



ALAGAPPA UNIVERSITY

(A State University accredited with A+ Grade by NAAC (CGPA: 3.64) in the Third Cycle
and Graded as Category-1 University by MHRD-UGC)



KARAIKUDI – 630 003

DIRECTORATE OF DISTANCE EDUCATION

M.Sc. (Psychology)

III Semester

36331

COGNITIVE NEURO PSYCHOLOGY

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SYLLABI BOOK MAPPING TABLE

COGNITIVE NEURO PSYCHOLOGY

Syllabi

Mapping in Book

Learning Objectives

- To explain the mediatory role of cognition in behavior
- To explain the process and function of attention
- To describe sensational, perceptual phenomena and its different scientific explanations
- To elucidate how the memory system functions
- To explain the process and function of Neuropsychology
- To describe Plasticity and Restoration of brain function

BLOCK 1: ROLE OF COGNITIVE BEHAVIOUR

UNIT I: Cognitive Psychology

1-10

Psychological processes- Emergence of different approaches to cognitive psychology information procession- connectionism & ecological perspective;

UNIT II: Attention

11-25

Model of attention-Functions of executive preconscious and conscious processing alerting mechanism- Selective attention: Bottom- up and top town processing automatically-division of attention-Theories of attention Bottle neck & spotlight concepts Filter model-attenuation theory- multimode theory- resources & capacity allocation model schema theory.

UNIT III: Introduction cognitive Neuropsychology

26-45

Meaning-History- Assumptions of Cognitive Neuropsychology- Neuroanatomy: the nervous system, surrounding structures (skull, blood vessels, meninges, ventricles)-spinal cord, brainstem, cerebellum, midbrain, thalamus, basal ganglia, cortex. The cellular foundations the nerve function: Types of nerve cells- functions- the Four lobes and their Functions.

BLOCK II :METHODS AND NEURAL PROCESS

UNIT IV: Methods

46-57

Case Study-Animal Studies – Human Lesion Studies- Structural (X-ray, CT,MRI) and functional (SPECT, FMRI, PET, NIRS) neuroimaging. Electrophysiological methods: electroencephalography (EEG), event-related potentials (ERP), magnetic encephalography (MEG). Controlling the brain- neurofeedback.

UNIT V: Perception & Attention

58-70

Visual pattern recognition: Template-matching model-Feature analysis-Object recognition-Face recognition. Speech recognition-Feature analysis of speech. Context and pattern recognition-FLMP model. Attention: Auditory attention-Filter theory- Attenuation

theory. Visual attention: Neural basis- Visual search- Binding problem- Visual neglect- Object based attention. Central attention-Automaticity-Stroop effect.

UNIT VI : Memory and Cognition

71-85

Memory: Atkinson and Shiffrin Model-Neural Networks Model- Kinds of information stored in Memory: Working Memory-Episodic and Semantic Memory- Procedural Memory Methods to Study Memory-Forgetting-Memory Distortion and Memory Construction Memory in Everyday Life- Memory and the Brain- Memory Improvement Techniques.

Cognition: Thinking- Basic Elements of Thought- Reasoning-Making Decisions- Problem solving and its Methods- Artificial Intelligence-Language and its Development- Language and Thought. Sensory memory: Visual-Auditory. Short-term memory-Working memory: addeley's theory-Long-term memory-Factors influencing memory-Techniques for studying textual material. Retention-Interference-Retrieval and inference: Plausible retrieval-Elaboration & inference – Eyewitness testimony & False memory. Associative structure and retrieval: Effect of encoding context-Encoding-specificity.

BLOCK III : PERCEPTUAL PHENOMENA

UNIT VII: Problem Solving And Reasoning

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Problem Solving process- Problem solving operators: Acquisition of operators- Analogy & imitation. Operator selection: Difference-reduction model-Mean- end analysis-Tower of Hanoi-Problem representation: Functional fixedness. Set effects. Reasoning about conditionals. Watson selection task-Permission schema-Probabilistic interpretation. Deductive reasoning: Categorical syllogism- Atmosphere hypothesis-Process explanation. Inductive reasoning: Hypothesis formation and testing.

UNIT VIII :Sensation & Perception

98-110

Theories of perception: top down and bottom up perspective-visuopatial sub codes pattern recognition-Perceptual phenomena Pain perception, constancies and illusions- mental imagery-

UNIT IX : Classical and modern Psychophysics:

111-117

Fechner's contributions- Weber's law Steven's power law- signal detection theory- ROC curve Top down processes- influence of motivation & learning on perception –role of culture perceptual organization-subliminal perception and synesthesia.

UNIT X: Memory

118-125

Encoding theories and models of memory two store model information processing approach levels of processing levels of recall- Sensory memory-short term memory- working memory models- Storage Long-term memory episodic and semantic memory- autobiographical memory-declarative and procedural memory- Implicit and explicit memory.

BLOCK IV: NEUROPSYCHOLOGY

UNIT XI : Retrieval

126-135

Recall reconstruction in memory- Forgetting: Theories interference decay organic causes encoding failure- failure of reconstruction-Met cognition: Meaning ad Concept and its implications.

UNIT XII : Neuropsychology

136-150

Assumptions and methods- functional modularity- anatomical functional architecture and substractivity.

UNIT XIII : Methods of investigation

151-164

Electrophysiological Single cell recordings, EEG and ERP Scanning and Imaging- CAT PET MRI and FMRI; Neuropsychological Battery Luria Nebraska Neuropsychological Battery, Halstead Retain Test Battery PGI Batter of Brain Behavior Dysfunction AIIMS neuropsychological battery; Neurodegenerative disorders Parkinson's Alzheimer, Huntington.

UNIT XIV : Neuropsychological Plasticity and Restoration of Brain

165-183

Historical antecedents and approaches-Types of brain injury- Methods of localization of cognitive functions in the Brain; Function Mind and Brain relationship-computer assisted neuropsychological rehabilitation and training.

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UNIT 1 COGNITIVE PSYCHOLOGY

Cognitive psychology

NOTES

1.1 INTRODUCTION

Cognitive psychology is the study of mental processes such as perceiving, remembering, and reasoning. Since the beginning of recorded history, people have expressed curiosity about the operation of the mind, largely because they believed that behaviour is the result of mental processes. For example, how are we to understand the very behaviour in which you are engaged at this moment, reading this course book? At one level, we are interested in explaining your ability to comprehend what you are reading, and in so doing, we are likely to appeal to processes of perception of words and computation of meaning. At another level, we might explain our motivation for reading in terms of our goal to complete this course, which in turn is motivated by our goal of obtaining a degree in order to follow some plan that you have for a career. The point is that our behaviour of reading this book is determined in part by our intent to meet some goal and fulfill some plan. Intentionality, goals, and plans are mental phenomena that affect behaviour. Further, the specific behaviour, in this case, reading, is understood by appeal to the specific mental processes involved in perception and comprehension of text. In short, the study of mental processes is important because these processes are responsible for much of our behaviours. In this unit you will be studying the definition and description of cognitive psychology, distinctive research methods, domains of cognitive psychology, metaphor of cognition etc.

1.2 OBJECTIVES

- Field of cognitive psychology;
- Provide a foundation on which to build an understanding of the topics in cognitive psychology;
- Describes some of the intellectual history of the study of human thinking; and
- Emphasizes some of the issues and concerns that arise when we think about how people think

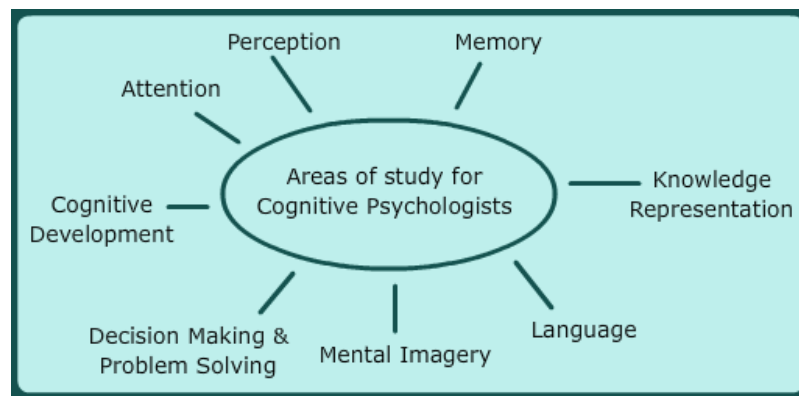
1.3 EMERGENCE OF DIFFERENT APPROACHES TO COGNITIVE PSYCHOLOGY

The word ‘cognition’ is derived from the Latin word *cognoscere*, meaning “to know” or “to come to know”. Thus, cognition includes the activities and processes concerned with the acquisition, storage, retrieval and processing of knowledge. In other words, it might include the processes that help us to perceive, attend, remember, think, categorize, reason, decide, and soon.

Self-Instructional Material

Cognitive psychology, as the name suggests, is that branch of psychology that deals with cognitive mental processes. *Sternberg (1999)* defined Cognitive psychology as that which deals with how people perceive, learn, remember, and think about information.” In 2005, Solso gave another definition of Cognitive psychology as the study of processes underlying mental events. In general, Cognitive psychology can thus be defines as that branch of psychology that is concerned with how people acquire, store, transform, use and communicate language.

The cognitive psychologists study the various cognitive processes that make up this branch. These processes include **attention**, the process through which we focus on some stimulus; **perception**, the process through which we interpret sensory information; **pattern recognition**, the process through which we classify stimuli into known categories; and **memory**, the process through which information is stored for later retrieval, and so on. Thus, the work of cognitive psychologists is extended to a number of areas, which can be depicted as follows



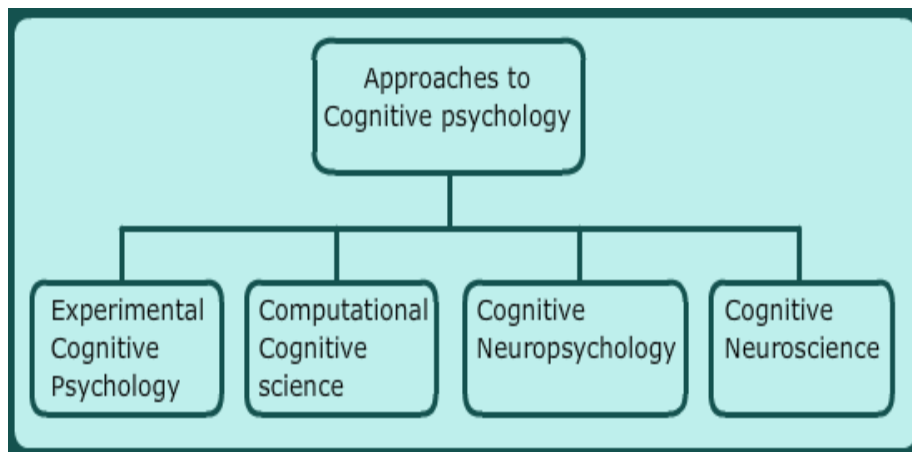
A Brief History of Cognitive Psychology

The roots of cognitive psychology can be traced back much further, and is intimately intertwined with the history of experimental psychology. This leads back to the time period when the empiricist, rationalist, and structuralist schools of thought which included philosophical works of Plato, Aristotle that dealt with the philosophy of mind, and also to the later works of Wundt, and Titchner involving introspection. However, for some period, the behaviorist school of thought dominated all the others, and the focus was shifted from thought to behavior.

Around the time between the 1950s and 1970s, the tide began to shift against behavioral psychology to focus on topics such as attention, memory and problem-solving. The formal discipline of “Cognitive Psychology” started in the mid-1900s during the cognitive revolution, and the term ‘cognitive psychology’ did not emerge until 1967. Dissatisfaction with behaviorism, World War II, and the growing technological advances in other fields such as computer sciences were a few major reasons behind the Cognitive revolution. The mental processes regained their focus in psychology, and their measurement began in objective, quantifiable methods.

In recent times, a number of different disciplines have started to come together and collaborate such as the fields of psychology, artificial intelligence, linguistics, philosophy, anthropology, and neuroscience, in order to gain a better insight into the field of cognitive psychology.

Approaches to Cognitive psychology



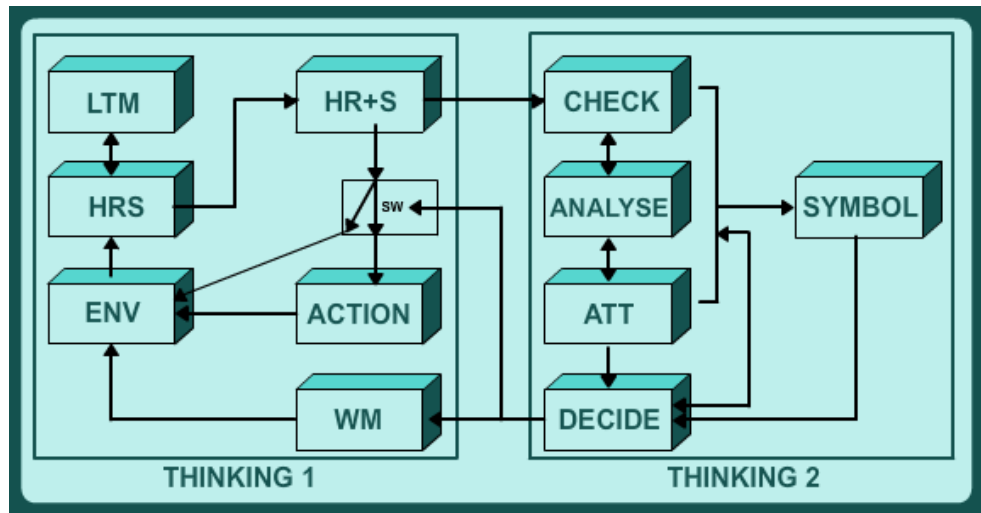
A number of different approaches have been proposed in order to better understand the field of cognitive psychology. Each of these approaches emphasizes a different aspect and highlight distinct features underlying the cognitive processes. These methods provide us with an insight into how the human mind functions by giving us a general idea about the workings of the basic cognitive processes that we engage in. Broadly, there are four major approaches that try to explain the various cognitive processes by highlighting the different important features. These approaches are: Experimental Cognitive Psychology, Computational Cognitive Science, Cognitive Neuropsychology, and Cognitive Neuroscience.

Experimental Cognitive Psychology –

This approach involves conducting tightly controlled experiments under laboratory conditions on healthy individuals. It generally includes experiments that designed in such a way that they might disrupt the cognitive processes and reveal their workings. The findings obtained through such experiments then lead to formulation of the theories, which in turn lead to testable claims.

Computational Cognitive Science –

This approach involves computational modeling through the recreation of some of the aspects of human cognition in the form of some computer program, or formula in order to predict behavior in novel situations. In other words, this approach basically involves creating computer based models of human cognitive functions, as well as some work on artificial intelligence.



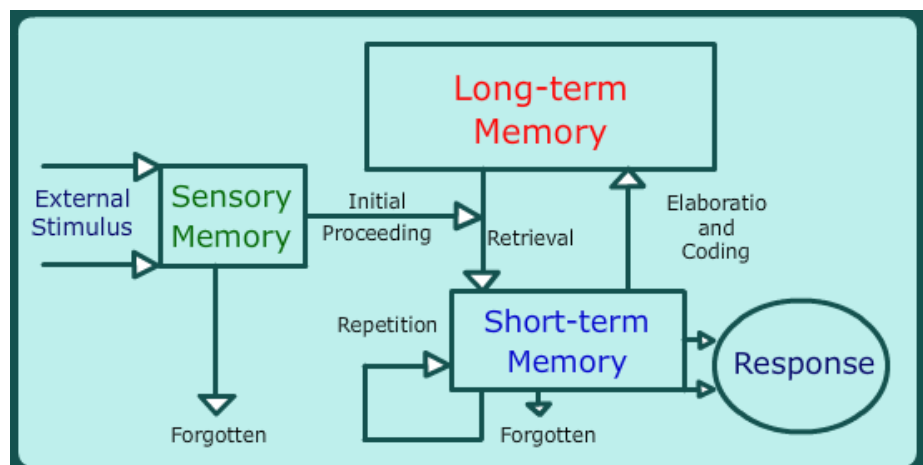
Cognitive Neuropsychology-

This approach to cognition investigates the various cognitive processes by studying the people who have suffered brain damage, and to find out whether damage to a particular brain region would result in a specific cognitive impairment. For example, damage to *region X* disrupts *ability Y*, and the people who have lost *ability Y* also have problems with *ability X*. Thus, such studies involving people with brain damages help us to make assertions regarding the healthy brain functions.

Cognitive Neuroscience -

This approach has gained popularity over the past decade or so, and involves brain-imaging devices to study cognitive functions. This can help to discover where these processes occur in the brain, and when. In other words, this approach involves using brain imaging and brain anatomy to study 'live' cognitive functioning in healthy individuals. Some of the methods used in the cognitive neuroscientific approach include:

- Single Unit Recording
 - Event Related Potentials (ERPs) Positron Emission Tomography (PET)
 - (Functional) Magnetic Resonance Imaging (fMRI, MRI) Magneto-encephalography (MEG)
 - Transcranial magnetic stimulation (TMS)



Information processing Theory

Since the 1960s and 1970s, the information processing approach has dominated the field of cognitive psychology. Basically, this approach draws an analogy between cognitive processing in humans and processing of information by a digital computer. This theory aims to explain the sequence of transformations that input information undergoes in order for a computer/mind to generate an output response. The researchers who follow this approach assume that the information is processed in stages and that it is then stored in specific places while being processed. The figure given below is a typical example of an information processing model

Some basic assumptions underline the information processing model. One assumption holds that the cognitive abilities of a person can be thought of as 'systems' of interrelated capacities, and finding out the relationship between these capacities can explain how individuals go about performing the specific cognitive tasks. This theory also assumes that like computers, people can also perform numerous cognitive feats by applying only a few mental operations to symbols.

Bottom-up Processing – In bottom-up processing, the stimulus reaches an inactive, unprepared organism, and the processing is directly affected by the stimulus input. In other words, the processing is essentially driven by what information an individual acquires from his or her environment. So here, the processing starts from the input level which is invariably the lower level of processing, and then goes on to its interpretation.

Serial Processing – As the name suggests, in serial processing, the processing of information happens 'serially'. The processing happens one by one, and one process is completed before the next one can start.

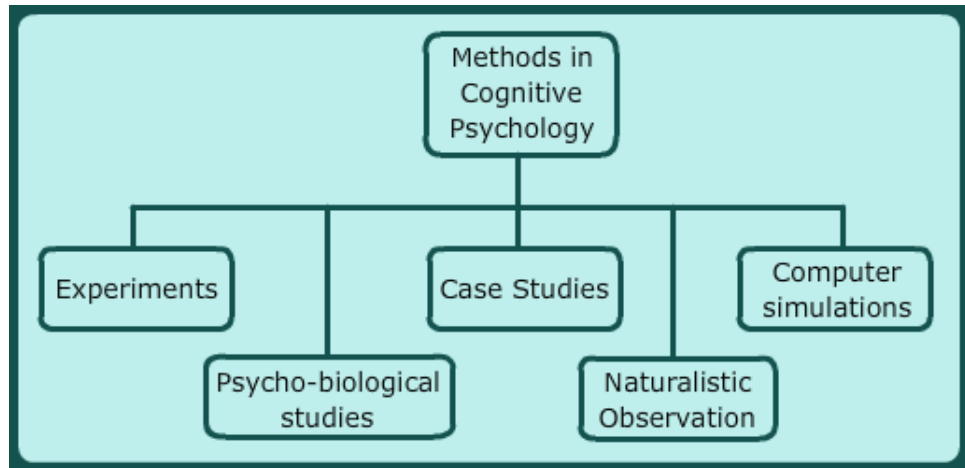
Parallel Distributed Processing theory

The parallel-distributed processing model states that information is processed simultaneously by several different parts of the cognitive system, rather than sequentially. In this type of processing model, the information that is received from the environment is processed in a number of different locations simultaneously, and then stored.

In 1986, the parallel distributed processing model was further extended. Rumelhart and McClelland extended it, and proposed the **Connectionistic approach** to processing. According to this, that information is stored in multiple locations throughout the brain in the form of networks of connections, called 'Nodes'. In this model, cognition is basically thought of as a network of connections among a number of simple processing units. Each unit is connected to other units in a large network, and has some level of activation at a given moment of time.

Research methods in Cognitive Psychology

A number of methods are employed in cognitive psychology in order to get an insight into the workings of higher mental processes.



Experiments –

In an experiment, a researcher manipulates a variable in order to see its effect on another variable. For example, suppose a person wants to know whether background noise affects performances on quantitative problems. One way of studying this would be to take a group of people and randomly assign them to two different groups, a *no-noise* group and a *white-noise* group. The first group is asked to solve the problems in a quiet environment and the second group tries to solve the problems whilst being exposed to white noise. In this case, the presence/absence of white noise is referred to as the *independent variable*. Our outcome measure is referred to as the *dependent variable*.

Psychobiological research –

Some researchers investigate the relationship between cognition and the brain's structures and activities. This is psychobiological research. One way of looking at such relationships is to conduct *post mortem* studies, to compare the brains of normal individuals with those who were known to have some kind of cognitive deficit. Also, one can also observe the performance of brain damaged individuals and their cognitive deficits. Researchers can also monitor an individual doing a cognitive task, with the help of various measures such as PET, MRI, or fMRI.

Case Studies –

Case studies are intensive investigations of individuals, usually people of exceptional ability or people with some sort of deficit. These studies may examine archival records, interviews, direct observation, or participant-observations.

Naturalistic Observation –

Another methodology open to researchers is to observe people in real-life settings, such as at home or at work. Observations may be done with the knowledge and consent of those being watched, or they may be covert, in which case people are not aware that they are being watched. The latter type of observation obviously requires the researcher to give particular thought to ethical considerations.

Computer Simulations –

Computer simulations aim to imitate aspects of human functioning. A particular cognitive theory may be implemented in a computer program. If the program runs successfully and produces outputs that resemble human responses, then one might conclude that the theory is coherent and plausible.

Application of Cognitive Psychology

Cognitive psychology is that branch of psychology that deals with the study of higher level mental processes. Some of the areas in which this branch finds its application in the real world are listed as follows –

Human Error Driving behavior Product design Visual behavior
Object / face recognition Human-machine interaction

Cognitive psychology

NOTES

Check your progress - 1

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. Any four cognitive Neuro scientific Approach

.....
.....
.....

PERSPECTIVE

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 parallelly 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 an all-or-none manner that is typical of computer memories. Smolensky (2000) has pointed out that connectionism entails commitment to mental representations or distributed patterns of neural activity and mental processes that involve 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. The models developed by the connectionists do not rely on explicit rules but learn through examples and are said to utilize sub-symbolic representations (Rumelhart & McClelland, 1986).

One common way of making sense of the workings of connectionist systems is to view them at a coarse, rather than fine, grain of analysis -- to see them as concerned with the relationships between different activation vectors, not individual units and weighted connections. Consider, for instance, how a fully trained Elman network learns how to process particular words. Typically nouns like "ball," "boy," "cat," and "potato" will produce hidden unit activation vectors that are more similar to one another (they tend to *cluster* together) than they are to "runs," "ate," and "coughed". Moreover, the vectors for "boy" and "cat" will tend to be more similar to each other than either is to the "ball" or "potato" vectors. One way of determining that this is the case is to begin by conceiving activation vectors as points within a space that has so many dimensions as there are units.

Self-Instructional Material

Figure 1.1 Activation of Two Units Plotted as Point in 2-D State Space

The human brain contains approximately 100 billion neurons. Some of them connect to ten thousand other neurons. Together they form *neural networks* (see figure 1.2). Each *unit* or *node* depicts a neuron or a group of neurons. Usually, an artificial neural network is made up of three layers: An input layer, a hidden layer, and an output layer (Thagard, 2005).

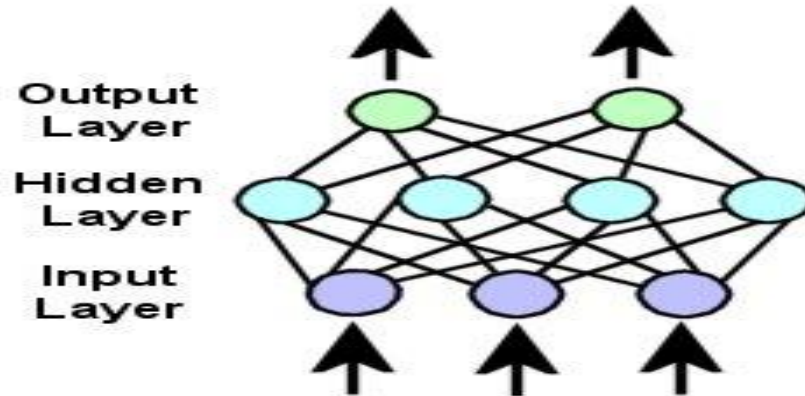


Figure 1.2 Neural Networks

The input layer receives information, e.g. from our senses, and distributes the signal throughout the network, also known as spreading activation. The hidden layer does not have a purpose initially, but serves an important role with respect to its connections with other units. The output unit passes information to other parts of the brain, which can generate the appropriate response in a particular situation. As an example, when we perceive an object, the input units receive certain properties like ‘brown’, ‘tail’, ‘four legs’, and ‘long hair’.

The output units will then be able to classify the object as ‘dog’. Finally, the connections between units can have different strengths, called weights. These weights can either be positive, resulting in excitation of the neurons they connect to, or negative, resulting in inhibition. The mechanism of learning is, in essence, adjustment of the weights of connections (Thagard, 2005; McLeod, Plunkett & Rolls, 1998).

How does a neural network represent knowledge of the world? There are two ways in which a connectionist model can store knowledge : Locally or distributed(Levoi.2005). In local representations, each concept is encoded by a single unit. This is not very likely, however, since it would imply the existence of grandmother cells, where one neuron is associated with only one specific stimulus. More realistic is the distributed representations approach, where one concept is encoded by several units. Distributed representations of knowledge have a few advantages compared to local representations of knowledge (LeVoi,2005:Thagard,2005).

Check your progress – 2

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. Howmany research methods in cognitive psychology ?

.....
 ...

1.5 SUMMARY

Cognitive psychology is the study of how people perceive, learn, remember, and think about information. A cognitive psychologist might study how people perceive various shapes, why they remember some facts but forget others, or how they learn language. Cognitive psychology is interested in what is generally called mental phenomena. In this sense, cognitive psychology IS the scientific study of the mind. Then we took up the various research methods that we use in cognitive psychology. Every research has a goal and it is achieved through appropriate methodology. It was noted that the goals of research in cognitive psychology was to find the how and why of thinking. It was pointed out that there are distinctive research methods in cognitive psychology. Each method has distinctive advantages and disadvantages. It was also noted that Cognitive psychologists often broaden and deepen their understanding of cognition through research in cognitive science. Cognitive science is a cross-disciplinary field that uses ideas and methods from cognitive psychology, psychobiology, artificial intelligence, philosophy, linguistics, and anthropology. Modern cognitive psychology freely, draws theories and techniques; from twelve principal areas of research, namely cognitive neuroscience, human and artificial intelligence, perception, thinking and concept formation, pattern recognition, developmental psychology, attention, language, representation of knowledge, imagery, memory and consciousness. Then we dealt with a brief history of cognitive psychology and highlighted the early thoughts on thinking, renaissance and beyond and the status of cognitive psychology as of today. We then discussed some of the key issues in cognitive psychology highlighting nature vs. nurture, rationalism vs. empiricism, structure vs. processes etc.

1.6 UNIT END EXERCISES

1. Describe the major historical schools of psychological thought leading up to the development of cognitive psychology.
2. Analyse how various research methods in cognitive psychology reflect empirist and rationalist approaches to gaining knowledge.
3. Design a rough sketch of a cognitive-psychological investigation involving one of the research methods described in this chapter. Highlight both the advantages and disadvantages of using this particular method for your investigation.
4. Describe Cognitive Psychology as it is today. How might you speculate that the field will change in the next 50 years?
5. How might an insight gained from basic research lead to practical use in an everyday setting?
6. Describe some real life situations related to different domains of cognitive psychology.
7. How might an insight gained from applied research lead to deepened understanding of fundamental features of cognition?

8. What was the importance of the computer to the development of cognitive psychology?
9. Next time you visit a supermarket or mall, pause for a few moments and observe the various examples of cognitive psychology which surround you. Pay particular attention to: 1) the use of forms and colours to gain attention, 2) your own reaction to environmental cues, 3) the use of memory in understanding language, context, and the interpretation of the sights and sounds of your environment. Note down your impressions of these matters and read them over in about a week. What principles discussed in this chapter apply?

1.7 ANSWERS TO CHECK YOUR PROGRESS

- 1) Single unit recording, event related potential, positron emission tomography, Magnetic resonance imaging.
- 2) Experiments, Case studies, Computer simulation, Naturalistic Observation Psycho Biological studies.

1.8 SUGGESTED READINGS AND REFERENCES

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UNIT 2 ATTENTION

Attention

NOTES

2.1 INTRODUCTION

The official beginning of cognitive science is usually placed as the Dartmouth symposium on information theory in 1956 (Miller, 1979). In Cognitive Psychology, George Miller published his seminal paper on short-term memory capacity 7 ± 2 and Leon Festinger published his work on Cognitive Dissonance in 1956 (Bechtel, Abrahamsen, & Graham, 1998). Artificial Intelligence as a discipline was born in 1956.

Multiple definitions exist for mind and the sciences of the mind including Psychology and Cognitive Science have played a critical role in defining and understanding mind. This chapter discusses the major approaches to studying the mind including the information processing approach, cognitive modeling, cognitive neuroscience, embodied and situated cognition as well as the emerging trends of increasing interdisciplinary and pluralism in cognitive science.

2.2 OBJECTIVES

- To Study the detailed information about attention
- To study the different theories of attention
- To know ,how we can perform more than one voluntary skill at the same time.
- To elucidate the process and function of attention

2.3 ATTENTION

Attention was earlier considered as a mental power but psychological experiments have now proved that it is simply a mental process. We cannot do anything without attention. Whatever work we do needs attention. Attention is related to consciousness. Paying attention to anything is to concentrate our consciousness on it. During all the time that we are awake our attention centres round something or the other.

Attention is the process whereby we can select from among the many competing stimuli present in our environment, facilitating processing of some while inhibiting processing of others. **Attention** is the behavioral and cognitive process of selectively concentrating on a discrete aspect of information, whether deemed subjective or objective, while ignoring other perceivable information. **Attention** has also been referred to as the allocation of limited processing resources.

Attention refers to the concentration and focusing of mental effort

- Selective
- Shiftable
- Divisible.

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This selection can be driven endogenously by our goals (e.g., to find a particular friend, to follow an instruction, to use an arrow to direct attention), or exogenously by a salient or novel stimulus that captures attention away from the task at hand (e.g., bright light, loud noise). Because there is too much information at any given moment for us to cope with, attention is the mechanism by which the most important information is selected for further processing.

The type of information that we miss and the conditions under which we miss it are, therefore, the flip side of the cognitive processes involved in attentional selection. Being unaware of the posters on the wall at a party is a failure of selection that is a property of selectively searching for features of a friend. Although we are capable of processing only a limited quantity of information in both space and time, fortunately selection does not occur randomly. Both our goals and the salience of information around us determine where and to what we attend.

2.3.1 Central and Marginal Consciousness

If we see only one thing at a time then how are we able to see many things one by one within a moment and how do we feel that we are seeing many things at a time As already remarked, we see a thing when we concentrate our consciousness on it. Our consciousness is divided into two parts: central and marginal. The object on which our attention goes becomes the part of central consciousness. Besides, there are many things which remain lying at the skirt of marginal consciousness and the mind is capable of bringing them into central consciousness whenever there is a need for the same.

The object which is in marginal consciousness may immediately move to central consciousness and vice versa. We may, therefore, say that the subject of attention goes on changing. Our experience is that we move our attention from one thing to another constantly. The object of attention will be the one on which our consciousness centres. In order to understand attention it is necessary to first understand the difference between attention and consciousness. We shall understand this below:

2.3.2 Attention and Consciousness

Our attention goes to an object when our consciousness centres around it, but from this to draw the conclusion that there is no difference between attention and consciousness will be wrong. We feel consciousness about the object coming within the purview of consciousness. The sphere of consciousness may be wide-ranging and attention may be only a part of it. All things in a room like picture, pen, chair, table, bed, fan, mirror etc., may come within the purview of our consciousness, but our attention may centre around the mirror only, because we are going to look at our body in it. Thus, consciousness has two fields-the aspect of attention and the aspect which is neglected. The attention aspect, for the time being, belongs to the central consciousness and the neglected aspect belongs to marginal consciousness. The marginal consciousness is often called sub-consciousness. How are we conscious about things lying in sub-consciousness when our attention does not go on them? The object in sub-consciousness gives hints of the entire environment of our consciousness. We get conscious of a thing when it moves out of sub-consciousness.

2.3.3 Studies of Dichotic Listening

- Dichotic listening tasks involve asking subjects to listen to different information in each ear.



Fig 1.3

- Shadowing: Messages are presented to both ears but subject is told to attend to only one of the messages and repeat it out loud.
 - By and large subjects find it easy to perform this task
 - Subjects can remember what was said on the attended channel.
 - Some things subjects DON'T know about the unattended channel
 - What words were spoken.
 - The topic being discussed.
 - The language of the voice.
 - Some things subjects DO know about the unattended channel
 - Whether it was a human voice or just noise
 - Whether it was a male or female voice.

