution.

TYPES OF APTITUDE TESTS

Aptitude tests can be conveniently grouped into two categories :-

(i) Multiple aptitude tests (MAT)

(ii) Special aptitude tests.

Multiple aptitude tests are those which intend to measure several aptitudes, each by an independent sub test. Hence multiple aptitude tests are not tests but rather batteries of tests.

Special aptitude tests are those which intend to measure only one aptitude.

They developed before multiple aptitude tests. Special aptitude tests developed at the time when primary emphasis in testing was placed on the general intelligence test & it was thought that

for describing the individual measurement of intelligence it must be supplemented by the measurement of special aptitude like mechanical, numerical etc. But later researches, particularly the factor analytic researches conducted by Thurstone & Guilford revealed that intelligence itself consists of several independent special aptitudes & since then the emphasis has shifted from special aptitude tests to multiple aptitude tests. Not only this, several special aptitude tests are now easily included in multiple aptitude batteries.

It must here be also mentioned that out of all the special aptitude tests, the test for mechanical aptitude was the earliest developed.

Types of Multiple Aptitude Tests:-

(A) Differential Aptitude Tests (DAT)

It is one of the most common multiple aptitude tests, first published in 1947. The battery has undergone several revisions & restandardization & presently it is available in its fifth edition.

The battery has been developed by Bennett, Seashore & Wesman & comprises of 8 subtests.

(1) Verbal reasoning (2) numerical ability (3) abstract reasoning (4) mechanical reasoning (5) clerical & speed accuracy (6) space relations (7) spelling & language. Part (I) Spelling Test (8) Part (II) Sentence & examinee required to distinguish faulty from correct grammar.

The battery is mainly meant for educational

and vocational counselling of students from grades

8 through 12. The whole battery has two equivalent forms S & T, and it roughly takes 3 hrs to administer it.

Scores on each subtest are converted into the percentile ranks for their proper interpretation. In addition to 8 subscores, a ninth subscore is provided by adding the scores on the verbal reasoning (V.R) test & numerical ability (N.A) test & subsequently the score is transformed into the percentile rank. The V.R & NA score becomes the index of general scholastic aptitude, which is interpreted as one index of mental ability. The DAT has also been adopted by Indian psychologists to suit local requirements.

Special Aptitude Tests :-

Although now days multiple Aptitude batteries are given preference but some times special aptitude tests are also considered. This is mainly because -

- (1) Special aptitude tests provide more flexibility in choice of the appropriate & relevant tests than multiple aptitude batteries.
- (2) There are certain aptitudes, which are seldom included & well covered by multiple aptitude batteries eg. artistic talents, musical talents creative talents, vision hearing etc.

SEASHORE MEASURES OF MUSICAL TALENTS: (A Special Aptitude test - it measures 'g' factor)

This test of musical aptitude was developed by Seashore, Lewis + Sackett (1939). It consists of six subtests namely -

- 1) The Pitch Test - (2) The loudness test, (3) The rhythm test -

- (4) The time test - (5) The timbre test (6) Tonal memory test -

The test is ~~present~~ meant for students from grade 4 to adults. Each item of seashore test consists of two tones & the examinee is to make judgement regarding the given characteristic of the tones, eg. in the pitch test examinee indicates whether or not the second tone is higher than the first tone & gradually each pair in the pitch test is made difficult by narrowing the difference between the 1st & the 2nd tone

This test has been criticized on grounds of not yielding meaningful results for a child below 10 yrs & that it only measures certain types of sensory discrimination which are essential but not sufficient for musical aptitude (Nunnally 1976)

GENERAL LIMITATIONS OF APTITUDE TESTS:

1) Most tests of aptitude don't measure all factors important for predicting success & do not consider the relationship between factors or the pattern of factors.

2) The weight attached to different factors may differ with each investigator.

(3) Many aptitude tests don't have sufficiently high validity.

(4) There is a problem of definition.

MEASUREMENT OF INTELLIGENCE

Although the fact that persons differ in intellectual & other psychological characteristics had been apparent to the observers for many centuries, it was only about 100 years ago that these differences were first studied scientifically & subjected to measurement & objective evaluation. Francis Galton was the first scientist to undertake systematic & statistical investigations of individual differences. Galton tried to measure intelligence by the means of the tests of imagery & sensory discrimination. He devised a test for the measurement of the delicacy of weight discrimination. He invented what is known as GALTON WHISTLE for measuring the sensitivity to high tones. In addition he suggested devices for testing visual & auditory discriminations, reaction time & muscular strength. Galton assumed that simpler & measurable sensory capacities are significantly correlated with Intelligence. Now it is well known that sensory & sensory motor tests have very little value for the study of the higher & more complex processes called Intelligence. Nevertheless Galton's work did strongly affect the course taken by the experimenter until about 1900 when the influence of Binet the French psychologist was felt.

