

COGNITIVE PSYCHOLOGY

STUDY MATERIAL

VI SEMESTER (CUCBCSS)

CORE COURSE

For

BSc

COUNSELLING PSYCHOLOGY

(2014 Admission onwards)



UNIVERSITY OF CALICUT

SCHOOL OF DISTANCE EDUCATION

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COGNITIVE PSYCHOLOGY

MODULE 1

Cognition refers to the processes through which information coming from the senses is transformed, reduced, elaborated, recovered and used. The term information refers to sensory input from the environment that informs us about what is happening there. Cognitive processes, thus are the processes involved in knowing about the world. They are importantly, attention, perception, learning, memory, and higher order processes like thinking, language, decision making and problem solving. The branch of memory that deals with cognitive process is called cognitive psychology.

PERSPECTIVES OF COGNITION

Information Processing Theory

The **information processing theory** is a cognitive approach to understanding how the human mind transforms sensory information. The model assumes that information that comes from the environment is subject to mental processes beyond a simple stimulus-response pattern. "Input" from the environment goes through the cognitive systems which is then measured by the "output". Information that is received can take several paths depending on attention, encoding, recognition, and storage. The central executive feature controls how much information is being processed, though more primitive sensory areas of the brain first accept environmental input. The theory looks at real time responses to presented stimuli and how the mind transforms that information. The model is used in several areas of research such as; cognitive development, neuroscience, social learning, and artificial intelligence.

Over long spans of time individuals process information with greater efficiency. The model assumes that through the process of maturation one develops greater abilities to attend to stimulus, recognize patterns, encode, and retrieve information. Over the life span individuals experience more information, associations, and ways to categorize the input. The process may seem passive, but the model assumes that input from the environment is actively being transformed and rehearsed thus becoming a part of long-term memory. For environmental information to become a part of long-term memory one must attend to, rehearse, and make sense of the stimuli. The interaction between nature and nurture coincide for changes in development. The model does not attempt nor can it distinguish between the two.

Information processing theory combines elements of both quantitative and qualitative development. Qualitative development occurs through the emergence of new strategies for information storage and retrieval, developing representational abilities

(such as the utilization of language to represent concepts), or obtaining problem-solving rules. Increases in the knowledge base or the ability to remember more items in working memory are examples of quantitative changes, as well as increases in the strength of connected cognitive associations. The qualitative and quantitative components often interact together to develop new and more efficient strategies within the processing system.

Information Processing Theory is currently being utilized in the study of computer or artificial intelligence. This theory has also been applied to systems beyond the individual, including families and business organizations. For example, Ariel (1987) applied Information Processing Theory to family systems, with sensing, attending, and encoding stimuli occurring either within individuals within the system or as the family system itself. Rogers, Miller, and Judge (1999) utilized Information Processing Theory to describe business organizational behavior, as well as to present a model describing how effective and ineffective business strategies are developed.

Connectionism

Connectionism is a set of approaches in the fields of artificial intelligence, cognitive psychology, cognitive science, neuroscience, and philosophy of mind, that models mental or behavioral phenomena as the emergent processes of interconnected networks of simple units. Connectionism entails commitment to mental representations are distributed patterns of neural activity and mental processes involves parallel transformations of neural activity patterns and changes in connections. In a connectionist model, knowledge is acquired through the interaction of the learning rule, architecture and modification through experience.

Connectionist models have been inspired by the neural architecture of the brain although the neurons they employ are a much simplified version of the real neurons. They typically employ parallel distributed processing and degrade in a graded manner. Processing is spread over multiple units and any loss results only in partial information loss and not in a all-or-none manner that is typical of computer memories.

The models developed by the connectionists do not rely on explicit rules but learn through examples and are said to utilize sub-symbolic representations. Connectionist models are networks made up of neurons or neuron-like elements and the connections between these neurons are typically modified through experience. The neural networks employ feed forward or recurrent connections. Many learning algorithms are used for changing weights in a neural network with the most popular ones being Hebb's rule and back propagation algorithm. Learning algorithms can be supervised, unsupervised, or based on reinforcement. Recurrent connections have been incorporated in an essentially multi-layer neural network architecture to handle time in a more explicit manner to model language processing.

HISTORY

Philosophical Antecedents of Psychology

Historians of psychology usually trace the earliest roots of psychology to two approaches to understanding the human mind:

- Philosophy seeks to understand the general nature of many aspects of the world, in part through introspection, the examination of inner ideas and experiences
- Physiology seeks a scientific study of life-sustaining functions in living matter, primarily through empirical (observation-based) methods.

Two Greek philosophers, Plato (ca. 428–348 B.C.) and his student Aristotle (384–322 B.C.), have profoundly affected modern thinking in psychology and many other fields. Plato and Aristotle disagreed regarding how to investigate ideas. Plato was a rationalist. A rationalist believes that the route to knowledge is through thinking and logical analysis. That is, a rationalist does not need any experiments to develop new knowledge. A rationalist who is interested in cognitive processes would appeal to reason as a source of knowledge or justification.