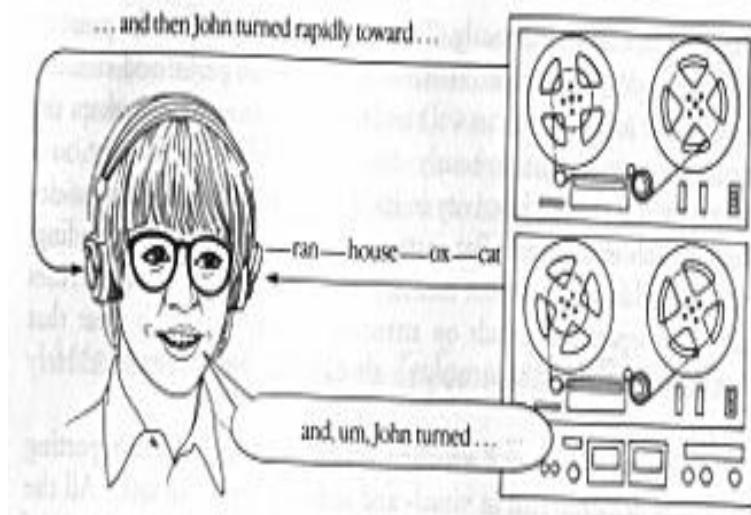


Fig 1.4

2.3.4 Types of Attention

Attention

There are four types of attention we consistently use and look :

NOTES

Divided attention

Some instances of divided attention are easier to manage than others. For example, straightening up the home while talking on the phone .Texting while you are trying to talk to someone .

Sustained attention

Sustained attention is also commonly referred to as one's attention span. It takes place when we can continually focus on one thing happening, rather than losing focus and having to keep bringing it back. People can get better at sustained attention as they practice it.



Fig 1.5

Executive attention

Executive attention is particularly good at blocking out unimportant features of the environment and attending to what really matters. It is the attention we use when we are making steps toward a particular end. For example, maybe you need to finish a research project by the end of the day.

2.3.5 Bottom-Up Processing

People are generally encouraged to think before acting. However, you may have found that sometimes you make good decisions without thinking about them first. For example, if someone offered you your favorite flavor of ice cream, but it was topped with pickles and hot sauce, chances are you'd be able to turn it down right away without first having to give it a

thought (unless you like that sort of thing). The reason you could reject that ice cream without first having to stop and think is because of a strategy called bottom-up processing.

Processing Types Compared

Processing is just a shorter way to say taking in information, analyzing it, and drawing conclusions or taking action. Processing involves the brain, the body, and emotions. There are two types of processing: top-down and bottom-up. Let's look at our ice cream scenario again.

In **top-down processing**, your brain is active first. You might think, 'How nice. My friend is offering me ice cream, and I would like some. I should take that from her. I wonder what kind it is.' This thought leads to **emotions** (happy, excited, grateful, curious) and then a response in the body (increased heart rate, smile, arms reaching out).

Bottom-up processing is simply about the process moving in the opposite direction. First comes the response in the body (eyes see the bowl and contents, nose smells chocolate, pickles, and hot sauce, stomach churns, face grimaces, head turns away). This leads to emotion (repulsion, disappointment) and the **brain's cognition and directive for action** (thinking 'That's nasty' and saying 'No thank you.'). As you can see from the chart below, bottom-up processing starts with the body and ends in the brain.

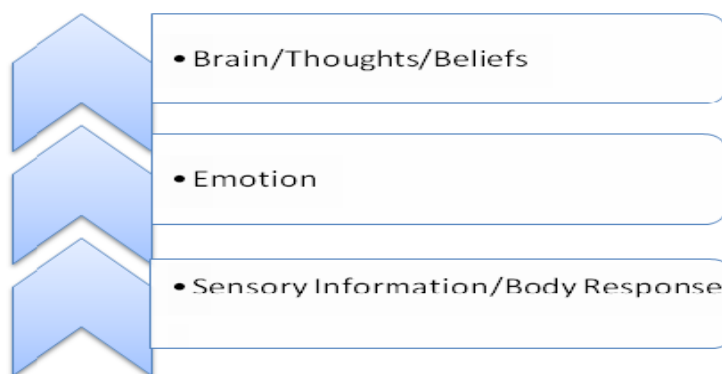


Fig 1.6

Occurrence of Bottom-Up Processing

As you can imagine, bottom-up processing can happen very quickly and with many processes all going on at once. Often, the time it takes for the process to start in the body and end with the brain is so fast that it is almost impossible to separate the steps. While we may be more familiar with talking about how we think than our bodily sensations, many would argue that bottom-up processing occurs much more frequently than top-down and that most of our decisions are made because of how our bodies react to the environment.

Bottom Up example



Fig 1.7 Stimulus-driven –Exogenous- Automatic

2.3.6 Top-Down Processing

Throughout the day, each of us is exposed to a potentially limitless number of sensory experiences. No matter where you are or what you're doing, there are multiple sights, sounds, smells, textures, and (if you're eating) even tastes, all flooding your senses and subsequently your brain as we speak. In psychology, these two separate systems are commonly thought of as sensation and perception. **Sensation** involves bringing in information through the five senses, and **perception** is how our brains make sense of that information.

Psychologists often refer to the way in which our sensation and perception systems work both separately and together as processing. In general, when it comes to processing in the context of sensation and perception, two types of processing are commonly described, namely **bottom-up processing** and **top-down processing**. Let's take a closer look at top-down processing.

Definition

Top-down processing refers to how our brains make use of information that has already been brought into the brain by one or more of the sensory systems. Top-down processing is a cognitive process that initiates with our thoughts, which flow down to lower-level functions, such as the senses. This is in contrast to bottom-up processing, which is the process of the senses providing information about the environment up to the brain.

Selective attention

Selective attention is the process of focusing on a particular object in the environment for a certain period of time. Attention is a limited resource, so selective attention allows us to tune out unimportant details and focus on what really matters."We must be *selective* in our attention by focusing on some events to the detriment of others. This is because attention is like a resource that needs to be distributed to those events that are important."

2.3.7 Selective Visual Attention

There are two major models describing how visual attention works. The "spotlight" model works much like it sounds - it proposes that visual attention works similar to that of a spotlight. Psychologist William James suggested that this spotlight includes a focal point in which things are viewed clearly. The area surrounding this focal point, known as the fringe, is still visible, but not clearly seen. Finally, the area outside of the fringe area of the spotlight is known as the margin.

The second approach is known as the "zoom-lens" model. While it contains all the same elements of the spotlight model, it also suggests that we are able to increase or decrease the size of our focus much like the zoom-lens of a camera. However, a larger focus area also results in slower-processing since it includes more information. As such limited attentional resources must be distributed over a larger area.

2.3.8 Selective Auditory Attention

Some of the best-known experiments on auditory attention are those performed by psychologist Colin Cherry. Cherry investigated how people are able to track certain conversations while tuning others out, a phenomenon he referred to as the "cocktail party" effect.

In these experiments, two auditory messages were presented simultaneously with one presented to each ear. Cherry then asked participants to pay attention to a particular message, and then repeat back what they had heard. He discovered that the participants were able to easily pay attention to one message and repeat it, but when they were asked about the contents of the other message, they were unable to say anything about it. Cherry found that when contents of the unattended message were suddenly switched (such as changing from English to German mid-message or suddenly playing backward) very few of the participants even noticed. Interestingly, if the speaker of the unattended message switched from male to female (or vice versa) or if the message was swapped with a 400-Hz tone, the participants always noticed the change. Cherry's findings have been demonstrated in additional experiments. Other researchers have obtained similar results with messages including lists of words and musical melodies.

Check your progress – 1

- Note: a. Write your answer in the space given below
b. Compare your answer with those given at the end of the unit

1. Define Executive attention

.....
.....

2. What is Selective Attention

.....

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is attended to, either early in the process or late.

2.4.1 Broadbent's Filter Model

Broadbent (1958) developed a theory of attention that attempted to account for the findings of Cherry and Mowbray. Broadbent proposed that the focus of attention is determined by three components: a selective filter, which led to a channel of limited capacity, which in turn led to a detection device. These components are represented in the following figure 1.9

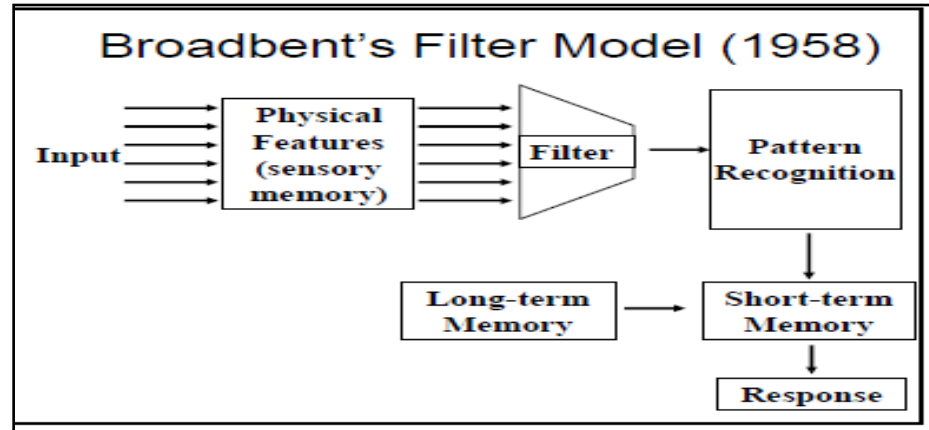


Fig 1.9

Basically, sensory register is a memory of stimuli that have recently been presented. Stimuli are stored in sensory memory in one of several channels, each channel corresponding loosely to a different sensory modality. Although the duration of this memory is brief, its contents are thought to be exact representations of the original stimuli. While they are stored in the sensory register, the stimuli are subjected to a pre attentive analysis, the selective filter determines which stimuli will undergo further processing. Those stimuli that are not selected are essentially tuned out: no further elaboration of them takes place.

Following their selection, the stimuli are shunted along a limited capacity channel to the detection device. The channel's relatively limited capacity has important implications for the human information processor. If asked to pay the capacity to carry all of the incoming information simultaneously to the detection device. Instead, the selective filter switches as rapidly as possible among the channels in the sensory register, in each case taking the information that has been loaded into that particular channel and transferring it to the shunting bottleneck theory. A great deal of information can be stored in the sensory laborious process that must be done serially-that is, one channel at a time.

Information in the shunting channel is transferred to the detection device, where an analysis of the information's meaning is carried out. According to Broadbent's position, we "know" only about stimuli that make it past the selective filter. Information that was stopped at that stage is subjected only to a pre attentive analysis, which is incapable of determining the stimuli's meaning.

This theory provides a reasonable account of Cherry's and Mowbray's findings. Recall that Mowbray(1953) found that subjects could apparently extract the meaning of only one story when two had been presented- one visually, the other aurally. In this case, the decrement in performance was produced by the selective filter's inability to switch between the auditory and visual channels rapidly enough. While information from one channel in the sensory register was extracted and loaded into the shunting channel, information in other channels of the sensory register could not be evacuated.

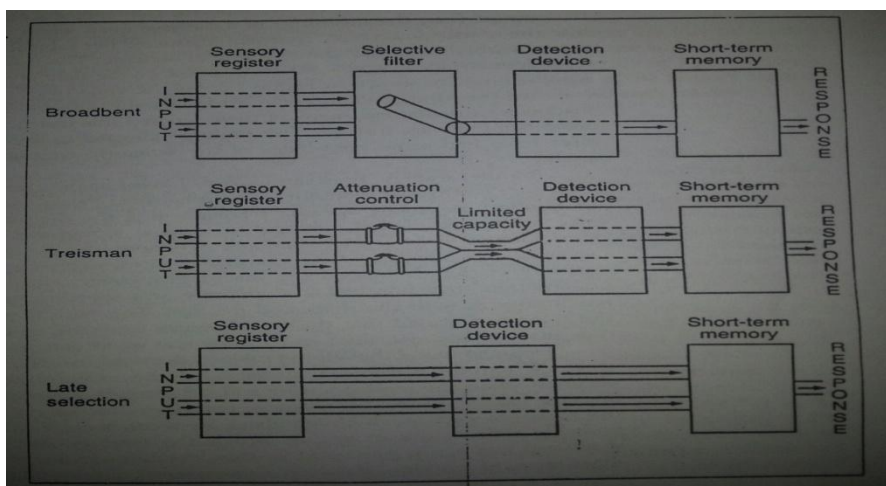


Fig 1.9

Regarding Cherry's findings: The filter is tuned to accept information from the shadowed ear. This information is loaded into the shunting channel and ultimately processed for meaning by the detection device. Material that is presented in the non-shadowed ear has a different fate. Because the filter is never opened to the non-shadowed ear, none of this material is transferred to the shunting channel and detection device. Consequently, the subjects in Cherry's study were able to report only the physical characteristics of the non-shadowed message. These characteristics were determined by the pre-attentive analysis.

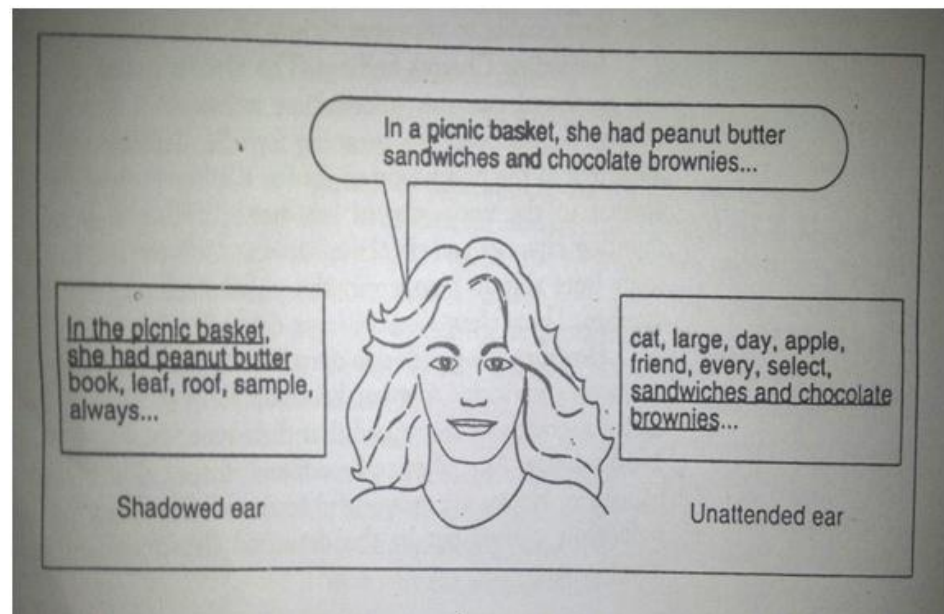


Fig 1.10

Similarly, Treisman (1960) reported that subjects could shadow the semantic content (i.e., the meaning) of a message even when the message was played into the non shadowed ear. Treisman instructed her subjects to shadow a particular a random string of words. At some point in the delivery, the semantic content switched ears, as shown in Figure 1.3. At the same time, the random words were switched into the shadowed ear. Although the subjects had been instructed to shadow a particular ear, many of them ignored this instruction and shadowed the meaningful message instead. This finding indicated to Treisman that the subjects must have had some knowledge of the semantic content of the non shadowed message.

Broadbent's Filter Theory -Issues

Fails to explain the cocktail party effect: Moray (1959) found that although his subjects could not recall nor recognize irrelevant messages presented as many as 35 times to the unattended ear, they frequently heard their own name when presented in this channel

2.4.2 Treisman's Attenuation Theory

Accordingly, Treisman proposed a modification of the basic theory, which is known as the attenuation model (Fig 1.4). According to this theory, incoming stimuli might undergo three different kinds of analysis, or tests. The first test analyzes the physical properties of the stimuli. For auditory stimuli, the physical properties are equivalent to acoustic properties such as pitch and intensity. The second test determines to acoustic properties such as pitch and intensity. The second test determines whether the stimuli are linguistic and, if so, groups the stimuli into syllables and words. The final test recognizes the words and assigns meanings to them. All three rests are not necessarily carried out on all incoming stimuli. Rather, the processing is continued until the competing stimuli can be disentangled from one another.

Distinguishing competing stimuli sometimes requires little processing. If you are talking to a man at a party, and the people standing and talking nearby happen to be women, the stimuli can be sorted out on the basis of the first test. Under these circumstances, you would probably not become aware of the semantic content of the women's speech, because their conversation was not processed to that point. If the first test fails to disentangle the stimuli, then a second level test must be carried out. For example, a friend called one day to tell me about the breakup of his latest romance. Unfortunately, he called in the middle of an exciting football game. Because the acoustic differences between the two messages were minimal, a second level test based on the syllables and words had to be carried out to separate the two messages. In this case, I did become aware of some of the words used in both messages.

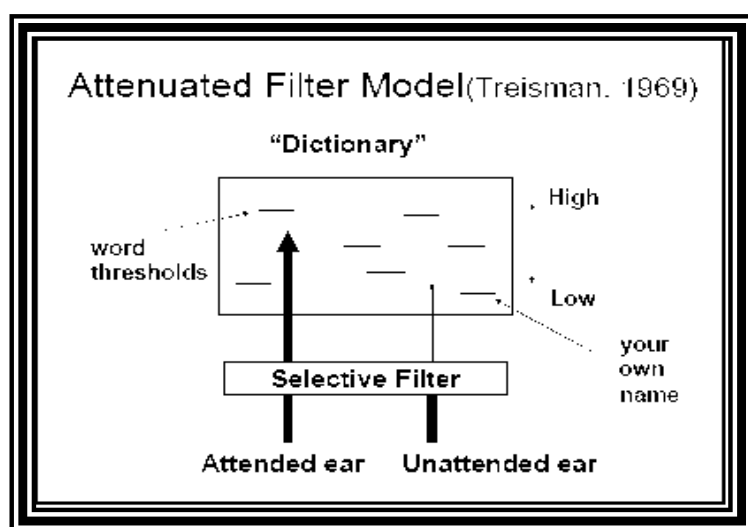


Figure 1.11

Attention attenuates the strength of some stimuli based on physical attributes. A newly proposed element is a 'dictionary'. This dictionary symbolizes information, or words, which require a very low threshold in order to be recognized. Some words (like your name, "danger", "fire" etc) have a lower threshold than others. The stimulus which exceeds the threshold is selected for pattern recognition.

Filter versus Attenuation Theory

Broadbent's filter is all-or-nothing (it does not allow through unattended messages), whereas Treisman's filter allows unattended messages through, but in an attenuated form.

Broadbent's is a simple single filter model, whereas Treisman's can be thought of as a two-stage filtering process: firstly, filtering on the basis of incoming channel characteristics, and secondly, filtering by the threshold settings of the dictionary units.

Both models are "early selection" models, in which selection occurs prior to pattern recognition.

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2.4.3 Memory Selection Models

Other researchers also believed that Broadbent's model was insufficient and that attention was not based solely on a stimulus's physical properties. The cocktail party effect serves as a prime example. Imagine that you are at a party and paying attention to the conversation among your group of friends. Suddenly, you hear your name mentioned by a group of people nearby. Even though you were not attending to that conversation, a previously unattended stimulus immediately grabbed your attention based on meaning rather than physical properties.

According to the memory selection theory of attention, both attended and unattended messages pass through the initial filter and are then sorted at a second-stage based upon the actual meaning of the message's contents. Information that we attend to based upon meaning is then passed into Short-term memory.

2.5 RESOURCE THEORIES OF SELECTIVE ATTENTION

More recent theories tend to focus on the idea of attention being a limited resource and how those resources are divided up among competing sources of information. Such theories propose that we have a fixed amount of attention available and that we must then choose how we allocate our available attentional reserves among multiple tasks or events.

"Attentional-resources theory has been criticized severely as overly broad and vague. Indeed, it may not stand alone in explaining all aspects of attention, but it complements filter theories quite well," suggests Sternberg (2009) in summarizing the different theories of selective attention. "Filter and bottleneck theories of attention seem to be more suitable metaphors for competing tasks that appear to be attentionally incompatible... Resource theory seems to be a better metaphor for explaining phenomena of divided attention on complex tasks."

Observations

A number of factors can influence selective attention in spoken messages. The location from where the sound originates can play a role. For example, you are probably more likely to pay attention to a conversation taking place right next to you rather than one several feet away.

Pashler (1998) notes that simply presenting messages to different ears will not lead to the selection of one message over the other. The two messages must have some sort of non-overlap in time in order for one to be selectively attended to over the other. As mentioned previously, changes in pitch can also play a role in selectivity.

The number of auditory selections that must be tuned out in order to attend to just one can make the process more difficult. Imagine that you are in a crowded room and many different conversations are taking place all around

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you. Selectively attending to just one of those auditory signals can be very difficult, even if the conversation is taking place nearby.

Learn more about how attention works some of the things you can do to improve your attention and why we sometimes miss what is right in front of us. Incoming stimuli, briefly held in a sensory register, undergo pre-attentive analysis by a selective filter on the basis of their physical characteristics. Those stimuli selected pass along a (very) limited capacity channel to a detection device. Stimuli not selected ('filtered' out) are not analyzed for meaning and do not reach consciousness.

Attention

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Multimode Theory (1970's)

The multimode theory of attention builds on the two prior theories and adds a new dimension called, "mode of selection." Mode of selection can be viewed on a continuum with "early mode" on one end and "late mode" on the other. A couple of things happen as you move from early to late mode of selection: the bottleneck shifts to filter input after pattern recognition, and attention capacity decreases. Both these events can inhibit the performance of secondary tasks.

Resources and capacity allocation model schema theory

Navon (1990) ran a dual-task experiment in which task A involved the classification of a visually presented digit – participants had to respond as to whether the digit was odd or even. In task B participants had to respond to a concurrently visually presented Hebrew letter. They had to decide whether the letter came from the first or second half of the alphabet. Both tasks were carried out under reaction time (RT) conditions. The typical instructions to participants in such tasks are that they should try to respond as quickly as they can without making too many errors. Performance on the two tasks was also manipulated across two conditions.

In the minimal requirements conditions, participants were given continuous within-trial feedback on how well they were expected to perform on both tasks. Performance requirements were systematically varied within a range that the participants could easily achieve. Moreover, for each level assessed, slightly more weightage was to be attributed to one of the tasks over the other by setting the RT deadline at a slightly lower level for one of the tasks. What this means is that participants were pushed to respond within a certain time limit for one of the tasks. This was accomplished by shortening the RT deadline – either press the key within this deadline or the response will be treated as an error. In this way the hope was to achieve a performance trade-off for the two tasks.

For example, as the RT deadline was lowered for task A, RTs on task B should lengthen. In contrast, in the optimum–maximum conditions, participants were told to try to maximise their response speed on one task even though the difficulty of the other task was altered. Again, according to a single resource model, any variation in the difficulty of one task ought to produce a concomitant variation in performance in the other task – a more

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difficult task requires more resources. (Remember the principle of complementarity). So even under the optimum–maximum requirements, there ought to have been a trade-off in task performance.

A schematic representation of the data from the experiment is presented in the following Figure. Consider performance in the minimum requirements condition first. Here there is a clear performance trade-off between the two tasks such that improvement on one is associated with a decrement on the other. RTs on task

A shortens as RTs on task B lengthen. Such a pattern is generally in line with single resource models. However, quite a different pattern emerged in the data for the optimum–maximum conditions: here there simply is no evidence of a similar performance trade-off. Now when participants attempted to maximise the speed of response on one task, performance was essentially unaffected by variation in the speed of response on the other task. So, when maximising speed on task A, varying the speed of response on task B failed to produce any change in task A responses.

According to Navon (1990), this suggests that the trade-off seen in the minimum requirements condition apparently does not necessarily reflect any limit on being able to perform both tasks concurrently as described by single resource models. Rather, it seems that the pattern of performance reflects participants' compliance with what they consider to be the objectives of the experiment. The more general and important conclusion is that participants appear to have more control over dual-task performance than is implied by the single constraint defined by a finite

pool of attentional resources. A performance trade-off may reflect nothing more than participants being able to perform in a manner that is asked of them. It therefore does not necessarily imply anything of significance about the nature and availability of attentional resources.

Check your Progress -2

Note: a. Write your answer in the space given below
b. Compare your answer with those given at the end of the unit

1. Write a types of attention

2.6 SUMMARY

In this unit psychological process, different types of attention and theories of attention are discussed .This will give a clear knowledge of attention in cognitive psychology.

2.7 UNIT –END ACTIVITY

Refer the different cognitive psychology books and collect the examples of bottom -up and top- down process in life

1. **Explain connectionism and ecological perspective.**
2. Define Attention: List the different types of attention?
3. Explain top-down and bottom -up processing with examples.
4. Describe Attenuation theory.

2.8 ANSWERS TO CHECK YOUR PROGRESS

1. Executive attention is particularly good at blocking out unimportant features of the environment and attending to what really matters.
2. Selective attention is the process of focusing on a particular object in the environment for a certain period of time.
3. i. Divided Attention ii. Sustain Attention iii. Executive Attention

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Attention
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Self-Instructional Material

UNIT 3 – INTRODUCTION

COGNITIVE NEURO PSYCHOLOGY

Introduction Cognitive
Neuro Psychology

NOTES

3.1 INTRODUCTION

Cognitive neuropsychology first began to flourish in the second half of the Nineteenth Century, initially in relation to disorders in the comprehension and production of spoken language (aphasia). Continental neurologists such as Broca (1861), Lichtheim (1873) and Wernicke (1874) studied patients with aphasia and inferred information-processing models of the normal language-processing system from the patterns of preserved and impaired language abilities they saw in their patients. They even expressed these models as box-and-arrow flowcharts of information processing, which is the universal notation in modern cognitive neuropsychology. This cognitive-neuropsychological approach was also applied to the understanding of disorders of written language, both reading and spelling (Bastian, 1869; Dejerine, 1891), and soon spread to other cognitive domains such as object recognition (Lissauer, 1890), calculation (Lewandowsky & Stadelmann, 1908) and many others.

3.2 OBJECTIVES

- in developmental cognitive neuroscience bear on theoretical concepts like critical periods in development, the modularity of mind, and the sources of development (i.e., nature and nurture).
- To cultivate a detailed understanding of at least one specific domain of neurocognitive development (e.g., memory, language, spatial cognition, attention, or object, face, or number perception).
- To become familiar on at least a basic level with concepts related to connectionist modeling of brain-behavior processes.
- To nurture an awareness of the value of maintaining a developmental perspective when endeavoring to understand brains and the cognitions and behaviors associated with them.

3.3 COGNITIVE NEURO PSYCHOLOGY

3.3.1 Meaning

Cognitive neuropsychology is a branch of cognitive psychology that aims to understand how the structure and function of the brain relates to specific psychological processes. Cognitive psychology is the science that looks at how mental processes are responsible for our cognitive abilities to store and produce new memories, produce language, recognize people and objects, as well as our ability to reason and problem solve. Cognitive neuropsychology places a particular emphasis on studying the cognitive effects of brain injury or neurological illness with a view to

Self-Instructional Material

inferring models of normal cognitive functioning.

Cognitive neuropsychology has its roots in the diagram making approach to language disorder that started in the second half of the 19th century. The discovery that aphasia took different forms depending on the location of brain damage provided a powerful framework for understanding brain function.

3.3.2 History

In 1861 Paul Broca, reported a post mortem study of an aphasic patient who was speechless apart from a single nonsense word: "Tan". Broca showed that an area of the left frontal lobe was damaged. As Tan was unable to produce speech but could still understand it, Broca argued that this area might be specialised for speech production and that language skills might be localized to this cortical area. Broca did a similar study on another patient, Lelong, a few weeks later. Lelong, like Tan, could understand speech but could only repeat the same 5 words. After examining his brain, Broca noticed that Lelong had a lesion in approximately the same area as his patient Tan. He also noticed that in the more than 25 patients he examined with aphasia, they all had lesions to the left frontal lobe but there was no damage to the right hemisphere of the brain. From this he concluded that the function of speech was probably localized in the inferior frontal gyrus of the left hemisphere of the brain, an area now known as Broca's area.

3.3.3 Assumptions of Cognitive Neuro psychology

The Central Nervous System

The central nervous system (CNS) consists of the parts of the nervous System that are encased in bone: the brain and the spinal cord. The CNS lies entirely within the skull. A side view of the rat brain reveals that are common to all mammals: the cerebrum, the cerebellum, and the brain stem.

The Cerebrum:

The rostral-most and largest part of the brain is the Cerebrum. It shows the rat cerebrum as it appears when viewed from above. Notice that it is clearly split down the middle into two cerebral hemispheres, separated by the deeps agittaflissure. In general, the right cerebral hemisphere receives sensations from, and controls movements of, the left side of the body. Similarly, the left cerebral hemisphere is concerned with sensations and movements on the right side of the body.

The Cerebellum:

Lying behind the cerebrum is the cerebellum (the word is derived from the Latin for "little brain"). While the cerebellum is in fact dwarfed by the large cerebrum, it actually contains as many neurons as both cerebral hemispheres combined. The cerebellum is primarily a movement control center that has extensive connections with the cerebrum and the spinal cord. In contrast to the cerebral hemispheres the left side of the cerebellum is concerned with movements of the left side of the body, and the right side of the cerebellum is concerned with movements of the right side.

The Brain Stem:

The remaining part of the brain is the brain stem, best observed in a midsagittal view of the brain. The brain stem forms the stalk from which the cerebral hemispheres and the cerebellum sprout. The brain stem is a complex nexus of fibers and cells that in part serves to relay information from the cerebrum to the spinal cord and cerebellum, and vice versa. However, the brain stem is also the site where vital functions are regulated, such as breathing, consciousness and the control of body temperature. Indeed, while the brain stem is considered the most primitive part of the mammalian brain, it is also the most important to life. One can survive damage to the cerebrum and cerebellum, but damage to the brain stem usually means rapid death.

The Spinal Cord:

The spinal cord is encased in the bony vertebral column and is attached to the brain stem. The spinal cord is the major conduit of information from the skin, joints, and muscles of the body to the brain, and vice versa. A transection of the spinal cord results in anesthesia (lack of feeling) in the skin and paralysis of the muscles in parts of the body caudal to the cut. Paralysis in this case does not mean that the muscles cannot function but that they cannot be controlled by the brain. The spinal cord communicates with the body via the spinal nerves, which are part of the peripheral nervous system (discussed below). Spinal nerves exit the spinal cord through notches between each vertebra of the vertebral column. Each spinal nerve attaches to the spinal cord by means of two branches: the dorsal root and the ventral root. The dorsal root contains axons bringing information into the spinal cord, such as those that signal the accidental entry of a thumbtack into your foot. The ventral root contains axons carrying information away from the spinal cord—for example, to the muscle in that jerk your foot away in response to the pain of the thumbtack.

The Peripheral Nervous System

All the parts of the nervous system other than the brain and spinal cord comprise the peripheral nervous system (PNS). The PNS has two parts: the somatic PNS and the visceral PNS.

The somatic PNS:

All the spinal nerves that innervate the skin, the joints, and the muscles that are under voluntary control are part of the somatic PNS. The somatic motor axons, which command muscle contraction, derive from motor neurons in the ventral spinal cord. The cell bodies of the motor neurons lie within the CNS, but their axons are mostly in the PNS. The somatic sensory axons, which innervate and collect information from the skin, muscles, and joints, enter the spinal cord via the dorsal roots. The cell bodies of these neurons lie outside the spinal cord in clusters called dorsal root ganglia. There is a dorsal root ganglion for each spinal nerve.

The Visceral PNS:

The visceral PNS, also called the involuntary, vegetative, or autonomic nervous system (ANS), consists of the neurons that innervate the internal organs, blood vessels, and glands. Visceral sensory axons bring

information about visceral function to the CNS, such as the pressure and oxygen content of the blood in the arteries. Visceral motor fibers command the contraction and relaxation of muscles that form the walls of the intestines and the blood vessels (called smooth muscles), the rate of cardiac muscle contraction, and the secretory function of various glands. For example, the visceral PNS controls blood pressure by regulating the heart rate and the diameter of the blood vessels. We will return to the structure and function of the ANS. For now, remember that when one speaks of an emotional reaction that is beyond voluntary control-like "butterflies in the stomach" or blushing it usually is mediated by the visceral

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3.3.4 NEURO ANATOMY – THE NERVOUS SYSTEM

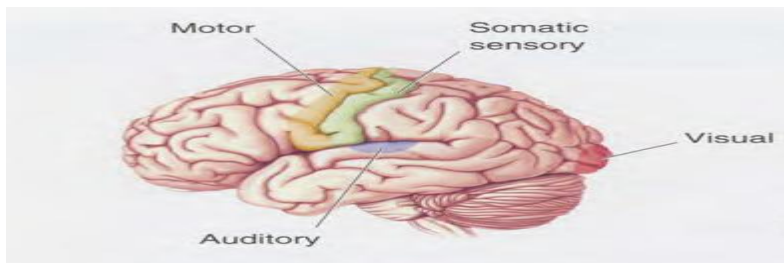
Cells Of The Nervous System

There are two main types of cells in the nervous system: **Neuroglia** and **Neurons**.

