The word intelligence, inspite of its wide current usage and ancient roots is a relatively recent term in psychological literature. The psychologists of the last century were bound to the old faculty psychology and they relegated the treatment of the subject under such terms as intellect, judgment and reason, which they seemingly considered synonymous with it. Thus, Baldwin defined intellect as "the faculty or capacity of knowing."

Our present day concepts of intelligence have expanded considerably. They are broader, more pragmatic, more concerned with learning and adaptive human behaviour. As Bingham said, "Intelligence is the ability to solve new problems and is the product of endowments, growth and opportunity." He also admitted that intelligence is


The great interest in intelligence as a basic subject matter of psychology began with the publications of Binet. Although, Binet attempted on several occasions to delimit the term, his primary concern was not with the definition but with the measurement of intelligence. A tremendous amount of research has been carried out in the area and now we can measure intelligence in many more ways than Binet did, that is with many more different kinds of tests and what is more important is that, we know much more about what it is we are measuring, namely, the elements or the factors that enter into our measures. We have to admit that intelligence is an abstract term and what we can reasonably expect of any attempt at definition is only a sufficiently clear and broad connotation as to what it comprehends. Not what it is, but it involves and eventually what it distinguishes.

The Definitions of Intelligence

Many psychologists have tried to put compact formal definitions of general intelligence. This is no doubt a praiseworthy and an important endeavour, but valuable insight can nevertheless be gained from them.
It is certainly not necessary here to attempt anything like a comprehensive catalogue of such definitions, but a reasonable number of samples is worth considering.

The definitions given by different psychologists can be classified in various ways. Here is an attempt to classify them according to the emphasis laid on various aspects.

(a) Global or Composite Definitions

(1) Cyril Burt:

"It is an all round mental ability."

(2) Wechsler:

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

(3) Stern:

Intelligence is a general capacity of an individual consciously to adjust his thinking to new requirements.


These global definitions emphasize the general nature of intelligence. They identify intelligence not with any particular ability but with general ability.

(b) Intelligence as Adjustment or Adaptation of the Individual to his Total Environment

Freeman:

Intelligence is the capacity to reorganize one's behaviour patterns so as to act more effectively and more appropriately in novel situations.\(^1\)

(c) Intelligence as a Single Ability

(4) Terman:

Intelligence is the ability to do abstract thinking.\(^2\)

(5) Thurstone:

Intelligence considered as a mental trait is the capacity to make impulses focal at their early unfinished stage of formation.\(^3\)

---

1 Frank S. Freeman, Theory and Practice of Psychological Testing (Calcutta: Oxford & IBH Publishing Co.) p.149.

2 Terman, Intelligence and its Measurement (Boston: Houghton Mifflin Co.,1921) p. 29.

3 L.L.Thurston, "The Nature of General Intelligence and Ability" (British Journal of Psychology, 14, 1923-24), 243-47.
(d) Other Definitions

(10) Paterson:

It is a biological mechanism by which the effects of a complexity of stimuli are brought together and given a somewhat unified effect in behaviour.¹

(11) Sandiford:

Intelligence is a function of central nervous system.²

(12) Buckingham:

Intelligence is the ability to act effectively under given condition.³

Implications of Various Definitions

A study of these and other definitions show how they fail to be complete and precise. They create an impression not of contradiction but of vagueness.

There are differences in emphasis but they can

¹ W. S. Monroe, Encyclopedia, p. 600.
be reconciled to some common agreement. There is a repeated appearance of the same points being emphasized with very minor changes. Perhaps a more comprehensive attempt to define intelligence has been made by Stoddard. According to him:

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 (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 discusses each of these attributes of intelligence at length. His main point of the definition is that all these attributes must be present simultaneously. We must not achieve difficulty merely through the gravity of a task.

'Difficulty' is measured by percentage of passing; 'Complexity' by number of kinds of
activity has all these attributes, the more intelligence it demands. None of the ingredients can be lacking.¹

Theories of Intelligence

Mental testing went on merrily for some time before some one asked the awkward question "What is intelligence". Most people believed in the "sovereign rule of one great power" - intelligence in all mental operations. If we accept the view that intelligence is all pervading mental power, we can infer that a person who performs one intellectual task well, will do others equally well. All psychologists, however, have not subscribed to the monarchic view. According to the 'Oligarchic doctrine' the mental ability consists not of one, but a few great powers each requiring a separate measurement. Some held the more extreme view which is named as the "anarchic doctrine". According to that there are as many abilities as there are human functions and all these abilities are independent of one another and the inference regarding any one cannot be made from the performance of any other. The theory suggests that the general intelligence is the average of several abilities and is measured by sampling. If we accept this

¹ Ibid., p. 7.
theory it will be difficult to decide which abilities should be measured by intelligence tests. If the abilities are really independent the average seems to be meaningless.