In contrast, Aristotle (a naturalist and biologist as well as a philosopher) was an empiricist. An empiricist believes that we acquire knowledge via empirical evidence—that is, we obtain evidence through experience and observation. In order to explore how the human mind works, empiricists would design experiments and conduct studies in which they could observe the behavior and processes of interest to them. Empiricism therefore leads directly to empirical investigations of psychology.

Most psychologists today seek a synthesis of the two approaches. They base empirical observations on theory in order to explain what they have observed in their experiments. In turn, they use these observations to revise their theories when they find that the theories cannot account for their real-world observations.

The contrasting ideas of rationalism and empiricism became prominent with the French rationalist René Descartes (1596–1650) and the British empiricist John Locke (1632–1704). Descartes viewed the introspective, reflective method as being superior to empirical methods for finding truth. He maintained that the only proof of his existence is that he was thinking and doubting. Descartes felt that one could not rely on one's senses because those very senses have often proven to be deceptive (think of optical illusions, for example). Locke, in contrast, had more enthusiasm for empirical observation. Locke believed that humans are born without knowledge and therefore must seek knowledge through empirical observation. Locke's term for this view was *tabula rasa* (meaning "blank slate" in Latin). The idea is that life and experience "write" knowledge on us. For Locke, then, the study of learning was the key to understanding the human mind. He believed that there are no innate ideas.

Psychological Antecedents Of Cognitive Psychology

Cognitive psychology has roots in many different ideas and approaches.

- Structuralism seeks to understand the structure (configuration of elements) of the mind and its perceptions by analyzing those perceptions into their constituent components (affection, attention, memory, sensation, etc.). The introduction of introspection as an experimental method was an important change in the field because the main emphasis in the study of the mind shifted from a rationalist approach to the empiricist approach of trying to observe behavior in order to draw conclusions about the subject of study. Consider, for example, the perception of a flower. Structuralists would analyze this perception in terms of its constituent colors, geometric forms, size relations, and so on. In terms of the human mind, structuralists sought to deconstruct the mind into its elementary components; they were also interested in how those elementary components work together to create the mind.
- Functionalism held that the key to understanding the human mind and behavior was to study the processes of how and why the mind works as it does, rather than to study the structural contents and elements of the mind. Because functionalists believed in using whichever methods best answered a given researcher's questions, it seems natural for functionalism to have led to pragmatism.
- Pragmatists believe that knowledge is validated by its usefulness. Pragmatists are concerned not only with knowing what people do; they also want to know what we can do with our knowledge of what people do. For example, pragmatists believe in the importance of the psychology of learning and memory. Because it can help us improve the performance of children in school. A leader in guiding functionalism toward pragmatism was William James. Even today, cognitive psychologists frequently point to the writings of James in discussions of core topics in the field, such as attention, consciousness, and perception.
- John Dewey (1859–1952) was another early pragmatist who profoundly influenced contemporary thinking in cognitive psychology. Dewey is remembered primarily for his pragmatic approach to thinking and schooling.
- Although functionalists were interested in how people learn, they did not really specify a mechanism by which learning takes place. This task was taken up by another group, associationists. Associationism examines how elements of the mind, like events or ideas, can become associated with one another in the mind to result in a form of learning. For example, associations may result from: contiguity (associating things that tend to occur together at about the same time); similarity (associating things with similar features or properties); or contrast (associating things that show polarities, such as hot/cold, light/dark, day/night).

- Associationist Hermann Ebbinghaus (1850–1909) was the first experimenter to apply associationist principles systematically. Specifically, Ebbinghaus studied his own mental processes.. Through his self-observations, Ebbinghaus studied how people learn and remember material through rehearsal, the conscious repetition of material to be learned. Among other things, he found that frequent repetition can fix mental associations more firmly in memory. Thus, repetition aids in learning.
- Another influential associationist, Edward Lee Thorndike (1874–1949), held that the role of “satisfaction” is the key to forming associations. Thorndike termed this principle the law of effect (1905): A stimulus will tend to produce a certain response over time if an organism is rewarded for that response. Thorndike believed that an organism learns to respond in a given way (the effect) in a given situation if it is rewarded repeatedly for doing so (the satisfaction, which serves as a stimulus to future actions). These ideas were the predecessors of the development of behaviorism.
- Behaviorism may be considered an extreme version of associationism. It focuses entirely on the association between the environment and an observable behavior. According to strict, extreme (“radical”) behaviorists, any hypotheses about internal thoughts and ways of thinking are nothing more than speculation. B. F. Skinner (1904–1990), a radical behaviorist, believed that virtually all forms of human behavior, not just learning, could be explained by behavior emitted in reaction to the environment. He rejected mental mechanisms. He believed instead that operant conditioning could explain all forms of human behavior. Skinner applied his experimental analysis of behavior. to many psychological phenomena, such as learning, language acquisition, and problem solving.
- Gestalt psychology states that we best understand psychological phenomena when we view them as organized, structured wholes. According to this view, we cannot fully understand behavior when we only break phenomena down into smaller parts. The maxim “the whole is more than the sum of its parts” aptly sums up the Gestalt perspective. To understand the perception of a flower, for example, we would have to take into account the whole of the experience. We could not understand such a perception merely in terms of a description of forms, colors, sizes, and so on.