Neuroglia cells

The function of neuroglia cells is to ensure structural support, nourishment and neuron protection. There are six types of Neuroglia cells: -

- Oligodendrocytes
- Astrocytes
- Ependyma
- Microglia
- Schwann



Neurons

Neurons are the fundamental functional units of the nervous system. They have several roles: -

- React to chemical and sensory stimuli
- Conduct the impulses
- Emit specific chemical regulators.

The Neuron is composed of: -

The cell body: It is composed of the nucleus (containing DNA and RNA) and the cell

membrane (which controls the movement of molecules between the cell and the surrounding

environment). It also contains cytoplasm, endoplasmic reticulum, nissl bodies, Golgi apparatus, mitochondria, lysosomes and neurotubules.

3.3.5 Surrounding structures

Skull

Skull, skeletal framework of the head of vertebrates, composed of bones or cartilage, which form a unit that protects the brain and some sense organs. The upper jaw, but not the lower, is part of the skull. The human cranium, the part that contains the brain, is globular and relatively large in comparison with the face. In most other animals the facial portion of the skull, including the upper teeth and the nose, is larger than the cranium. In humans the skull is supported by the highest vertebra, called the atlas, permitting nodding motion. The atlas turns on the next-lower vertebra, the axis, to allow for side-to-side motion. In humans the base of the cranium is the occipital bone, which has a central opening (foramen magnum) to admit the spinal cord. The parietal and temporal bones form the sides and uppermost portion of the dome of the cranium, and the frontal bone forms the forehead; the cranial floor consists of the sphenoid and ethmoid bones. The facial area includes the zygomatic, or malar, bones (cheekbones), which join with the temporal and maxillary bones to form the zygomatic arch below the eye socket; the palatine bone; and the maxillary, or upper jaw, bones. The nasal cavity is formed by the vomer and the nasal, lachrymal, and turbinate bones. In infants the sutures (joints) between the various skull elements are loose, but with age they fuse together. Many mammals, such as the dog, have a sagittal crest down the centre of the skull; this provides an extra attachment site for the temporal muscles, which close the jaws.

BLOOD CELLS

WBC

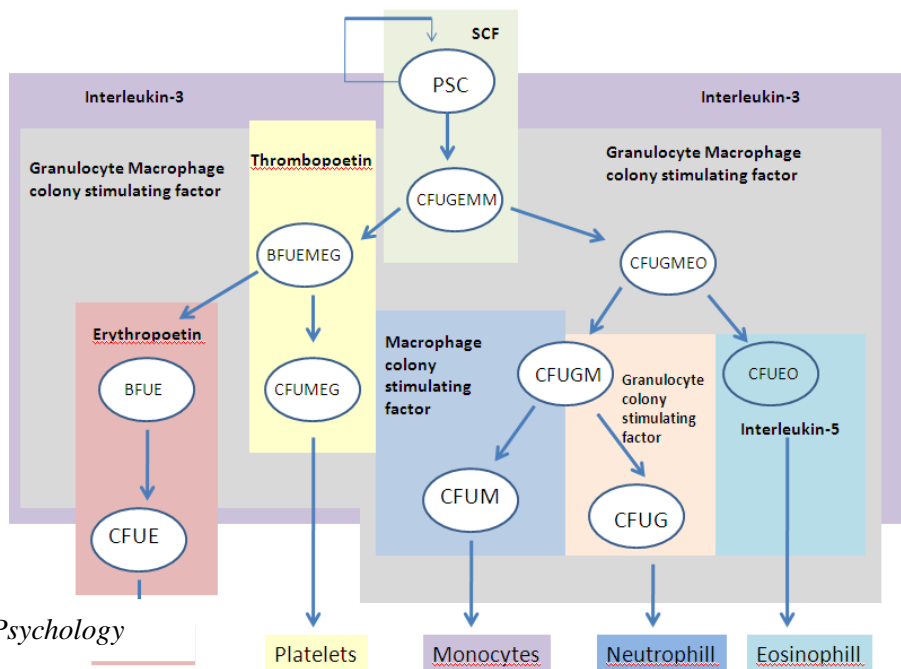
White blood cells (WBCs) or Leukocytes confer immunity to organisms. The density of the leukocytes in the blood has been reported to be 5000-7000 /mm³. They are of two types namely granulocytes (cytoplasm having granules) and agranulocytes (cytoplasm lacking granules). Further, granulocytes can be distinguished into neutrophil, eosinophil and basophil. The granules in the granulocyte lineage have different affinity towards neutral, acid or basic stains giving the cytoplasm different colors. The agranulocytes are lymphocytes and monocytes. The proportion of each type of leucocyte along with their primary function in blood is listed in Table 1.

Granulocyte

Neutrophil	50 - 70	Phagocytizing bacteria
Eosinophil	2 - 4	Attack parasites and phagocyte antigen-antibody complexes.
Basophil	0.5 - 1	Secrete anti-coagulant and vasodilatory substances as histamines and serotonin

Agranulocyte

Lymphocyte	20 - 40	Main constituent of the immune system
Monocyte	3 - 8	Replenish resident macrophages and dendritic cells



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The Meninges

The Meninges are 3 fine membranes covering the brain and spinal cord. They are called the **Dura**, **Arachnoid** and the **Pia Mater**.

The Dura

The dura has two layers; the outer layer fuses with the periosteum, the inner layer forms compartments throughout the skull. It is fibrous and inelastic in nature. The inner layer of the cerebral dura continues to form the spinal dura. It has a protective function (Martin 2003).

The Arachnoid

The arachnoid is the middle layer. It is a thin and fragile layer, which surrounds the brain.

The Pia Mater

The Pia is the final and innermost layer is the final layer. It is a 'mesh like, vascular membrane which derives its blood supply from the internal carotid and vertebral arteries (Hickey 1997 pg

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45). It follows the convolutions of the cerebral surface. CSF absorption occurs by the **arachnoid villi**, which are small projections into the venous sinuses of the brain from the subarachnoid space. They are unidirectional valves (Martin 2003). When CSF pressure exceeds the venous pressure CSF flows through the villi and drains into the Superior Sagittal sinus until the pressure is equalized.

The CNS, that part of the nervous system encased in the skull and vertebral column, does not come in direct contact with the overlying bone. It is protected by three membranes collectively called the meninges (singular: meninx), from the Greek for "covering." The three membranes are the duramater, the arachnoid membrane, and the pia matter. The outermost covering is the dura mater, from the Latin words meaning "hard mother," an accurate description of the dura's leatherlike consistency. The dura forms a tough, inelastic bag that surrounds the brain and spinal cord. Just under the dura lies the arachnoid membrane (from the Greek for "spider"). This meningeal layer has an appearance and a consistency resembling a spider web. The pia mater, the "gentle mother," is a thin membrane that adheres closely to the surface of the brain. Along the pia run many blood vessels that ultimately dive into the substance of the underlying brain. The pia is separated from the arachnoid by a fluid-filled space. This subarachnoid space is filled with salty clear liquid called cerebrospinal fluid (CSF). Thus, in a sense, the brain floats inside the head in this thin layer of CSF.

The Ventricular System

We noted that the brain is hollow. The fluid-filled caverns and canals inside the brain constitute the ventricular system. The fluid that runs in this system is CSF, the same as the fluid in the subarachnoid space. CSF is produced by a special tissue called the choroid plexus, in the ventricles of the cerebral Hemispheres CSF flows from the paired ventricles of the cerebrum to a series of connected unpaired cavities at the core of the brain stem. CSF exits the ventricular system and enters the subarachnoid space by way of small openings, or apertures, located near where the cerebellum attaches to the brain stem. In the subarachnoid space, CSF is absorbed by the blood vessels at special structures called arachnoid villi. If the normal flow of CSF is disrupted, brain damage can result. We will return to fill in some details about the ventricular system in a moment. As we will see, understanding the organization of the ventricular system holds the key to understanding how the mammalian brain is organized.

The Spine And Spinal Cord

The Spine.

The spine is composed of individual bones called **vertebrae**, which allow the spinal column to be flexible. There are 33 bones in total. Each vertebra has two main parts. The **Arch** is the posterior segment, which is made up of 2 **pedicles**, 2 **lamina** and 7 **processes** (4 articular, 2 transverse and 1 spinous). The **spinal foramen (canal)** provides the spinal cord protection and is formed by the vertebral spinal foramina. The **Body** is the anterior (solid) segment. The vertebrae are of different sizes and proportions according to their role. The **Odontoid process** is a perpendicular protrusion on the axis, which the atlas sits on.

This allows flexion, extension and head rotation. Thoracic vertebrae are larger than cervical vertebrae and limit movement. Lumbar vertebrae allow extension and flexion. The pelvis is fused to the vertebral column by the sacrum.

The Spinal Cord

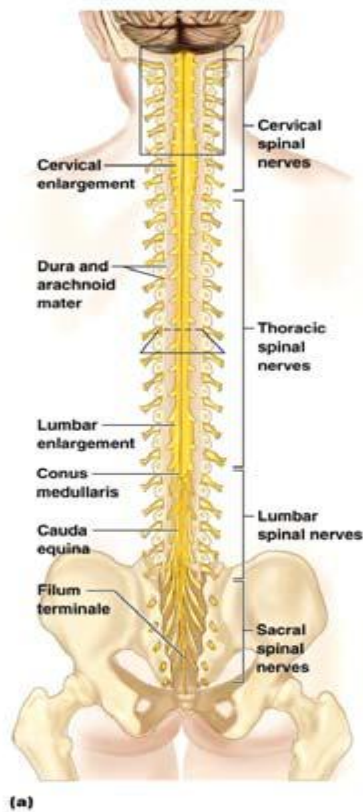
The spinal cord is part of the central nervous system. It is composed of neurons. It is protected by the vertebral column, covered by meninges and cerebro spinal fluid flows around the spinal cord.

Two principle arteries supply the spinal cord. The '**anterior spinal artery** supplies the anterior

2/3rds of the spinal cord and the **posterior spinal artery** supplies the posterior 1/3rd of the spinal cord' (Zejdlik 1992 pg 57). The spinal cord extends from the foramen magnum and finishes at the 1st/2nd lumbar vertebrae. The spinal cord is made up of **Grey Matter** (groups of neuronal cell bodies) and **White Matter** (nerve fibres of myelinated neurons). The **grey matter** is situated centrally in an 'H' shape in the cord. The 'horn cells' provide a junction between the central and peripheral nervous system. The anterior horn cells convey motor information from the brain to the muscles and glands of the body, whilst the posterior horn cells convey sensory information up to the brain. The **white matter** has ascending and descending myelinated nerve fibres. Each are grouped into bundles or 'tracts'. They are arranged together according to their functions.

For example:

- Fibres that relay pain and temperature messages are grouped together in the Lateral spinothalamic tract.
- The Corticospinal tract relays messages about voluntary motion
- The Posterior columns relay information about proprioception, deep touch and vibration.



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Spinal cord- The transformation of the caudal neural *Introduction Cognitive Neuro Psych* cord is straightforward compared to the differentiation of the brain. With the expansion of the tissue in the walls, the cavity of the tube constricts to form the tiny CSF-filled spinal canal. Cut in cross section, the gray matter of the spinal cord (where the neurons are) has the appearance of a butterfly. The upper part of the butterfly wing is the dorsal horn, and the lower part is the ventral horn. The gray matter between the dorsal and ventral horns is called the intermediate zone. Everything else is white matter, consisting of columns of axons that run up and down the spinal cord. Thus, the bundles of axons running along the dorsal surface of the cord are called the dorsal columns the bundles of axons lateral to the spinal gray matter on each side are called the lateral columns, and the bundles on the ventral surface are called the ventral columns.

Spinal Nerves

The spinal nerves are part of the peripheral nervous system. There are two types: -

Efferent (Motor) neurons transmit motor information from the brain via the spinal cord to the appropriate part of the body. The motor tracts are described as either upper motor neurons or lower motor neurons.

- **Upper motor neurons (UMN)** are elongated neurons from the brain running through the spinal cord. The brain can suppress or inhibit the lower motor neurons via the UMN preventing hyperactivity due to focal stimuli (Zejdlik 1992).

• **Lower Motor Neurons (LMN)** start in the spinal cord and travel to the muscle fibres. An involuntary reflex response can occur (a reflex arc) in the LMN. This occurs when a 'LMN transmits a stimulation from a muscle to the cord where it synapses with another LMN, which in turn carries the response back to the muscle'. (Zejdlik 1992 pg 70)

Afferent (Sensory) neurons: - Carry sensory information from the body to the cord and then onward to the brain. The ANS role is to ensure a stable internal environment (Marieb 2007). It has autonomic control over involuntary vital functions. This includes cardiovascular (heart rate, blood pressure & temperature), appetite, fluid balance, GI tract, metabolism and sleep (Zejdlik 1992). The Hypothalamus, brain and spinal cord all play a role in governing the ANS.

There are two parts to the ANS: -

- Sympathetic Nervous System (SNS)
- Parasympathetic Nervous System (PNS)

The Sympathetic Nervous System.

It is part of a persons "fight or flight" phenomenon. It is triggered by stressful situations.

Its role is: -

- It allows the body to increase heart rate, blood pressure & respirations.
- It will reduce non-vital functions such as GI activity & urinary requirements.
- It also ensures that extra red blood cells released by the spleen for any additional energy requirements.
- The final role is to ensure that the adrenal glands release epinephrine.

The SNS (also known as the Thoraco-Lumbar system) extends from T1 to L2. Where the nerve roots meet and link with a sympathetic ganglion. This group of sympathetic nerve tissue extends from the cranium to the coccyx. The neurotransmitter for this system is norepinephrine.

The Parasympathetic System

This system restores the balance, conserves and ensures normal functions are maintained. Its

role is: -

- Reduces heart rate, blood pressure and respiration.
- Ensures non-vital functions are returned to normal function e.g. increase GI activity.

The Parasympathetic system's (also named the Craniosacral System) preganglionic fibres emerge with cranial nerves III, VII, IX and X. The neurotransmitter for this system is Acetylcholine.

Types of cerebral territories:

Anterior circulation

Artery

Territory Served

Internal Carotid

Arises from the external carotids to supply the anterior circulation

Ophthalmic

Optic nerves and orbits

Anterior Cerebral (ACA)

Frontal and Parietal lobes – branches supply the leg area of the motor cortex.

Anterior Communicating (ACoA)

Joins the ACAs together and ganglia and internal capsule. *Introduction Cognitive Neuro Psych*

Middle Cerebral (MCA)

Lateral surface of hemispheres. Occlusion may lead to face and arm deficits and dysphasia.

Anterior choroidal

Supplies the choroids plexus and the hippocampus.

Posterior Communicating (PCoA)

Connects the MCAs & PCAs hence joining the anterior (carotid) and posterior (vertebrobasilar) circulations together.

Posterior circulation

Posterior Cerebral (PCA)

Occipital and temporal lobe, midbrain and choroid plexus (3rd ventricle). Signs of occlusion may present with visual deficits, amnesia or language problems.

Basilar (BA)

Arises from the vertebral arteries to supply the posterior circulation. Vessels from the basilar supply the cerebellum and pons.

Superior Cerebellar

Cerebellum and midbrain

Pontine

Pons

Anterior Inferior Cerebellar (AiCA)

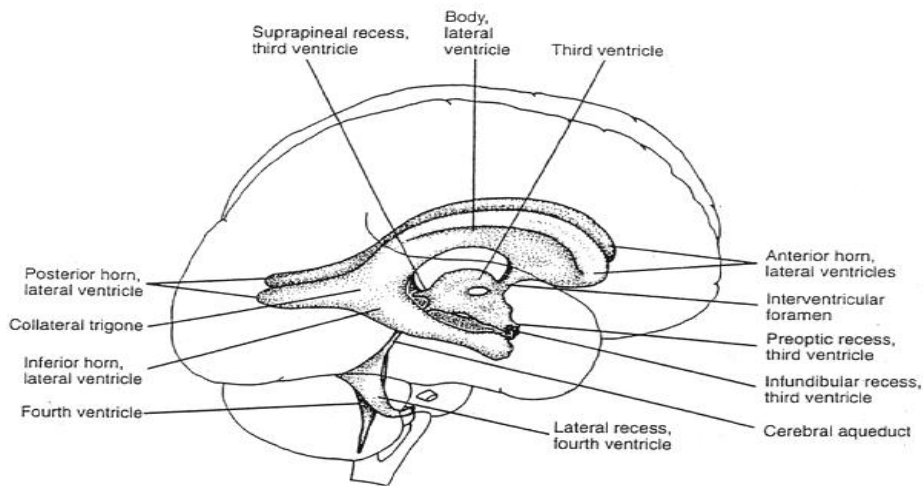
Cerebellum and pons

Posterior Inferior Cerebral (PiCA)

Choroid Plexus (4th ventricle). Cerebellum medulla

Afferent and Efferent Axons:

Our discussion of the PNS is a good place to introduce two terms that are used to describe axons in the nervous system. Derived from the Latin, afferent ("carry to") and efferent ("carry from") indicate whether the axons are transporting information toward or away from a particular point. Consider the axons in the PNS relative to a point of reference in the CNS. The somatic or visceral sensory axons bringing information into the CNS are afferents.



Forebrain

The next important developments occur in the forebrain, where secondary Vesicles sprout off on both sides of the pros encephalon. The secondary vesicles are the optic vesicles and the telencephalic vesicles. The unpaired structure that remains after the secondary vesicles have sprouted off is called the diencephalon, or "between brain". Thus, the forebrain at this stage consists of the two optic vesicles the two telencephalic vesicles, and the diencephalon. The optic vesicles grow and invaginate (fold in) to form the optic stalks and the optic cups, which will ultimately become the optic nerves and the two retinas in the adult. The important point is that the retina at the back of the eye, and the optic nerve connecting the eye to the diencephalon, are part of the brain, not the PNS.

Differentiation of the Telencephalon and Diencephalon:

The telencephalic vesicles together form the telencephalon, or "endbrain," consisting of the two cerebral hemispheres. The telencephalon continues to develop in four ways: (1) The telencephalic vesicles grow posteriorly so that they lie over and lateral to the diencephalon. (2) Another pair of vesicles sprout off the ventral surfaces of the cerebral hemispheres, giving rise to the olfactory bulbs and related structures that participate in the sense of smell . (3) The cells of the walls of the telencephalon divide and differentiate into various structures. (4) White matter systems develop, carrying axons to and from the neurons of the telencephalon.

The Midbrain:

the midbrain differentiates relatively little during subsequent brain development. The dorsal surface of the mesencephalic vesicle becomes a structure called the tectum (Latin for "roof"). The floor of the midbrain becomes the tegmentum. The CSF-filled space in between constricts into a narrow channel called the cerebral aqueduct. The aqueduct connects rostrally with the third ventricle of the diencephalon. Because it is small and circular in cross section, the cerebral aqueduct is a good landmark for identifying the midbrain.

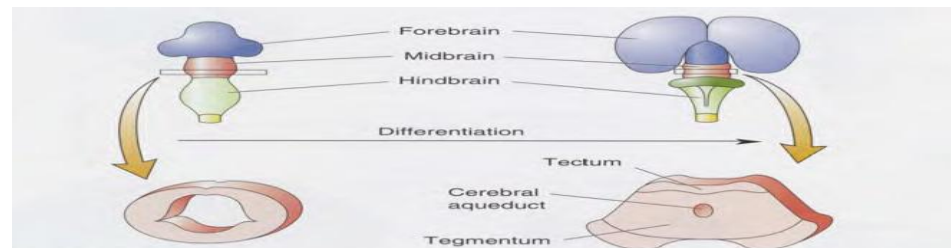
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Midbrain Structure-Function Relationships:

For such a seemingly simple structure, the functions of the midbrain are

remarkably diverse. Besides serving as a conduit for information passing from the spinal cord to the forebrain and vice versa, the midbrain contains neurons that contribute to sensory systems. The control of movement, and several other functions. The midbrain contains axons descending from the cerebral cortex to the brain stem and the spinal cord. For example, the corticospinal tract courses through the midbrain en route to the spinal cord. Damage to this tract in the midbrain on one side produces a loss of voluntary control of movement on the opposite side of the body.

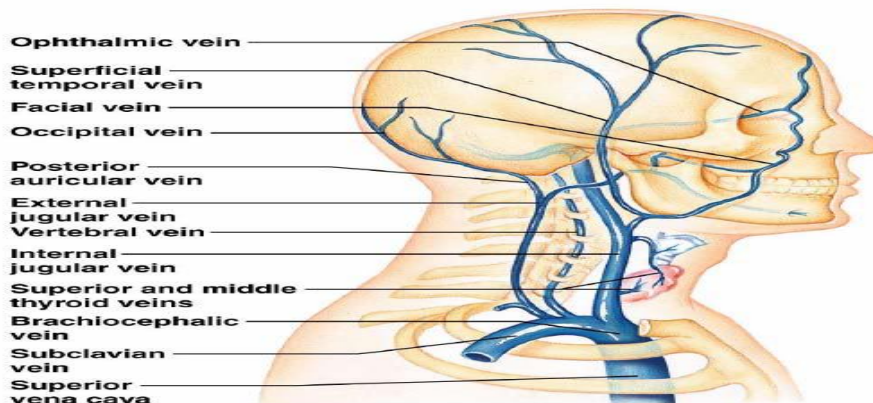
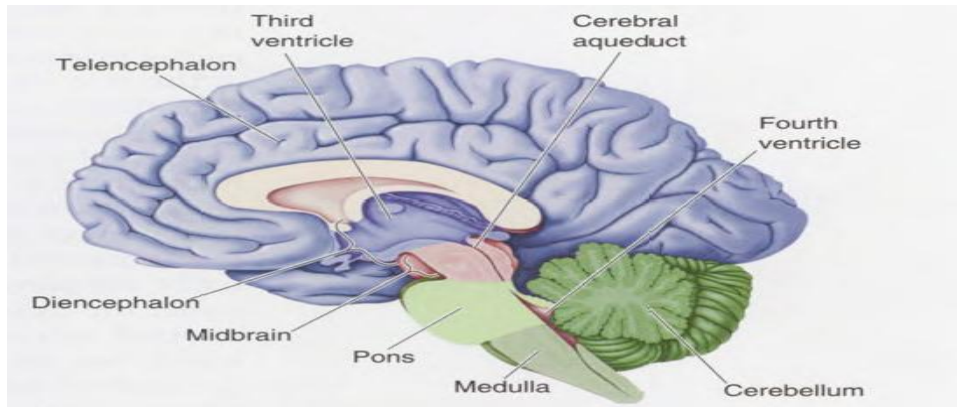


Hind Brain:

The hindbrain differentiates into three important structures: the cerebellum, the pons, and the medulla oblongata-also called, simply, the medulla. The cerebellum and pons develop from the rostral half of the hindbrain (called the metencephalon); the medulla develops from the caudal half (called the myelencephalon). The CSF-filled tube becomes the fourth ventricle, which is continuous with the cerebral aqueduct of the midbrain. At the three-vesicle stage, the rostral hindbrain in cross section is a simple tube. In subsequent weeks, the tissue along the dorsal-lateral wall of the tube, called the rhombic lip, grows dorsally and medially until it fuses with its twin on the other side. The resulting flap of brain tissue grows into the cerebellum. The ventral wall of the tube differentiates and swells to form the pons.

The Ventricular system of the Brain:

COMPONENT	RELATED BRAIN STRUCTURES
Lateral ventricles	Cerebral cortex Basal tel encephalon
Third ventricle	Thalamus Hypothalamus
Cerobral aqueduct	Tectum Mid brain tegmentum
Fourth ventricle	Cerebellum Pons Medulla



The Cerebrum

The brain (**Encephalon**) is a highly complex organ, which weighs about 1400g and is divided into three major areas: **Cerebrum**, **Brain Stem** and **Cerebellum**.

The Hemispheres

The Cerebrum consists of two **Cerebral Hemispheres**. They are separated incompletely by the **Great Longitudinal Fissure**. The surface grey and white matter contains neuroglia and nerve fibres.

There are three types of myelinated nerve fibres:

- Transverse:** These interconnect the two hemispheres.
- Projection:** These connect the cerebral cortex to the lower portion of the brain and spinal cord.
- Association:** These connect the various areas within the hemispheres.

The Basal Ganglia.

The basal ganglia are a group of nuclei deep within the hemispheres. It is composed of: -

- **Lenticular nucleus** (made up of the globus pallidus and putamen)
- **Caudate nucleus**
- **Amygdaloid**
- **Clastrum**

The **Corpus striatum** is the combined name for the Lenticular nucleus and the caudate nuclei. The role of the basal ganglia is to control fine body motor control.

The Diencephalon

The diencephalon is made up of the **Thalamus, Hypothalamus, Subthalamus** and **Epithalamus**.

The **Thalamus** is the last point where nerve impulses are processed before they continue ascending up to the cortex (Hickey 1997). It has several roles:

-
- 1) Conscious awareness
- 2) Focusing attention
- 3) The reticular activating system
- 4) The limbic system.

The Pituitary Gland

The pituitary gland (or Hypophysis) is found in the base of the skull and connects to the hypothalamus by the hypophysial stalk (or infundibulum). The role of the gland is to secrete hormones. The pituitary gland has two lobes; anterior and posterior. The anterior lobe secretes: - growth stimulating hormone (GSH), adrenal stimulating hormone (ACTH), thyroid stimulating hormone (TSH), Prolactin, follicle stimulating hormone (FSH) and Luteinizing hormone (LH) (Hickey 1997).

The cerebellum is made up of three layers: -

a) The **Cortex**: This is composed of the **granular**, the **piriform** and the **molecular** layers. b) The **White Matter**: This contains the afferent and efferent impulse connections. c) The **Cerebellar nuclei** (the Dentate, the Fastigial, the Interposed and the Vestibular nuclei).

The cerebellum can also be divided anteriorly to posteriorly. The **Spinocerebellum** strip is controls posture and gait. The **Vestibulocerebellum** strip is controls responses to the Vestibular nucleus allowing coordination of space and movement. The **Pontocerebellum** strip coordinates voluntary muscle activity and tone (Fitzgerald et al 2003). The cerebellar peduncles are tracts that carry information from the cerebellum to the brainstem.

The Brainstem

The brainstem is composed of three main parts; the **Midbrain, Pons** and **Medulla**. The brain stem has ascending and descending tracts which carry information from the cerebral hemispheres to the spinal cord as vice versa. Ten of the twelve cranial nerves originate in the brainstem. The brain stem also contains a complex network of fibres called the **Reticular Formation**.

The Midbrain

The midbrain sits between the diencephalon and the pons. It is made up of the tectum (roof), the tegmentum (posterior part) and the crus cerebri (peduncle). The midbrain acts as a passageway for the hemispheres and the lower brain and it is also the centre for the auditory and visual reflexes.

The Pons

The Pons is situated between the midbrain and the medulla. It is divided into the ventral (basal) and the dorsal (tegmentum). The pons acts as a connection between the midbrain and the medulla allowing fibres to travel through from one to the other. Within the tegmentum the spinothalamic tracts and parts of the reticular activating system (controls consciousness) can be located.

The Medulla

The Medulla oblongata is situated between the pons and the spinal cord. The corticospinal tracts (pyramidal) cross the medulla. The medulla controls a variety of functions including; 'transmission of information for head and eye movement co-ordination, motor and sensory tract pathways, cardiac, respiratory and vasomotor centres' (Hickey 1997 pg 59).

The Reticular Activating System.

The reticular formation (RF) is a group of complex and diffuse fibres that originates in the brain stem extending up into the cerebral cortex via the thalamus. The reticular activating system (RAS) is involved in the normal regulation of consciousness focusing on attention, the sleep-wake cycle and sensory perception (Marieb 2007; Hickey 2003).

The Limbic System

The Limbic system is a group of fibres and tracts that form around the brainstem. This limbic system is composed of the hypothalamus, the cingulate nucleus, the fornix, the hippocampus, the thalamus and the Amygdaloid nucleus (Fitzgerald et al 2002). It has a series of complex functions including; basic instincts, short-term drive and emotional drives.

Check your progress - 1

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. Define the Medulla

.....
.....

2. What is the Pituitary Gland

.....
.....

3.4 CELLULAR FOUNDATIONS OF THE NERVE FUNCTION

3.4.1 Types of nerve cells and functions

The Cranial Nerves

In addition to the nerves that arise from the spinal cord and innervate the body, there are 12 pairs of cranial nerves that arise from the brain stem and innervate (mostly) the head. Each cranial nerve has a name and a number associated with it (originally numbered by Galen, about 1800 years ago, from anterior to posterior). Some of the cranial nerves are part of the CNS, others are part of the somatic PNS, and still others are part of the visceral

PNS. Many cranial nerves contain a complex mixture of axons that perform different functions. The cranial nerves and their various functions are summarized in the chapter appendix.

There are twelve cranial nerves, which form part of the peripheral nervous system. Each nerve has a number (roman numeral) and a name. The nerves may have a sensory or motor function or may have a combined role. The first two cranial nerves originate in the brain, travelling through the cerebral hemispheres, whilst the remaining ten originate from the brainstem. Acronyms can be used to assist in remembering the 12 cranial nerves, one is:-

On Old Olympus Towering Top A Famous Vocal German Viewed Some Houses

Cranial nerve I: The Olfactory nerve

The olfactory nerve is a sensory nerve, which deals with the sense of smell. In each nostril are specialised receptors. The olfactory nerve is made up of olfactory chemoreceptor cells whose axons end in the olfactory bulb. The olfactory tract then continues to the medial olfactory area and the lateral olfactory area in the frontal lobe where the information is then processed.

Cranial Nerve II: The Optic nerve

The optic nerve arises from retina. The nerve runs posteriorly until it meets the other optic nerve at the optic chiasm.

Cranial Nerve III: The Oculomotor nerve.

This is a motor nerve. It has several functions:

- The innervation of four out of the six muscles that control movement of the eyeball

(Hickey 1997).

o Inferior Oblique Muscle: - Upward & outward movement

o Inferior Rectus: - Downward

o Superior: - Upward

o Medial: - Inward

- Innervation of the muscle allowing the lifting/elevation of the upper eyelid.

Innervation of the smooth muscle of the iris, which controls pupil size (constriction/dilation) and the ciliary body muscles, which allow for lens accommodation.

Cranial Nerve IV: The Trochlear Nerve.

This is a motor nerve innervating the superior oblique muscle of the eyeball, which allows the eyeball to rotate downward and inward.

Cranial Nerve V: The Trigeminal Nerve

This is a mixed nerve and has a joint motor and sensory role. Its sensory component is divided into three branches; the ophthalmic, the maxillary and the mandibular conveying light touch, pain and temperature. It is involved in the corneal reflex. The motor component allows the jaw reflex and the jaw muscles to masticate.

Cranial Nerve VI: The Abducens Nerve

This is a motor nerve. It innervates the lateral rectus muscle. This allows the eyeball to rotate outwards. It arises from a nucleus in the floor of the

4th ventricle (Hickey 1997).

Cranial Nerve VII: The Facial Nerve

This is a mixed nerve. The nerve emerges from the pons. The motor component innervates muscles for facial expression. This allows blinking, eye closure, smiling & showing the teeth. The sensory component innervates the anterior 2/3rd of the tongue, the salivary glands and the lacrimal glands.

Cranial Nerve VIII: The Vestibulocochlear Nerve

This is a sensory nerve often referred to as the acoustic nerve. It is composed of two branches; the cochlear branch and the vestibular branch.

The Vestibular Branch controls balance, body position and body orientation. The receptor organs are the Cristae ampullare (one in each semi circular canal) and the maculae of utricle. It innervates the organs of the thoracic and abdominal cavities as well as the larynx, pharynx and the palate. It also has an efferent limb of the gag and swallow reflexes. This nerve conveys sensation from the heart, lungs, GI Tract and the carotid sinus & body.

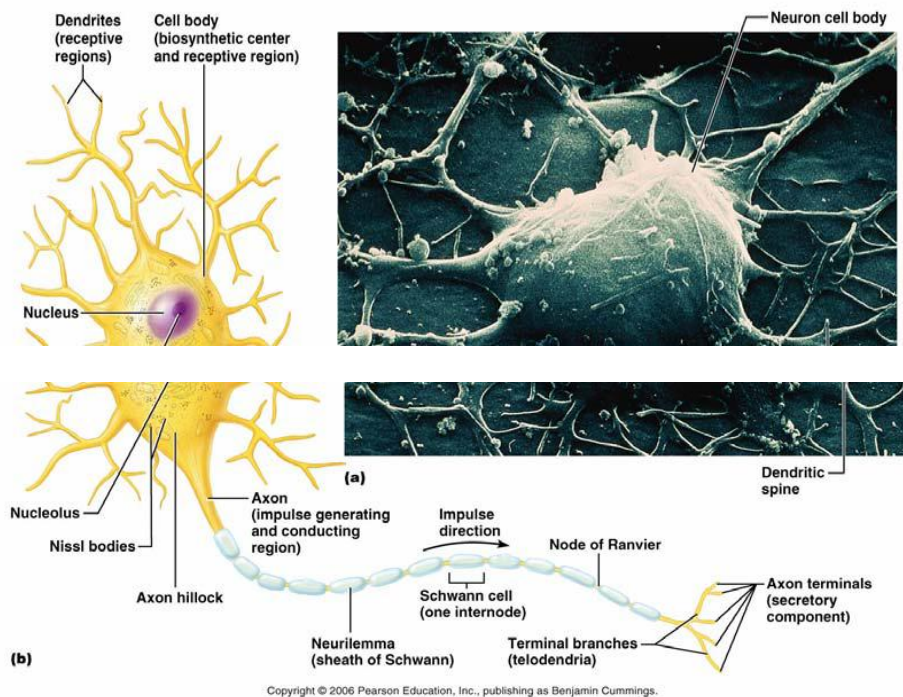
Cranial Nerve XI: The Spinal Accessory Nerve.

