UNIT 1 THEORIES OF INTELLIGENCE (G AND S FACTORS AND THE MODEL OF JP DAS)

Structure

1.0 INTRODUCTION

Right from the dawn of civilisation man has often wondered about individual differences in abilities, yet it was not until the third quarter of the nineteenth century that efforts could be made about understanding its complex nature. Intelligence is a broad term that is employed by layman to denote the presence of such qualities as alertness, quickness of mind, level of one's academic success, status in an occupation, or the acquisition of an eminence in a particular field of endeavour and so on. In this unit we will deal with the nature and meaning of intelligence. We will also discuss some of the most important theoretical models of intelligence so as to understand its nature. We will begin with some definitions to bring home the point that even among the psychologists there is a lack of unanimity about this term. We will also briefly outline a historical perspective on individual differences and human abilities. Following this there will be a discussion on the Spearman's Two factor theory consisting of G and S factors, and a critical appraisal of the theory. We would also be dealing with Thorndike's theory of intelligence and PASS theory of intelligence put forward by JP Das and colleagues.

1.1 OBJECTIVES

After reading this unit, you will be able to:

- Define the term intelligence;
- Obtain a brief overview of individual differences and intelligence;

- Discuss Spearman's Two-Factor theory of intelligence;
- Make a critical appraisal of Two-Factor theory;
- Describe J. P. Das, Nagliery, and Kirby's PASS theory of intelligence; and
- Analyse the PASS theory.

1.2 THE NATURE OF INTELLIGENCE

Intelligence is hard to define. In the Indian systems of thought *buddhi* (intellect)—defined as *nischayatmikabuddhih* (decision maker) is described as an inner instrument (*antahkarana*), which possesses wisdom, prudence, emotion, societal values, and relations. In our common parlance when people speak of intelligence, they nod knowingly as if they all share a common definition. However, their understanding of the phenomenon of intelligence may widely vary. For some quickness of answering a question might reflect intelligence, while for others leading a successful life might be due to one's intelligence. Psychologists, too, differ in their definitions of intelligence. We all know what we mean when we use this term, but we find it terribly difficult to precisely define it.

1.2.1 Theoretical Definitions of Intelligence

Intelligence has been defined as the sum total of everything you know, as the ability to learn or profit from experience, as the ability to solve problems or as the ability to cope with the demands of the environment. Indeed there is nothing wrong with any of these definitions. The problem arises when we try to search for a definition that seems to say it all precisely. We have been using "intelligence" as a general label for so many cognitive abilities that it defies a specific definition. In 1921, a symposium was organised to define intelligence. Thirteen psychologists specialising in the area of intellectual assessment considered the definitional aspects of intelligence. The symposium proceedings, published in a special issue of the *Journal of Educational Psychology*, revealed that the experts had thirteen different views on the nature of intelligence. Some of the definitions given by experts are given below:

"…intelligence, that is to say, reasoning, judgment, memory, and the power of abstraction" (Binet 1890, cited in Sattler, 1988, p. 45)

"Intelligence is a general capacity of the individual consciously to adjust his thinking to new requirements" (Stern, 1914)

"An individual is intelligent in proportion as he is able to carry on abstract thinking" (Terman, 1921, p. 128)

"Intelligence is the capacity of the organism to adjust itself to an increasingly complex environment" (Spearman, 1927)

In 1986, Sternberg and Determan found that twenty-four prominent scholars had twenty-four different definitions of intelligence. Sternberg (1997) has attempted a comparison of the two surveys. He has remarked that in the 1921 survey, the elements that appeared most often in the definitions were "(a) higher level abilities (such as abstract reasoning, mental representation, problem solving, and decision making), (b) ability to learn, and (c) adaptation to meet the demands of the environment. In the 1986 survey, the most common elements were (a) higher

level abilities, (b) that which is valued by culture, and (c) executive process" (Sternberg, 1997, p.1030).

Snyderman and Rothman (1987) have presented responses of over 1,000 experts that belonged to different disciplines such as psychology, sociology, education, and genetics. Of the thirteen descriptions rated by the respondents, there was nearly unanimous agreement that abstract reasoning, the capacity to acquire knowledge, and problem solving ability were important elements of intelligence.

Per cent of respondents showing agreement on thirteen descriptor elements of intelligence given by Snyderman and Rothman (1987) are given below:

Table Showing Responses of Experts on Thirteen Elements of Intelligence

Descriptor	% of Respondents Checking as Important
Abstract thinking or reasoning	99.3
Problem solving ability	97.7
Capacity to acquire knowledge	96.0
General knowledge	88.3
Memory	80.5
Adaptation to one's environment	77.2
Mental speed	71.7
Linguistic competence	71.0
Mathematical competence	67.9
Creativity	59.6
Sensory acuity	24.4
Goal directedness	24.0
Achievement motivation	18.9

Source: Snyderman & Rothman (1987)

Most of the earlier definitions as well as recent ones include the elements that have been given above. We will mention a couple of recent definitions to support our statement.