I. Faculty Theory of Binet

Binet regards general intelligence as a complex mental quality involving at least three factors:

(i) The ability to comprehend a problem and the due direction of the mind towards it.

(ii) The capacity to make the necessary adaptations to the need of the situation.

(iii) The power of self-criticism.

The later theories no longer adopt the view that mind is made up of several faculties.

II. Two Factor Theory of Spearman

Spearman was trying to find correlation between the different abilities during the year 1904. He said:

1 Spearman and Jones Wynn, Op. Cit., p. 28.
All branches of intellectual activity have in common one fundamental function or group of functions, whereas the remaining or specific elements seem in every case to be wholly different from that in all the others.¹

If in a battery of tests, intercorrelations are calculated and arranged in a hierarchical order, the table of correlations shows a significant consistency. The central factor common to all abilities tested was called "g" or "general intelligence" by Spearman. He further said that every ability also has a 'specific factor' or 's' which unlike 'g' is unique for that particular ability. Any given ability can be divided into two parts - a common 'g' and a specific 's'. The ratio of 'g' to 's' differs for different abilities.

Most of the intelligence tests measure this 'g' or general intelligence with some degree of success. It is relatively constant for the same individual but varies greatly from individual to individual. The nature of 'g' and its identification with general intelligence are still disputed and Spearman himself is not very clear whether 'g' can be called intelligence at all. However, he asserts that the best tests of intelligence are those

which are rich in 'g'. Apparently he means that 'g' and intelligence are identical.

Spearman calls his doctrine of the two factors 'eclectic' because it includes the amount of truth in each of the three doctrines, the monarchic, the anarchic and the oligarchic. The monarchic view is justified if we regard 'g' a constitutional monarch, a big factor in the state but not the sole one. The anarchic view holds with specific factors, for they are like free, independent, individual citizens. The oligarchic view is true to the extent that 'faculties' distinct from universal factor, and fairly distinct from the specific factors are revealed in the broad 'group' factors.

**Tetrad Equation**

If a, p, b, q stand for abilities and rap, rbq, raq, rbp are coefficients of correlations between the various pairs denoted by the suffix, then:

\[
\text{rap} \times \text{rbq} - \text{raq} \times \text{rbp} = 0
\]

This relation Spearman calls tetrad equation, the quantity on the left being the tetrad difference. It is well to remember that the truth of the equation depends not on theory but on experimentally observed
facts.

Thorndike and Thomson tried to interpret this tetrad equation in a different way and the technique of factorial analysis was developed. It showed the group factors such as verbal ability (V), numerical ability (N), spatial ability (S), perceptual ability (P) reasoning ability (R) and the memory ability (M). These valuable suggestions made Spearman to take up the work again and he showed that the abilities could be analysed. It gives the large general factors and smaller group factors.

Thomson has offered another explanation of the tetrad difference. According to him:

Any activity such as mental 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.¹

Some are rightly endowed by heredity, some by opportunity and education, some by both, some by neither.¹

III. Sampling Theory of Thomson

Thomson preferred to think that a number of factors are at play in carrying out any activity and these factors are the sample of all those which an individual has at his command. The supporters of this theory and Thomson himself seem ambiguous in their criticism when they state:

The sampling theory neither denies nor asserts general ability, though it says that it has not been proved, nor does it deny specific factors on the other hand, it does not deny the absence of group factors.²

Moreover, in Thomson's own words:

It does not deny the general ability, for if the samples are large, there will of course be factors common to all activities. On the other hand, it does affect the general ability if the samples may not be so large as this and no single factor may occur in any activity.

¹ Ibid., p. 54.
IV. A Single Factor Theory of Thorndike

According to Thorndike there is nothing whatever common to all mental functions or to any part of them. He admits that there is a positive relation between desirable single traits in a single individual.

Having a large measure of one good quality increases the probability that one will have more than the average of any other good quality.¹

According to him there are three main types of intelligence.

(i) Social intelligence, or ability to understand and deal with persons.

(ii) Concrete intelligence or ability to understand and deal with things as in skilled trades and scientific appliances.

(iii) Abstract intelligence, or ability to understand and deal with verbal and mathematical symbols.

V. Group Factor Theories of Hull and Kelly

According to Hull and Kelly the general factor is of minor importance. A group factor is one which is common to only a group of activities, it is narrower in extent than the general factor and broader than specific. The major relationships among tests be attributed to a relatively small number of broad group factors, chief among these are manipulations of spatial relations (K), facility with numbers (N), verbal material (V), memory and mental speed (M).