This is motor nerve. Its roots originate in the medulla and the cervical spinal cord. It innervates the sternocleidomastoid and trapezius muscles allowing head rotation and shoulder shrugging.

Cranial Nerve XII: The Hypoglossal Nerve.

This is a motor nerve. It innervates the tongue allowing speech and swallow.

The cell processes are composed of the dendrites and cell axon. The dendrites carry impulses from another neuron to the cell body and impulses then travel down the axon.



3.4.2 The four lobes and their functions

The Lobes.

The **frontal lobe** is situated at the front of the cerebrum. It has a variety of functions: -

- Controls autonomic functions (e.g. respiratory and blood pressure)
- Allows concentration
- Increases depth and abstract ability in thought and memory
- Aids word formation (Broca's area)
- Controls motor function in motor cortex

The **Parietal lobe** is situated on the top of the cerebrum. It has several functions: -

- Allows sensibility
- Sensation of touch, position, pressure and vibration
- Allows analysis of sensory information
- Defines shape, size, weight, texture, consistency
- Allows awareness of body orientation

The **Temporal lobe** is situated to the side of the cerebrum. It has: -

- Auditory receptive area (Wernicke's)
- Interpretative area for the integration of auditory, visual and somatic information
- Allows memory and intellectual ability.

The **Occipital lobe** is situated posteriorly in the cerebrum

Check your progress- 2

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. Write a name of four lobes

.....
.....

3.5 SUMMARY

Cognitive neuropsychology is a branch of cognitive psychology that aims to understand how the structure and function of the brain relates to specific psychological processes. Cognitive psychology is the science that looks at how mental processes are responsible for our cognitive abilities to store and produce new memories, produce language, recognize people and objects, as well as our ability to reason and problem solve. Cognitive neuropsychology places a particular emphasis on studying the cognitive effects of brain injury neurological illness with a view to inferring models of normal cognitive functioning. Evidence is based on case studies of individual brain damaged patients who show deficits in brain areas and from patients who exhibit double dissociations.

3.6 UNIT END EXERCISES

1. Explain about nervous system.
2. List out the type of nerve cells
3. Draw the diagram of brain.

3.7 ANSWERS TO CHECK YOUR PROGRESS

1. The Medulla oblongata is situated between the pons and the spinal cord. It controls a variety of functions such as motor and sensory tract pathways, cardiac, respiratory and vasomotor centres.
2. The Pituitary gland is found in the base of the skull and connects to the hypothalamus by the hypophysial stalk. It has two lobes, anterior and posterior.
3. i. frontal lobe ii. Parietal lobe iii. Temporal lobe iv. Occipital lobe

3.8 SUGGESTED READINGS

1. Schacter, Daniel L. (2000). "Understanding Implicit memory: A cognitive neuroscience approach". In Gazzaniga, M.S. (ed.). *Cognitive Neuroscience: A Reader*. Wiley. ISBN 978-0-631-21659-9. The term cognitive neuropsychology often connotes a purely functional approach to patients with cognitive deficits that does not make use of, or encourage interest in, evidence and ideas about brain systems and processes
2. Harlow, John Martyn (1868). "Recovery from the Passage of an Iron Bar through the Head". Originally published in *Publications of the Massachusetts Medical Society*. 2: 327–347.
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4. Carlson, Neil R. (2013). *Physiology of Behavior*. NJ, U.S: Pearson Education, Inc., p. 132.
5. Miller, G. A. (2003). The cognitive revolution: a historical perspective. *Trends in Cognitive Sciences*, 7(3), 141-144. doi: 10.1016/s1364-6613(03)00029-9.

UNIT 4 :METHODS AND NEURAL PROCESS

Methods and Neural
Process

NOTES

4.1 INTRODUCTION

The study of brain behaviour relationship evolved with the development of a science of human behaviour based on the function of human brain, known as neuropsychology. Neuropsychology is the study of brain-behaviour relationship with the development of a science of human behaviour based on the function of human brain behaviour relationships to clinical problems and neurological assessment, which is sensitive to the condition of the brain. Man's interest in this area extends back at least 2500 years, when Pythagoras argued that the brain was the site of human reasoning. Approximately 100 years later, Hippocrates claimed that the brain was the organ of the intellect and recognized that a depressed skull fracture on the right side of the head could produce motor paralysis on the (contra lateral) left side of the body. Neuropsychology can be divided into two branches. The first, clinical neuropsychology includes behavioural neurology and deals with patients with cerebral lesions. The second branch is experimental neuropsychology, which studies normal subjects in the laboratory by a range of techniques including specialized physiological techniques (Sbordone, Saul, & Purisch, 2007).

4.2 OBJECTIVES

1. Upon completion of neurology residency, residents should be able to:
 - a. Discuss key elements of the principles and physics, bioeffects, clinical applications, indications, interpretation, and quality improvement for each of the major neuroimaging modalities.
 - b. Describe the integration of neuroimaging studies into clinical practice for best patient care.
 - c. Provide a log of cases performed or interpreted under supervision for all applicable neuroimaging modalities.
 - d. Discuss the expected neuroimaging findings for the major disease categories as outlined in the curriculum.
2. Upon completion of neurology residency, residents could be able to:
 - a. Demonstrate eligibility for the certification examination in one or more neuroimaging modalities.
 - b. Demonstrate successful fulfillment of credentialing criteria for the performance or interpretation of neuroimaging studies.
 - c. Independently perform and interpret specific neuroimaging studies.

Self-Instructional Material

4.3 METHODS

4.3.1 Studies

The first neuropsychological laboratory in the United States was set up by Ward C. Halstead in 1935. He used neuropsychological tests to study the effects of brain damage on a wide range of cognitive, perceptual, and sensory motor functions. In 1951, Halstead collaborated with his former student, Ralph M. Reitan, who had established a neuropsychology laboratory at Indiana University Medical Centre. Reitan (1955) modified Halstead's neuropsychological battery and created what is now described as the "Halstead-Reitan Battery." Reitan administered this battery to a number of patients with documented focal and diffuse brain damage, as well as to a group of hospitalized control patients, presumably free of brain disease, and developed a set of test norms. Indices developed by Reitan allowed him to localize brain damaged areas, as well as to infer the cause of the neurological injury (Wheeler, Burke, & Reitan, 1963).

Anna-Lise Christensen, a Danish psychologist, Luria's tests and method of neuropsychological assessment were introduced in the United States in 1975 under the title of Luria's Neuropsychological Investigation. In an attempt to rectify this, Charles Golden, Thomas Hammeke, and Arnold Purisch administered the several hundred test items contained in Luria's Neuropsychological Investigation to normal controls and later to neurological patients. They utilized discriminant function statistical analysis techniques to determine which test items were sensitive to the presence of brain damage. Their research (Golden et al., 1978) resulted in a battery of 269 items, which could be administered to a patient in 2 or 3 hours. This test battery was eventually named the Luria-Nebraska Neuropsychological Battery and first introduced in 1978.

4.3.2 Structural neuroimaging

CAT SCAN – Computerized Axial Tomography

It is used as a special detector instead of film.

MRI – Magnetic Resonance Imaging

It is used in strong magnetic fields and pulses to spin hydrogen atoms in water. After spinning, Hydrogen atoms emit transmissions which are picked up by a scanner and constructed into a "picture".

EEG – Electro Encephalo Graph

It directly measures the electrical activity from large populations of cells. Electrical currents pass through the scalp – measured by a large group of electrodes. The activity closest to the skull is most easily measured.

4.3.3 Functional Neuroimaging

Single Photon Emission Computed Tomography (SPECT) measures physiological functioning in the brain and is similar to PET (Please see Positron Emission Tomography). In contrast to PET, SPECT uses commercially available stable low level radioisotopes and is therefore less expensive, more convenient for clinical use, is widely used clinically.

Methods and Neural
Process

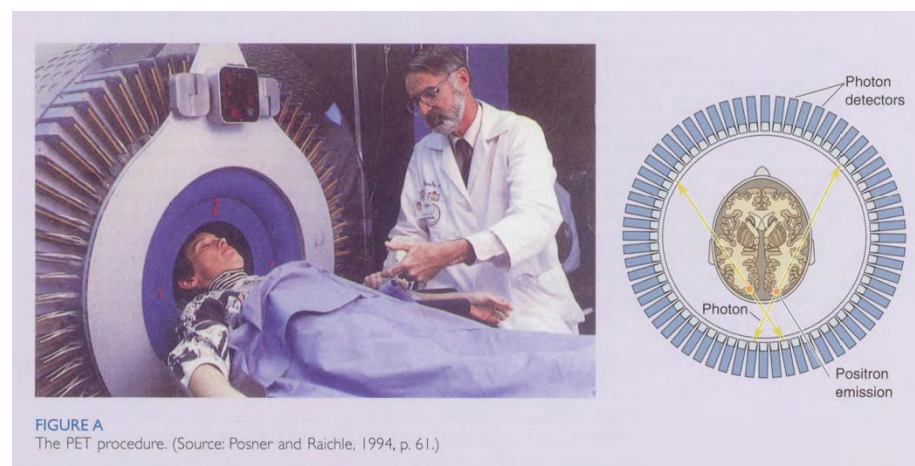
NOTES

Self-Instructional Material

Transcranial magnetic stimulation (TMS) is a non-invasive technique that is used to map cortical functions in the brain, such as identifying motor or speech areas. With TMS, a large electromagnetic coil is placed on the scalp, near the forehead. An electromagnet is then used to create a rapidly changing magnetic field, inducing weak electric currents. Unlike the mapping function, a repetitive form of TMS, called rTMS, is used therapeutically to treat depression.

PET – Positron Emission Tomography

Radioactive molecules injected into the blood to measure brain activity. As radioactive molecules decay, they release positrons. Positrons coincide with electrons and release gamma rays. PET machines detect gamma rays and are able to pinpoint when they came from. Usually uses radioactive glucose or oxygen.



fMRI – Functional Magnetic Resonance Imaging

It uses very strong magnets – 1.5 tesla to 11 tesla currently in use. 1.5 tesla has a strength equivalent to 30000 times the force of gravity. 3 to 4 tesla is about the “norm”.

Single Cell Recording:

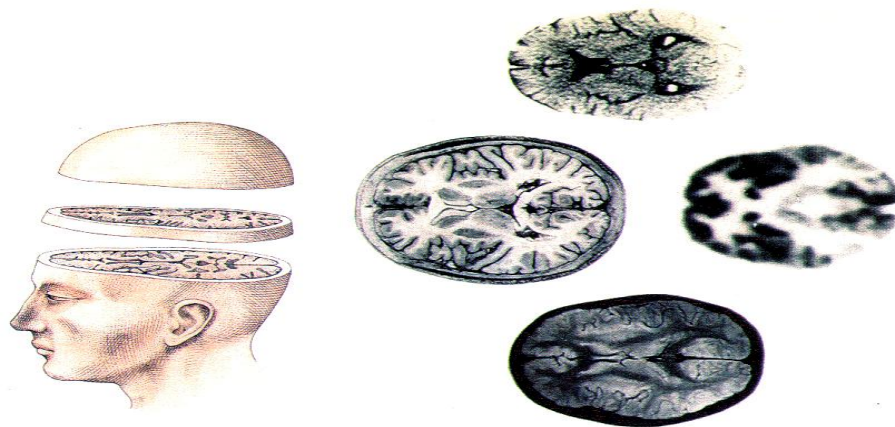
It is used extensively in animal studies. A microelectrode is inserted into brain tissue and recordings of action potentials can be made from nearby neurons, ideally a single neuron. Recordings are typically extracellular. The animal can then be presented with various sensory stimuli or trained to perform some task, and the effects on neural activity can be monitored.

Single Cell Recording

- Specific response patterns of individual neurons can be recorded in response to specific stimuli.
- Simultaneous multiple cell recording; however responses cannot be related to specific circuitry.
- Electric stimulation can be used to suppress functionality of brain regions.

Functional Magnetic Resonance Imaging (fMRI)

Brain Imaging: Anatomy



NIRS

Near infrared spectroscopy (NIRS) is a non-invasive optical imaging technique that uses low levels of light to measure blood flow changes in the brain associated with brain activity, such as performance of a task. NIRS combines excellent temporal resolution (~ 1 ms) with reasonable spatial resolution (~ 1 cm), and can be made relatively insensitive to head or body motion. It has helped to advance basic science brain mapping studies, identifying areas of the brain associated with a range of motor and visual tasks. The NIRS systems provide non-invasive measurements of oxygen saturation, hemoglobin and cytochrome C levels. The NIRS Brain Imaging Laboratory includes a 200 square foot subject testing room dedicated for simple optical experiments. For more complex experiments, the optical instrumentation is portable and can be moved to a particular research environment.

4.3.4 Controlling the brain

Imaging the Living Brain

For centuries, anatomists have investigated the structure of the brain by removing it from the head, sectioning it in various planes, staining the sections, and examining the stained sections. Much has been learned by this approach, but there are some limitations. Most obviously, the brain removed from the head is dead. This, to say the least, limits the usefulness of this method for examining the brain, and for diagnosing neurological disorders, in living individuals. Neuro anatomy has been revolutionized by the introduction of exciting new methods that enable one to produce images of the living brain. Here we briefly introduce them.

Computed Tomography:

Computer Assisted Tomography (CT) uses special x-ray equipment to obtain three-dimensional anatomical images of bone, soft tissues and air. An x-ray emitter rotated around the head measures the rays' intensities from different angles. Sensors measure the amount of radiation absorbed by different tissues; a computer uses the differences in X-ray absorption to

form cross-sectional images or “slices” of brain called “tomograms.” CT can be done quickly, and so is used extensively in the ER to identify evidence of brain trauma, such as swelling or bleeding (as from hemorrhagic stroke or a ruptured brain aneurysm). Some types of electromagnetic radiation, like X-rays, penetrate the body and are absorbed by various "radiopaque" tissues. Thus, using X-ray-sensitive film, one can make two-dimensional images of the shadows formed by the radiopaque structures within the body. This technique works well for the bones of the skull, but not for the brain. The brain is a complex three-dimensional volume of slight and varying radiopacity, so little information can be gleaned from a single two dimensional X-ray image. An ingenious solution, called computed tomography(CTI, was developed by Godfrey. Hounsfields and Allan Cormack, who shared the Nobel Prize in 1979. The goal of CT is to generate an image of a slice of brain. (The word tomography is derived from the Greek for "cut.") To accomplish this, an X-ray source is rotated around the head within the plane of the desired cross section. On the other side of the head, in the trajectory of the X-ray beam, are sensitive electronic sensors of X-irradiation. The information about relative radiopacity obtained with different "viewing" angles is fed to a computer that executes a mathematical algorithm on the data. The end result is a digital reconstruction of the position and amount of radiopaque material within the plane of the slice. CT scans noninvasively revealed, for the first time, the gross organization of gray and white matter, and the position of the ventricles, in the living brain.

Magnetic Resonance Imaging:

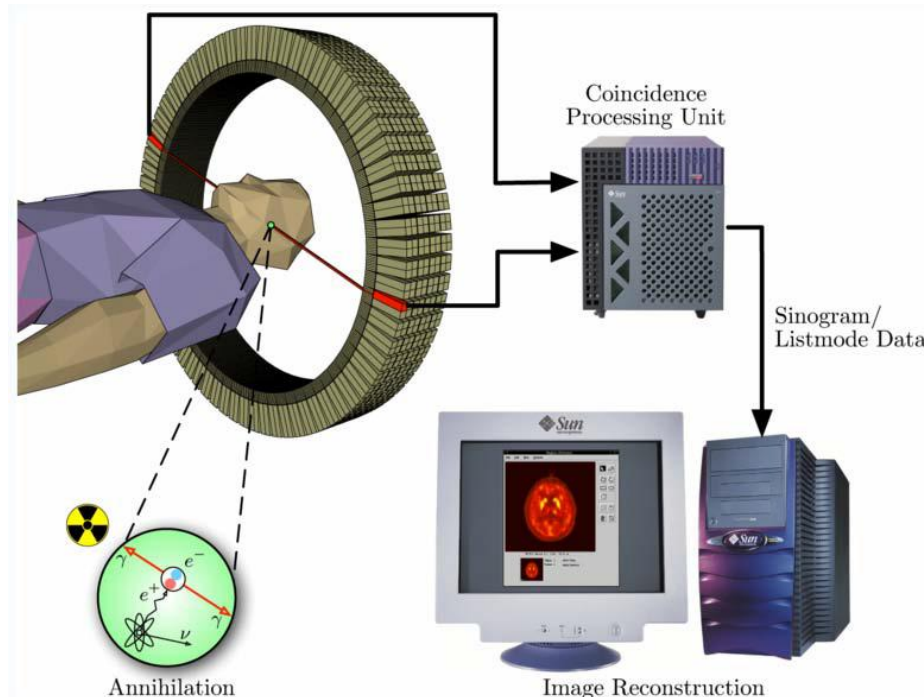
While still used widely, CT is gradually being replaced by a newer imaging method, called magnetic resonance imaging (MRI). The advantages of MRI are that it yields a much more detailed map of the brain than CT it does not require X-irradiation, and images of brain slices can be made in any plane desired. MRI uses information about how hydrogen atoms in the brain respond to perturbations of a strong magnetic field. The electromagnetic signals emitted by the atoms are detected by an array of sensors around the head and fed to a powerful computer that constructs a map of the brain. The information from an MRI scan can be used to build a strikingly detailed image of the whole brain.

Functional Brain Imaging:

Functional MRI (fMRI) shows the brain in action. It is a highly sensitive but indirect measure that is used to elucidate processes involved in higher cognitive functioning, including identification of motor and task activation areas; and reorganization of function following injury to a single brain area. It is based on the principle that changes in regional cerebral blood flow and metabolism are coupled to changes in regional neural activity involved in brain functioning, such as memorizing a phrase or remembering a name. Almost all fMRI techniques use the contrast mechanism called BOLD.

The two "functional imaging" techniques now in widespread use are Positron emission tomography(PET) and functional magnetic resonance imaging (fMRI). While the technical details differ, both methods detect changes in regional blood flow and metabolism within the brain (Box 7.3).

The basic principle is simple. Neurons that are active demand more glucose and oxygen. The brain vasculature responds to neural activity by directing more blood to the active regions. Thus, by detecting changes in blood flow, PET and fMRI reveal the regions of brain that are most active under different circumstances.



IMAGING TECHNIQUES AT-A-GLANCE

Angiography uses a radiopaque dye injected through a catheter into a blood vessel to detect a blockage or narrowing of the vessel. The vessel is outlined on x-ray as white. Arterial spin labeling (ASL) is a perfusion contrast used with fMRI. It is used to quantify regional cerebral blood flow noninvasively to provide absolute quantification of cerebral blood flow, which renders it sensitive to both static function and changes occurring over longer intervals.

Bioluminescent probes are used in molecular imaging. They utilize the enzyme luciferase to generate and emit light by an organism, providing real-time analyses of disease processes—particularly infections and cancer progression—at the molecular level in living organisms, including laboratory animals. The enzyme is found in fireflies, glowworms, deep sea marine organisms and some bacteria and fungi.

BOLD (blood oxygenation level dependent) MRI is the contrast agent used in most fMRI imaging. (Please see “Functional MRI” below.) BOLD contrast reflects a complex interaction between the volume of blood, its flow, and its transport of oxygen by an iron-containing protein in red blood cells. Functional contrast is produced when the oxygen is released from the iron and taken up and used by brain cells (indicating that they are active).

After the iron loses the oxygen, the iron becomes highly magnetized when exposed to the MRI magnetic field.

Deep brain stimulation (DBS) involves implanting electrodes in specific areas in the brain and externally stimulating the electrodes to measure electrical activities of neurons and their electrochemical pathways. DBS is used therapeutically to treat intractable Parkinson's disease and essential tremor, and is being studied for possible use in intractable depression and other brain conditions. It is also used in a few highly specialized centers to explore the neuronal underpinnings of cognition.

Diffusion-Perfusion-weighted MRI is a combination technique used to estimate the "ischemic penumbra." This is the brain tissue that has suffered from reduced blood flow following ischemic stroke but has not yet died and is the target of intensive therapy.

Diffusion-tensor MRI (DTMRI) measures microscopic water motion in tissues, and in the brain this motion is facilitated along white matter tracts that connect brain regions. Computerized mathematical models construct the images of the white matter tracts. It is used extensively pre-surgically to plan, such as to identify and spare these tracts during surgical removal of a brain tumor. Diffusion-weighted MRI shows whether brain tissue has been damaged due to insufficient blood flow to the tissue.

Electroencephalography (EEG) measures the electrical activity that is produced by neurons as recorded from electrodes placed along the scalp.

Fluorescence resonance energy transfer (FRET) is a molecular imaging technique that reveals the interaction between two or more fluorescent probes in tissue cultures. It is used, for instance, to visualize a molecule binding to its receptor on a cell.

Fluorescence microscopes are used with fluorescent probes that emit light of short wavelength to reveal biochemical activities within a cell in human and animal tissue cultures. These microscopes have the highest resolution of all cellular imaging devices. They can be used to identify a single fluorescently labeled molecule or differentiate activities of several differently colored fluorescent molecules in the same cell.

Fluorescent probes are used in molecular imaging to visualize molecules and their actions. The probes are green fluorescent protein, its yellow, blue and cyan-colored mutants, and red fluorescent proteins. Fluorescent probes that emit light of short wavelengths are used with fluorescent light microscopes to image molecules that are close to the surface in laboratory cultures of thin human or animal tissues.

Intravital Light Microscopic technologies use light-emitting probes as contrast to visualize the activities of specific molecules and the cells they compose. Imaging is undertaken in tissues surgically biopsied from humans and laboratory animals. Imaging is also undertaken in small laboratory animals, but is confined to the specific location under view.

Genetic Transfer is used in molecular imaging to introduce bioluminescent and fluorescent probes into the animal. The gene that produces bioluminescence or fluorescence is cloned in the laboratory and introduced into a laboratory animal. The gene is introduced into the laboratory animal either by inserting it into a harmless virus (called a vector) that gets into a specific type of cell, or by inserting it into a stem cell that differentiates into a cell that expresses the luminescence or fluorescent protein. (Please also see Adoptive Transfer, a related technique.)

Intravital Macroscopic Imaging technologies use light-emitting probes as contrast to visualize specific molecules and the cells they compose in small laboratory animals and in a few larger laboratory animals. The molecules can be imaged everywhere they occur in body as opposed to a single location (please see intravital light microscope technologies); and, the molecules can be imaged as they move throughout the body, including the brain. (Please also see Macroscopic Optical Scanning techniques.)

Laser Doppler Ultrasound employs laser technology to combine information from both light and sound. It is a non-invasive and highly sensitive method for measuring even tiny changes in the rate of blood flow velocity (speed) within arteries throughout the body, including the brain. Its primary use in the brain is for monitoring severely head injured patients, especially those in coma, in intensive care units.

Macroscopic Optical Scanning techniques image the actions of molecules and cells that are illuminated with bioluminescent or fluorescent probes in live laboratory animals. These techniques enable scientists to visualize actions of cells or molecules anywhere they occur within living small laboratory animals, and in some cases in laboratory sheep and pigs. (Please also see Intravital Macroscopic Imaging Technologies.)

Magnetic Resonance Imaging (MRI) is a non-invasive technology with high resolution that is used primarily to image brain structure and function. It is based on the principle that changes in regional cerebral blood flow and metabolism are coupled to changes in regional neural activity involved in brain functioning. Significant contrast in tissue can be attributed to changes either in blood flow alone, or in metabolism alone, or in blood flow and metabolism.

Magnetic Resonance Spectroscopy (MRS) is a non-invasive technique that measures biochemical changes in the brain over time, characterizing brain diseases according to the natural history of the chemical changes produced. MRS is conducted in an MRI scanner, uses magnetization and radio waves from hydrogen protons in non-water atoms, such as carbon and nitrogen, and produces a color chart (“spectra”) that reflects the concentrations of molecules according to their chemical composition.

Multi-photon laser microscopy is a molecular imaging technology that is used to study the actions of specific cells in the brain over time. The technology relies on the simultaneous absorption of two or more photons by a molecule to image fluorescent probes with long wavelengths that

penetrate deep into tissues. It is used in thick tissue cultures and small laboratory animals.

Optical Probes are used in cellular and molecular imaging. They are molecules that have been specially labeled to emit light of various wavelengths, to “contrast” the target cells of interest from other cells.

Optical tomographic imaging is a molecular imaging technology used to study biochemical activity that occurs deep within the tissues of live laboratory animals. Near infrared (NIR) light is used in combination with fluorescent probes. Light of a specific wavelength is shined on the animal; in turn this light excites the target molecule to emit light at a different wavelength, which is monitored by tomographic detectors placed in a circle around the animal to collect light coming from various directions. Computers combine the multiple individual views into three-dimensional images.

Perfusion-weighted MRI shows areas of the brain in which blood flow has been altered.

Positron Emission Tomography (PET) measures physiological functioning in the brain. It provided the first opportunity to explore the parts of the brain that were activated in undertaking specific tasks; now it is primarily used to study neurotransmitters, actions of pharmaceutical drugs, and the expression of specific genes in the brain. PET is based on the principle that changes in regional cerebral flow and metabolism in brain regions are coupled to changes in neural activity in those regions. PET uses ionizing radiation (radioisotopes) as tracers. Each radioisotope attaches to a specific molecule (carbon, nitrogen, oxygen and fluorine). The regional distribution of exogenously administered positron-emitting tracers is measured using tomographic imaging. PET can quantify tiny concentrations of the radioisotope tracer so its measurements of change are exquisitely sensitive. PET, using new tracers that attach solely to the protein beta amyloid, may become a means to help diagnose Alzheimer’s disease and identify patterns predictive of conversion from mild cognitive impairment to Alzheimer’s.

Structural MRI measures the nuclear magnetic resonance of the body’s own molecules, water protons, to create a computerized three-dimensional image of tissues. Variations in water located in different brain structures and compartments provide contrast, and the ability to see the spatial orientation of various brain structures. The contrast differentiates the brain’s gray matter (primarily nerve cell bodies) from white matter (primarily axons and their myelin sheaths) which are the nerve cell communication cables that connect brain regions. Many disease processes result in water content changes; these are reflected in the image produced to provide diagnostic information.

Ultrasound uses sound waves to determine the locations of surfaces within tissues, and differentiates surfaces from fluids. It does so by measuring the

time that occurs between the production of an ultrasonic pulse to the production of the echo created when the surface reflects the pulse.

X-rays measure the density of tissues. They use photons, a quantum of visible light that possesses energy. The photons are passed through the body, deflected and absorbed to different degrees by tissues, and recorded as they pass out of the body onto a silver halide film. Dense structures such as bone, which block most of the photons, appear white; structures containing air appear black; and muscle, fat and fluids appear in various shades of gray.

Check your progress -1

Note: a. Write your answer in the space given below
b. Compare your answer with those given at the end of the unit

1. What is Angiography?
.....

2. What does functional MRI shows?

4.4 ELECTROPHYSIOLOGICAL METHODS

Electroencephalography (EEG)

- Recording electric activity from the surface of the brain.
- Two main types:
 - General activity patterns (e.g. synchronization patterns, sleep stages)
- Event related responses (ERP): Specific patterns elicited by certain stimuli.
 - Time resolution is very good (scope of milliseconds).
 - Localization is rather poor (large regions at best).

Event Related Potential (ERP)

An **event-related potential (ERP)** is the measured brain response that is the direct result of a specific sensory, cognitive or motor event. More formally, it is any stereotyped electrophysiological response to a stimulus. The study of the brain in this way provides a noninvasive means of evaluating brain functioning. ERPs are measured by means of EEG. The MEG equivalent of ERP is the ERF, or event-related field. Evoked potentials and induced potentials are subtypes of ERPs. ERPs are used extensively in neuroscience, cognitive psychology, cognitive science and research. The timing of these responses is thought to provide a measure of the timing of the brain's communication or timing of information processing. For example, in the checkerboard paradigm described above, healthy participants' first response of the visual cortex is around 50–70 ms. The P300 response has also been studied in the context of information and memory detection.

Magnetoencephalography (MEG) maps brain activity by measuring magnetic fields that are generated by neural activity in the brain. It is used to investigate the basis of sensory processing and motor planning in the brain.

Controlling the brain

Neuro feedback

The activity in your brain determines everything you feel and do. While most people have normal brain function, they still have brain imbalances or chronic emotions that affect their day to day life. This is where neurofeedback can help. Neurofeedback is a way to train brain activity; it is biofeedback for the brain. To understand neurofeedback, first we need to understand a little about brainwaves. Brain waves are the electrical impulses produced as your brain cells communicate with one another. Brainwaves tell us a great deal about how you feel and function; your thought habits, stress levels, underlying mood and overall brain function.

Check your progress – 2

Note: a. Write your answer in the space given below
b. Compare your answer with those given at the end of the unit

1. What is mean by X –Ray?
.....
.....

4.5 SUMMARY

Neuroimaging or brain imaging is the use of various techniques to either directly or indirectly image the structure, function, or pharmacology of the nervous system. It is a relatively new discipline within medicine, neuroscience, and psychology.^[1] Physicians who specialize in the performance and interpretation of neuroimaging in the clinical setting are neuroradiologists.

Neuroimaging falls into two broad categories:

- Structural imaging, which deals with the structure of the nervous system and the diagnosis of gross (large scale) intracranial disease (such as a tumor) and injury.
- Functional imaging, which is used to diagnose metabolic diseases and lesions on a finer scale (such as Alzheimer's disease) and also for neurological and cognitive psychology research and building brain-computer interfaces.

4.6 UNIT –END ACTIVITY

1. Explain about structural neuro imaging techniques.
2. List out the functional neuro imaging techniques.
3. Tell about electro physiological methods

4.7 ANSWERS TO CHECK YOUR PROGRESS

1. Angiography uses a radiopaque dye injected through a catheter into a blood vessel to detect a blockage or narrowing of the vessel. The vessel is outlined on X-ray as white.
2. It shows the brain in action. It is highly sensitive but indirect measure that is used to elucidate process involved in higher cognitive functioning .
3. X- ray measure the density of tissues. They use photons, quantum of visible light that possesses energy.

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Methods and Neural
Process

NOTES

Self-Instructional Material

UNIT 5: PERCEPTION AND ATTENTION

Perception and Attention

NOTES

5.1 INTRODUCTION

When you walk through a busy street, a large number of stimuli bombard your sense organs, but you can take in and use only a very small number of stimuli. For example, a number of people criss-cross each other wearing different colour dresses, cars and buses pass through on the nearby road, shops and buildings also attract your attention. However, only a small and selected part of the available stimulation is registered by an individual for processing and the rest is filtered out. This process of selectively responding to a stimulus or range of stimuli is called attention. A large number of stimuli that are available in the external world, attentional processes limit the reception of stimuli selectively. Thus, attentional processes serve the tuner function in filtering information selectively for further processing that finally leads to perception.

5.2 OBJECTIVES

- explain the nature and functions of attention
- describe the process of perception
- explain perception of shape and illusions
- understand the problem of space perception and cues used in it
- describe the factors influencing perception
- describe extra sensory perception.

5.3 RECOGNITION

5.3.1 Visual pattern recognition

Pattern recognition occurs when information from the environment is received and entered into short term memory, causing automatic activation of a specific content of long term memory. An early example of this is learning the alphabet in order. When a carer repeats 'A, B, C' multiple times to a child, utilizing the pattern recognition, the child says 'C' after he/she hears 'A, B' in order. Recognizing patterns allow us to predict and expect what is coming. The process of pattern recognition involves matching the information received with the information already stored in the brain. Making the connection between memories and information perceived is a step of pattern recognition called identification. Pattern recognition requires repetition of experience. Semantic memory, which is used implicitly and subconsciously is the main type of memory involved with recognition.

Self-Instructional Material

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Pattern recognition is not only crucial to humans, but to other animals as well. Even koalas, who possess less-developed thinking abilities, use pattern recognition to find and consume eucalyptus leaves. The human brain has developed more, but holds similarities to the brains of birds and lower mammals. The development of neural networks in the outer layer of the brain in humans has allowed for better processing of visual and auditory patterns. Spatial positioning in the environment, remembering

findings, and detecting hazards and resources to increase chances of survival are examples of the application of pattern recognition for humans and animals.

There are six main theories of pattern recognition: template matching, prototype matching, feature analysis, recognition by components theory, bottom-up and top-down processing, and Fourier analysis. The application of these theories in everyday life is not mutually exclusive. Pattern recognition allows us to read words, understand language, recognize friends, and even appreciate music. Each of the theories applies to various activities and domains where pattern recognition is observed. Facial, music and language recognition, and seriation are a few of such domains. Facial recognition and seriation occur through encoding visual patterns, while music and language recognition use the encoding of auditory patterns.