Emergence of Cognitive Psychology

In the early 1950s, a movement called the “cognitive revolution” took place in response to behaviorism. Cognitivism is the belief that much of human behavior can be understood in terms of how people think. It rejects the notion that psychologists should avoid studying mental processes because they are unobservable. Cognitivism is, in part, a synthesis of earlier forms of analysis, such as behaviorism and Gestaltism. Like

behaviorism, it adopts precise quantitative analysis to study how people learn and think; like Gestaltism, it emphasizes internal mental processes.

Psychobiology

One of Watson's former students, Karl Spencer Lashley (1890–1958), brashly challenged the behaviorist view that the human brain is a passive organ merely responding to environmental contingencies outside the individual. Instead, Lashley considered the brain to be an active, dynamic organizer of behavior. Lashley sought to understand how the macro-organization of the human brain made possible such complex, planned activities as musical performance, game playing, and using language. None of these activities were, in his view, readily explicable in terms of simple conditioning.

Donald Hebb (1949) proposed the concept of cell assemblies as the basis for learning in the brain. Cell assemblies are coordinated neural structures that develop through frequent stimulation.

Linguist Noam Chomsky stressed both the biological basis and the creative potential of language. He pointed out the infinite numbers of sentences we can produce with ease. He thereby defied behaviorist notions that we learn language by reinforcement. Even young children continually are producing novel sentences for which they could not have been reinforced in the past.

Technological Underpinnings

By the end of the 1950s, some psychologists were intrigued by the tantalizing notion that machines could be programmed to demonstrate the intelligent processing of information. By 1956 a new phrase had entered our vocabulary. Artificial intelligence (AI) is the attempt by humans to construct systems that show intelligence and, particularly, the intelligent processing of information. Chess-playing programs, which now can beat most humans, are examples of artificial intelligence

Ulric Neisser's book *Cognitive Psychology* (Neisser, 1967) was especially critical in bringing cognitivism to prominence by informing undergraduates, graduate students, and academics about the newly developing field. Neisser defined cognitive psychology as the study of how people learn, structure, store, and use knowledge.

Allen Newell and Herbert Simon (1972) proposed detailed models of human thinking and problem solving from the most basic levels to the most complex. By the 1970s cognitive psychology was recognized widely as a major field of psychological study with a distinctive set of research methods.

MODULE 2

COGNITIVE NEUROPSYCHOLOGY

Neuropsychology is the study of the effects of lesions or dysfunctions of the Central Nervous System (CNS) on cognition and behaviour. Neuropsychology is useful for both research and clinical purposes:

1. It explores the functional architecture of the mind and its neural correlates;
2. It provides patients with a diagnosis and possibly with rehabilitative recommendations.

A revolution occurred when patient-based neuropsychology and cognitive psychology eventually came together. The main tenet of cognitive psychology is that mental activity (i.e. cognition) is information processing. By varying stimuli and instructions to the subjects, and by measuring their responses, cognitive psychologists make inferences about the information processing that intervenes between stimulus and response.

The term cognitive neuropsychology is applied to the analysis of those handicaps in human cognitive function that result from brain injury. Cognitive neuropsychology is essentially interdisciplinary, drawing both on neurology and on cognitive psychology for insights into the cerebral organization of cognitive skills and abilities. Cognitive function is the ability to use and integrate basic capacities such as perception, language, actions, memory, and thought. The focus of clinical cognitive neuropsychology is on the many different types of highly selective impairments of cognitive function that are observed in individual patients following brain damage. The functional analysis of patients with selective deficits provides a very clear window through which one can observe the organization and procedures of normal cognition. Clinical cognitive neuropsychology has been successful in demonstrating a large number of dissociations between the subcomponents of cognitive skills. This enables to conclude that such components are dependent on distinct neural systems. cognitive neuropsychologists seek to explain the patterns of impaired and intact cognitive performance seen in brain-injured patients in terms of damage to one or more of the components of a theory of normal cognitive functioning and, on the other hand, to draw conclusions about normal, intact cognitive processes from observed disorders.