VI. Hierarchical Group Factor Theory of Burt

Burt classified abilities into three distinguished types according to their range: (1) General ability entering into every test belonging to a certain broad genesis, (2) Special abilities, each limited to certain groups or species, and (3) Individual or specific abilities, each peculiar to a single test. Thus the whole set of factors could apparently be arranged in a rough hierarchical scheme.

VII. Thurstone's Concept of Intelligence

This theory was recently proposed by Thurstone. By means of an elaborate type of factor analysis,
Thurstone arrived at the conviction that intelligence is made up of nine "primary mental abilities" as follows:

(i) Visual or spatial ability
(ii) Perceptual ability
(iii) Numerical ability
(iv) Logical or verbal relations ability
(v) Fluency in dealing with words
(vi) Memory
(vii) Inductive ability
(viii) Deductive ability
(ix) Ability to restrict the solution of a problem.

His view is that ability in any particular activity such as understanding an article on atomic energy, solving problems in engineering, writing poetry, selling medicines, or learning to do any of these activities depends upon a combination of the nine primary mental abilities. Some of the primary abilities are more essential and function more extensively in certain skills than in others. For example, numerical ability, visual and spatial ability and inductive ability might be more essential in learning to be an engineer than in learning
with words and perceptual abilities might be of outstanding importance.

Thurstone's primary mental abilities are general in the sense that they enter in some degree into all complex intellectual activities but they are not regarded as types of energy as in Spearman's view. This theory assumes that the components of intelligence can be more definitely isolated than what seems to be believed by Thorndike. In fact, Thurstone feels that prediction and guidance based on knowledge of all the nine primary abilities each considered by itself and in relation to the others, will be more fruitful than actions based on a single test of intelligence in general.

Later Studies of Intelligence

Currently there seems to be greater recognition of the failure of multiple factor profiles to fulfil their promise and scepticism over the proliferation of factors. In 1962 Lloyd Humphreys came out in favour of something very similar to the British 'g' group factor model, and in the year 1964 McNemar trechantly criticized the American multiple factorist's as "fragmentation of ability into more and more factors of less and less importance."¹

A general intelligence factor seems unavoidable since substantial positive intercorrelations are found when any cognitive tests are applied to a fairly large representative population. But at the same time intelligence has many aspects which can usefully be represented as Thurstone did, in terms of partially distinct though overlapping primary factors. The trouble arises because any one of these major primaries can be endlessly fractioned, depending simply on the number and variety of different tests in that areas which the psychometrist can think of and on the restriction in the range of 'g' in the tested population.

Test intercorrelations are affected not only by test content but by the form or technique of the test, its speed, level of difficulty of the items, whether multiple choice or creative response, whether analogies, series of much diagnostic interest have been variously referred to as method factors (Campbell & Fiske, 1959)\(^1\), formal factors and work attitude (Vernon, 1958)\(^2\), instrument factors

---


(Cattell, 1961)\(^1\), and response sets (Cronbach, 1950)\(^2\).

**VIII Hierarchical Group Factor Theory of Vernon**

By consistently applying large and varied test batteries, Vernon could manage to put different factors in the hierarchical order.

After removing the 'g' factor (whether by group factors technique or by rotation of centroid factors), the positive residual correlations always fall into two main groups - the v.ed. of the verbal-educational group and the spatial-practical-mechanical group. The v.ed. factor usually yields additional minor fluency and divergent thinking abilities—scholastic and n or number sub-factors. Likewise the km complex includes perceptual, physical and psychomotor, as well as spatial and mechanical factors, which can be further subdivided by more detailed testing.

---


In addition, there seems to be various cross-links. For example, clerical tests usually combine verbal ability and perceptual speed P, likewise Maths and Science both depend on number and spatial abilities n and k. Sometimes an inductive reasoning ability can be distinguished, though most of the common variance of reasoning tests is pt to be absorbed into 'g'. At a still lower level in the hierarchy come what are usually referred to as specific factors, though of course any specific can be turned into an additional narrow group factor devising additional tests.

Now despite certain differences of analytic technique and interpretation of factors, the hierarchical model and the multiple factor models are fundamentally in agreement. It is just as legitimate to start as it were from the bottom upwards - that is to say, to extract the primaries - and from their intercorrelations calculate the second order factors and if need be a third order factor, corresponding to our major group factors and 'g'. Bernyer (1958)\(^1\) has shown that the two approaches can yield almost identical results.

Diagram shown on the next page shows the hierarchical order or abilities as shown by Vernon.¹

From the point of view of practical tester, the hierarchical model seems more logical since in making educational and vocational decision, he can cover most of the ground just by applying g or $g + v$ tests and then supplement by spatial mechanical, clerical, number or other group factor tests where relevant.