5.3.2 Template matching model

Template matching theory describes the most basic approach to human pattern recognition. It is a theory that assumes every perceived object is stored as a "template" into long-term memory. Incoming information is compared to these templates to find an exact match. In other words, all sensory input is compared to multiple representations of an object to form one single conceptual understanding. The theory defines perception as a fundamentally recognition-based process. It assumes that everything we see, we understand only through past exposure, which then informs our future perception of the external world. For example, A, A, and A are all recognized as the letter A, but not B. This viewpoint is limited, however, in explaining how new experiences can be understood without being compared to an internal memory template.

5.3.3 Feature analysis

Multiple theories try to explain how humans are able to recognize patterns in their environment. Feature detection theory proposes that the nervous system sorts and filters incoming stimuli to allow the human (or animal) to make sense of the information. In the organism, this system is made up of feature detectors which are individual neurons, or groups of neurons, that encode specific perceptual features. The theory proposes an increasing complexity in the relationship between detectors and the perceptual feature. The most basic feature detectors respond to simple properties of the stimuli. Further along the perceptual pathway, higher organized feature detectors are able to respond to more complex and specific stimuli properties. When features repeat or occur in a meaningful sequence, we are able to identify these patterns because of our feature detection system.

5.3.4 Object recognition

An object recognition system finds objects in the real world from an image of the world, using object models which are known a priori. This task is surprisingly difficult. Humans perform object recognition effortlessly and instantaneously. Algorithmic description of this task for implementation on machines has been very difficult. In this chapter different steps in object recognition some techniques have been used for object recognition in many applications. The different types of recognition tasks that a vision system may need to perform are discussed the

complexity of these tasks and present approaches useful in different phases of the recognition task are discussed.

5.3.5 Face recognition

Recognizing faces is one of the most common forms of pattern recognition. Humans are incredibly effective at remembering faces, but this ease and automaticity belies a very challenging problem. All faces are physically similar. Faces have two eyes, one mouth, and one nose all in predictable locations, yet humans can recognize a face from several different angles and in various lighting conditions. Neuroscientists posit that recognizing faces takes place in three phases. The first phase starts with visually focusing the physical features. The facial recognition system then needs to reconstruct the identity of the person from previous experiences. This provides us with the signal that this might be a person we know. The final phase of recognition completes when the face elicits the name of the person. Although humans are great at recognizing faces under normal viewing angles, upside-down faces are tremendously difficult to recognize. This demonstrates not only the challenges of facial recognition but also how humans have specialized procedures and capacities for recognizing faces under normal upright viewing conditions.

5.3.6 Speech recognition

Speech recognition applications include voice user interfaces such as voice dialing (e.g. "call home"), call routing (e.g. "I would like to make a collect call"), domestic appliance control, search (e.g. find a podcast where particular words were spoken), simple data entry (e.g., entering a credit card number), preparation of structured documents (e.g. a radiology report), determining speaker characteristics, speech-to-text processing (e.g., word processors or emails), and aircraft. The term *speech recognition* refers to identifying the speaker, rather than what they are saying. Recognizing the speaker can simplify the task of translating speech in systems that have been trained on a specific person's voice or it can be used to authenticate or verify the identity of a speaker as part of a security process.

5.3.7 Feature analysis of speech – context and pattern recognition

Context recognition is a process that identifies user's real-time contextual situations from sensory data, using pattern recognition, signal processing and machine learning algorithms.

Biological explanations of pattern recognition do not account for the effect of context on perception. In other words, our own expectations and knowledge can influence our perception of patterns. This has been called **top-down processing** (whereas perception based on features of the stimuli is a **bottom-up process**). Evidence that context influences perception comes from **Palmer (1975)**. He presented participants with pictures of familiar scenes and then briefly flashed a picture of an object. If the object fitted with the context of the scene, identification was very good.

However, participants performed poorly if the object was not related to the scene.

Pattern recognition involves making sense of and identifying the objects we see. This topic is closely related to perception, which explains how the sensory inputs we receive are made meaningful. Two explanations for how we perceive objects are the template **matching hypothesis** and the feature **detection model**.

A template is a pattern used to produce items of the same proportions. The template-matching hypothesis suggests that incoming stimuli are compared with templates in the long term memory. If there is a match, the stimulus is identified.

5.3.8 FLMP model

FUZZY LOGICAL MODEL OF PERCEPTION (FLMP) The FLMP assumes that the various speech signals specifying a single event are continuously integrated during categorization, leading to perceptual experience and action. Before integration, however, each source is evaluated (independently of the other source) to determine how much that source supports various alternatives. The integration process combines these support values to determine how much their combination supports the various alternatives. The perceptual outcome for the perceiver will be a function of the relative degree of support among the competing alternatives.

Check your progress – 1

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. Write a note on Speech Recognition

.....

2. What is Alternating attention

.....

.....

Perception and Attention

NOTES

NOTES

5.4 ATTENTION

5.4.1 Auditory attention

Auditory attention allows us to rapidly and precisely direct our acoustic

•Selective attention

- Focus on some things; block out others
- When on overload; fatigued
- “Cocktail party phenomena”

Self-Instructional Material

–Hear you name in a crowd

ATTENTION

Perception and Attention

NOTES

The official beginning of cognitive science is usually placed as the Dartmouth symposium on information theory in 1956 (Miller, 1979). In Cognitive Psychology, George Miller published his seminal paper on short-term memory capacity 7 ± 2 and Leon Festinger published his work on Cognitive Dissonance in 1956 (Bechtel, Abrahamsen, & Graham, 1998). Artificial Intelligence as a discipline was born in 1956. Advances in key interfacing disciplines especially computer science, psychology, neuroscience and linguistics enabled the development of Cognitive Science as a discipline of its own studying the mind. In the last 50 years, cognitive science and its interfacing disciplines have developed at a tremendous pace resulting in an a significant expansion of research on the brain, intelligent machines and the mind.

Types of Attention

- ❖ A hierarchic model based on the recovering of attention processes of brain damage patients after coma (Sohlberg and Mateer).
- ❖ **Focused attention:** The ability to respond discretely to specific visual, auditory or tactile stimuli.
- ❖ **Sustained attention (vigilance):** The ability to maintain a consistent behavioral response during continuous and repetitive activity.
- ❖ **Selective attention:** The ability to maintain a behavioral or cognitive set in the face of distracting or competing stimuli. Therefore it incorporates the notion of "freedom from distractibility."
- ❖ **Alternating attention:** The ability of mental flexibility that allows individuals to shift their focus of attention and move between tasks having different cognitive requirements.
- ❖ **Divided attention:** This is the highest level of attention and it refers to the ability to respond simultaneously to multiple tasks or multiple task demands.
- ❖ **Overt attention** is the act of directing sense organs towards a stimulus source.
- ❖ **Covert attention** is the act of mentally focusing on one of several possible sensory stimuli.

Types of Attention: Bottom Up



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Stimulus-driven

Exogenous

Automatic

Types of Attention: Top-down



Goal-driven
Endogenous
Controlled

Early Theories of Attention:

Bottleneck Theories versus Capacity Model Theories

Both are based on the idea that humans have limited information processing capacity: i.e. we are never able to deal with all the inputs that continuously flood into our processing systems from our senses and memory, and even if we were, we are limited in the number of motor responses we can make. Bottleneck theories are a strong version of this limited capacity idea, in that only one message at a time can enter consciousness, since at some point processing is reduced to a single channel.

Capacity models, on the other hand, are a weaker version, in that information can be processed via many channels but that there is a fixed capacity limit to be distributed amongst the channels.

THEORIES OF ATTENTION:

1. Bottleneck Theories

–Early Selective Attention, “Filter Theory”(Broadbent ,1958)

–Attenuation Theory (Treisman, 1960)

–Late-selection Theory (Deutsch and Deutsch,1963)

–Pertinence Model (Norman, 1968)

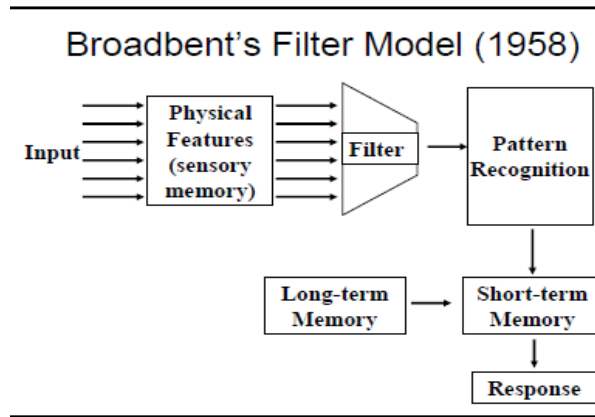
2. Capacity Theories

–Capacity Theory (Kahneman, 1973)

–Multimodal Theory (Johnson and Heinz, 1978)

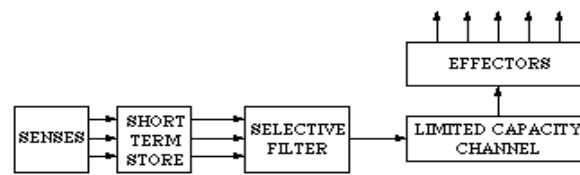
5.4.2 Filter theory

Broadbent’s Filter Theory



Experiments were based on “Dichotic Listening Tasks”

Figure 5-5. Simplified version of Broadbent's Model of Information Flow (1958).



5.4.3 Attenuation Theory

Attenuation Theory Treisman (1960):

If the channels are switched midway in a sentence, we follow the sentence, not the ear.

Figure 5-7. Channel Switching.

Attended Ear :	sitting at the mahogany	/	three
Unattended Ear:	let us look at these	/	table

Subjects would recall: “sitting at the mahogany table” or “let us look at these three”

(Treisman, 1960)

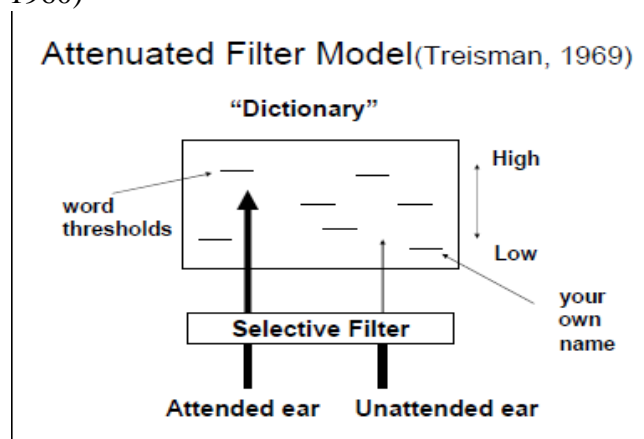
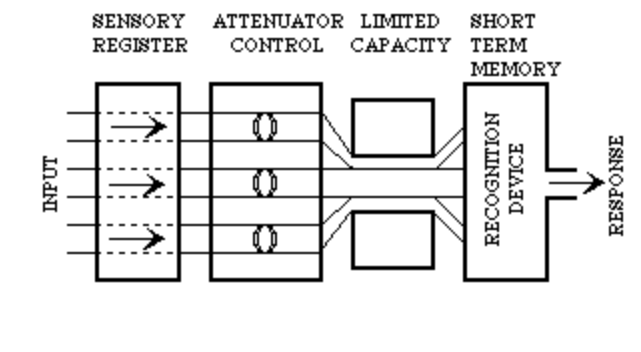


Figure 5-3. Treisman and Geffen's Attenuator Model of Attention.



Attention ATTENUATES the strength of some stimuli based on physical attributes. A newly proposed element is a 'dictionary'. This dictionary symbolizes information, or words, which require a very low threshold in order to be recognized. Some words (like your name, "danger", "fire" etc) have a lower threshold than others. The stimulus which exceeds the threshold is selected for pattern recognition.

Filter versus Attenuation Theory

i. Broadbent's filter is all-or-nothing (it does not allow through unattended messages), whereas Treisman's filter allows unattended messages through, but in an attenuated form.

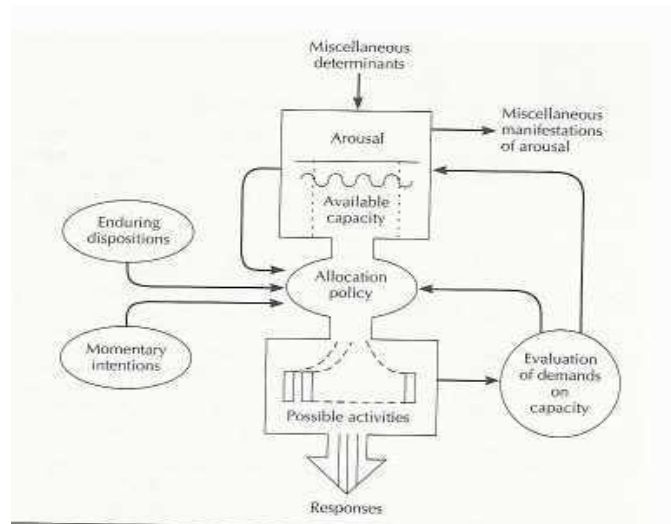
ii. Broadbent's is a simple single filter model, whereas Treisman's can be thought of as a two-stage filtering process: firstly, filtering on the basis of incoming channel characteristics, and secondly, filtering by the threshold settings of the dictionary units.

iii. Both models are "early selection" models, in which selection occurs prior to pattern recognition.

Capacity Model (Kahneman, 1973)

- Limit on the capacity to perform mental work.
- Control the allocation of capacity
- Activities compete for attentional resources
- When demand exceeds supply, performance suffers or fails entirely

- Capacity
 - Varies with level of arousal
- Allocation of resources
 - Enduring dispositions
- Reflect rules of involuntary attention
 - Momentary intentions
- Reflect specific goals



- Supplements previous bottom-up analysis with a consideration of top-down influences
- Emphasizes concept of processing resources
- Attention and mental effort are strongly correlated
- Arousal can work to increase processing resources
- Attention is the process of allocating capacity to various inputs.

5.4.4 Visual attention

The visual attention mechanism may have at least the following basic components [Tsotsos, et. al. 1995]:

- (1) the selection of a region of interest in the visual field;
- (2) the selection of feature dimensions and values of interest;
- (3) the control of information flow through the network of neurons that constitutes the visual system; and
- (4) the shifting from one selected region to the next in time .

There are two kinds of execution methods: one is bottom-up or stimulus-driven, such as exogenous attention; another is top-down or goal-directed, such as endogenous attention. Combining some neurological models of attention, Perry and Hodges [Perry and Hodges 1999] have divided attention into three broad categories:(1)Selectiveattention and shifting Its defining characteristics are focusing on single relevant stimulus or processing at one time while ignoring irrelevant or distracting stimuli; (2) Sustained attention Its defining characteristics are the maintenance of abilities to focus attention over extended periods of times; and(3) Divided attention The defining characteristics are sharing of attention by focusing on more than one relevant stimulus or process at one time.

Neural basis

Attention is critical to countless daily tasks, from operating machinery to maintaining safety in high security settings. Eventually, researchers plan to develop a unified model of attention that applies across multiple domains,

from single cells to large brain circuits.

Visual search

Visual Constancies

1)Shape Constancy

- Frisbee –round yet on table seems eclipse; KNOW = Round

2)Location Constancy

- Telephone pole “fly by” as we drive; KNOW = stay there

3)Size Constancy

- Friend not growing as come closer; car not shrinking as leaving

4)Brightness Constancy

- Snow still white even in darkness

5)Color Constancy

- Indoor = more yellow;
- Outdoor = more blue: KNOW = same color

Blinding problem

•Intentional blindness

- Fail to consciously perceive something because you aren't attending to it.
- Look but do not see
- Pro: protect from overload
- Con: bad if talk on cell –not see car
- Cornea –bends light waves so the wave can be focused on the retina
- Pupil –Opening that changes size depending on amount of light
- Lens–changes shape to bring objects into focus
- Retina-Visual receptors; neural tissue back of eyeball’s interior; upside down
- Rods-Visual receptors that respond to dim light; non color; cat at night
- Cones-Visual receptors involved in color vision and sharpness of vision
- Iris –color of eye; muscles control the size of the pupil
- Optic nerve –sends visual information to the brain

•TrichromaticTheory

- Three mechanisms in visual system;
- Three basic types of cone; Blue Green Red

•Opponent-process theory

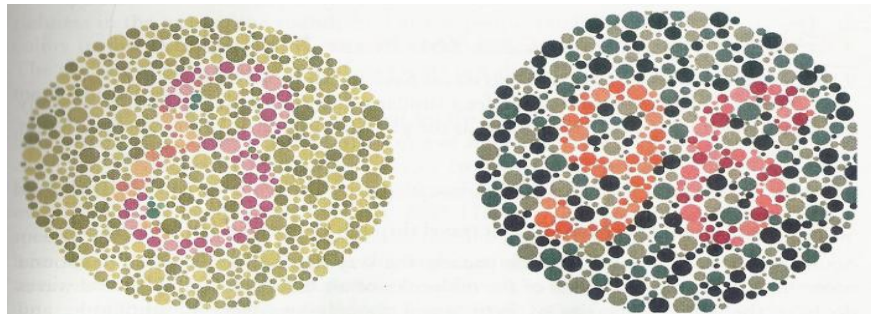
- Visual system treats pairs of colors as opposing or antagonistic
- –Visual neurons are stimulated by light of one color and inhibited by light of another color

Color Blindness

- Black White Grey

-Color deficient

- Unable to distinguish red and green
- Rare; not see blue and yellow



Object-based attention

Object-based attention refers to the relationship between an ‘object’ representation and a person’s visually stimulated, selective attention, as opposed to a relationship involving either a spatial or a feature representation; although these types of selective attention are not necessarily mutually exclusive. Research into object-based attention suggests that attention improves the quality of the sensory representation of a selected object, and results in the enhanced processing of that object’s features.

The concept of an ‘object’, apropos object-based attention, entails more than a physical thing that can be seen and touched. It includes a perceptual unit or group, namely, elements in a visual field (stimuli) organised coherently by Gestalt factors such as collinearity, closure, and symmetry.

5.4.5 Central attention

The encoding of information into WM is considered by some to be a central attention task (e.g. Jolicoeur and Dell’Acqua, 1998). If WM consolidation requires central attention, then dual-task combinations of encoding and central attention should result in substantial interference. There is evidence both for and against this. Pashler (1993) found that participants’ ability to encode a spatial array was not affected by overlap with a speeded tone judgment. In his task, a speeded tone requiring a manual response was followed, with a variable SOA, by a matrix of red or black squares. The matrix array had to be encoded quickly because it was masked 100ms after presentation. If the speeded tone task interfered with the consolidation of the matrix pattern, this would manifest as a drop in recognition accuracy for short SOAs. Instead, the results showed little evidence of dual-task interference, suggesting that the consolidation of a visuospatial array can occur undeterred while central attention is engaged. Similar results have been found using partial report or detection as the second task (Blake and Fox, 1969; Pashler, 1991; Posner and Boies, 1971; but see Comstock, 1973).

Automaticity

Automaticity is the ability to do things without occupying the mind with the low level details that are required; this is usually the result of learning, repetition, and practice. For instance, when riding a bicycle we do not have to concentrate on turning the pedals, balancing, and holding on to the

handlebars but instead those processes are automatic and we can concentrate on watching the road and traffic around us.

Some other examples of automaticity are:

- Driving a car
- Speaking
- Walking/running

For language learning, Segalowitz (2003) characterized automaticity as a more efficient, more accurate, and more stable performance. As such, automaticity is often linked with fluency in language learning.

Stroop effect

The Stroop effect was first demonstrated by J. Ridley Stroop in 1935. Since then, many experiments have been conducted and found similar phenomenon. In the classic Stroop test, participants are given words, such as “red” or “blue” and these words are coloured either congruently or incongruently. The participant must report the colour of the word, not the word itself. The reactions times are measured and are usually higher for incongruent trials than for congruent trials. This difference is called the Stroop effect. The predominant explanation for Stroop effect is automaticity or automatic processes. Solso, (2005, p. 98) explains that automaticity occurs when an action becomes so highly practiced that it happens without intent and little conscious awareness. He goes further to say that automaticity occurs so that we can focus on challenging tasks that require more of our attention. This explanation, when applied to the Stroop effect implies that reading is more automatic than colour naming, and

therefore automatic processes interfere with our performance on the Stroop test.

Check your progress – 2

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the

uni

1. What is Cognitive Science

.....
.....

5.5 SUMMARY

Attention plays an important role in perception. Its most important function is to filter out information that is not relevant at a particular moment; that is selecting the input of information for further processing. The four important functions of attention are: Alerting function, Selective function, Limited Capacity channel, and Vigilance.

-Alerting function refers to the processes by which an organism is physiologically and mentally prepared for a particular situation. It prepares an individual for a task with readiness to respond.

-Selectivity refers to the process in which the stimuli of interest are focused and others are ignored or filtered out.
-The task that requires attentional resources cannot be carried out simultaneously.
The information is processed serially; it is due to limited capacity channel.
-Maintaining attention on one task for some time is called sustained attention or vigilance. Sustained attention on some task, especially of monotonous nature, leads to decrement in performance.
-How we construct a world of reality from information that we receive from our sense organs, is what we study in perception.

5.6 UNIT –END ACTIVITY

1. What are the main functions of attention?
 2. Describe the theories of attention..
-

5.7 ANSWERS TO CHECK YOUR PROGRESS

1. The term speech recognition refers to identifying the speaker, rather than what they are saying.
 2. The ability of mental flexibility that allows individuals to shift the focus of attention and move between tasks having different cognitive requirements.
 3. Cognitive science can be roughly defined as the study of the mind or mental processes It has also been defined as the study of the nature of intelligences.
-

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UNIT 6: MEMORY AND COGNITION

Memory and Cognition

6.1 INTRODUCTION

NOTES

Memory is vital to experiences; it is the retention of information over time for the purpose of influencing future action. If we could not remember past events, we could not learn or develop language, relationships, or personal identity. **Cognition** is "the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses". It encompasses many aspects of intellectual functions and processes such as attention, the formation of knowledge, memory knowledge, memory and working memory, judgment and evaluation, reasoning and computation, problem solving and decision making, comprehension and production of language. Cognitive processes use existing knowledge and generate new knowledge.

6.2 OBJECTIVES

- Describe the three stages in the process of learning and remembering
 - To study the different theories of memory
 - To provide the knowledge about meta cognition
 - To provide the knowledge of how the memory system functions
-

6.3 MEMORY

6.3.1 Memory models

Atkinson & Shiffrin model:

Psychologists began studying memory in the late 19th century, although interest in memory waned under the influence of behaviorism until the "Cognitive revolution" of the 1960s. In 1890 William James proposed a distinction between two kinds of memory, which he called primary and secondary memory. The **Atkinson–Shiffrin model** (also known as the **multi-store model** or **modal model**) is a model of memory proposed in 1968 by **Atkinson & Shiffrin**. The model asserts that human memory has three separate components:

1. a sensory register, where sensory information enters memory,
2. a short term store, also called *working memory* or *short-term memory*, which receives and holds input from both the sensory register and the long-term store, and
3. a long term store, where information which has been rehearsed (explained below) in the short-term store is held indefinitely.

Primary memory is immediate memory for information momentarily held in consciousness, such as a telephone number. Secondary memory is the vast store of information that is unconscious except when called back into primary memory such as the 10 or 20 phone numbers a person could bring to mind if he wanted to call various friends, family members, stores, and, so forth. James's distinction is embodied in what we will call in the Standard Model of memory (Modal model), which has guided research on memory and cognition since the 1960s (Atkinson & Shiffrin,

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1968; Healy & McNamara, 1996)

Neural networks model

An *artificial neural network* is a network of simple elements called *artificial neurons*, which receive input, change their internal state (*activation*) according to that input, and produce output depending on the input and activation.

Kinds of information stored in memory:

The standard model is predicated on the metaphor of the mind as a computer, which places information into different memory stores (the system's "hardware") and retrieves and transforms it using various programs ("software"). According to this model, memory consists of three stores: sensory memory (or sensory registers), short term memory (James's primary memory) and long term memory (James's secondary memory). Storing and retrieving memories involves passing information from one store to the next and then retrieving the information from long term memory.

6.3.2 Kinds of information stored in memory

Working Memory:

Working memory refers to the temporary storage and processing of information that can be used to solve problems, respond to environmental demands or achieve goals. Working memory is active memory: Information remains in working memory only so long as the person is consciously processing, examining, or manipulating it. Working memory includes both a temporary memory store and a set of strategies, or control processes, for mentally manipulating the information momentarily held in that store..

Declarative memory:

It can be semantic or episodic (Tulving, 1972). Semantic memory (or Generic memory) refers to a general knowledge or facts, such as the knowledge that summers are hot in Katmandu or that NaCl is the chemical formula for table salt. The term is somewhat misleading because semantic implies that general knowledge is stored in words, whereas people know many things about objects, such as their color or smell, that are encoded as sensory representation.

Episodic Memory:

It consists of memories of particular events, rather than general knowledge. Episodic memory allows people to travel mentally through time, to remember thoughts and feelings from the recent or distant past or to imagine the future (Wheeler et al., 1997). In everyday life, episodic memory is often Autobiographical, as when people remember what they did on their 18 th birthday or what they ate yesterday. It is also closely linked to semantic memory, since when people experience similar episodes over time (such as 180 days a year in a school or hundreds of

thousands of interactions with their father), they gradually develop generic memories of what those situations were like (eg., “I used to love weekends with my father”).

Procedural Memory:

Procedural memory is for skills. People are often astonished to find that even though they have not skated for 20 years, the skills are reactivated easily, almost as if their use had never been interrupted. When people tie their shoes, put a backspin on a tennis ball, speak grammatically, or drive a car, they are drawing on procedural memory.

Explicit Memory:

It involves the conscious retrieval of information. Researchers distinguish between two kinds of explicit retrieval: Recall and Recognition.

Recall is the spontaneous conscious recollection of material from LTM, as when a person brings to mind memories of her wedding day or the name of capital of Egypt.

Recognition refers to the explicit feeling or remembrance that something currently perceived has been previously encountered or learned (as when a researcher asks a subject to identify a word on a list that was on a different list the previous day).

Implicit Memory:

It is evident in skills, conditioned learning, and associative memory. It can be seen in skills such as turning the wheel in the right direction when the car starts to skid in the snow, which skilled drivers in cold regions do before they have even formed the thought “I’m skidding”, as well as in responses learned through classical and operant conditioning, such as avoiding a food that was once associated with nausea even when the person has no explicit recollection of the event.

6.3.3 Methods to study memory

Forgetting

Forgetting or **disremembering** is the apparent loss or modification of information already encoded and stored in an individual's long term memory. It is a spontaneous or gradual process in which old memories are unable to be recalled from memory storage. Forgetting also helps to reconcile the storage of new information with old knowledge. Problems with remembering, learning and retaining new information are a few of the most common complaints of older adults. Memory performance is usually related to the active functioning of three stages. These three stages are encoding, storage and retrieval. The flipside of memory is Forgetting, the inability to remember. Ebbinghaus (1885) documented over a century ago a typical pattern of forgetting that

occurs with many kinds of declarative knowledge, beginning with rapid initial loss of information after initial learning and only gradual decline thereafter.

Memory Distortion

Memories aren't exact records of events. Instead, memories are reconstructed in many different ways after events happen, which means they can be distorted by several factors. These factors include schemas, source amnesia, the misinformation effect, the hindsight bias, the overconfidence effect, and confabulation.

Memory construction

The formulation of new memories is sometimes called **construction**, and the process of bringing up old memories is called **reconstruction**. Yet as we retrieve our memories, we also tend to alter and modify them. A memory pulled from long-term storage into short-term memory is flexible. New events can be added and we can change what we think we remember about past events, resulting in inaccuracies and distortions. A growing body of evidence suggests that the information entered into memory is often altered in various ways over time—and these alterations can reduce its accuracy and change its meaning. Such changes fall under two major headings- memory distortion, alterations in what is retained and later recalled, and memory construction, the addition of information that was not actually present.

6.3.4 Memory in everyday life

Memory and the brain

Different brain regions with associated memory and cognitive functions

Brain parts	Memory processes
Frontal lobe	Working and STM
Temporal lobe	Hearing sense
Parietal lobe	Spatial memory
Occipital lobe (visual cortex)	Visual memory
Thalamus	Attention
Mamillary body	Episodic memory
Caudate nucleus	Memories of instinctive skills
Caudate nucleus (temporal, right)	Instinctive actions, e.g., grooming is stored here
Putamen	Procedural skills
Putamen (temporal, right)	Learning skills, e.g., the ability to ride a motorbike
Amygdala	Emotional memories
Hippocampus	Activated to transfer experiences into memories, e.g., STM to LTM
Cerebellum	Conditional memories, e.g., events linked by time
Central executive (frontal, right)	Holds entire plan, including visual elements

Memory improvement techniques

'Mnemonic' is another word for memory tool. Mnemonics are techniques

for remembering information that is otherwise quite difficult to recall: A very simple example is the ‘30 days hath September’ rhyme for remembering the number of days in each calendar month. Our brains evolved to code and interpret complex stimuli such as images, colors, structures, sounds, smells, tastes, touch, positions, emotions and language. We use these to make sophisticated models of the world we live in. Our memories store all of these very effectively.

The following things to make your mnemonics more memorable:

Use positive, pleasant images. Your brain often blocks out unpleasant ones. Use vivid, colorful, sense-laden images – these are easier to remember than drab ones.

Use all your senses to code information or dress up an image. Remember that your mnemonic can contain sounds, smells, tastes, touch, movements and feelings as well as pictures.

Give your image three dimensions, movement and space to make it more vivid. You can use movement either to maintain the flow of association, or to help you to remember actions.

Exaggerate the size of important parts of the image.

Use humor! Funny or peculiar things are easier to remember than normal ones.

Similarly, rude rhymes are very difficult to forget!

Symbols (red traffic lights, pointing fingers, road signs, etc.) can code quite complex messages quickly and effectively.

Check your progress – 1

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. Define Episodic memory

.....

.....

.....

.....

2. Write down the factors influencing memory?

.....

6.4 COGNITION

6.4.1 Thinking

Thought (also called **thinking**) – the mental process in which beings form psychological associations and models of the world. Thinking is manipulating information, as when we form concepts, engage in problem solving, reason and make decisions. Thought, the act of thinking, produces thoughts. A thought may be an idea, an image, a sound or even an emotional feeling.

Basic elements of thought

The "parts" or elements of thinking are as follows:

1. All reasoning has a **purpose**
2. All reasoning is an attempt to **figure something out, to settle some question, to solve some problem**
3. All reasoning is based on **assumptions**
4. All reasoning is done from some **point of view**
5. All reasoning is based on **data, information and evidence**
6. All reasoning is expressed through, and shaped by, **concepts and ideas**
7. All reasoning contains **inferences** or **interpretations** by which we draw **conclusions** and give meaning to data
8. All reasoning leads somewhere or has **implications and consequences.**

Reasoning

It is one of the best forms of controlled thinking consciously towards the solution of a problem. As Sherman defined, "**reasoning is a process of thinking during which the individual is aware of a problem identifies, evaluates, and decides upon a solution**". Reasoning is used not only when we want to solve an immediate problem but also when we anticipate future problems.

Decision making

Decision-making can be regarded as a problem-solving activity yielding a solution deemed to be optimal, or at least satisfactory. It is therefore a process which can be more or less rational or irrational and can be based on explicit or tacit knowledge and beliefs. Tacit knowledge is often used to fill the gaps in complex decision making processes. Usually both of these types of knowledge, tacit and explicit, are used together in the decision-making process.

Human performance has been the subject of active research from several perspectives:

- Psychological: examining individual decisions in the context of a set of needs, preferences and values the individual has or seeks.
- Cognitive: the decision-making process regarded as a continuous process integrated in the interaction with the environment.
- Normative: the analysis of individual decisions concerned with the logic of decision-making, or communicative rationality, and the invariant choice it leads to.

6.4.2 Problem solving and its methods

Problem solving does take some time and attention more of the latter than the former. But less time and attention than is required by a problem not well solved. What it really takes is a willingness to slow down.

1. Identify the issues.

- Be clear about what the problem is.

- Remember that different people might have different views of what the issues are.
- *Separate the listing of issues from the identification of interests (that's the next step!).*

2. Understand everyone's interests.

- This is a critical step that is usually missing.
- Interests are the needs that you want satisfied by any given solution. We often ignore our true interests as we become attached to one particular solution.
- The best solution is the one that satisfies everyone's interests.
- This is the time for active listening. Put down your differences for awhile and listen to each other with the intention to understand.
- *Separate the naming of interests from the listing of solutions.*

3. List the possible solutions (options)

- This is the time to do some brainstorming. There may be lots of room for creativity.
- *Separate the listing of options from the evaluation of the options.*

4. Evaluate the options.

- What are the pluses and minuses? Honestly!
- *Separate the evaluation of options from the selection of options.*

5. Select an option or options.

- What's the best option, in the balance?
- Is there a way to "bundle" a number of options together for a more satisfactory solution?

6. Document the agreement(s).

- Don't rely on memory.
- Writing it down will help you think through all the details and implications.

7. Agree on contingencies, monitoring, and evaluation.

- Conditions may change. Make contingency agreements about foreseeable future circumstances (If-then!).
- How will you monitor compliance and follow-through?
- Create opportunities to evaluate the agreements and their implementation. ("Let's try it this way for three months and then look at it.")