"Intelligence, as a hypothetical construct, is the aggregate or global capacity of the individual to act purposefully, to think rationally and to deal effectively with his environment" (Wechsler, 1944). More recently, Wechsler (1975) defined intelligence as "the capacity of an individual to understand the world about him and his resourcefulness to cope with its challenges" (p.139).

"…a human intellectual competence must entail a set of skills of problem solving—enabling the individual to resolve genuine problems or difficulties that he or she encounters, and, when appropriate, to create an effective product—and must also entail the potential for finding or creating problems—thereby laying the groundwork for the acquisition of new knowledge." (Gardner, 1983, pp. 60-61)

"Intelligence comprises the mental abilities necessary for adaptation to, as well as shaping and selection of, any environmental context." (Sternberg, 1997, p.1030)

A common element of several of the definitions that we have quoted is adaptation, the ability to modify one's behaviour to meet the environmental demands. A second common element is the ability to think abstractly using symbols. The ability to acquire new information or to learn through experience is similarly the third common element. However, it appears that the quest for a satisfactory definition of intelligence is an unending search.

1.2.2 Operational Definition of Intelligence

Observing the diversity of theoretical definitions in the 1921 survey, about which we discussed above, Boring (1923) operationally defined that "intelligence is what intelligence tests measure". You may notice that this operational definition sidesteps the thorny conceptual problem of coming to grips with the "true" nature of intelligence; it does not solve it. Nonetheless it does what operational definitions are supposed to do—it gives us a definition we can start working with. Most intelligence tests have been constructed with the assumption that intelligence is some kind of general attribute, more or less of which exists in everyone and which determines how an individual will be able to deal with a problem situation. However, this sort of assumption is not supported by recent theoretical models of intelligence that we will discuss next.

1.2.3 Historical Perspective on Individual Differences and Human Abilities

It is extremely surprising that in spite of tremendous advances in mathematical sciences by the year 1800, systematic studies of human abilities were not undertaken until third quarter of the nineteenth century. Impressed by Charles Darwin's *Origin of species*, his cousin Francis Galton devoted increasing attention toward measurement of anthropological and psychological phenomena. He coined the term *mental test* and invented the first psychological test methods to measure intelligence and ability. He founded the first test laboratory in London in 1882 at which visitors could take a battery of psychological tests on a fee-paying basis. Each visitor was tested on a variety of physical and sensory tests, including height, weight, breathing power, strength of pull, hearing, sight, and colour sense. Galton believed that psychological traits could also be inherited like physical characteristics. In statistics he made important contribution by developing and applying correlation method, which, at his guidance, was later continued by his student Karl Pearson, who eventually developed the product-moment correlation. Though his tests bear no resemblance to the advanced psychological tests, he definitely deserves to be credited with the title of Father of psychological testing and individual differences.

Alfred Binet's early work on human abilities resembled the work of Galton. Binet's work on intelligence testing took a practical turn during the opening years of the twentieth century, when he was commissioned by the French government to identify mentally deficient children in French schools. Faced with this problem, Binet, in collaboration with Theodore Simon, completed his first test in 1905. This test comprised a list of 30 problems concerning the child's ability to understand and reason with the objects in the environment. The problems ranged in level of difficulty and the test was tried on a sample of 50 children.

This was a very important step in the testing of intelligence.

In 1908, a revision was made in which items were arranged in terms of age levels. The highest age level that a child could perform successfully was called his *mental age*. Later, William Stern (1914) suggested that this be divided by the chronological age for each child, which multiplied by 100 became the intelligence quotient, the IQ, as it has come to be known. The influence of Binet on the measurement of intelligence can hardly be overstated. All subsequent work on the measurement of intelligence is modeled after Binet's test.

Self Assessment Questions

1) How does a layman define intelligence?

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2) What were the common factors that emerged regarding the definition of intelligence in the 1921 symposium of thirteen experts?

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3) On which elements there is maximal agreement in the Snyderman and Rothman data on 1000 experts?

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4) How will you operationally define the phenomenon of intelligence?

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5) Present a brief account of individual differences.

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1.3 SPEARMAN'S TWO-FACTOR THEORY OF INTELLIGENCE

Charles Spearman published an epoch-making study in 1904, which indeed proved to be the crucial step toward quantitative testing of theories, as opposed to simple quantification or measurement. He used the techniques of correlational analysis and factor analysis, both of which had been developed earlier by Karl Pearson, in relation to the scores obtained by groups of children on various intelligence tests. His historical significance can be seen in the development of the factor analytical method and in its explicit use for the first time. It is with regard to such importance that Guilford (1954, p. 472) has stated: "No single event in the history of mental testing has proved to be of such momentous importance as Spearman's proposal of his famous two-factor theory in 1904."