Simon & Binet in 1905 invented the first

scientific test of Intelligence. The aim of this test was not as much to measure intelligence as was to discriminate ^{sub-}normal from ^{the}subnormal. The important assumption behind Binet's Test was that the nature of intelligence changes. Therefore items must be graded by age as well as difficulty. Therefore items used for testing intelligence at the age three are not appropriate at the age of ten. Thus Binet's test are the collection of sub-tests, one for each year of age.

Binet introduced the concept of mental age (M.A.). If a child can pass the items on which an average 9yr old is successful the child is said to have M.A. of 9 yrs. This age is independent of chronological age (C.A.). If a 6yr old child can pass the items of the tests passed by the average 9yr old he is said to have M.A. of 9 yrs.

Mental age is one of the method of scoring performance on an intelligence scale. Rather than earning points by passing the items the child earns months & years of mental age as credit. When two children are tested a child with higher MA (mental Age) is one who has passed more difficult items.

Suppose a child passes all the items upto the age scale of 7 & then 4 out of 6 items each worth of 2 months of mental age on a age scale of 8 & then succeeds on 2 of the 6 items on the age scale of 9 & fails to answer all the items on the age scale of 10 & above.

The child's M.A. score in this case is 7yrs + 8months + 4months
= 8yrs.

The highest level at which all items are passed by a given child is his BASAL AGE. The tester adds additional credit for each item until he reaches a CEILING AGE, that is lowest age level at which all items within the test are failed.

Using these procedures Binet & Simon gave a test by Age Scale in 1905. The first major revision of Binet's Test was done by Terman in 1916. The revised test was named as STANFORD-BINET TEST. This test included the concept of IQ (Intelligence Quotient) given by STERN. IQ is $\frac{MA}{CA} \times 100$. Stanford Binet Test consisted of 90 items arranged in AGE SCALE. The 1916 revision saw an advancement in standardisation especially in administration of test items & in securing of norms truly representative age groups. Another revision was in 1937 but it was in 1960 revision that a new method of IQ computation was introduced. All age levels now have Standard Deviation of 16 IQ point which makes it possible to compare performance of children of one age level with another.

LIMITATIONS OF INTELLIGENCE TEST/-

1) CULTURE BIAS - The issue of culture bias is a major criticism

of intelligence tests. In U.S. for instance generations of BLACKS have been tested with questions that were standardised on white ~~class~~ middle class group. Allegations of cultural bias focus on two aspects of discrimination. First intelligence tests typically have required knowledge or perception that may be culture specific.

The second form of discrimination is the language in which the test is written. Formal English puts at disadvantage a sizeable no. of minority group members for whom English is a second language. Faced with these criticisms the test designer have attempted to eliminate the most obvious instances of cultural bias. There have been attempts to leave the tests culture free or make them culture specific i.e. aimed at measuring

) The PIGEONHOLE EFFECT / CATEGORISATION /

The major criticism of intelligence testing is that it fails to take into account varying rates of intellectual growth & therefore risks locking children into categories prematurely. The Pigeonhole effect can stigmatise some young children unfairly by sidetracking them into classes meant for slow learners. The possible effect of Pigeonholing children under fast & slow labels has been demonstrated in an experiment by Rescott

§ Jacobson. They showed that how teachers' expectations can influence their perception of children's performance & thus the grades they awarded.

ACHIEVEMENT VS APTITUDE :

In general, aptitude tests are designed to predict later performance, which has not yet been achieved. Thus, a test for learning languages might be composed of various measures of abilities that are thought to be important in the learning of language. Such a test might be composed of measures of memory ability, concentration & verbal fluency. Intelligence tests have been historically thought of as general tests of aptitude, particularly scholastic ability.

Achievement tests, on the other hand, are the tests designed to measure the degree to which a particular skill or body of knowledge has already been mastered. For example, classroom tests, such as a final exam in introductory psychology, reflect the mastery & understanding of the material & are a type of achievement test.

A no. of critics have argued that traditional intelligence tests reflect achievement as well as aptitude characteristics. Most questions in intelligence tests require previous knowledge of language or basics of arithmetic & thus intelligence test scores reflect what individuals have already learned as well as their aptitudes or learning potentials.