Artificial intelligence

Artificial intelligence (AI) is the simulation of human intelligence processes by machines, especially computer systems. These processes include learning (the acquisition of information and rules for using the information), reasoning (using rules to reach approximate or definite conclusions) and self-correction. AI can be categorized as either weak or strong. Weak AI, also known as narrow AI, is an AI system that is designed and trained for a particular task. Virtual personal assistants, such as Apple's Siri, are a form of weak AI. Strong AI, also known as artificial general intelligence, is an AI system with generalized human cognitive abilities. When presented with an unfamiliar task, a strong AI

system is able to find a solution without human intervention.

Language and its development

The **origin of language** and its evolutionary emergence in the human species have been subjects of speculation for several centuries. The topic is difficult to study because of the lack of direct evidence. Consequently, scholars wishing to study the origins of language must draw inferences from other kinds of evidence such as the fossil record, archaeological evidence, contemporary language diversity, studies of language acquisition, and comparisons between human language and systems of communication existing among animals.

Language and thought

A variety of different authors, theories and fields purport influences between **language and thought**. Psychologists attempt to explain the emergence of thought and language in human evolution. There are two bodies of thought forming around this debate. Lingualism, which claims that there is no thought without language and denies the intelligibility of any kind of thought whatsoever in the absence of language.

6.4.3 Sensory memory

Suppose you grab a handful of quarters (say, 6 or 7) from your pocket at the laundromat and, while looking away, stretch out your hand so that all of the coins are visible. Sensory registers hold information about a perceived stimulus for a split second after the stimulus disappears, allowing a mental representation of it to remain in memory briefly for further processing (Sperling, 1960).

Visual - Auditory

The term iconic storage is used to describe visual sensory registration. For a brief period after an image disappears from vision, people retain a mental image (icon) of what they have seen. This visual trace is remarkably accurate and contains considerably more information than people can report before it fades (Baddeley & Patterson, 1971). The duration of icons varies from approximately half a second to 2 seconds, depending on the individual, the content of the image, and the circumstances (Neisser, 1976).

The auditory counterpart of iconic storage is called echoic storage (Battacchiet al., 1981). Most readers have probably had the experience of hearing a voice or a sound “echo” in their minds after the actual sound has stopped. Some researchers suggest that humans may have 2 types of echoic memory systems, one for nonspeech and the other for speech sounds, lateralized to the right and left hemispheres of the brain, respectively (Ardila et al., 1986).

Short term memory:

STM has limited capacity; that is, it does not hold much information. On the average, people can remember about 7 pieces of information at a time, with a normal range of from 5 to 9 items (Miller, 1956). That phone numbers in most countries are 5 to 7 digits is no mere coincidence. Hermann Ebbinghaus (1885) was the first to note the 7 item limit to STM. Ebbinghaus pioneered

the study of memory using the most convenient and agreeable subject he could find himself with a method that involved inventing some 2300 nonsense syllables (such as *pir* and *vup*). Ebbinghaus randomly placed these syllables in lists of varying lengths and then attempted to memorize the lists, he used nonsense syllables rather than real words to try to control the possible influence of prior knowledge on memory. He also found that he could memorize up to 7 syllables, but no more in a single trial. The limits of STM seem to be neurologically based, as they are similar in other cultures, including those with very different languages.

Rehearsal – short term memory is not, however, a completely passive process of getting pumped off a stool. People can control the information stored in the STM. For eg, after looking up a phone number, most people will repeat it over and over in their minds to prevent it from fading until they have dialed the number. This procedure is known as Rehearsal. This kind of rehearsal is known as Maintenance Rehearsal, since its purpose is to maintain information in STM.

It is also important in transferring information to long term memory which will not surprise anyone who has ever memorized a poem, lines from a play, or a math formula by repeating it over and over. As we will see, however, maintenance rehearsal is not as useful for storing information in long term memory as more actively thinking about the information while rehearsing, a procedure known as Elaborative Rehearsal.

Working Memory:

Working memory refers to the temporary storage and processing of information that can be used to solve problems, respond to environmental demands or achieve goals. Working memory is active memory: Working memory includes both a temporary memory store and a set of strategies, or control processes, for mentally manipulating the information momentarily held in that store. These control processes can be as simple as maintenance rehearsal – such as repeating a phone number over and over until we have finished dialing it – or as complex as trying to solve an equation in our heads.

Baddeley's theory

The original model of Baddeley & Hitch was composed of three main components; the *central executive* which acts as supervisory system and controls the flow of information from and to its *slave systems*: the *phonological loop* and the *visuo-spatial sketchpad*. The phonological loop stores verbal content, whereas the visuo-spatial sketchpad caters to visuo-spatial data. Both the slave systems only function as short-term storage centers. In 2000 Baddeley added a third slave system to his model, the *episodic buffer*. Baddeley & Hitch's argument for the distinction of two domain-specific slave systems in the older model was derived from experimental findings with dual-task paradigms. Performance of two simultaneous tasks requiring the use of two separate perceptual domains (i.e. a visual and a verbal task) is

nearly as efficient as performance of the tasks individually. In contrast, when a person tries to carry out two tasks simultaneously that use the same perceptual domain, performance is less efficient than when performing the tasks individually.

Long Term Memory:

Here representation of facts, images, thoughts, feelings, skills and experiences may reside for as long as a lifetime. According to the standard model, the longer information remains in STM, the more likely it is to make a permanent impression in LTM. Recovering information from LTM known as Retrieval, involves bringing it back into STM. Although researchers have offered many explanations for the serial position effect, one explanation proposed by advocates of the standard model involves the distinction between long term and short term storage (Atkinson & Shiffrin, 1968). When people are trying to remember a list of words, they rehearse them in their minds. The first words on the list receive considerable rehearsal, but as the number of words steadily increases, the person has less opportunity to rehearse each one. Thus, words toward the beginning of the list are better remembered - a phenomenon called the Primacy Effect - because they are more likely to be stored in LTM. Items at the end of a list are also remembered better than those in the middle. This phenomenon, known as Recency Effect, was originally studied by Mary Calkins (1905), a pioneer in memory research (and the first female president of the American Psychological Association; see Madigan & O'Hara, 1992).

Factors influencing memory

- Transience (passage of time) , Blocking
- Absent mindedness (lack attention; divided attention; failure to remember to do things in future -> cues
- Memory misattribution (source errors) ,Suggestibility

Techniques for studying textual memory

The difference between a study group and a tutorial situation is that a tutor is someone who can be relied on to know what he/she is talking about. For best results, here are the ways to use a study group:

1. When: Joining a study group after learning the facts and ideas needed to know to avoid learning incorrect information.
2. Why: The purpose of the group should be conversation--sit back, listen to the others, and tell what you know. This exercises your sight and sound senses and your mouth muscles, so you benefit three ways.
3. How: An effective technique is for each member to prepare five essay questions in advance and then for the group to take turns answering them all. If your group needs to work on memorization of facts, drill one another with clue words.

4. Where: Choose a place where there are no distractions so the group can give its entire attention to the subject.

Retention

Retention is the capability to hold information, and retrieval is the recollection of held information in the mind in response to external stimuli. Cognitive research literature has highlighted that these processes are related to one another and also to factors such as learning, testing, and capacity limit of memory, attention demand, and complexity of material.

Interference theory:

It points to interference as the prime culprit in memory failure: memories of similar information tends to interfere with one another, as when students confuse two theories they learned about around the same time or two similar sounding words in a foreign language. Finding the right path in the neural wilderness is difficult if two paths are close together and look alike. Proactive interference refers to the interference of previously stored memories with the retrieval of new information, as when a person calls a new romantic partner by the name of an old one. In Retroactive interference new information interferes with retrieval of old information.

6.4.5 Retrieval & inference

For information to be retrievable from memory, it must be encoded, or cast into a representational form that can be readily accessed from memory. The degree to which information is elaborated, reflected upon, and processed in a meaningful way during memory storage is referred to as the depth or level of processing. Although deeper processing tends to be more useful for storing information for the long term, ease of retrieval depends on the match between the way information is encoded and later retrieved, a phenomenon is known as the encoding Specificity principle. Similar contexts during encoding and retrieval provide retrieval cues – stimuli or thoughts that can be used to facilitate recollection. Aside from level of processing, two other variables related to encoding that influence accessibility of memory are the spacing of study sessions and the use of multiple and refundant representational modes.

Mnemonic devices are systematic strategies for remembering information (named after the Greek word mneme, which means “memory”).

The method of loci associates new information with a visual image of a familiar place. Cicero attributed this technique to the ancient Greek poet Simonides, who was attending a banquet when he was reportedly summoned by the gods from the banquet hall to receive a message. In his absence, the roof collapsed, killing everyone. The bodies were mangled beyond recognition, but Simonides was able to identify the guests by their physical placement around the banquet table. He thus realized that images could be remembered by fitting them in orderly arrangement of locus.

Peg method associates new information with a rhyme that also helps create

a visual image. For eg you might create a number rhyme that you cannot possibly forget, such as :One is a bun, two is a shoe, three is a tree, four is a forth. Note that each number in this rhyme is associated with an object that can be easily be visualized.

SQ3R method helps students study textbook material efficiently by inducing them to survey, question, read, recite and review.

Two possible definitions of "inference" are:

1. A conclusion reached on the basis of evidence and reasoning.
2. The process of reaching such a conclusion.

Much of memory is inference at the time of recall – not actual retrieval of facts.

Memory d

Bransford et al. -- inference can lead to incorrect recall:

Turtles resting on or beside a log and a fish swam beneath them.

Subjects were most confused by test sentences whose meaning was implied by the studied sentences (“beneath it”).

Plausible retrieval

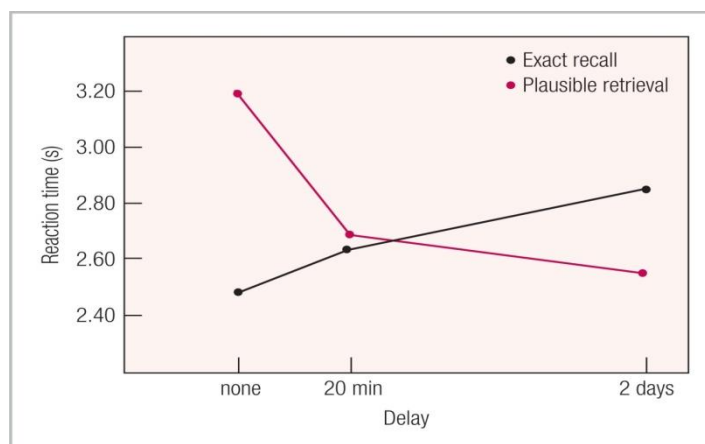
Reader – much of recall is plausible inference not actual recall.

■ Darth Vader inferred to be evil, not remembered to be evil.

■ Heir to hamburger chain story – subjects asked to recall exact details and make plausible inferences.

After a delay, plausible inference is faster and does not decay as much as exact memory, with no fan effect.

Plausible Retrieval after a Delay:



Inference and Elaboration

□ Elaboration leads to more inferences.

■ Information added as a “theme” to a story results in better recall of studied material and more inferences (Nancy & the doctor).

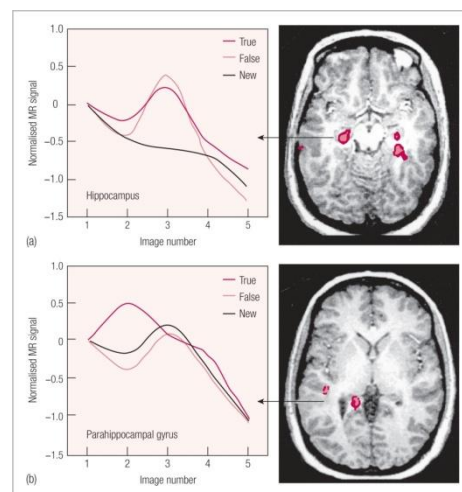
□ Intruded inferences are not necessarily “errors” but help guide our thinking and behavior.

□ Listerine court case – false inferences, not just false statements, not permitted.

Eyewitness testimony

Eyewitness testimony is often relied upon in the judicial system. It can also refer to an individual's memory for a face, where they are required to remember the face of their perpetrator, for example. However, the accuracy of eyewitness memories sometimes questioned because there are many factors that can act during encoding and retrieval of the witnessed event which may adversely affect the creation and maintenance of the memory for the event. Experts have found evidence to suggest that eyewitness memory is fallible. It has long been speculated that mistaken eyewitness identification plays a major role in the wrongful conviction of innocent individuals.

False Memories and the Brain



The parahippocampus retains the sensory experience of seeing the word. The hippocampus extracts and stores the meaning.

□ When exact memory is needed, inferences and reconstructive processes can be misleading.

□ False memory syndrome – memories that never happened can be “planted.”

6.4.6 Associative structure and retrieval

Association has served as the core theoretical construct throughout the history of writings on memory. An association is not observed; rather, it is inferred from the tendency of one item to evoke another. Associations that come to mind quite naturally, like the association of king and queen or of bread and butter, relate to the meaning of the constituent items. This meaning develops through extensive experience, usually involving the temporal co-occurrence of the items in many different situations. But associations can also be formed between nominally unrelated items in a single exposure. For example, when attending closely to a pair of items presented in temporal proximity (e.g., a name-face pair, or a hotel room number) we can quickly take hold of the association, at least temporarily. Sometimes, a salient new association may be encoded well enough after a single encounter that it can be recalled, or at least recognized, after a long delay.

Effect of encoding context

- **Recall is better if the physical context during learning is also present during testing.**

■ **Experimenter clothing, setting.**

■ **Under water.**

- **Eich suggests that context effects depend on integrating context and the material to be learned.**

6.5 SUMMARY

The memory plays a role in all our activities. It helps us remember all kinds of information (personal memories, common knowledge, automatic processes...) for a more or less long while (from a few seconds to an entire life). It is essential in creating and developing our personality, it is a direct witness of our own past (episodic memory), and also of history and common knowledge (semantic memory). The memory is therefore one of the most essential cognitive functions in a person's life.

Cognition is "the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses". It encompasses many aspects of intellectual functions and processes such as attention, the formation of knowledge, memory knowledge, memory and working memory, judgment and evaluation, reasoning and computation, problem solving and decision making, comprehension and production of language. Cognitive processes use existing knowledge and generate new knowledge.

6.6 UNIT END ACTIVITY

1. Write some memory improvement techniques
2. List out the types of memory
3. What is forgetting?

6.7 ANSWERS IN CHECK YOUR PROGRESS

1. It consists of memories of particular events rather than general knowledge it allows people to travel mentally through time , to remember thoughts and feelings from the recent or distant past or to imagine the future.

2. i. Blocking ii. absent mind iii. Suggestibility

3. Mnemonic is another word for memory tool. It is remembering information that is otherwise quite difficult recall.

6.8 SUGGESTED READINGS

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Memory and Cognition

NOTES

Self-Instructional Material

UNIT 7: PROBLEM SOLVING AND REASONING

Problem Solving and Reasoning

7.1 INTRODUCTION

NOTES

Some problems, such as those that arise between parents and children as they try to get along with one another, may have emotional content; others, such as mathematical problems, are less emotional, but may involve emotions (e.g., anxiety) in certain circumstances, such as when math problems appear on an exam). Research on problem solving generally makes use of problems that are less emotional in nature, but it is thought that the types of strategies we use are similar for both emotional and non emotional problems. The overarching goal of research on problem solving has been to identify the strategies we use when we are confronted by an novel situation and must decide on a course of action. The problem solver must identify the problem, find away of representing it, and choose a course of action that will make it possible to achieve the goal.

7.2 OBJECTIVES

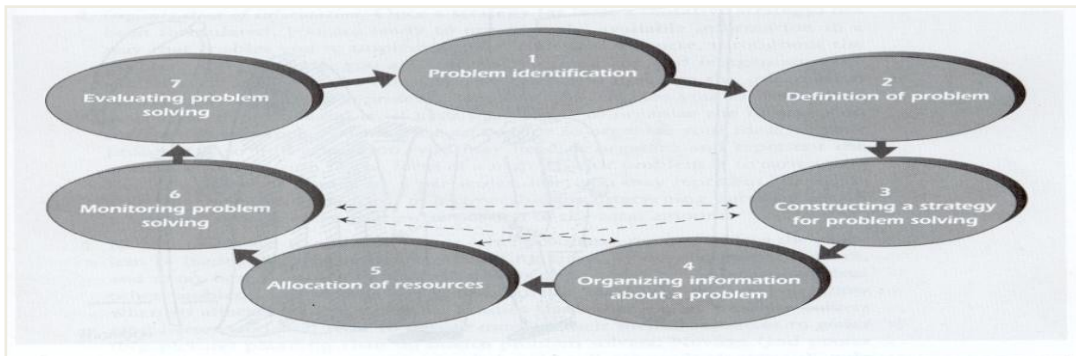
- To understand that complex problems that may otherwise be difficult to solve may have a simple recursive solution.
- To learn how to formulate programs recursively.
- To understand and apply the three laws of recursion.
- To understand recursion as a form of iteration.
- To implement the recursive formulation of a problem.

7.3 PROBLEM SOLVING

7.3.1 Problem solving process

- 1) Explore different kinds of problems and break down the basic anatomy of a problem.
- 2) Look at methods for successful problem solving and strategies that impede successful solutions.
- 3) Discuss three important issues related to problem solving:
 - Transfer, Incubation, Insight
- 4) Examine personality characteristics/individual differences related to problem solving:
 - Talent, Creativity, Expertise

Self-Instructional Material



Types of Problems:

Well-defined - problems with a limited set of inputs and operations that have a definite answer and a definite solution procedure.

EX: algebra problems

Fuzzy - problems with a functionally infinite set of inputs and operations with no obvious definite solution or best answer.

EX: psychology exam

Everyday problems:

I need to get to the bank, and the grocery store, mail my phone bill, go to class and show up for my job at 2:00. How can I get all of these things done?

Natural progression

- Theory vs. application
- Inside vs. outside the lab

Problem solving operators

Problem Space

The concept of a problem-solving *state* is probably the most basic term in the Newell and Simon characterization of problem solving. A problem solution can be characterized as the solver beginning in some initial state of the problem, traversing through some intermediate states, and arriving at a state that satisfies the goal. If the problem is finding one's way through a maze, the states might be the various locations in the maze. If the problem is solving the Tower of Hanoi problem, the states would be various configurations of disks and pegs. The actual reference of *state* is ambiguous. It could mean either some external state of affairs or some internal coding of that state of affairs. Newell and Simon, with their emphasis on problem solving by computer, typically took it to mean the internal coding.

The second key construct is that of a problem-solving *operator*. An operator is an action that transforms one state into another state. In the maze the obvious operators are going from one location to another, whereas in Tower of Hanoi they are various movements of disks. An operator can be characterized by what must be true for it to apply and what change it produces in the state.

Analogy and imitation

Analogies provide a way of applying (mapping) known information (source) to novel problem solving domains (target). Analogical Transfer

Depends on two factors:

Structural similarity - similar to deep structure

Surface similarity - similar to surface structure

Imitation learning, rooted in the long tradition of social learning, can be defined as a mechanism where behaviors or skills are acquired by watching others perform. “Perhaps the most important learning technique in the social domain is that of imitation, or observational learning”. In the natural world, learning by imitation makes evolutionary sense for social animals because it allows them to learn and transmit successful methods and strategies, possibly acquired over many generations.

7.3.2 Operator selection

***Difference Reduction Method* - create a number of attainable subgoals that will reduce the difficulty of the task to a series of manageable steps.**

EX: cannibal missionary problem

Generate/Test - Generate a potential solution; see how well it works.

EX: professor's age

Alternative Representations - try describing the problem space in a different modality (e.g., visual instead of verbal)

EX: Monk-Mountain problem

Army-Cannon Problem

Solution Reversal - start at the end state and try to work your way back to the beginning state.

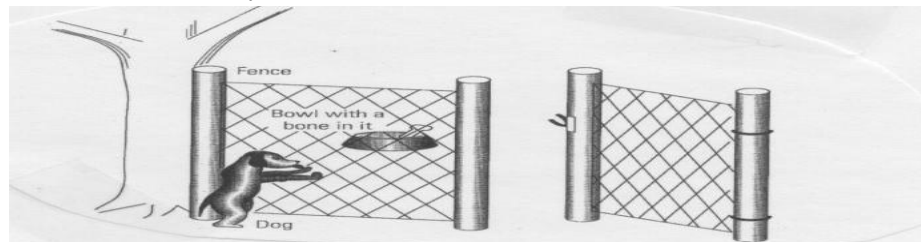
EX: Ten Pennies

Means-end analysis - create a subgoal that will allow a certain operator to become useful.

EX: Sultan the Monkey

Difference reduction - bias to make the move that will have the greatest affect on the distance to the goal state.

EX:



Difference reduction issues: People

C	O	L	D
—	—	—	—
—	—	—	—
—	—	—	—
W	A	R	M

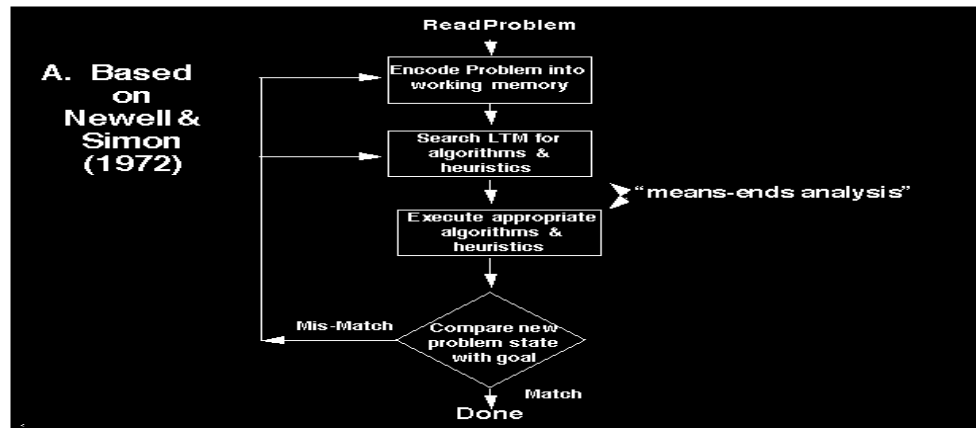
F	A	L	L
—	—	—	—
—	—	—	—
—	—	—	—
C	O	L	D

Cannibal-Missionary Problem: Difference Reduction

Three cannibals and three missionaries are the West side of the Connecticut River. As you know, there are hardly any bridges across the CT River, so the folks decide to take a boat. The only rowboat available carries two people. Your job is to get all 6 people across the river, with the following stipulation. If you leave more cannibals than missionaries on one side of the river, it's curtains for the missionaries.

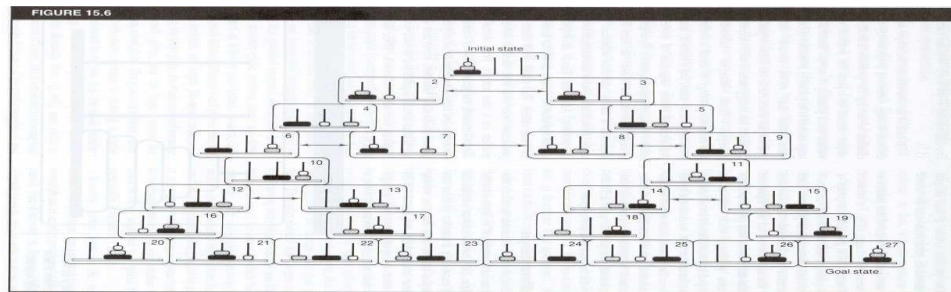
Means-Ends Analysis

Two key features often observed of human problem solving are *difference reduction* and *subgoaling*. Difference reduction refers to the tendency of problem solvers to select operators that produce states more similar to the goal state. People are very reluctant to pursue paths that temporarily take them in the direction of states less similar to the goal (see Anderson 1990b). One of K6hler's (1927) interests was to understand the difficulties various species of animals have with detour problems that require them to take a nondirect path to the goal. So the reliance on similarity is hardly unique to humans. Anderson (1990) can be consulted for arguments that this reliance on similarity is adaptive in that most problems can be effectively solved by moving in the direction of the goal. Of course, how one measures similarity can be tricky, and some kinds of problem-solving learning take the form of developing more useful ways of assessing similarity to the goal state. This is often characterized as problem solvers going beyond the surface features of a problem to its deep features (e.g., Chi, Feltovich, & Glaser. 1981). why difference reduction and subgoaling are so pervasive in human problem solving and how they relate to one another. It illustrates the logic of means –ends analysis.

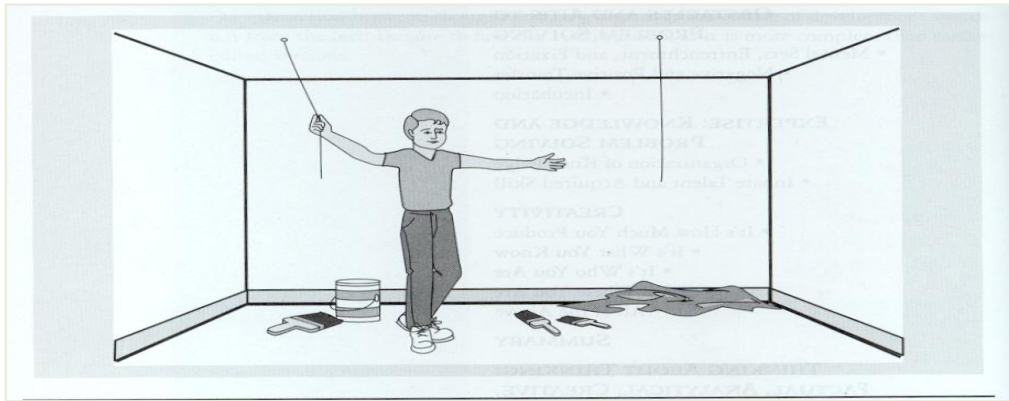


Tower of Hanoi:

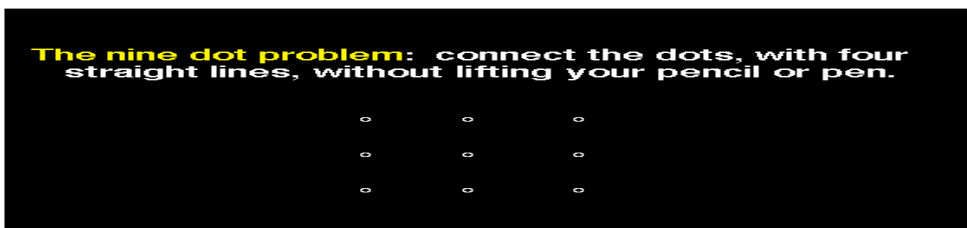
This famous puzzle tower of hanoi was invented by the French mathematician Edouard Lucas in 1883 and has been frequently used in problem-solving studies. In the three-disk version of the task, disks must be moved from peg 1 (the initial state) to peg 3 (the goal state) under specific constraints: only one disk may be moved at a time, and a larger disk may never be put on a smaller one.



In the case of Tower of Hanoi, the disk to be moved must be on top of the source peg and must be smaller than the smallest disk at the destination peg. Its effect is to change the location of the disk. Newell and Simon conceived of the problem solver as having an internal representation of the operators, their preconditions, and their effects. Together the concepts of state and operator define the concept of a *problem space*. At any state some number of operators apply, each of which will produce a new state, from which various operators can apply producing new states, and so forth. It illustrates the complete problem space for the three-disk Tower of Hanoi problem, one of the smaller of the problem spaces. As can be seen, many problem spaces are closed with only a finite set of reachable states and loops among those states. Within the problem-space conception, the problem in problem solving is *search*, which is to find some sequence of problem solving operators that will allow traversal in the problem space between the current state and a goal state.



2 string problem figure above



Characteristics of problem solving

- Goal Directedness
- Sequence of steps
- Cognitive operations
- Subgoal decomposition

7.3.3 Problem representation

We want a representation to be

- Rich enough to express the knowledge needed to solve the problem.
- As close to the problem as possible: compact, nature and maintainable.
- Amenable to efficient computation
 - It is able to express features of the problem that can be exploited for computational gain. It is able to trade off accuracy and computation time/ space. It is able to be acquired from people, data and past experience.

Creativity

a) Amount of ideas one produces

I give you a problem and ask you to create as many solutions as you can think of. I measure diversity, numerosity and appropriateness of your responses

b) It's what you know

Creative people study their domain more, so they know more, and therefore, can produce more valuable and new ideas by combining and reshaping what they already know.

c) It's who you are

openness to new ideas, new ways of thinking and seeing the world; intrinsic motivation

d) *It's where you are*

your environment (parents) and social, scientific, and artistic communities in which you are raised all play a role

Check your Progress – 1

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. Write a characteristics of problem solving

.....

.....

7.4 REASONING

7.4.1 Reasoning about conditionals

Reasoning is the action of coming to a conclusion when provided information. In reasoning, a person has to actively and skillfully conceptualize, apply, analyze, synthesize and/or evaluate information gathered from past experiences or reflections. Reasoning means inference of unknown things on the basis of known facts. Different forms of reasoning occur in different fields like philosophy, psychology, mathematics, computer science, law, medical and logic mathematics..

According to Skinner (1968), “Reasoning is the word used to describe the mental recognition of cause and effect relationships. It may be prediction of an event from an observed cause or the inference of a cause from an observed event.” Skinner emphasizes on mental recognition of cause and effect relationships.

Characteristics of Reasoning

Characteristics of Reasoning given by psychologists are as under (C.P.Patel, 1991; M.S.Ansari, 2007):

1. It is needed when we can not arrive at solution of a problem by applying direct approach of responding.
2. It helps in developing insight for learning or problem solving.
3. It goes in the direction given to the learner, i.e., it is always goal directed.
4. It is productive thinking not wastage of time or energy. We get something after employing the process.
5. It works as an important tool for solving problem.
6. It is creative and reflective in nature.
7. It is a function of intelligence. A dull child is not supposed to employ reasoning process.
8. It is inductive and deductive both.
9. Reasoning Ability develops gradually. It means that experiences are also

helpful in developing reasoning power along with intelligence.

10. There may be more than one logic to draw an inference, i.e., reasoning is multi dimensional.

Wason Selection Task

The Wason Selection Task, is one of the most repeated tests of logical reasoning in the world of experimental psychology. In this task, the subject is given a conditional rule ‘If antecedent (P) then subsequent (Q)’ that applies to four cards placed in front of him, facing upwards. An example of it is:

Subjects are shown a set of four cards placed on a table, each of which has a figure on one side and a colored patch on the other side. They have to ensure that cards have been produced in accordance with the following rule: *“If a card has a circle on one side, then it has the color yellow on the other side.”*

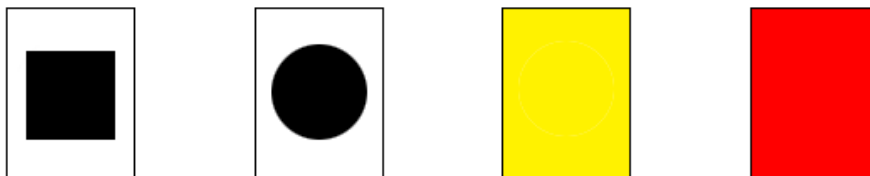


Figure 1. Wason Selection Task (borrowed from [2])

The correct response is to turn cards 2 and 4. However, in this test, less than 10% of the subjects found the correct solution. Evolutionary psychologists hypothesize that subjects find the Wason task much easier to solve if it is placed in the context of a social rule that they are asked to enforce. This suggests that humans “solve the social-rule problem with a specialized mental module that evolved to catch cheaters in a social environment.” For instance, the following rule: *“If a person drinks an alcoholic drink, then they must be over the age of 21 years old.”*



Figure 2. Wason Selection Task set in context of a social rule (borrowed from [2])

A higher percentage of subjects did succeed in this task. This experimental evidence supports the aforementioned hypothesis that the task proves to be easier if the rule to be tested is one of social exchange and the subject is asked to enforce the rule. This supports the claim of evolutionary psychologists that certain features of human psychology could be “mechanisms that have evolved, through natural selection, to solve specific problems of social interaction, rather than expressions of general intelligence.”

Permission schema

permission schemas might not have a logical structure that is equivalent to conditional logic. A second experiment examined selection task performance using the same two relations in context. Performance on the permission schema was superior to that found with the relation of multiple causality.

Probabilistic interpretation

There are two broad categories of **probability interpretations** which can be called "physical" and "evidential" probabilities. Physical probabilities, which are also called objective or frequency probabilities, are associated with random physical systems such as roulette wheels, rolling dice and radioactive atoms. In such systems, a given type of event (such as a die yielding a six) tends to occur at a persistent rate, or "relative frequency", in a long run of trials. Physical probabilities either explain, or are invoked to explain, these stable frequencies. The two main kinds of theory of physical probability are frequentist accounts.

Types of Reasoning

Aristotle was the first writer to give an extended, systematic treatment of the methods of human reasoning. He identified two major methods of reasoning, analysis and synthesis. Analytical reasoning is known as deductive reasoning and synthetically reasoning as inductive reasoning. Formal logic has been described as the science of deduction. The study of inductive reasoning is generally carried out within the field known as informal logic or critical thinking. Reasoning is divided into two broad types, (A) Deductive Reasoning and (B) Inductive Reasoning.