COGNITIVE NEUROSCIENCE

Cognitive neuroscience is the study of how the brain enables the mind. Brain science explores how individual neurons operate and communicate to form complex neuronal architectures that comprise the human brain. Cognitive science uses the experimental methods of cognitive psychology and artificial intelligence to create and test models of higher-level cognition such as thought and language. Cognitive neuroscience bridges these two domains. It maps higher-level cognitive functions to known brain architectures and known modes of neuronal processing. Cognitive neuroscientists tend to have a background in experimental psychology, neurobiology, neurology, physics, and mathematics.

Methods employed in cognitive neuroscience include psychophysical experiments, functional neuroimaging, electrophysiological studies of neural systems and, increasingly, cognitive genomics and behavioral genetics. Cognitive neuroscience has employed multiple techniques to study cognition including single cell electrophysiology, lesion studies, brain stimulation, electroencephalography (EEG) and event related potentials (ERP), magnetic encephalography (MEG), neuroimaging using positron emission tomography (PET) and functional magnetic resonance imaging (fMRI), and transcranial magnetic stimulation). Lesion studies and studies with patients have been used to identify the neural structures underlying specific cognitive mechanisms.

Clinical studies in psychopathology in patients with cognitive deficits constitute an important aspect of cognitive neuroscience.

COGNITIVE SCIENCE

In more recent times, beginning early in the 1900s, scientists began projecting the idea that there is much more to the human mind than merely programmed responses, as held by behaviourists. As computer models were being built that simulated levels of human thought, scientists began to understand more about the reasoning process, becoming aware of the complexity of the operations that go on within the mind.

With the understanding of the **neural networks**, the paths of nerve signals that produce and support thinking operations in the brain, developed in the 1980s and 1990s, the complexity of the physical structure of the brain grew more evident. Through various ways of taking pictures of the brain, neuroscientists were able to see the system change, adapting to experiences and becoming a different system on a daily basis. Every day, the experiences modify the person by remapping his/her brain. These paved way for the emergence of cognitive neuroscience as an independent field.

Cognitive science can be roughly defined as the study of the mind or mental processes. Cognitive science has also been defined as the study of the nature of intelligence. According to the Stanford Encyclopedia of Philosophy, Cognitive science “is the interdisciplinary study of mind and intelligence, embracing philosophy, psychology, artificial intelligence, neuroscience, linguistics, and anthropology”.

Cognitive science is the study of the mind, including its structure and everything it does. It includes a variety of research sciences, including:

- **Education**, the study of how people learn
- **Philosophy**, the study of knowledge, reality, and existence
- **Artificial intelligence**, the study of thinking machines and systems
- **Psychology**, the study of behavior and the mind
- **Neuroscience**, the study of the nervous system
- **Linguistics**, the study of language
- **Anthropology**, the general study of the human society and culture.

MODULE 3

Memory is our ability to encode, store, retain and subsequently recall information and past experiences in the human brain. It can be thought of in general terms as the use of past experience to affect or influence current behaviour. Memory is the sum total of what we remember, and gives us the capability to learn and adapt from previous experiences as well as to build relationships. It is the ability to remember past experiences, and the power or process of recalling to mind previously learned facts, experiences, impressions, skills and habits.

MODELS OF MEMORY

THE TRADITIONAL MODEL OF MEMORY OR STAGES OF MEMORY MODEL

Richard Atkinson and Richard Shiffrin (1968) proposed an alternative model that conceptualized memory in terms of three memory stores:

- a sensory store, capable of storing relatively limited amounts of information for very brief periods;
- a short-term store, capable of storing information for somewhat longer periods but of relatively limited capacity as well; and
- a long-term store, of very large capacity, capable of storing information for very long periods, perhaps even indefinitely

The model differentiates among structures for holding information, termed stores, and the information stored in the structures, termed memory. Today, cognitive psychologists commonly describe the three stores as sensory memory, short-term memory, and long-term memory. Also, Atkinson and Shiffrin were not suggesting that the three stores are distinct physiological structures. Rather, the stores are hypothetical constructs—concepts that are not themselves directly measurable or observable but that serve as mental models for understanding how a psychological phenomenon works.

Sensory Store

The sensory store is the initial repository of much information that eventually enters the short- and long-term stores. Strong evidence argues in favor of the existence of an iconic store. The iconic store is a discrete visual sensory register that holds information for very short periods. Its name derives from the fact that information is stored in the form of icons. These in turn are visual images that represent something. Icons usually resemble whatever is being represented. Similarly, auditory information enter the echoic store.

Short-Term Store

The short-term store does more than hold onto a few items. It also has some control processes available that regulate the flow of information to and from the long-term store, where we may hold information for longer periods. Typically, material remains in the short-

term store for about 30 seconds, unless it is rehearsed to retain it. Information is stored acoustically (by the way it sounds) rather than visually (by the way it looks). In general, our immediate (short-term) memory capacity for a wide range of items appears to be about seven items, plus or minus two. An item can be something simple, such as a digit, or something more complex, such as a word. Information can be retained in short term store through maintenance rehearsal.