**Psychological Origins of Factors**

At the same time, the general factor theory has its difficulties, in particular that 'g' is not, as Spearman believed, determinant, that is to say, one and the same 'g' whatever cognitive tests one likes to apply, psychologically it is the all round level of our thinking skills; while statistically it is merely the average of a battery of tests of intellectual capacities which are so diverse that the group factors or facets involved in each separate test mostly cancel one another out. Hence although we know what kinds of tests are most saturated with 'g' it can still vary according to the particular

Vernon's Sketch of Possible Hierarchy of Abilities

General (g)

Major Group Factors

Verbal educational (v:ed)

Practical (k:m)

Minor Group Factors

Verbal (v)

Number (n)

Mechanical information

Spatial (k)

Manual
measures the psychologist likes to use.

Modern psychologists stress the need to get away from the notion of intelligence as a definite entity, an autonomous mental faculty, which simply matures as children grow up. Rather we have to think of it as in terms of a cumulative formation of more and more complex and flexible schemata (Piaget's term)\(^1\) or phase sequences (Hebb)\(^2\), or what Miller, Galanter and Pribram (1960)\(^3\) call plans, which develop through interactions between the growing organism and its environment. They depend both upon environmental stimulation and on active exploration and experiment; i.e., they are formed and organized by use. This implies, to a much greater extent than Piaget seems to have recognized, that they also depend upon personality and motivational factors, organic and social drives, curiosity and interests; and that they are channelled by family, cultural and educational pressures. Intelligence, then, refers to the totality of concepts and skills, the

---

techniques or plans of coping with problems which have crystallized out of the child's previous experience. Most representative of these as Ferguson points out, are the thinking skills which have been overlearned and which are transferrable to a wide variety of new situations. Although, of course, each person's accumulation of skills is different, all persons who have been brought up within a fairly homogeneous culture can reasonably be compared at any set of tasks which that culture values and which it likes to include within its conception of intelligence. But obviously also, the whole structure, from perceptual and linguistic schemata upwards, may differ markedly in other cultures.

IX Guilford's Structure of Intellect

Guilford had published a report in the year 1959 on the discovery of components of intelligence as obtained by means of the experimental application of the method of factor analysis. He states that each intellectual component or factor is a unique ability that is needed to do well in a certain class of tasks or tests. Again, he states that the factors can be classified because they resemble one another in certain ways. He gives us three

---

major classifications which give rise to his three dimensional model for the structure of intellect.

With five kinds of operations, four kinds of contents and six kinds of products involved in intellectual performances, there should be $4 \times 5 \times 6$ or 120, primary mental abilities. The model has been diagramatically shown in the following figure, and the contents being discussed in the next paragraphs.
Operations: Major kinds of intellectual activities or processes; things that the organism does with the raw materials of information.

Cognition: Discovery, awareness, rediscovery, or recognition of information in various forms; comprehension or understanding.

Memory: Retention of information in any form.

Divergent production: Generation of information from given information, where the emphasis is upon variety of output from the same source.

Convergent production: Generation of information from given information, where the emphasis is upon achieving unique or conventional.

Evaluation: Reaching decisions or making judgments concerning the goodness (correctness, suitability, adequacy, desirability) of information in terms of criteria of identity, consistency, and goal satisfaction.

Contents: General varieties of information.

Figural Content: Information in concrete form, as perceived or as recalled in the form of images. The term 'figural' implies some degree of organization of structuring.
Symbolic Content: Information in the form of signs, having no significance in and of themselves, such as letters, numbers, musical notations.

Semantic content: Information in the form of meanings to which words commonly become attached, hence most notable in verbal thinking; involved in doing verbal tests, where the things signified by words must be known.

Behavioral content: Information, essentially non-verbal, involved in human interactions, where awareness of the attitudes, needs, desires, intentions, thoughts, etc. of other persons and of ourselves is important.

Products: Results from the organism's processing of information.

Units: Relatively segregated or circumscribed items of information having 'thing' character.

Classes: Aggregates of items of information grouped because of their common properties.

Relations: Recognized connections between units of information based upon variables that apply to them.

Systems: Organized or structured aggregates of items of information; complexes of interrelated or interacting parts.
Transformations: Changes in existing or known information or in its use, as in production.

Implications: Extrapolations of information in the form of expectancies, predictions, antecedents and consequents.

A reasonable general prediction from the above mentioned cubical model would be that correlations between factors are in direct proportion to proximity within the system when the orders of the categories are properly arranged.

The study of intelligence, its definitions, theories, and factors made in this chapter will be very helpful in studying development of intelligence tests in the last century which are being discussed in the next chapter.

However, an attempt has been made to accept any one of the definitions or theories mentioned above. In framing the present test, however, an effort has been made to construct a test that will assess the higher mental abilities of an individual. The next chapter deals with a study of existing test of intelligence and selection of the form and items for the present test.
Selected References