7.4.2 Deductive Reasoning

Conditional reasoning is basically reasoning with "if". It has been studied to decide if human reasoning is logical. In propositional logic, meanings are different from those in natural language. Deductive reasoning may be defined as the ability to draw logical conclusions from known statements or evidences or principles. Here, one starts with some already known or established generalized statement or principle and applies it to specific cases. In deductive reasoning, arguments claim to provide logically conclusive ground for their conclusions.

Syllogistic reasoning

A *syllogism* consists of two premises or statements followed by a conclusion. The validity of the conclusion depends only on whether it follows logically from the premises. *Belief bias* is when people accept believable conclusions and reject unbelievable conclusions, irrespective of their logical validity or invalidity. Klauer et al. (2000) found various biases in syllogistic reasoning, including a base-rate effect, in which performance is influenced by the perceived probability of syllogisms being valid. Stuppel and Ball (2008) found with syllogistic reasoning that people took longer to process unbelievable premises than believable ones. Stuppel et al. (2013) found participants were more likely to accept conclusions that matched the premises in surface features than those not matching.

Conditional reasoning has its origins in a system of logic known as propositional logic. Performance on conditional reasoning problems is

typically better for the modus ponens inference than for other inferences (e.g., modus tollens). Conditional reasoning is influenced by context effects (e.g., the inclusion of additional premises).

Hypothetical Syllogism (Modus Ponens)

A syllogism is simply a three line argument that consists of exactly two premises and a conclusion. A hypothetical syllogism is a syllogism that contains at least one hypothetical or conditional (i.e., if-then) premise. So that such type of deductive reasoning is also known as conditional reasoning. Here is an example, Premise-1: If there is a heavy rain, the streets will be full of water. Premise-2: There is a rain.

Categorical Syllogism

Here, the reasoning is depended upon some categorical statements; statements of the premises begin typically with “all”, “none” or “some” and conclusion start with “therefore” or “hence”. Here is an example, All crows are birds. All birds lay eggs. Therefore, all crows lay eggs.

7.4.3 Inductive Reasoning

The statement or proposition is based on general observations and experiences; such reasoning is called as inductive reasoning. Inductive reasoning contrasts strongly with deductive reasoning. Even in the best or strongest cases of inductive reasoning, the truth of the premises does not guarantee the truth of the conclusion. Here is an example of inductive reasoning, a child prepares a boat from newspaper and put it into water during raining, after rain try to put it in bath-tube and check it. The child replicate this experiment several time in differ places and come to the conclusion that the paper boat can float on water for some time. This type of behavior or generalization is inductive reasoning.

Atmosphere hypothesis

A common form error in categorical reasoning in which you accept a conclusion as valid if it contains the same quantifier – ‘some’, ‘all’, or ‘no’ – as appears in the premises. The use of these terms in the two premises conveys an overall mood that leads participants to accept a conclusion containing the same term.

Process explanation

The four-step approach to solving problems that we mentioned at the beginning of this article will serve you well in many situations. However, for a more comprehensive process, you can use Simplex, Appreciative Inquiry or Soft Systems Methodology (SSM). These provide detailed steps that you can use to solve a problem effectively.

Dual-process theories

There are two process involved in human reasoning:

- One system involves unconscious processes and parallel processing, and is independent of intelligence.
- The other system involves conscious processes and rule-based serial processing, has limited capacity and is linked to intelligence.

Hypothesis formation and testing

Hypothesis Testing is vital because in the real world one should be much more interested in the population even though it is the sample data that helps to understand the population. It is essential in problem solving to know what the population is doing. Using the Hypothesis Testing procedure, this chapter shows how to test a population is performing against a specific mean. It starts comparing variances and means for two populations. The chapter discusses: 1 Sample t Test for comparing the mean of a population to a target value; Paired t Test for comparing the means of two dependent populations; 2 Variances Test for comparing the levels of variation of two independent populations; 2 Sample t Test for comparing the means of two independent populations. It uses examples to consider each of the tests.

Karl Popper (1968) argued for a distinction between confirmation and falsification: *Confirmation* involves obtaining evidence to confirm the correctness of one’s hypothesis. *Falsification* involves attempting to falsify hypotheses by experimental tests.

Check your progress -2
Note: a. Write your answer in the space given below
b. Compare your answer with those given at the end of the unit
1. List out the types of Reasoning
.....
.....

7.5 SUMMARY

Many of the brain areas linked to perception, attention, and memory are also highly involved in reasoning and problem solving. There is a very good reason for this—reasoning and problem solving are typically highly demanding of attention and memory. You must determine the goal of the current problem; you must perceive and extract there levant properties of the current stimulus that will assist you to meet this goal; and, while keeping the current goal active in working memory, you must determine how the current features of the stimulus relate to the current goal and which operations to perform next. There quisite preliminary visual feature analyses, object identification, and object location analyses would utilize resources in the occipi-tal, temporal, and parietal lobes, respectively.

7.6 UNIT END ACTIVITY

1. What is the nature of problem solving?
2. How do we use heuristics or“ mental shortcuts” to solve problems?
3. How do we use analogies to solve new problems?
4. What is the difference between induction and deduction?
5. How do our knowledge and beliefs influence “logical” reasoning?
6. How do our brains coordinate the vast amount of processing involved in problem solving and reasoning?

7.7 ANSWERS IN CHECK YOUR PROGRESS

1. i. Goal Directedness ii. Sequence of steps iii. Cognitive operations
iv. Subgoal decomposition
2. Deductive Reasoning, Syllogistic reasoning.

7.8 SUGGESTED READINGS

1. Luchins, A. S. (1942). Mechanization in problem solving: The effect of Einstellung. *Psychological Monographs*, 54 (Whole No. 248).
2. Öllinger, Jones, & Knoblich (2008). Investigating the effect of mental set on insight problem solving. *Experimental Psychology*, 55(4), 269–270.
3. Jump up to:^a Wiley, J (1998). "Expertise as mental set: The effects of domain knowledge in creative problem solving". *Memory & Cognition*. 24 (4): 716–730. doi:10.3758/bf03211392.

Problem Solving and
Reasoning

NOTES

Self-Instructional Material

UNIT 8: SENSATION AND PERCEPTION

Sensation and Perception

NOTES

8.1 INTRODUCTION

Perception is the impression made by an object through processes of sensory organs and central nervous system. Perception is sensation plus meaning. Sensations tell us the qualities like colour, taste, sound or smell and perceptions interpret them as objects. Perception is a process but it may be analysed into two factors. It involves sensation through the stimulation of a sense organ and an interpretation of the sensation. We sense qualities: we perceive objects. The two processes involved in perception stand out separately in daily experience.

Perception, is a combination of sensation and thought.(the true beginning of knowledge) sensations give us only the raw material of knowledge and perception is the first step by which that material is elaborated into a definite knowledge of the external world, the attributes and relations of objects outside us. It brings us in direct contact through their sensible qualities and connects them with previous experience so as to enable us to locate that thing in our system of knowledge.

Attempts to differentiate between sensation and perception go far back into the history of philosophical and psychological thought. A simple discrimination between the two functions can be expressed thus: sensations are the elementary impressions gathered by sense-organs with little or no interpretation given by the central nervous system.

The Epistemology of Perception



8.2 OBJECTIVES

- To study the different theories of perception.
- To study the different laws of perception and sensation
- To study the sensational, perceptual phenomena and its different scientific explanations.

8.3 THE BOTTOM-UP THEORIES OF PERCEPTION EXPLANATION

The characteristic feature of bottom-up theories of perception is the fact that the content and quality of sensory input play a determinative role in influencing the final percept. Sensory input, in their view, represents the cornerstone of cognition and by its own nature it determines further

Self-Instructional Material

sensory data processing. For example, when perceiving a tree, our sensors collect the basic data (such as points, horizontal or vertical lines) as the main individual characteristics of the object which are later connected to build more complex, assembled surfaces and shapes in order to create complex perception of the object we identify as a tree. Therefore, we call this data-driven processing perception. With respect to the emphasis these theories put on the nature of sensory input, it is no surprise that most of them significantly correlate with philosophical realism, which suggests that our percepts are directly induced by external objects and more or less correspond to them. A typical prototype of such direct realism is Gibson's theory of direct perception.

8.3.1 Gibson's theory of direct perception

J. J. Gibson believed that our cognitive apparatus was created and formed by a long evolutionary influence of external environment which is apparent in its structure and abilities. We learned to extract precisely the information which is necessary for our survival. In accordance with Darwin's assumption, the pressures of the environment caused our receptors to be created and formed so that they became sensitive to relevant stimulus from the environment and they adapted to the environment. Such interpretation of perception is called the ecological one because it attributes the determinative role to the environment and to its influence on the whole process of perception.

The basis of Gibson's theory is the conviction that our perception is determined by optical flows — optic arrays, which Gibson is regarded as some sort of structures or patterns of light in the environment. The visual terminology he was using is not important since, analogically, it can be used for auditory or tactile components of perception. Gibson believed that a human perceives objects (their sensory qualities) in a way by which packets of information arrays determined (structured) by objects, enter his sensors. The beams of light reflect off the surface of objects and thus, carry the information about their shape, size, texture, etc. Similarly, our ears are impacted by arrays of vibrating waves or by the influence of tangible objects. These information beams — arrays — form an extremely broad set of information flows, as in our environment there are billions of beams impacting our receptors from the entire perception field we happen to be in.

Gibson thought, the main part of information contained in information beams around us is invariant. This is a result of the fact that we perceive reality which is independent of us and our position is only a slight determinant of what we are able to capture from the world. So, if we change our position, we are changing a set of information that is available to us, but we are not changing reality itself. Information structures such as texture gradient, optical array and horizon-ratio relation are some of the key points of our environment.

The texture gradient is created, if there are elements which, by gradual increase of distance from the observer, gather in his vision field into more

and more compact formations.

8.3.2 Features of Gibson's Theory

The optic array

The starting point for Gibson's Theory was that the pattern of light reaching the eye, known as the optic array, containing all the visual information necessary for perception

This optic array provides unambiguous information about the layout of objects in space. Light rays reflect off of surfaces and converge into the cornea of your eye.

Perception involves 'picking up' the rich information provided by the optic array in a direct way with little/no processing involved.

Because of movement and different intensities of light shining in different directions it is an ever changing source of sensory information. Therefore, if you move, the structure of the optic array changes.

According to Gibson, we have the mechanisms to interpret this unstable sensory input, meaning we experience a stable and meaningful view of the world.

Changes in the flow of the optic array contain important information about what type of movement is taking place. The flow of the optic array will either move from or towards a particular point.

If the flow appears to be coming from the point, it means you are moving towards it. If the optic array is moving towards the point you are moving away from it.

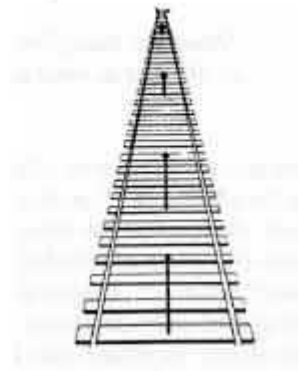
8.3.3 Invariant Features

The optic array contains invariant information that remains constant as the observer moves. Invariants are aspects of the environment which don't change. They supply us with crucial information.

Two good examples of invariants are texture and linear perspective.



Texture Gradient
giving the
appearance of
depth



Linear Perspective

Parallel lines, eg railway tracks, appear to converge as they recede into the distance.

Sensation and Perception

Another invariant is the horizon-ratio relation. The ratio above and below the horizon is constant for objects of the same size standing on the same ground.

Affordances

Are, in short, cues in the environment that aid perception. Important cues in the environment include:

OPTICAL ARRAY: The patterns of light that reach the eye from the environment.

RELATIVE BRIGHTNESS: Objects with brighter, clearer images are perceived as closer

TEXTURE GRADIENT: The grain of texture gets smaller as the object recedes. Gives the impression of surfaces receding into the distance.

RELATIVE SIZE: When an object moves further away from the eye the image gets smaller. Objects with smaller images are seen as more distant.

SUPERIMPOSITION: If the image of one object blocks the image of another, the first object is seen as closer.

HEIGHT IN THE VISUAL FIELD: Objects further away are generally higher in the visual field

8.3.4 Pros and cons of the theory of direct perception

The theory of direct perception faces many serious problems. By a series of experiments it has been proven, that starting first with rodents, it is necessary and quite effective to form mental representations and involve memory tracks when integrating with the world. Rodents, mammals and

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mainly all the primates reach better results in an environment they had lived before, which points out the importance of mental maps. Gibson's theory is also unable to explain the plethora of visual illusions such as the Ames room, which prove the importance of previous experience for assessing visual stimuli. The most significant shortcoming of the herein presented theory is the concept of affordance. The statement that a visual field can offer us a sufficient amount of information about the usage of objects independent of our previous experience is very problematic. The theory of direct perception does not address the question of visual field organization, to gestalt figures and it completely ignores the difference between seeing the object and understanding it as a particular object. This is precisely the moment that may be considered as one of the most significant differences between the ecological theory of J. J. Gibson and constructivist theories.

Check your progress – 1

Note: a. Write your answer in the space given below
 b. Compare your answer with those given at the end of the unit

1. What is perception

.....

8.4 THE TOP-DOWN INDIRECT PERCEPTION THEORIES

The key feature separating the top-down theories and the bottom-up theories is the participation of higher cognitive functions in the process of perception in the form of support of discrimination and interpretation of perceived contents. While top-down theories prefer direct perception without participation of knowledge and previous experience, according to the theories of indirect perception, perception is possible only by means of mental representation, computation or creating a picture of a given reality. Sensory data must be organized and captured by cognitive apparatus and then interpreted on the basis of available knowledge. The philosophical basis for this approach to perception is The Critique of Pure Reason by Kant. According to this work, thoughts without content (Inhalt) are empty (leer), intuitions without concepts are blind (A50–51/B74–76). Only by understanding (begreifen) the image (e.Anschauung) via a concept (r.Begriff) one realizes, what he is experiencing and only then can we call this cognition.

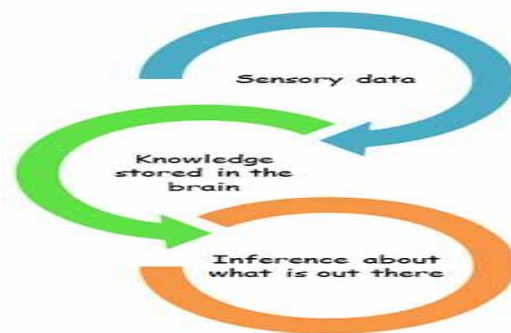
8.4.1 Constructivist theories

Constructivist theories assume that the process of perception is a highly active process of extracting sensory stimuli, their evaluation, interpretation and backward organization of sensory stimulus. Perception is the end product of the interaction between stimulus and internal hypotheses, expectations and knowledge of the observer, while motivation and

emotions play an important role in this process. Perception is thus influenced by a wide range of individual factors that can lead to an inadequate interpretation. (Eysenck, Keane, 2008, 74).

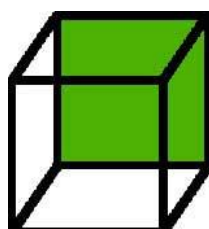
8.4.2 Gregory's theory

One of the most popular constructivist theories of perception is Gregory's theory. While Gibson integrated the phylogenetic flow of time (the influence of evolution on cognitive apparatus) into the process of perception, Gregory used also the flow of ontogenetic time. He claims that sensory data found on receptors are just some sort of energy samples, but they are of no great importance themselves. Their importance is based on our previous experience. Data have the past and the future; they change themselves and they influence each other. They have some hidden aspects that emerge only if influenced by various conditions. (Gregory, 1990, 219). Gregory believes this process, just like any other similar process of reading, requires higher cortex centers activity and learning. Perception is a matter of receptors as well as of brain. The name of his book *Eye and Brain* follows this idea.



Gregory often points out that for interpretation of sensory data, experience is more important than sensory image. Our conclusions about stimuli such as the Müller-Lyer Illusion or the Ponzo Illusion prove that. We perceive both by using our experience with spatial perception, which we apply to two-dimensional outlines. We suppose that two parallel lines of the same size are not of the same length because they are bordered by opposite oriented arrows. Gregory believes, we interpret this illusion (drawing) through our experience with the distant corner of a room versus the near corner of a building. Also in a Ponzo Illusion, we use the rules of perspective to interpret the size of objects.

8.4.3 Evidence to Support Gregory's Theory Perceptions can be ambiguous



The Necker cube is a good example of this. When you stare at the crosses on the cube the orientation can suddenly change, or 'flip'. It becomes unstable and a single physical pattern can produce two perceptions. Gregory argued that this object appears to flip between orientations because the brain develops two equally plausible hypotheses and is unable to decide between them. When the perception changes though there is no change of the sensory input, the change of appearance cannot be due to bottom-up processing. It must be set downwards by the prevailing perceptual hypothesis of what is near and what is far.

8.4.4 Evaluation of Gregory's theory

One of the main features of Gregory's concept is the fact that it is able to clarify the reasons of our errors and inaccuracies quite well. It seems that contrary to Gibson, Gregory found mechanisms for explaining illusions and reasons why our perception is so complex and holistic. One of the greatest advantages of his approach is that while speaking of the process of perception, it takes into account our personal history and that he understood that to operate with sensory data does not necessarily mean to perceive, but to perceive always means to integrate feelings into a broader context of our beliefs and opinions. On the other hand, it is necessary to add, that there are some shortcomings to be found in Gregory's theory. One of them is its inability to satisfactorily explain the relative correctness and universality of most of our daily perceptions. Despite having quite different personal histories, motivations, expectations and emotional statuses, our perceptions are nearly identical. If our perception is determined by construction of internal hypotheses and mental models, it is surprising that they are so universally widespread and that they are so similar, almost identical when dealing with the same stimuli.

8.4.5 Computational theories

Another example of the bottom-up theories are computational theories. The core of their approach is the expansion of Helmholtz's belief in unconscious inference and evaluation of sensory stimuli. Proponents of computational theories are trying to solve the issue of perception by eliminating the question of conscious experience, while at the same time utilizing some of Gregory's premises. They believe that perception is not determined by conscious intentionality or motivation, but that it is being operated by relatively easy mechanical rules which can be applied to unconscious entities as well. A typical example of developing computational theories is the field of applied informatics and artificial intelligence.

8.4.6 Marr's model of perception

David Marr approached perception as problem solving. According to him, to find a solution, it is important to analyze what the visual system should do in order to make the perception successful. Marr called this level computational since it assumes that each function (perception is a function) can be understood as a computational operation (consisting of sequenced steps) leading to a desired outcome. Marr's second level specifies a representation system which identifies inputs with algorithms, that

transform inputs into representations. A second level of solving a problem is a detailed analysis of specific actions which we must take while transforming physical stimuli into mental representations. A third problem is the analysis of the means enabling us to carry out a specific operation. This level is called the hardware level (Rookes, Willson 2000, 34) or implementation level. Full 3D vision assumes a high level of conceptualization. While in 2D, a sketch we suppose the plasticity of the object, understanding of the 3D vision also involves what we do not see. If we are looking at a sphere or a cube, we never see the front and the back part at the same time. The fact, that it is three-dimensional or it has the back part as well, is just our belief — our understanding of the object as a 3D geometrical entity. Such understanding is not based on visual experience (we never see the back part), but on logic — on our understanding of things as three-dimensional objects.

8.5 VISUOSPATIAL PERCEPTION

This is one component of cognitive functioning and it refers to our ability to process and interpret visual information about where objects are in space. This is an important aspect of cognitive functioning because it is responsible for a wide range of activities of daily living. For instance, it underlies our ability to move around in an environment and orient ourselves appropriately. Visuospatial perception is also involved in our ability to accurately reach for objects in our visual field and our ability to shift our gaze to different points in space. The association areas of the visual cortex are separated into 2 major component pathways, and are believed to mediate different aspects of visual cognition.

Check your progress – 2

Note: a. Write your answer in the space given below
b. Compare your answer with those given at the end of the unit

1. Define Constructivist theories

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8.6 PERCEPTUAL PHENOMENA

8.6.1 Constancy

Constancy refers to how our perception of objects remains the same despite changes in their image on the retina. Constancy is seen in the perception of a number of different properties of objects such as size, shape, color, and orientation.

Size constancy refers to perceiving familiar objects as approximately the same size regardless of their distance from the observer. Thus, for example,

a person's size does not appear to expand or contract as they come toward you or move away, even though their image on the retina does become larger and smaller based on their distance.

Shape constancy refers to an object's shape being perceived as remaining the same despite being viewed from different perspectives with different shapes being projected onto the retina. A circular shape such as a pie on a table for example, is still perceived as circular even when you sit down at the table and perceive it from the side. This is despite the fact that circles viewed from the side produce not circular but elliptical images on the retina.

Perceptual constancy is one of the hallmarks of the field of perception, for it strongly indicates that visual perception involves more than the direct registration of the retinal image in the brain. Without perceptual constancy the world would be perceived as a booming blur of chaotic confusion in which the sizes, shapes, and colors of objects would be constantly shifting. Thus it can be seen that perceptual constancy serves an important adaptive function.

8.6.2 Perception of motion

The perception of motion has been the subject of much research. The mystery lies in how perceived movement cannot be accounted for by the movement of an object's image across the retina. If that were so, movement of the observer, or eye movement would lead to perceived object movement. For example, while riding a bike, the rest of the world would be perceived as moving. Another phenomenon of motion perception that cannot be fully explained by sensory processes involves saccades, which are rapid directed eye movements. Because the eye sees detail only in a small area in the center of the eye called the fovea, in order to obtain detailed information from any object or scene, the eye must perform saccades so that the fovea receives enough information. Yet, the images of stationary objects do not appear to move even when their retinal image moves due to saccades.

8.6.3 Form perception

Form perception is what enables us to identify objects and distinguish them from each other. Rather than a loose grouping of apparently separate stimuli, we see the world as organized with interrelated objects having definite shapes and forms. And as with many other perceptual phenomena, the light projected onto the retina from objects cannot account for our visual perception of the world. It seems perceiving form involves certain organizational principles, many of which were discovered by the Gestalt school of psychology. These rules or principles illustrate our tendency to organize and group separate elements of the visual world. In the figure-ground rule, Gestalt psychologists found that when looking at unfamiliar scenes, familiar or consistent shapes tend to stand out as figures, and unfamiliar or undifferentiated shapes are perceived as the background.

8.6.4 Depth perception

This entails perceiving the three-dimensionality of the world and objects. This clearly involves more than the nature of images sent to the retina since the retina has a two dimensional surface and images projected onto it are two-dimensional. In the 1800s researchers discovered that our binocular vision greatly aids depth perception. Binocular vision refers to having two eyes that are at slight distances from one another, so that each receives a slightly different perspective of the object or scene being focussed upon. It seems that these small differences in perspective greatly aid depth perception. The ears also use the slight differences in time between stimulation received to locate the source of sounds.

8.6.5 Illusions

Illusions are misperceptions of stimuli, where what is perceived does not correspond to the actual dimensions or qualities of the physical stimulus. Geometrical illusions usually involve the misperception of the direction or size of parts of figures.

8.6.6 Classical theory

What is sometimes referred to as classical theory is usually associated with Hermann von Helmholtz who believed perception results from a process of unconscious inference about what the stimulus affecting the sense organs is most likely to be. He thought these unconscious inferences are formed by past experiences and learning, and they are unconscious because people are clearly not aware of making them.

8.6.7 Gestalt theory

Probably the most well-known theory of perception, Gestalt theory, developed partly as a reaction against the view that perception could be broken into simpler elements and that it was the result of learned mental associations between simple sensations. This view, the basis of Helmholtz's theory, was also put forth without the process of unconscious inference by such famous psychologists as W. Wundt and E.B. Titchener. Gestalt theory, founded by K. Koffka, W. Köhler, and M. Wertheimer, argued that while simple sensations could be seen as making up organized perceptions, our nervous system is primed to perceive the organization of sensory stimuli over the individual sensory elements themselves. The process of organization is basic to perception, and the common saying, "the whole is greater than the sum of its parts," illustrates this important concept.

8.6.8 Psychophysical or direct theory

This theory as put forth by J. J. Gibson holds that perception may be fully explained by the properties of the stimulation we receive from the world interacting with our sensory capabilities. Characteristics of scenes and events in the physical world may give sufficient information for the

nervous system to be able to specify them.

8.6.9 Modern sensory physiology

This theory proposed by E. Hering and E. Mach believes the structure of the nervous system may fully explain at least some perceptual constancies as well as depth perception. E. Hering also proposed that there may be visual receptor cells organized into certain functional patterns that provide color sensation.

8.6.10 Emotion

Reflecting a trend across psychology as a whole, there has been a renewed and increased interest in how emotion influences perception and attention. This research investigates such questions as how emotion influences the focus and duration of attention, how quickly the emotional meaning of various stimuli can be processed, and whether individuals attend to positive and negative stimuli in different ways.

8.6.11 Neuropsychology

Neuropsychologists study changes in thinking due to brain injury, and use brain imaging techniques such as magnetic resonance imaging (MRI) and positron emission tomography (PET) scans, to examine the activity of the brain while performing high-level mental tasks such as problem-solving. A number of their findings have challenged explanations of perception based on behavioral studies. And improvements in brain imaging techniques hold the promise of shedding even more light on the neural basis of perception

8.6.12 Ecological psychology

Ecological psychology attempts to specify the unchanging and limiting aspects of perceptual stimuli in the environment. They also stress how the nature of perceptual stimuli supports perception. This approach is most closely associated with the psychologist J.J. Gibson.

8.6.13 Artificial intelligence

This is an interdisciplinary field combining research and theory from cognitive psychology and computer sciences. It focuses on the development of artificial systems, such as computers, that show thinking processes similar to humans. This approach believes that for a complete explanation of perception it is necessary to divide it into three levels of analysis: 1) hardware or its physiological aspects, 2) algorithms for operation or what the processes of perceiving are, and 3) the theory of the task to be performed or what are the qualities of our environment that enable perception. It is hoped that these divisions will serve as an important intellectual tool and aid our understanding of perception. Perception is a field ripe with unanswered questions that continues to fascinate researchers who may greatly benefit from new technologies and new perspectives.

Check your progress – 3

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. What is the Ecological Psychology?

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8.7 SUMMARY

In this Unit you have studied in detail about sensation and perception theories.

8.8 UNIT –END ACTIVITY

Explain Gestalt principles of perceptual organization.

1. Discuss pros and cons of the theory of Direct Perception
2. Explain perceptual phenomena

8.8 ANSWERS IN CHECK YOUR PROGRESS

1. Perception is the impression made by an object through processes of sensory organs and central nervous system .
2. Constructivist theories assume that the process of perception is a highly active process of extracting sensory stimuli, their evaluation, Interpretation and backward organization of sensory stimulus.
3. Ecological psychology attempts to specify the unchanging and limiting aspects of perceptual stimuli in the environment. They also stress how the the nature od perceptual stimuli supports perception. This approach associated by J.J.Gibson.

8.9 SUGGESTED READING

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Sensation and Perception

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Self-Instructional Material

UNIT 9: CLASSICAL AND MODERN PSYCHOPHYSICS

Classical and Modern
Psychophysics

NOTES

9.1 INTRODUCTION

Psychophysics is the scientific study of the relationship between stimuli (specified in physical terms) and the sensations and perceptions evoked by these stimuli. The term *psychophysics* is used to denote both the substantive study of stimulus-response relationships and the methodologies used for this study. Psychophysics is the study of physical stimuli and their relation to sensory reactions. Of the energy that strikes the sensory surfaces of man and the animals, only a restricted fraction is capable of eliciting a reaction. Thus, visual responses in man are triggered by a narrow band of the vast electromagnetic spectrum (wavelengths between about 400 and 750 milli microns); and auditory responses result from periodic displacements of the eardrum in the frequency range from about 20 to 20,000 cycles per second (cps). Over these stimulus ranges, neither the eye nor the ear is uniformly responsive: to produce a sensation may require thousands of times more energy at one wavelength or frequency than at another. It is the goal of psychophysics to map out the relations between the physical events and the psychological responses of organisms, and thus to provide a basic, over-all description of the function of the senses.

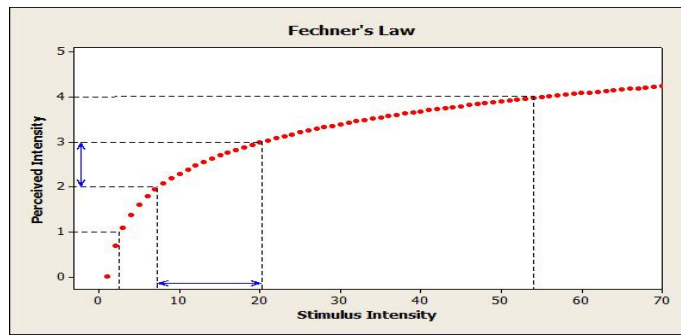
9.2 OBJECTIVES

- a. To give you some idea of what subjects experience when participating in a psychophysical threshold experiment.
- b. to gain experience in psychophysical methods and calculation of threshold under the various methods.
- c. To begin to understand how it is possible to learn about the operation of human sensory systems.

9.3 FECHNER'S LAW

Weber's brother-in-law, Gustav Fechner, took the field a noticeable step forward in 1860 with the publication of his *Elements of psychophysics*. Fechner was able to estimate precisely how intensely a person would report experiencing a sensation based on the amount of stimulus energy actually present. He assumed that for any given stimulus, all ends (just noticeable difference) are created equal; that is, each additional end feels subjectively like one incremental (additional) unit in intensity. He recognized that at low stimulus intensities, only marginal increases in stimulation are required to produce subjective effects as large as those produced by enormous increases in stimulation at high levels of intensity.

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9.4 WEBER'S LAW

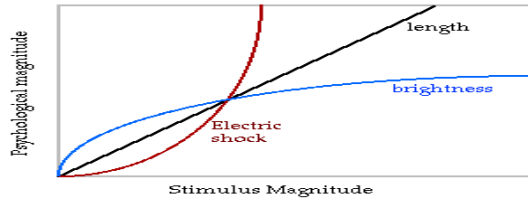
In 1834, the German physiologist recognized not only this lack of a one to one relationship between the physical and psychological words but also the existence of a relationship between them. Regardless of the magnitude of two stimuli, the second must differ from the first by a constant proportion - for eg, it must be a tenth larger - for it to be perceived as different. This relationship is called Weber's law. That constant proportion - the ratio of change in intensity required to produce a jnd compared to the previous intensity of the stimulus - can be expressed as a fraction, called the Weber fraction.

The Weber fraction

The Weber fraction varies depending on the individual, stimulus, context and sensory modality. For eg, the Weber fraction for perceiving changes in heaviness is 1/50. This means that the average person can perceive an increase of one pound if added to a 50 pound bag, two pounds added to 100 pounds, and so forth. The Weber fraction for a sound around middle C is 1/10, which means that a person can hear an extra voice in a chorus of 10 but would require two voices to notice an increase in loudness in a chorus of 20.

9.5 STEVENS' S POWER LAW

Fechner's law was modified by S.S.Stevens (1961, 1975) because it did not quite apply to all stimuli and senses. For eg, the relation between perceived pain and stimulus intensity is the opposite of most other psychophysical relations:



According to Stevens's power law as the perceived intensity of a stimulus grows arithmetically, the actual magnitude of the stimulus grows exponentially, that is, by some power (squared, cubed, etc.). The exponent varies, however, for different senses, just as the weber fraction varies. Where the exponent is larger than 1, however, as for sensations produced by electric shock (where the exponent is 3.5), the magnitude of sensations grows quite rapidly as stimulation increases. Thus, Stevens's power law can predict subjective experiences of pain intensity as readily as brightness.

Check your progress – 1

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

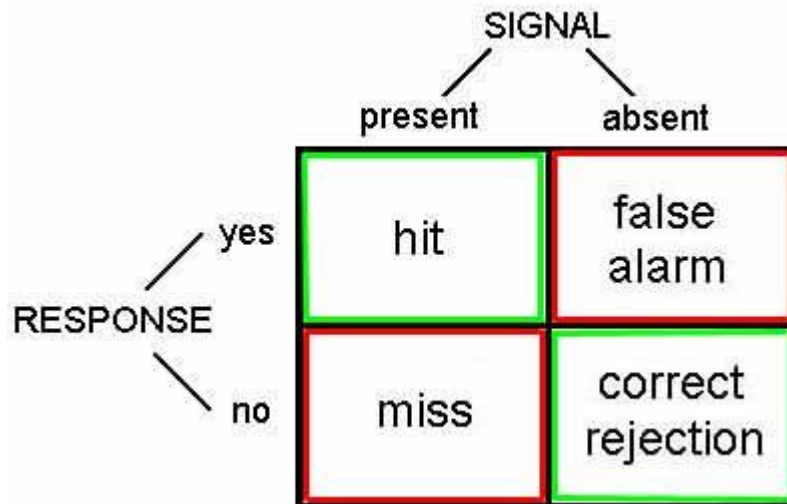
1. Write down the weber fraction?

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9.6 SIGNAL DETECTION THEORY

Information and Criterion

I begin here with a medical scenario. Imagine that a radiologist is examining a CT scan, looking for evidence of a tumor. Interpreting CT images is hard and it takes a lot of training. Because the task is so hard, there is always some uncertainty as to what is there or not. Either there is a tumor (signal present) or there is not (signal absent). Either the doctor sees a tumor (they respond "yes") or does not (they respond "no"). There are four possible outcomes: hit (tumor present and doctor says "yes"), miss (tumor present and doctor says "no"), false alarm (tumor absent and doctor says "yes"), and correct rejection (tumor absent and doctor says "no"). Hits and correct rejections are good. False alarms and misses are bad.