Spearman was critical of Binet and Simon's (1905) practice of assembling a hodgepodge of problems for testing intelligence without first testing for the presence of a general factor or without weighing the problems in terms of their loadings on the general factor. He was concerned to test the theory that the obtained intercorrelations between various tests of intelligence were due entirely to a general intellective factor "g". In addition to that, he also recognised specific factors, "s" factors, which were specific to particular tests. Eysenck (1972, pp. 1-2) has contended that "essentially his point was that under these conditions matrices of intercorrelations between tests should be of rank one; he did not use matrix algebra himself, but his formulas are the equivalent of more modern versions." Spearman (1927) elaborated and revised his work in "*The abilities of man*."

To understand his theory, let us assume that any correlation between two tests used by Spearman implies a factor common to both, plus two specific factors. Let the two tests be called *a* and *b*, the common factor "*g*", and the two specific factors *sa* and *sb*, as shown in the diagram drawn by Guilford (1953), which are reproduced below in Fig. 1.1.

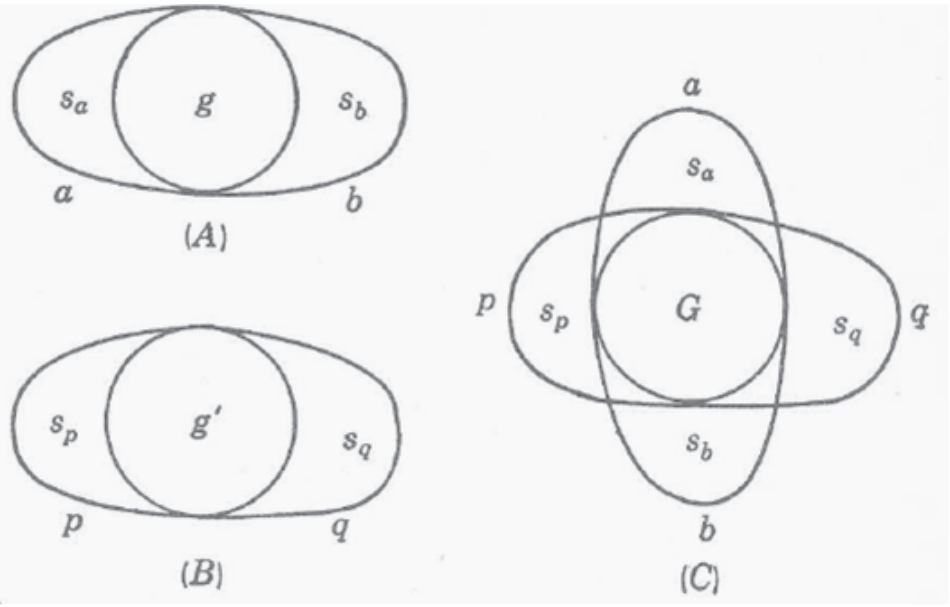

Fig.1.1: Graphical representation of Spearman's two factor theory
(*Source:* Guilford, 1953, p. 472)

In terms of the two-factor theory, we may regard that tests *a* and *b* are two measures of the common element "*g*", with the two remainders *sa* and *sb*. Similarly, let *p* and *q* be two other tests with *"g"* as the common element as shown in the Figure above. For some experiments, Spearman (1904) reported the correlations between "*g*" and "*g"* to approximate a value of 1.00. This meant that "*g*" and "*g"* were practically identical. Spearman believed that all intellectual activity contained some element or factor in common. This "*g*",or general factor, was postulated to be important in every mental act, although some acts were thought to depend upon it more than others. The difference between people in intelligence was a matter of how much "*g*"they possessed. Spearman called this general factor as "mental energy."

Spearmen's analysis of intelligence was actually an interpretation of certain observations by using the method of *tetrad difference*. The correlation matrix, which he used for finding the criterion of proportionality and for calculating the tetrad difference, is given below:

Table Showing Intercorrelations of Subtests Reported by Spearman (1927)

Subtests	1	2	3	4	5	6	7
Analogies	…	.50	.49	.55	.49	.45	.45
Completion	.50	…	.54	.47	.50	.38	.34
Understanding paragraphs	.49	.54	…	.49	.39	.44	.35
Opposites	.55	.47	.49	…	.41	.32	.35
Instructions	.49	.28	.39	.41	…	.32	.40
Resemblances	.45	.38	.44	.32	.32	…	.35
Inferences	.48	.34	.35	.35	.40	.35	…

***Source*:** Spearman (1927) *The abilities of man*. New York: Macmillan, (p.149)

Guilford (1953, pp. 473-474) has shown that for any correlation matrix the criterion of proportionality can be easily calculated, following which the tetrad difference between various subtests can also be found.