Long-Term Store

Theoretically, the capacity of Long Term Store could be unlimited, the main constraint on recall being accessibility rather than availability. Duration might be a few minutes or a lifetime. Suggested encoding modes are semantic (meaning) and visual(pictorial) in the main but can be acoustic also. Long term store is broadly divided into two: declarative memory, consisting of semantic memory (which stores factual knowledge) and episodic memory (which stores life events); and procedural memory. For information to enter long term store, elaborative rehearsal is needed. Information are meaningfully stored in long term store using associations with existing information, conceptual hierarchies, organisation and imagery.

THE LEVELS-OF-PROCESSING MODEL

A radical departure from the three-stores model of memory is the levels-of-processing framework, developed by Craik & Lockhart, which postulates that memory does not comprise three or even any specific number of separate stores, but rather varies along a continuous dimension in terms of depth of encoding. In other words, there are theoretically an infinite number of levels of processing (LOP) at which items can be encoded through elaboration—or successively deeper understanding of material to be learned. There are no distinct boundaries between one level and the next. The emphasis in this model is on processing as the key to storage. The level at which information is stored will depend, in large part, on how it is encoded. Moreover, the deeper the level of processing, the higher, in general, is the probability that an item may be retrieved. The levels-of-processing framework can also be applied to nonverbal stimuli.

The model describes three levels of processing:

The first level is simply perception, which gives us our immediate awareness of the world around. At a deeper level, the structural features of the input (what it sounds or looks like) are analysed. At the deepest level, meaning of the input is analysed, giving the best memory.

As in the stages of memory model, rehearsal plays a major role in the deeper processing of information. But according to this model, simply repeating the information- maintenance rehearsal- is not enough. For deeper levels to be reached, the rehearsal must be elaborative. Elaboration refers to the degree to which the incoming information is processed so that it can be tied to, or integrated with, existing memories.

VISUAL PERCEPTION

There are different views on how we perceive the world. These views can be summarized as bottom-up theories and top-down theories. Bottom-up theories describe approaches where perception starts with the stimuli whose appearance is taken through the eye. Therefore, they are data driven (i.e., stimulus-driven) theories. Many theorists prefer top-down theories, according to which perception is driven by high-level cognitive processes, existing knowledge, and the prior expectations that influence perception. These theories then work their way down to considering the sensory data, such as the perceptual stimulus.

BOTTOM-UP THEORIES

The four main bottom-up theories of form and pattern perception are direct perception, template theories, feature theories, and recognition-by-components theory.

Theory Of Direct Perception

According to Gibson's theory of direct perception, the information in our sensory receptors, including the sensory context, is all we need to perceive anything. As the environment supplies us with all the information we need for perception, this view is sometimes also called ecological perception. In other words, we do not need higher cognitive processes or anything else to mediate between our sensory experiences and our perceptions. Existing beliefs or higher-level inferential thought processes are not necessary for perception.

Template Theories

Template theories suggest that we have stored in our minds myriad sets of templates. Templates are highly detailed models for patterns we potentially might recognize. We recognize a pattern by comparing it with our set of templates. We then choose the exact template that perfectly matches what we observe. We see examples of template matching in our everyday lives. Fingerprints are matched in this way.

Feature-Matching Theories

Yet another alternative explanation of pattern and form perception may be found in feature-matching theories. According to these theories, we attempt to match features of a pattern to features stored in memory, rather than to match a whole pattern to a template or a prototype. In Oliver Selfridge's Pandemonium Model, there are four kinds of demons: image demons, feature demons, cognitive demons, and decision demons. The "image demons" receive a retinal image and pass it on to "feature demons." Each feature demon calls out when there are matches between the stimulus and the given feature. These matches are yelled out at demons at the next level of the hierarchy, the "cognitive (thinking) demons." The cognitive demons in turn shout out possible patterns stored in memory that conform to one or more of the features noticed by the feature demons.

A “decision demon” listens to the pandemonium of the cognitive demons. It decides on what has been seen, based on which cognitive demon is shouting the most frequently.

Recognition-By-Components (RBC) Theory

According to Biederman’s recognition-by-components (RBC) theory, we quickly recognize objects by observing the edges of them and then decomposing the objects into geons, which are simple 3-D geometric shapes. They include objects such as bricks, cylinders, wedges, cones, and their curved axis counterparts. The geons also can be recomposed into alternative arrangements. You know that a small set of letters can be manipulated to compose countless words and sentences. Similarly, a small number of geons can be used to build up many basic shapes and then myriad basic objects.

TOP-DOWN THEORIES

In contrast to the bottom-up approach to perception is the top-down, constructive approach. In constructive perception, the perceiver builds (constructs) a cognitive understanding (perception) of a stimulus. The concepts of the perceiver and his or her cognitive processes influence what he or she sees. The perceiver uses sensory information as the foundation for the structure but also uses other sources of information to build the perception. This viewpoint also is known as intelligent perception because it states that higher-order thinking plays an important role in perception. It also emphasizes the role of learning in perception.

Instead of viewing these theoretical approaches as incompatible, we may gain deeper insight into perception by considering the approaches to be complementary. Sensory information may be more richly informative and less ambiguous in interpreting experiences than the constructivists would suggest. But it may be less informative than the direct-perception theorists would assert. Similarly, perceptual processes may be more complex than hypothesized by Gibsonian theorists.

MODULE 4

TRADITIONAL THEORIES OF INTELLIGENCE

SPEARMAN'S TWO-FACTOR THEORY

It was developed in 1904 by an English Psychologist Charles Spearman. Spearman, using an earlier approach to factor analysis, found that scores on all mental tests (regardless of the domain or how it was tested) tend to load on one major factor. Spearman suggested that these disparate scores are fueled by a common metaphorical “pool” of mental energy. He named this pool the general factor, or *g*. He proposed that intellectual abilities were comprised of two factors : one general ability or common ability known as ‘G’ factor and the other a group of specific abilities known as ‘S’ factor. ‘G’ factor is universal inborn ability. Greater ‘G’ in an individual leads to greater success in life. ‘S’ factor is acquired from the environment. It varies from activity to activity in the same individual.

Mathematically, Spearman’s theory, in brief, is that every individual measurement of every intellectual ability may be resolved into two factors, one of which is a “general factor” (*g*) common to all the abilities measured, and the others “specific factor” (*s*) peculiar to each particular ability. This statement may be translated into mathematical form by representing the score (*S*) of an individual on a given mental test by the simple equation

$$S = a_1g + a_2s,$$

where the letters “*a*₁” and “*a*₂” represent the “weights” or “loads” of the two factors ‘*g*’ and ‘*s*’, respectively.

MULTIFACTOR THEORIES

Thurstone’s Theory Of Primary Mental Abilities

Using his new approach to factor analysis, Thurstone found that intelligent behaviour does not arise from a general factor, but rather emerges from seven independent factors that he called *primary abilities*: word fluency, verbal comprehension, spatial visualization, number facility, associative memory, reasoning, and perceptual speed.

Based on these factors Thurstone constructed a new test of intelligence known as “Test of Primary Mental Abilities (PMA).”

Thorndike’s multifactor theory:

Thorndike believed that there was nothing like General Ability. Each mental activity requires an aggregate of different set of abilities. He distinguished the following four attributes of intelligence :

- (a) Level—refers to the level of difficulty of a task that can be solved.
- (b) Range—refers to a number of tasks at any given degree of difficulty.
- (c) Area—means the total number of situations at each level to which the individual is able to respond.
- (d) Speed—is the rapidity with which we can respond to the items.

GUILFORD'S MODEL OF STRUCTURE OF INTELLECT

Guilford (1967, 1985, 1988) proposed a three dimensional structure of intellect (SI) model. According to Guilford every intellectual task can be classified according to its (1) content, (2) the mental operation involved and (3) the product resulting from the operation.. The SI model includes Content dimension, Products dimension, and Operations dimension, represented as a cube with each of the three dimensions occupying one side. Each ability is defined by a conjunction of the three categories, occupying one cell in the three-dimensional figure. There are five categories of Content including visual, auditory, symbolic, semantic, and behavioral. Six categories exist in the Products dimension including units, classes, relations, systems, transformation, and implications. The five kinds of Operations include cognition, memory, divergent production, convergent production, and evaluation.

Guilford's SI Theory is an open system such that it allows for newly discovered categories to be added in any of three directions. Many of the abilities are believed to be correlated with each other. The 5 x 6 x 5 figure provides at least 150 possible abilities, with over 100 having been empirically verified. The model also suggests where new abilities may be discovered based on existing abilities.

VERNON'S HIERARCHICAL THEORY

Beginning in 1969, Vernon became increasingly involved in studying the contributions of environmental and genetic factors to intellectual development. Vernon continued to analyze the effects of genes and the environment on both individual and group difference in intelligence. He concludes that individual difference in intelligence are approximately 60 percent attributable to genetic factors, and that there is some evidence implicating genes in racial group differences in average levels of mental ability.

Vernon's description of different levels of intelligence may fill the gaps between two extreme theories, the two-factor theory of Spearman, which did not allow for the existence of group factors, and the multiple-factor theory of Thurstone, which did not allow a "g" factor. Intelligence can be described as comprising abilities at varying levels of generality:

1. The highest level : "g" (general intelligence) factor with the largest source of variance between individuals.

2. The next level : major group factors such as verbal-numerical-educational and practical-mechanical-spatial-physical ability. The verbal educational factor may be sub-divided into verbal and numerical sub-factors, and the practical mechanical factor into mechanical information, spatial, and psychomotor ability.
3. The next level : minor group factors are divided from major group factors.
4. The bottom level : ‘‘s’’(specific) factor.
5. Such a hierarchical structure thus resembles an inverted genealogical tree, with ‘g’ at the top, ‘s’ factors at the bottom, and progressively narrower group factors in between.