Let us understand what is tetrad difference? In recent years the quantity F, called the 'tetrad-difference', has become very important in psychological investigations as to the possible nature of the underlying causes of mental activities. If there are four such activities, and r_{13}, r_{24}, etc., the six correlation coefficients, (F is defined by the equation $F = r_{13}r_{24} - r_{14}r_{23}$. The value of F, in practice, approximates to zero.)

The tetrad difference thus in all cases comes to zero. The variation in measured intelligence that was not explainable in terms of this general factor or "*g*" was attributed by Spearman to specific factors or "*s*". There were many different specific factors. All intellectual tasks require some amount of "*g*." according to Spearman, the more highly the two functions were correlated, the more highly saturated they were with "*g*." Tests that are thought to have high "*g*" loadings involve abstract reasoning, comprehension, and problem solving.

Graphic illustration of "*g*" and "*s*" can be made following Guilford (1953, pp. 474-475), which is reproduced below (Fig.2). In this Figure "Spearman's "*g*" factor is shown as the large central circle and the specifics as small circles grouped

about *G*. Each ellipse stands for a mental test. The ellipses are permitted to overlap *G* to different extents in order to indicate the fact that some tests are more heavily "loaded" with *G* than others. The amount of correlation between any two tests is determined by the extent to which the two tests are loaded with *G*. Thus, tests *a* and *b* will have a relatively high correlation, since they have much in common in *G*. Tests *a* and *c* will be scarcely correlated at all, since both have small loadings with *G*." (Guilford, 1953, pp. 474-475)

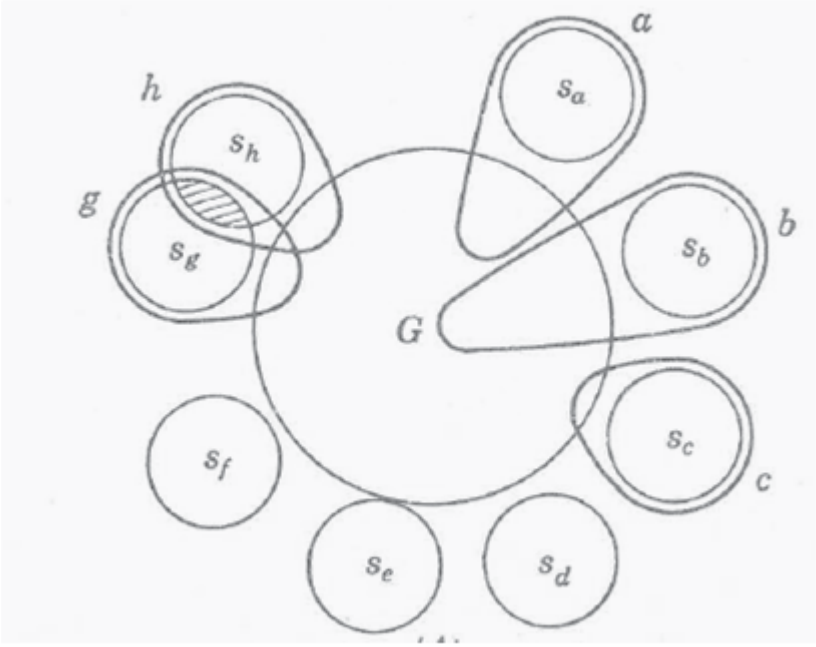

Fig. 1.2: Graphical representation of group factor in Spearman's two factor theory
(*Source:* Guilford, 1953, p. 475)

Inter correlation matrices prepared by Spearman and his students showed that some tests had something in common besides factor *G*. That meant that there were some correlations that were over and above that demanded by a single common factor *G*. Spearman at first attributed this to overlapping *s* factors. However, some tests may have a higher correlation than that attributable to *G* alone. Such an additional common factor became known as a *group factor*, which was found to play a role not only in two tests but also in a number of tests. "Among the group factors that Spearman and his associates came to recognise are verbal ability, numerical ability, and possible factors of mental speed, mechanical ability, attention, and imagination" (Guilford, 1953, p. 475).

Spearman's theories of intelligence are very stimulating and his contribution to the psychology of intelligence can be regarded important mainly for two major reasons.

1) First, he developed the mathematical models for studying "*g*" and for that purpose he laid the foundation of factor analysis. The logic and method of correlational analysis was afterward followed by other researchers for developing multi-factorial theories of intelligence.

2) Second major importance of Spearman's work is that it established a scholarly tradition in the investigation of human abilities.

According to Nunnally (1978, p. 508) "Spearman was concerned much more with *understanding* human abilities than with just measuring them. Spearman

had many interesting theories about *G*, its biological basis, the influence of culture, the interaction of *G* with manifestations of abilities in daily life, and the relation of *G* to speed, fatigue, and other variables."

1.3.1 Critical Appraisal of Two-Factor Theory

Several criticisms were levelled against formulation of the two-factor theory. One of the standard criticisms of the factor analytic approach is that it was purely psychometric and failed to provide a cognitive theory. However, Sternberg and Frensch (1990) have convincingly argued that this criticism was misplaced.

Spearman (1923) proposed that intelligence depended on a number of qualitative principles of cognition, for example "the presenting of any character together with any relation tends to evoke immediately the knowing of the correlative character" (p.91).

According to M. W. Eysenck (1990) Spearman also described "five quantitative principles of cognition, which are relevant to intelligence: conative control, fatigue, mental energy, primordial potencies, and retentivity" (p. 192).

Jensen (1998) confirmed the existence of "g" by the method of confirmatory factor analysis.

Carroll (1993) also noted the presence of "g" at Stratum III in her hierarchical factor analysis. We will now attempt a critical appraisal of the two-factor theory and see how it has helped in the development of newer models of intelligence.

1.3.1.1 Thorndike's Theory

One of the sharpest critics of Spearman's two-factor theory was E. L. Thorndike (1926), who believed that the inter correlations studied by Spearmen were too small to test the question of a common factor. He objected very strongly to the idea of the existence of a characteristic such as general intelligence. Instead of one kind of factor, he maintained that there are a large number of separate characteristics that make up intelligence.

He argued that instead of generality of intelligence, communality in the acts of people to perform intelligently needed to be looked into. According to Thorndike, the common element does not reside in the individual but in the nature of the tasks themselves. People differ in their ability to perform any specific act in terms of the level of difficulty they can manage. They also differ in the range or number of tasks they can or cannot perform.

For Thorndike, intelligence was more like a series of skills or talents and several or many tasks might call for the same kind of ability. According to him, the correlations between various tests are the result of the fact that the tests have features in common with each other even though they are called as measures of different aspects.

Thorndike's contention that there is no general intelligence but very specific acts has, however, does not hold water in view of the fact that some tasks have so many elements in common that it is desirable to classify them into groups such as arithmetical reasoning, visual perception, word meaning, analogy, etc.

Thorndike has classified intellectual activity into three broad types: (i) social intelligence, (ii) concrete intelligence, and (iii) abstract intelligence. However, this is a classification of the type of tasks and not an analysis of mental organisation itself. One can notice that the discrepancy of point of view between Spearman and Thorndike is basically a theoretical one and the types that interested Thorndike are essentially the same as the measures which Spearmen used in his correlation matrix.

1.3.1.2 Thomson's Theory

Among the other critics of Spearman, G. H. Thomson (1939) has argued that the inter correlations between tests are actually the result of common samplings of independent factors. As such if the tests incorporate many of these independent factors in common, i.e., the tests are all measuring some of the same factors, they will be highly inter correlated and it will appear that they are measuring one general factor "*g*."

Thomson has accordingly proposed a sampling theory, which maintains that every test samples a certain range of elementary abilities; some with a wide range and some with a narrow range. The degree of correlation between any two tests depends upon the number of units of ability that they have in common.

According to Thomson, abilities combine in such a way that their correlations approach Spearman hierarchical order. Thomson believed in a "general ability" like Spearman's "*g*", but according to him it was not a basic entity; it was rather a constant combination of the ability elements.

In like manner, the group factors are combinations of more limited collections of ability elements, while specific factors are composed of elements that restrict their appearance to single tests.

Guilford (1953) has refuted Thomson's contentions saying that "there seems to be little likelihood of demonstrating experimentally the existence of the elements hypothesized" (p.476).

1.3.1.3 Thurstone's Theory

L .L. Thurstone (1935) offered a new factor model in the nineteen thirties. Using improved techniques of statistical analysis, he came to vastly different conclusions from Spearman about nature of intelligence. Thurstone generalised Spearmen's methods and formulas, translated them into matrix algebra and carried out large-scale studies, using as many as fifty-seven tests on one group of subjects. On the basis of these studies he concluded that instead of Spearmen's "*g*" factor, seven primary abilities fitted the data much better.

Eysenck (1972) has given two reasons of this type of apparently conflicting findings. The first related to population sampled. Spearman had worked with random samples of the population (usually children), Thurstone worked only with students. The second related to the choice of tests: "Spearman has explicitly stated that tests should not be too similar to each other; if they were, then the "s" factors would overlap and cause additional correlations which would emerge as separate factors and disturb the unit rank of the matrix. Thurstone used groups of tests which were very similar, often almost identical, and consequently his study could certainly not be considered as a test of Spearman's hypothesis" (Eysenck, 1972, p. 2).

Thurstone later on recognised the force of these points and incorporated them in his subsequent work which enabled him to find "a hierarchical structure of intellect, with "g" at the top, and the "primary abilities" (whose inter correlations necessitated the postulation of "g") at a lower level; the actual tests used, whose inter correlations gave rise to the "primary abilities", would if course be at a lower level still" (Eysenck, 1972, p.2).