MODULE 5

CONTEMPORARY THEORIES OF INTELLIGENCE

GARDNER'S THEORY OF MULTIPLE INTELLIGENCE:

Howard Gardner in his book ‘Frames of Mind, The Theory of Multiple Intelligence’ (1983), puts forth a new and different view of human intellectual competencies. He argues boldly and cogently that we are all born with potential to develop a multiplicity of Intelligence, most of which have been overlooked in our testing society, and all of which can be drawn upon to make us competent individuals. The potential for musical accomplishments, bodily mastery and spatial reasoning, and the capacities to understand ourselves as well as others are, Gardner argues, “the multiple forms of intelligence that we must add to the conventional—and typical tested—logical and linguistic skills long called I.Q.”.

The multiple intelligence theory is that people possess eight types of intelligence : linguistic, logical, spatial, musical, motor ability, interpersonal, intrapersonal and naturalistic intelligence.

Visual-Spatial - think in terms of physical space, as do architects and sailors. Very aware of their environments. They like to draw, do jigsaw puzzles, read maps, and daydream. They can be taught through drawings, verbal and physical imagery. Tools in educating them include models, graphics, charts, photographs, drawings, 3-D modelling, video, videoconferencing, television, multimedia, texts with pictures/charts/graphs.

Bodily-kinesthetic - use the body effectively, like a dancer or a surgeon. Keen sense of body awareness. They like movement, making things, touching. They communicate well through body language and be taught through physical activity, hands-on learning, acting out, role playing. Tools include equipment and real objects.

Musical - show sensitivity to rhythm and sound. They love music, but they are also sensitive to sounds in their environments. They may study better with music in the background. They can be taught by turning lessons into lyrics, speaking rhythmically, tapping out time. Tools include musical instruments, music, radio, stereo, CD-ROM, multimedia.

Interpersonal - understanding, interacting with others. These students learn through interaction. They have many friends, empathy for others, street smarts. They can be taught through group activities, seminars, dialogues. Tools include the telephone, audio conferencing, time and attention from the instructor, video conferencing, writing, computer conferencing, E-mail.

Intrapersonal - understanding one's own interests, goals. These learners tend to shy away from others. They're in tune with their inner feelings; they have wisdom, intuition and motivation, as well as a strong will, confidence and opinions. They can be taught

through independent study and introspection. Tools include books, creative materials, diaries, privacy and time. They are the most independent of the learners.

Linguistic - using words effectively. These learners have highly developed auditory skills and often think in words. They like reading, playing word games, making up poetry or stories. They can be taught by encouraging them to say and see words, read books together. Tools include computers, games, multimedia, books, tape recorders, and lecture.

Logical -Mathematical - reasoning, calculating. Think conceptually, abstractly and are able to see and explore patterns and relationships. They like to experiment, solve puzzles, ask cosmic questions. They can be taught through logic games, investigations, mysteries. They need to learn and form concepts before they can deal with details

Naturalistic: An ability to identify and distinguish among different types of plants, animals, and weather formations that are found in the natural world.

Gardner accentuates two primary claims: 1) All individuals possess the full range of intelligences—the intelligences are what that define human beings, cognitively speaking; (2) No two individuals, not even identical twins, exhibit precisely the same profile of intellectual strengths and weaknesses. These constitute the principal scientific claims of the theory.

STERNBERG'S TRIARCHIC THEORY

Psychologist Robert Sternberg (1985) has constructed a three—pronged, or triarchic theory of intelligence. Sternberg states that Intelligence is: "Purposive adaptation to, shaping of, and selection of real-world environments relevant to one's life". Purposive means that intelligence is directed towards goals, however vague or subconscious they may be. This means that intelligence is indicated by one's attempts to adapt to one's environment.

The Three types of intelligence are :

Analytical Intelligence (componential) —is what we generally think of as academic ability. It enables us to solve problems and to acquire new knowledge. Problem—solving skill include encoding information, combining and comparing pieces of information and generating a solution. Sternberg believes that Analytical Intelligence is based on the joint operations of metacomponents, performance components and knowledge acquisition components of intelligence

- **Metacomponents:** control, monitor and evaluate cognitive processing. These are the *executive* functions to order and organise performance and knowledge acquisition components. They are the higher-order processes that order and organise the performance components. Used to analyze problems and pick a strategy for solving them. They decide what to do and the performance components actually do it.