Self Assessment Questions

1) How did Spearman develop his two-factor theory?

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2) How an intercorrelation matrix is used for identifying the factors?

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3) What are the two main contributions of Spearman according to Nunnally?

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4) Present a critical appraisal of two-factor theory?.

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1.4 DAS, NAGLIERY AND KIRBY'S PASS THEORY

The theories of Spearman, Thorndike, Thomson, Thurstone that we discussed above, and other similar ones, are based on isolating factors after administering several intelligence tests over a large sample of subjects. They did not take into account how an input, e.g. a test item is received and processed and how a cognitive reorganisation takes place prior to giving a response. Das, Nagliery, and Kirby (1994) have developed a theory-based, multidimensional view of intelligence with constructs borrowed from contemporary research in neuropsychology, information processing and human cognition.

This theory has four components: Planning, Attention-Arousal, Simultaneous, and Successive (PASS) processing systems (see Fig.1.3).

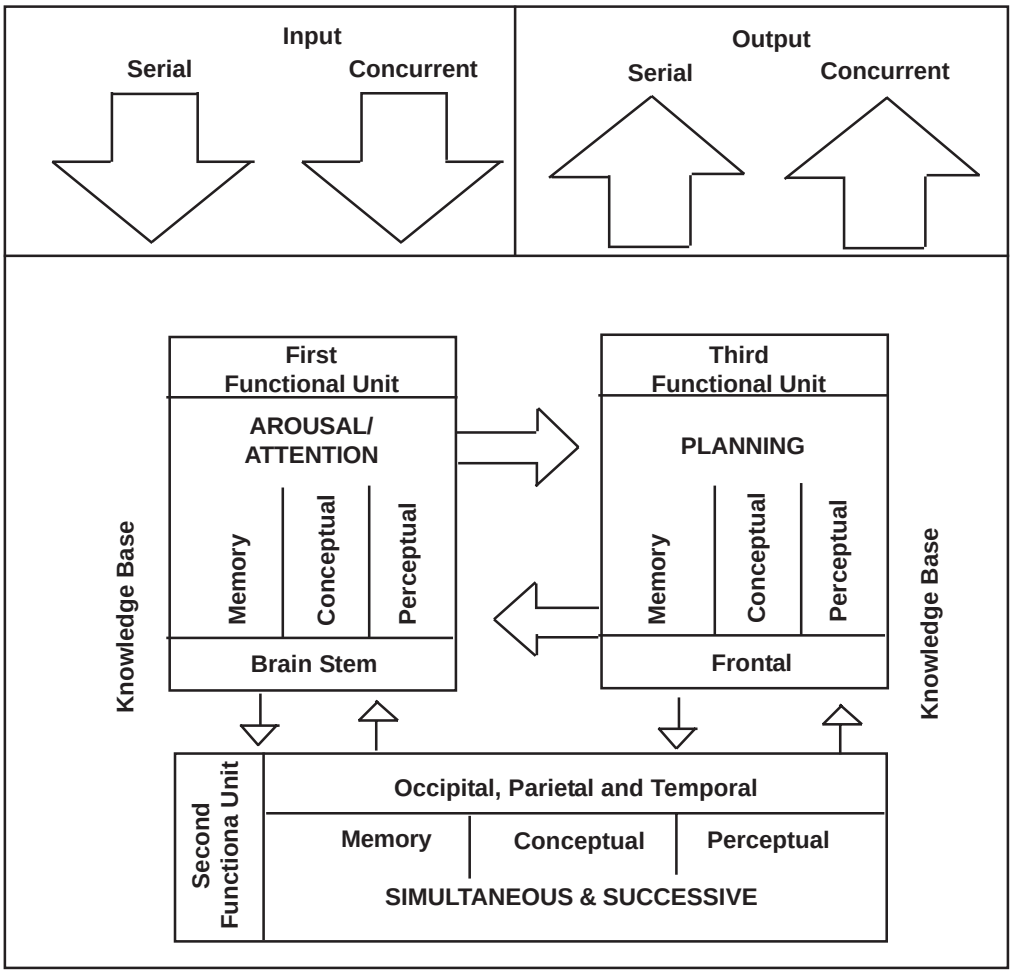

Fig. 1.3: Pictorial presentation of PASS model

(*Source:* Das, 2004; p.10)

Alexander R. Luria's (1966; 1973; 1980) pioneering researches in the fields of neuropsychology, information processing, and cognitive psychology have provided the theoretical foundation to the PASS theory. Luria divided human cognitive processes into three primary functional units.

i) Maintaining appropriate cortical arousal and attention to allow for adequate vigilance and discrimination between stimuli is the primary function of the first unit.

ii) The second unit is responsible for obtaining, elaborating upon, and storing information using successive and simultaneous processes.

iii) The third functional unit is responsible for programming as well as the regulation and control of mental activity (i.e., executive functioning). Planning, self-monitoring, and structuring of cognitive activities are provided by this functional unit.