- **Performance Components:** execute strategies assembled by the metacomponents. They are the basic operations involved in any cognitive act. They are the cognitive processes that enable us to encode stimuli, hold information in short-term memory, make calculations, perform mental calculations, mentally compare different stimuli, retrieve information from long-term memory.
- **Knowledge acquisition components:** are the processes used in gaining and storing new knowledge - i.e. capacity for learning. The strategies used to help memorize things exemplify the processes that fall into this category.

Creative Intelligence (experiential) —is defined by the abilities to cope with novel situations and to profit from experience. The ability to quickly relate novel situations to familiar situations (that is, to perceive similarities and differences) fosters adaptation. Moreover, as a result of experience, we also become able to solve problems more rapidly.

Practical Intelligence (contextual) —or “street smarts”, enable people to adapt to the demands of their environment. For example, keeping a job by adapting one’s behavior to the employer’s requirements is adaptive. But if the employer is making unreasonable demands, reshaping the environment (by changing the employer’s attitudes) or selecting an alternate environment (by finding a more suitable job) is also adaptive. Practical intelligence is a combination of:

- (a) adaptation to the environment in order to have goals met
- (b) changing the environment in order to have goals met
- (c) or, if (a) and (b) don't work moving to a new environment in which goals can be met

THEORY OF EMOTIONAL INTELLIGENCE

According to Goleman (1995), Emotional Intelligence consists of “abilities such as being able to motivate oneself and persist in the face of frustrations; to control impulse and delay gratification; to regulate one’s moods and keep distress from swamping the ability to think : to empathize, and to hope”. To Goleman, emotional competencies are not innate talents, but rather learned capabilities that must be worked on and can be developed to achieve outstanding performance. Goleman believes that individuals are born with a general emotional intelligence that determines their potential for learning emotional competencies

The Five Components of Emotional Intelligence

Self-awareness. The ability to recognize and understand personal moods and emotions and drives, as well as their effect on others. Hallmarks of self-awareness include self-confidence, realistic self-assessment, and a self-deprecating sense of humor.

Self-regulation. The ability to control or redirect disruptive impulses and moods, and the propensity to suspend judgment and to think before acting. Hallmarks include trustworthiness and integrity; comfort with ambiguity; and openness to change.

Internal motivation. A passion to work for internal reasons that go beyond money and status -which are external rewards, - such as an inner vision of what is important in life, a joy in doing something, curiosity in learning, a flow that comes with being immersed in an activity. A propensity to pursue goals with energy and persistence. Hallmarks include a strong drive to achieve, optimism even in the face of failure, and organizational commitment.

Empathy. The ability to understand the emotional makeup of other people. A skill in treating people according to their emotional reactions. Hallmarks include expertise in building and retaining talent, cross-cultural sensitivity, and service to clients and customers.

Social skills. Proficiency in managing relationships and building networks, and an ability to find common ground and build rapport. Hallmarks of social skills include effectiveness in leading change, persuasiveness, and expertise building and leading teams.

PASS THEORY OF INTELLIGENCE

Neuropsychological research has consistently demonstrated that the brain is made up of interdependent, but separate, functional systems. Neuroimaging studies and clinical studies of individuals with brain lesions make it clear that the brain is modularized. Based on A.R. Luria's (1966) seminal work on the modularization of brain function, and supported by decades of neuroimaging research, J.P. Das, first in 1975, proposed the PASS theory of intelligence. This theory divides intelligence into four interrelated cognitive processes:

1. **Planning:** This is the ability to make decisions about how to solve problems and perform actions. It involves setting goals, anticipating consequences and using feedback. Planning also involves the attention-arousal, simultaneous and successive processing functions described below, and is associated with the frontal lobes of the brain.
2. **Attention-Arousal:** This involves the ability to selectively attend to stimuli while ignoring other distractions. Individuals with Attention Deficit Disorder (ADD) have impairments in this area. The arousal functions are generally associated with the brain stem and thalamus, whereas the higher attentional processes are thought to be related to the planning functions of the frontal lobe.
3. **Simultaneous Processing:** This involves the ability to integrate separate stimuli into a cohesive, interrelated whole. Simultaneous processing is necessary for language comprehension, as in: "Who is the person in the following statement: My mother's father was his only son?" The occipital and parietal lobes are thought to be important for these functions.
4. **Successive Processing:** This involves the ability to integrate stimuli into a sequential order. An example of this process is the sequencing of letters and words

in reading and writing. This type of processing is believed to be related to frontal-temporal lobe functioning.

According to the PASS theory, information first arrives at the senses from external and internal sources, at which point the four cognitive processes activate to analyze its meaning within the context of the individual's knowledge base (e.g. semantic and episodic knowledge, implicit and procedural memories, and so on). Thus, the same information can be processed multiple ways. One unusual property of the PASS theory of cognitive processes is that it has proven useful for both intellectual assessment (e.g. the CAS) and educational intervention.