To elaborate further, the first functional unit, attention-arousal, is located in the brain stem and reticular activating system. This unit provides the brain with the appropriate level of arousal or cortical tone and "directive and selective attention" (Luria, 1973, p. 273).

Attentional processes are engaged when a multidimensional stimulus array is presented to the subject, and the task requires selective attention to one dimension,

and the inhibition of response to other, often more salient stimuli. Luria stated that only under optimal conditions of arousal can the more complex forms of attention involving "selective recognition of a particular stimulus and inhibition of responses to irrelevant stimuli" occur (Luria, 1973, p.271). Moreover, Luria also maintains that only when sufficiently aroused and when attention is adequately focused can an individual utilise processes within the second and third functional units.

About the second functional unit, Luria described "two basic forms of integrative activity of the cerebral cortex" which are responsible for "receiving, analysing, and storing information" through the use of simultaneous and successive processing.

Simultaneous processing is associated with the occipital-parietal areas of the brain.

The essential aspect of simultaneous processing is the surveyability; that is, each element is related to every other element. Das (2004) has explained with the help of following example.

"To produce a diagram correctly when given the instruction, "draw a triangle above a square that is to the left of a circle under a cross," the relationships among the shapes must be correctly comprehended" (Das, 2004, p. 9).

Successive processing is associated with the fronto-temporal areas of the brain and involves the integration of stimuli into a specific serial order where each component is related to the next. That is, in successive synthesis, "each link integrated into a series can evoke only a particular chain of successive links following each other in serial order". For example, in language processing, successive processes involved with are decoding and producing syntax, and articulating speech.

The third functional unit is located in the prefrontal divisions of the frontal lobes of the brain (Luria, 1980). Luria stated that "the frontal lobes synthesize the information about the outside worlds . . . and are the means whereby the behaviour of the organism is regulated in conformity with the effect produced by its actions" (p.263).

Planning processes provide for the programming, regulation and verification of behaviour and are responsible for behaviours, such as asking questions, problem solving, and the capacity for self-monitoring. Other activities of the third functional unit include regulation of voluntary activity, impulse control, and various linguistic skills, such as spontaneous conversation. The third functional unit provides for the most complex aspects of human behaviour including personality and consciousness.

All four processes of the PASS theory have been operationally defined by Das, Nagliery and Kirby (1994). Planning processes are required when a test demands that the individual makes some decisions about how to solve a problem, execute an approach, activate attentional, simultaneous, and successive processes, monitor the effectiveness of the approach and modify it as needed.

Planning processes are involved when a person is asked to decide how to perform a test and is inhibited by the imposition of strict rules about how to perform. For

example, writing a composition involves generation of a plan, organisation of the ideas, control over what is presented when, examination of the product, and revisions to make the final result consistent with the intended goal.

Planning is clearly associated with the frontal lobes, especially the prefrontal cortex. It has connections with the rest of the brain as described before, including the parietal, temporal, and occipital lobes that are responsible for information coding (simultaneous and successive processing), as well as with sub cortical areas that determine the level of arousal and affective reactions to different conditions on the basis of past experiences.

Attention arousal is a complex process of the PASS theory. Arousal keeps the persons alert. It is associated with the activity of the brain stem and the lower part of the cerebral cortex. Attention on the other hand is associated with the frontal lobes and the lower portion of the cortex together.

Simultaneous processing is broadly associated with the occipital and the parietal lobes, while successive processing is associated with frontal temporal lobes

Knowledge base is an integral component of the PASS model and therefore all processes are embedded within this dimension. The base of knowledge included in the PASS model is intended to represent all information obtained from the cultural and social background of the individual, because this determines the form of mental activity. Children's use of language to analyse, generalise, and encode experience is a critical determinant of the base of knowledge, because mental processes cannot develop apart from the appropriate forms of social life.

The final component of the PASS model is output or action and behaviour. It is suggested that both simultaneous and successive processes must be used in the processing of cognitive tasks. Das (1998, p. 221) has thus explained its salient features: "The PASS theory of intelligence (1) has given us tests to measure intelligence as a set of cognitive processes, (2) discusses what the major processes are, and (3) guides us in the remediation of processing difficulties."

Cognition is a dynamic process that works within the context of the individual's knowledge base, responds to his experiences, and is subject to developmental variations When considering the measurement of cognitive processes, it must be noted that the effective processing is accomplished through the integration of knowledge with planning, attention, simultaneous, and successive processes as demanded by the particular task. Although these processes are interrelated and nonstop, they are not equally involved in all tasks. For that reason, cognitive assessment tasks for planning, attention, simultaneous, and successive processing were developed to adhere to PASS theory and predominantly require a specific cognitive process (Das, Nagliery, & Kirby, 1994).

Taking the lead of Das and by using the multivariate techniques of cluster analysis, Ronning (2004) developed ability/achievement normative taxonomies for reading and mathematics of children in the age group of 8 to 17 years. The core profiles that emerged provided important comparisons for evaluating individual profiles, as well as added to the information explaining common variability in the child population. The taxonomies werebased upon 711 children in the 8 to 17 year old portion of the standardisation sample ofthe Cognitive Assessment System (CAS) who were co-administered the Woodcock-Johnson Tests of Achievement–Revised

(WJ-R ACH). Ability/reading and ability/mathematics normative taxonomies were developed from the Planning, Attention, Simultaneous, and Successive scales of the Cognitive Assessment System (Das, Nagliery, & Kirby, 1994) in conjunction with four reading and three math WJ-RACH subscales. Eight reading and five math clusters were identified and described using demographics and overall ability and achievement levels, which enabled Ronning (2004) to develop intervention programme also.

1.4.1 Critical Appraisal of PASS Theory

The PASS theory has provided a novel approach to assess intelligence. It is cognitive in orientation and it bases its tests on neuropsychological theories of Luria. Of great importance of Das, Nagliery, and Kirby (1994) was to move away from conventional tests of intelligence and to provide a theory-based multidimensional view of intelligence that is built on contemporary research on human cognition. It has a practical utility also. Undoubtedly all tests of intelligence attempt at tapping cognitive aspects. However, most of them approximate to the underlying processing of informational input.

Another attribute of this theory is that it has developed a Cognitive Assessment System (CAS) test also, which offers a unique opportunity to examine the relative contribution of cognitive processes as a testee undergoes a testing scenario. CAS has four subscales, named after PASS, and the test items are specially designed to assess a testee's proficiency in each of them separately as well as collectively.

Self Assessment Questions

1) How are neuropsychological concepts of Luria incorporated in the PASS theory?

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2) Why planning has been given so much importance in PASS theory?

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3) What is the main contribution of knowledge base in PASS theory?

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4) Present a critical appraisal of PASS theory.

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1.5 LET US SUM UP

Intelligence is a concept that is so commonly referred by each one of us, but which is so difficult to define. There is a general agreement that thinking, reasoning, problem solving and decision making are all of relevance to intelligence. However, there is less agreement about the extent to which each component contributes to it. Much research on intelligence during the first half of the twentieth century was based upon the factor-analytic approach. This approach was pioneered by Spearman (1904;1923;1927) and his two-factor theory achieved the desired success in stimulating a whole host of researches in identifying the factors of intelligence. Eventually Spearman's work culminated in describing the hierarchical structure of intelligence. The research work that was directed at testing his theory extended the evidence that is consistent with the view that there is a general factor of intelligence (the "g"), together with a number of more specific factors. The various measures of intelligence, about which we shall study in a subsequent unit, have attested the ubiquitous presence of "g" as well.

It is a known fact that tests of intelligence, beginning with that of Binet and Simon (1905), have played an important input in predicting school success (or its absence) since the turn of the century. The various tests that were developed in criticism of Spearman, however, incorporated a number of similar characteristics. Intelligence test batteries differ in other ways, such as the theoretical underpinnings and appropriate uses of the test, as well as the types of questions utilised.We have already discussed the views of Thurstone who extended support to Spearman when methodology was followed as suggested by Spearman. Jensen (1998) and Carroll (1993) have found the presence of "g" in their factor analyses.

The PASS theory of Das, Nagliery and Kirby (1994) is an information processing theory, which has taken its inspiration from the pioneering neuropsychological and cognitive psychological researches of Alexander Luria (1966; 1973; 1980). Luria described human cognitive processes within the framework of three functional units. The function of the first unit is cortical arousal and attention; the second unit codes information using simultaneous and successive processes; and the third unit provides for planning, self-monitoring, and structuring of cognitive activities. Luria's work on the functional aspects of brain structures formed the basis of the PASS model and was used as a blueprint for defining the important components of human intellectual competence.

A Cognitive Assessment System (CAS) has also been developed by Das, Nagliery and Kirby (1994) and a number of researches on various aspects of human cognition have extended increasing support to the contentions of the proponents of this theory. The Cognitive Assessment System is an individualised assessment that may be used for a variety of purposes, including diagnosis, eligibility, determination of discrepancies, reevaluation, and instructional planning.

1.6 UNIT END QUESTIONS

1) How do general people explain intelligence?
2) What commonalities has Sternberg noted in the 1921 and 1986 surveys about definitions of intelligence?
3) Give a historical account of individual differences.
4) How far it is correct to state that Spearman was concerned much more with understanding intelligence than measuring it?
5) Discuss the salient features of two-factor theory.
6) Critically appraise Spearman's two-factor theory.
7) What constructs has PASS theory borrowed from the fields of neuropsychology and information processing?
8) Give operational definitions of all four processes of PASS theory.

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