There are two main components to the decision-making process: information acquisition and criterion.

Information acquisition: First, there is information in the CT scan. For example, healthy lungs have a characteristic shape. The presence of a tumor might distort that shape. Tumors may have different image characteristics: brighter or darker, different texture, etc. With proper training a doctor learns what kinds of things to look for, so with more practice/training they will be able to acquire more (and more reliable) information. Running another test (e.g., MRI) can also be used to acquire more information. Regardless, acquiring more information is good. The effect of information is to increase the likelihood of getting either a hit or a correct rejection, while reducing the likelihood of an outcome in the two error boxes.

Criterion: The second component of the decision process is quite different. For, in addition to relying on technology/testing to provide information, the medical profession allows doctors to use their own judgement. Different doctors may feel that the different types of errors are not equal. For example, a doctor may feel that missing an opportunity for early diagnosis may mean the difference between life and death. A false alarm, on the other hand, may result only in a routine biopsy operation. They may choose to err toward "yes" (tumor present) decisions. Other doctors, however, may feel that unnecessary surgeries (even routine ones) are very bad (expensive, stress, etc.). They may choose to be more conservative and say "no" (no tumor) more often. They will miss more tumors, but they will be doing their part to reduce unnecessary surgeries. And they may feel that a tumor, if there really is one, will be picked up at the next check-up.

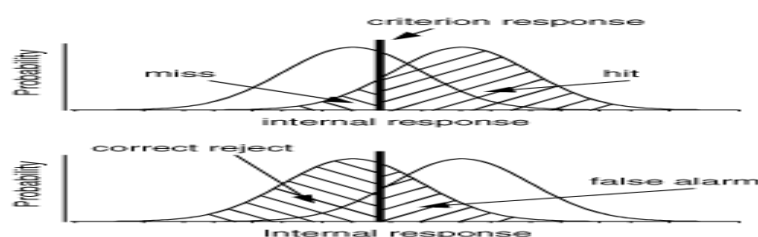


Figure: Internal response probability of occurrence curves for noise-alone and signal-plus-noise trials. Since the curves overlap, the internal response for a noise-alone trial may exceed the internal response for a signal-plus-noise trial. Vertical lines correspond to the criterion response.

Check your progress – 2

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. Name the components of the decision making process

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9.7 THE RECEIVER OPERATING CHARACTERISTIC

We can describe the full range of the doctor's options in a single curve, called an *ROC curve*, which stands for receiver-operating characteristic. The receiver-operating characteristic captures, in a single graph, the various alternatives that are available to the doctor as they move their criterion to higher and lower levels.

ROC curves are plotted with the false alarm rate on the horizontal axis and the hit rate on the vertical axis. We already know that if the criterion is high, then both the false alarm rate and the hit rate will be very low. If we move the criterion lower, then the hit rate and the false alarm rate both increase. So the full ROC curve has an upward sloping shape.

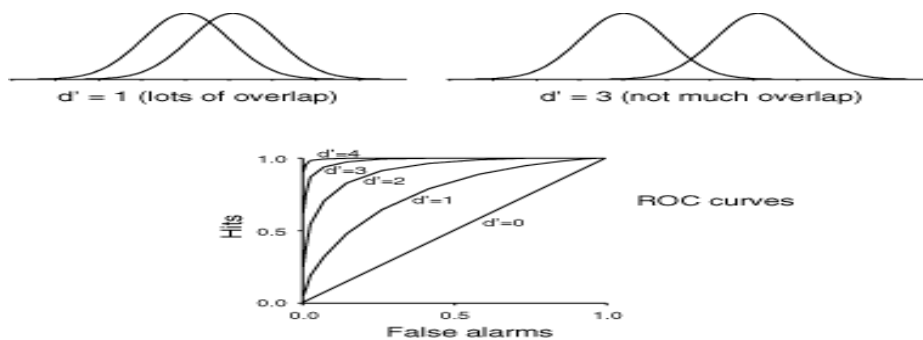


Figure: Internal response probability of occurrence curves and ROC curves for different signal strengths. When the signal is stronger there is less overlap in the probability of occurrence curves, and the ROC curve becomes more bowed.

Motivation and perception:

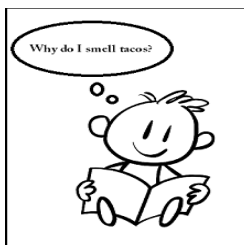
Motivation, like cognition, can exert a top-down influence on perception. This was the argument of a school of perceptual thought in the late 1940s called the New Look in perception, which focused on the impact of emotion, motivation and personality on perception (Dixon, 1980; Erdelyi, 1985; Bruners, 1992; Uleman & Bargh, 1989). On classic experiment examined the effects of food and water deprivation on identification of words (Wispe

& Drambarean, 1953). The experimenters placed participants in one of three groups. Some went without food for 24 hours prior to the experiment; some ate nothing for 10 hours; and others ate just beforehand. The researchers then flashed two kinds of words on a screen so rapidly that they were barely perceptible: neutral words (eg., serenade and hunch) and words related to food (eg., lemonade and munch). They noticed some striking differences when they presented subjects with neutral versus taboo words (such as sexual words). In one study, the researcher exposed participants to neutral and taboo words so quickly that they could barely recognize even a flash of light (Blum, 1954). These findings suggest that more emotionally evocative taboo words attract attention even below the threshold of consciousness, but that they are harder to recognize consciously than neutral words.

9.8 SUBLIMINAL PERCEPTION AND SYNESTHESIA

Perception without awareness is not the same thing as "subliminal perception." Subliminal perception is supposed to occur when a stimulus is too weak to be perceived yet a person is influenced by it. One type of subliminal perception is easy to replicate. In a procedure called priming, a stimulus is flashed for a split second then quickly masked with another stimulus. Then a target word is shown and the subject is asked to identify it as quickly as possible. If the priming stimulus bears a close relationship to the target word, the subject can respond slightly faster. This is a genuine subliminal effect, because the priming stimulus cannot be seen consciously, and subjects cannot report what it is. However, the effect lasts only a tenth of a second (Greenwald, Draine, & Abrams, 1996). Priming is a robust (easily replicated) effect useful to language researchers for investigating relationships between word meanings.

Synesthesia is a neurological phenomenon that causes one sensory response to automatically trigger another sense simultaneously. In general, very little is known about synesthesia or precisely why it occurs. Moreover, it is difficult to identify because it might only happen to a person under certain circumstances and they might not pay much attention to it.



Synesthesia is a crossing of sensory wiring that causes two or more senses to respond to one stimuli.

Check your progress – 3

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. Define Stevens power law

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9.9 SUMMARY

In this Unit you have studied in detail about psychophysics and perception theories.

Classical and Modern
Psychophysics

NOTES

9.10 UNIT –END ACTIVITY

1. Explain the difference between Classical and modern psychophysics.
2. Illustrate Fechner's Law
3. Describe the Signal Detection theory of perception

9.11 ANSWERS IN CHECK YOUR PROGRESS

1. The ratio of change in intensity required to produce and compared to the previous intensity of the stimulus.
 2. Information acquisition and criterion
 3. Stevens's powers law state as the perceived intensity of a stimulus grows arithmetically, the actual magnitude of the stimulus grows exponentially, that is by some power.
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9.12 UGGESTED READING

1. Gibson J.J (1966) *The Senses considered as Perceptual Systems* Boston Houghton Mifflin
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Self-Instructional Material

UNIT 10 : MEMORY

Memory

10.1 INTRODUCTION

NOTES

Memory is the relatively permanent storage form of the learned information. It is not a single, unitary phenomenon. Rather, the brain processes, stores and retrieves information in different ways to suit different needs. The neural circuits that connect a sensory event with a learned behavioural response to that event must have been altered in some way to support the learning. This change is called memory trace. The actual laying down of the memory in a more – or – less permanent form is called memory consolidation. Memory can be viewed in two broad categories: Implicit memory, in which the person has no previous awareness of the memory, can not describe the learned information except through behavior and cannot necessarily remember how, when, or where the learning occurred: and declarative memories, which are involved in remembering facts and events.

10.2 OBJECTIVES

- Describe the three stages in the process of learning and remembering
- To study the different theories of memory
- To provide the knowledge about meta cognition
- To provide the knowledge of how the memory system functions

10.3 ENCODING THEORIES

Encoding refers to the initial experience of perceiving and learning information. Psychologists often study recall by having participants study a list of pictures or words. Encoding in these situations is fairly straightforward. However, “real life” encoding is much more challenging. When you walk across campus, for example, you encounter countless sights and sounds—friends passing by, people playing Frisbee, music in the air. So, an important first principle of encoding is that it is selective: we attend to some events in our environment and we ignore others. A second point about encoding is that it is prolific; we are always encoding the events of our lives—attending to the world, trying to understand it. But if something does happen that seems strange—during your daily walk across campus, you see a giraffe—then we pay close attention and try to understand why we are seeing and what we are seeing.



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A giraffe in the context of a zoo or its natural habitat may register as nothing more than ordinary, but put it in another setting - in the middle of a campus or a busy city - and its level of distinctiveness increases dramatically. Distinctiveness is a key attribute to remembering events.

The term flashbulb memory was originally coined by Brown and Kulik (1977) to describe this sort of vivid memory of finding out an important piece of news. The name refers to how some memories seem to be captured in the mind like a flash photograph; because of the distinctiveness and emotionality of the news, they seem to become permanently etched in the mind with exceptional clarity compared to other memories. The process of encoding always involves recoding—that is, taking the information from the form it is delivered to us and then converting it in a way that we can make sense of it. For example, you might try to remember the colors of a rainbow by using the acronym ROY G BIV (red, orange, yellow, green, blue, indigo, violet). The process of recoding the colors into a name can help us to remember. However, recoding can also introduce errors—when we accidentally add information during encoding, then remember that *new* material as if it had been part of the actual experience (as discussed below).



Creating imagery is part of the technique Simon Reinhard uses to remember huge numbers of digits, but we can all use images to encode information more effectively. The basic concept behind good encoding strategies is to form distinctive memories (ones that stand out), and to form links or associations among memories to help later retrieval (Hunt & McDaniel, 1993). Using study strategies such as the ones described here is challenging, but the effort is well worth the benefits of enhanced learning and retention. Encoding—the initial registration of information—is essential in the learning and memory process.

10.3.1 Two store model of memory:

In 1890 William James proposed a distinction between two kinds of memory, which he called primary and secondary memory. Primary memory is immediate memory for information momentarily held in consciousness, such as a telephone number. Secondary memory is the vast store of information that is unconscious except when called back into primary memory such as the 10 or 20 phone numbers a person could bring to mind if

Memory

NOTES

he wanted to call various friends, family members, stores, and, so forth. James's distinction is embodied in what we will call in the Standard Model of memory (Modal model), which has guided research on memory and cognition since the 1960s (Atkinson & Shiffrin, 1968; Healy & McNamara, 1996).

10.3.2 Information Processing model:

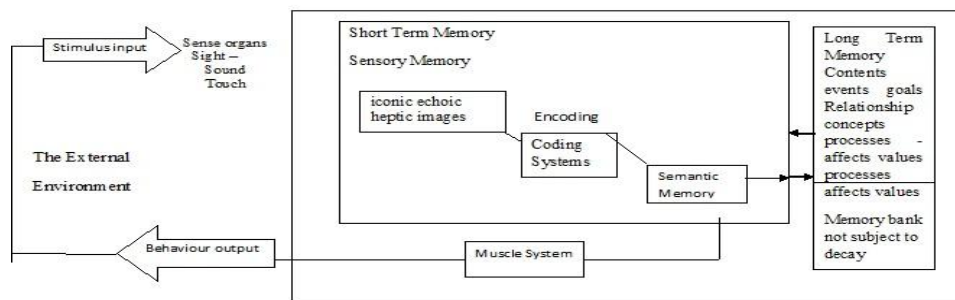
The standard model is predicated on the metaphor of the mind as a computer, which places information into different memory stores (the system's "hardware") and retrieves and transforms it using various programs ("software"). According to this model, memory consists of three stores: sensory memory (or sensory registers), short term memory (James's primary memory) and long term memory (James's secondary memory).

Information Processing Theory

The term 'Theory' has been used designate the information processing approach. Kail and Bisanz (1983) proposed information processing as a framework within which a multitude of theories have emerged: This-framework is characterised by a large number of research programs which sometimes offer different views about the types of components comprised in a person's processing system and their modes of interactions. Here the term theory will be used along with approach and model to designate the information processing framework.

The attraction of information processing theory can be understood only in the light of wants which have marked experimental psychology. Chomsky in his review of skinner's book, verbal learning (1959) argued his Own research on language acquisition and concluded that learning theory is subjective rather than objective in its definition and observation. The Worldwar II had contributed human beings as information transmitters and decision makers. In 1960s. a new generation of psychologists willing to talk about the mind emerged. After ten years, psychologists moved from an emphasis on behaviour to a focus on thinking, from a notion of passive learner to active learner. The human processing system consists of four major elements: 1. Sense organs 2. Short-term memory 3. Long-term memory 4. Muscular system. The system involves functions and processes within each element and interactions among these elements.

Figure 1
The Mental Apparatus



A Hypothetical model of the human information - processing system by C Michel, International Encyclopedia on Educational Technology.

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10.3.3 Sensory memory:

Sensory registers hold information about a perceived stimulus for a split second after the stimulus disappears, allowing a mental representation of it to remain in memory briefly for further processing (Sperling, 1960). The term iconic storage is used to describe visual sensory registration. Presenting another image or even a flash of light directly after the first image disappears erases the original icon (Schiller, 1965), much as a new movie recorded on an old videotape erases prior material. The movie analogy is apt in another way; motion pictures are really rapidly flashed sequences of still frames.

The auditory counterpart of iconic storage is called echoic storage (Battacchiet al., 1981). Most readers have probably had the experience of hearing a voice or a sound “echo” in their minds after the actual sound has stopped. Some researchers suggest that humans may have 2 types of echoic memory systems, one for nonspeech and the other for speech sounds, lateralized to the right and left hemispheres of the brain, respectively (Ardila et al., 1986).

10.3.4 Short term memory:

Information about them is passed on to short term memory (STM), a memory store that holds a small amount of information in consciousness – such as a phone number for roughly 20 to 30 seconds, unless the person makes a deliverable effort to maintain it longer by repeating it over and over (Waugh & Norman, 1965). STM has limited capacity; that is, it does not hold much information. On the average, people can remember about 7 pieces of information at a time, with a normal range of from 5 to 9 items (Miller, 1956). That phone numbers in most countries are 5 to 7 digits is no mere coincidence. Hermann Ebbinghaus (1885) was the first to note the 7 item limit to STM. Ebbinghaus pioneered the study of memory using the most convenient and agreeable subject he could find himself with a method that involved inventing some 2300 nonsense syllables (such as *pir* and *vup*). Ebbinghaus randomly placed these syllables in lists of varying lengths and then attempted to memorize the lists, he used nonsense syllables rather than real words to try to control the possible influence of prior knowledge on memory. He also found that he could memorize upto 7 syllables , but no more in a single trial. The limits of STM seem to be neurologically based , as they are similar in other cultures, including those with very different languages.

10.3.5 Storage



Memory

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Memory traces, or engrams, are NOT perfectly preserved recordings of past experiences. The traces are combined with current knowledge to reconstruct what we think happened in the past. Every experience we have changes our brains. That may seem like a bold, even strange, claim at first, but it's true. We encode each of our experiences within the structures of the nervous system, making new impressions in the process—and each of those impressions involves changes in the brain. Psychologists (and neurobiologists) say that experiences leave memory traces, or engrams (the two terms are synonyms). Memories have to be stored somewhere in the brain, so in order to do so, the brain biochemically alters itself and its neural tissue. Just like you might write yourself a note to remind you of something, the brain “writes” a memory trace, changing its own physical composition to do so. It is important to understand that memory traces are not perfect little packets of information that lie dormant in the brain, waiting to be called forward to give an accurate report of past experience.

Retroactive interference refers to new activities (i.e., the subsequent lunches) during the retention interval (i.e., the time between the lunch 17 days ago and now) that interfere with retrieving the specific, older memory (i.e., the lunch details from 17 days ago). But just as newer things can interfere with remembering older things, so can the opposite happen. **Proactive interference** is when past memories interfere with the encoding of new ones. For example, if you have ever studied a second language, often the grammar and vocabulary of your native language will pop into your head, impairing your fluency in the foreign language.



Memory

Retroactive interference is one of the main causes of forgetting (McGeoch, 1932). In the module *Eyewitness Testimony and Memory Biases* Elizabeth Loftus describes her fascinating work on eyewitness memory, in which she shows how memory for an event can be changed via misinformation supplied during the retention interval. For example, if you witnessed a car crash but subsequently heard people describing it from their own perspective, this new information may interfere with or disrupt your own personal recollection of the crash. In fact, you may even come to remember the event happening exactly as the others described it! This misinformation effect in eyewitness memory represents a type of retroactive interference that can occur during the retention interval (see Loftus [2005] for a review). Of course, if correct information is given during the retention interval, the witness's memory will usually be improved.

Memory

Check your progress-1

- Note: a. Write your answer in the space given below
 b. Compare your answer with those given at the end of the unit

1. Compare primary memory and secondary memory

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10.4 LONG TERM MEMORY

Here, representation of facts, images, thoughts, feelings, skills and experiences may reside for as long as a lifetime. According to the standard model, the longer information remains in STM, the more likely it is to make a permanent impression in LTM. Recovering information from LTM known as Retrieval, involves bringing it back into STM.

In free recall tasks, the experimenter presents subjects with a list of words, one at a time, and then asks them to recall as many as possible. When the delay is relatively short between presentation of the list and recall, participants are more likely to remember words towards the beginning and end of the list than those in middle. This phenomenon is known as the Serial Position Effect.

Although researchers have offered many explanations for the serial position effect, one explanation proposed by advocates of the standard model involves the distinction between long term and short term storage (Atkinson & Shiffrin, 1968). When people are trying to remember a list of words, they rehearse them in their minds. The first words on the list receive considerable rehearsal, but as the number of words steadily increases, the person has less opportunity to rehearse each one. Thus, words toward the beginning of the list are better remembered - a phenomenon called the Primacy Effect - because they are more likely to be stored in LTM.

10.4.1 Working Memory:

Working memory refers to the temporary storage and processing of information that can be used to solve problems, respond to environmental demands or achieve goals. Working memory is active memory: Information remains in working memory only so long as the person is consciously processing, examining, or manipulating it. Working memory includes both a temporary memory store and a set of strategies, or control processes, for mentally manipulating the information momentarily held in that store.

10.4.2 Declarative memory:

It can be semantic or episodic (Tulving, 1972). Semantic memory (or Generic memory) refers to a general knowledge or facts, such as the knowledge that summers are hot in Katmandu or that NaCl is the chemical formula for table salt. The term is somewhat misleading because semantic implies that general knowledge is stored in words, whereas people know many things about objects, such as their color or smell, that are encoded as sensory representations.

10.4.3 Episodic Memory:

It consists of memories of particular events, rather than general knowledge. Episodic memory allows people to travel mentally through time, to remember thoughts and feelings from the recent or distant past or to imagine the future (Wheeler et al., 1997). In every day life, episodic memory is often

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Autobiographical, as when people remember what they did on their 18th birthday or what they ate yesterday. It is also closely linked to semantic memory, since when people experience similar episodes over time (such as 180 days a year in a school or hundreds of thousands of interactions with their father), they gradually develop generic memories of what those situations were like (eg., “I used to love weekends with my father”).

10.4.4 Procedural Memory:

Procedural memory is for skills. People are often astonished to find that even though they have not skated for 20 years, the skills are reactivated easily, almost as if their use had never been interrupted. When people tie their shoes, put a backspin on a tennis ball, speak grammatically, or drive a car, they are drawing on procedural memory. Other procedural skills are less obvious, such as reading, which involves a set of complex procedures for decoding strings of letters and words.

10.4.5 Explicit Memory:

It involves the conscious retrieval of information. Researchers distinguish between two kinds of explicit retrieval: Recall and Recognition. Recall is the spontaneous conscious recollection of material from LTM, as when a person brings to mind memories of her wedding day or the name of capital of Egypt. Recognition refers to the explicit feeling or remembrance that something currently perceived has been previously encountered or learned (as when a researcher asks a subject to identify a word on a list that was on a different list the previous day).

10.4.6 Implicit Memory:

It is evident in skills, conditioned learning, and associative memory. It can be seen in skills such as turning the wheel in the right direction when the car starts to skid in the snow, which skilled drivers in cold regions do before they have even formed the thought “I’m skidding”, as well as in responses learned through classical and operant conditioning, such as avoiding a food that was once associated with nausea even when the person has no explicit recollection of the event. For eg, they might be exposed to a list of words that are relatively rarely used in everyday conversation, such as Assassin. A week later, they may have no idea whether “Assasin” was on the list, but if asked to fill in the missing letters of a word fragment such as A_A_IN, they are more likely to complete it with the word “assassin” than control subjects who studied a different list the week earlier.

10.4.7 Retrieval:

Similar contexts during encoding and retrieval provide retrieval cues – stimuli or thoughts that can be used to facilitate recollection. Mnemonic devices are systematic strategies for remembering information (named after the Greek word mneme, which means “memory”). The method of loci associates new information with a visual image of a familiar place. Peg method associates new information with a rhyme that also helps create a visual image. For eg you might create a number rhyme that you cannot possibly forget, such as :One is a bun, two is a shoe, three is a tree, four is a forth. Note that each number in this rhyme is associated with an object that can be easily be visualized.

SQ3R method helps students study textbook material efficiently by inducing them to survey, question, read, recite and review.

Check your progress - 2

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. What is Declarative Memory

.....

.....

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10.5 SUMMARY

In this unit you have studied in details about the theories of memory

10.6 UNIT –END ACTIVITY

Write in detail about the Memory .Discuss the importance of memory

1. Explain information processing approach
2. Explain the two store model of memory.
3. Write in detail about short term memory and Long term memory.

10.7 ANSWERS IN CHECK YOUR PROGRESS

1. Primary memory is immediate memory for information momentarily held in consciousness such as a telephone number. Secondary memory is the vast store of information.
2. It can be semantic or episodic. Semantic memory refers to a general knowledge or facts.

10.8 SUGGESTED READING

1. Borkwski J Carr M & Pressely .M. (1987) Spontaneous strategy use Perspectives from metacognitive theory Intelligence
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6. Parimala Fathima M (2009) Infusion of cognition and metacognition today's publication
7. Saravanakumar AR. (2008) Metacognitive perspectives New Century Book house Pvt Ltd.
8. Valimaa Blum R (2009) The Phenome in cognitive phonology episode memories of both meaningful and meaningless units. Cognitextes 2 DOI

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UNIT 11: RETRIVAL

Retrival

11.1 INTRODUCTION

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The aim of information retrieval is to provide the user with the “best possible” information from a database. The problem of information retrieval is determining what constitutes the best possible information for a given user query. A common form of interaction for information retrieval is for the user query. These are then used by the information retrieval system to identify information that meets the user’s needs. For example, in a bibliographic database, a user might be interested in finding thesis on some topic. It has been found that different retrieval methods often retrieve different sets of relevant documents. A particular retrieval method will usually retrieve some relevant documents not retrieved by other methods. In this thesis, we will explore thesis retrieval based on different structures (title, abstract and bibliography), weighting schemes and similarity measures.

11.2 OBJECTIVES

- Describe the three stages in the process of learning and remembering
- To study the different theories of forgetting
- To provide the knowledge about meta cognition
- To provide the knowledge of how the memory system functions

11.3 RETRIEVAL

For information to be retrievable from memory, it must be encoded, or cast into a representational form that can be readily accessed from memory. The degree to which information is elaborated, reflected upon, and processed in a meaningful way during memory storage is referred to as the depth or level of processing. Although deeper processing tends to be more useful for storing information for the long term, ease of retrieval depends on the match between the way information is encoded and later retrieved. This phenomenon is known as the encoding Specificity principle. Mnemonic devices are systematic strategies for remembering information (named after the Greek word mneme, which means “memory”).

The method of loci associates new information with a visual image of a familiar place. Cicero attributed this technique to the ancient Greek poet Simonides, who was attending a banquet when he was reportedly summoned by the gods from the banquet hall to receive a message. In his absence, the roof collapsed, killing everyone. The bodies were mangled beyond recognition, but Simonides was able to identify the guests by their physical placement around the banquet table. He thus realized that images could be remembered by fitting them in orderly arrangement of locus.

Peg method associates new information with a rhyme that also helps create

a visual image. For eg you might create a number rhyme that you cannot possibly forget, such as :One is a bun, two is a shoe, three is a tree, four is a forth. Note that each number in this rhyme is associated with an object that can be easily be visualized.

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SQ3R method helps students study textbook material efficiently by inducing them to survey, question, read, recite and review.

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11.4 FORGETTING

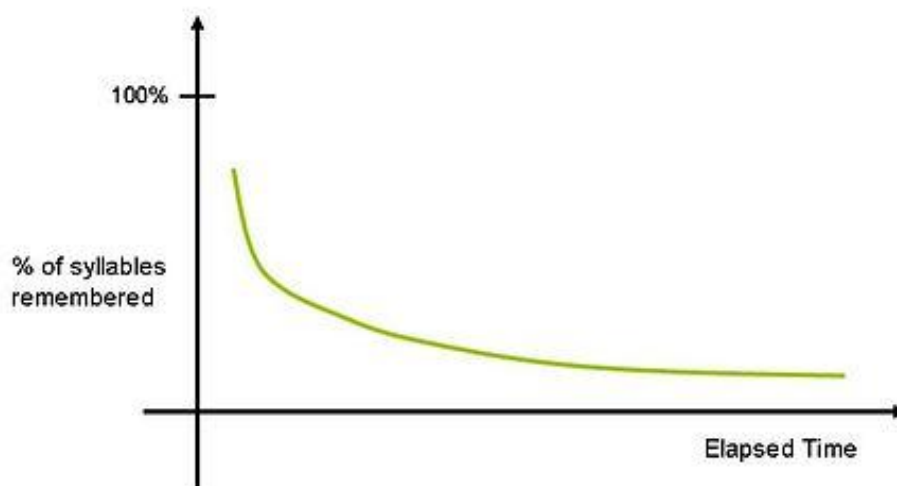
The flipside of memory is Forgetting, the inability to remember. Ebbingaus (1885) documented over a century ago a typical pattern of forgetting that occurs with many kinds of declarative knowledge, beginning with rapid initial loss of information after initial learning and only gradual decline thereafter.

Flashbulb memories – vivid memories of exciting or highly consequential events – are sometimes highly accurate but sometimes completely mistaken. Eyewitness testimony is also subject to many biases and errors, although people are more likely to remember central, emotionally significant details.

There are several theories that address why we forget memories and information over time, including trace decay theory, interference theory, and cue-dependent forgetting.

11.4.1 Trace Decay Theory

The trace decay theory of forgetting states that all memories fade automatically as a function of time. Under this theory, you need to follow a certain pathway, or trace, to recall a memory. If this pathway goes unused for some amount of time, the memory decays, which leads to difficulty recalling, or the inability to recall, the memory. Rehearsal, or mentally going over a memory, can slow this process. But disuse of a trace will lead to memory decay, which will ultimately cause retrieval failure. This process begins almost immediately if the information is not used: for example, sometimes we forget a person's name even though we have just met them.



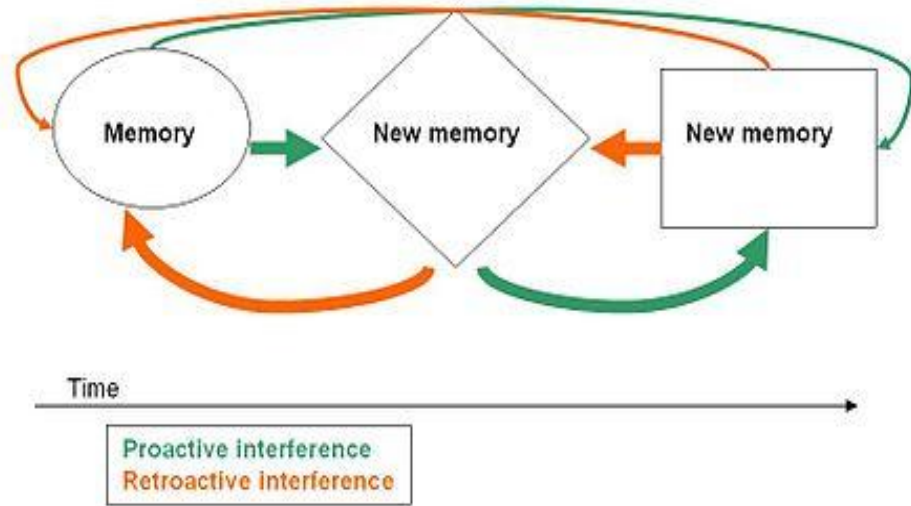
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11.4.2 Interference Theory

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It is easier to remember recent events than those further in the past. "Transience" refers to the general deterioration of a specific memory over time. Under interference theory, transience occurs because all memories interfere with the ability to recall other memories. Proactive and retroactive interference can impact how well we are able to recall a memory, and sometimes cause us to forget things permanently.



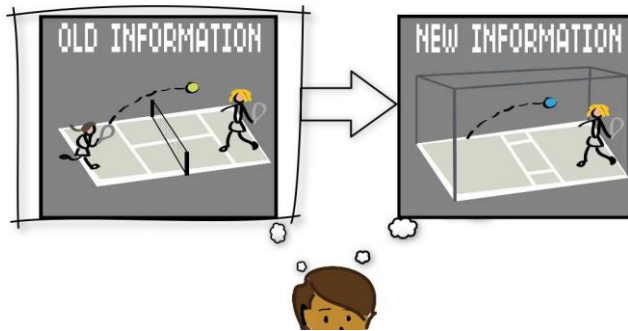
Memory interference

Both old and new memories can impact how well we are able to recall a memory. This is known as proactive and retroactive interference.

Proactive Interference

Proactive interference occurs when old memories hinder the ability to make new memories. In this type of interference, old information inhibits the ability to remember new information, such as when outdated scientific facts interfere with the ability to remember updated facts. This often occurs when memories are learned in similar contexts, or regarding similar things. It's when we have preconceived notions about situations and events, and apply them to current situations and events. An example would be growing up being taught that Pluto is a planet in our solar system, then being told as an adult that Pluto is no longer considered a planet. Having such a strong memory would negatively impact the recall of the new information, and when asked how many planets there are, someone who grew up thinking of Pluto as a planet might say nine instead of eight.

Proactive Interference



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Examples of proactive memory

When the landscape of a shopping store changes, you will look for things in their old places instead of their new ones.

You were taught to solve a math problem the wrong way, you have trouble learning and remembering how to do the problem the new (right) way.

You learned how to speak Spanish but now you can't remember the French you're learning because the Spanish blocks the new language.

Using a bigger keyboard when you are used to a smaller one

Retroactive Interference

Retroactive interference occurs when old memories are changed by new ones, sometimes so much that the original memory is forgotten. This is when newly learned information interferes with and impedes the recall of previously learned information. The ability to recall previously learned information is greatly reduced if that information is not utilized, and there is substantial new information being presented. This often occurs when hearing recent news figures, then trying to remember earlier facts and figures. An example of this would be learning a new way to make a paper airplane, and then being unable to remember the way you used to make them.



11.4.3 Cue-Dependent Forgetting

Cue-dependent forgetting, also known as retrieval failure, is the failure to recall information in the absence of memory cues. There are three types of cues that can stop this type of forgetting:

- Semantic cues are used when a memory is retrieved because of its association with another memory. For example, someone forgets

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everything about his trip to Ohio until he is reminded that he visited a certain friend there, and that cue causes him to recollect many more events of the trip.

- State-dependent cues are governed by the state of mind at the time of encoding. The emotional or mental state of the person (such as being inebriated, drugged, upset, anxious, or happy) is key to establishing cues. Under cue-dependent forgetting theory, a memory might be forgotten until a person is in the same state.
- Context-dependent cues depend on the environment and situation. Memory retrieval can be facilitated or triggered by replication of the context in which the memory was encoded. Such conditions can include weather, company, location, the smell of a particular odor, hearing a certain song, or even tasting a specific flavor.

11.4.4 Other Types of Forgetting

Trace decay, interference and lack of cues are not the only ways that memories can fail to be retrieved. Memory's complex interactions with sensation, perception, and attention sometimes render certain memories irretrievable.

Absent mindedness

If you've ever put down your keys when you entered your house and then couldn't find them later, you have experienced absentmindedness. Attention and memory are closely related, and absentmindedness involves problems at the point where attention and memory interface. Common errors of this type include misplacing objects or forgetting appointments. Absentmindedness occurs because at the time of encoding, sufficient attention was not paid to what would later need to be recalled.

Blocking

Occasionally, a person will experience a specific type of retrieval failure called blocking. Blocking is when the brain tries to retrieve or encode information, but another memory interferes with it. Blocking is a primary cause of the tip-of-the-tongue phenomenon. This is the failure to retrieve a word from memory, combined with partial recall and the feeling that retrieval is imminent. People who experience this can often recall one or more features of the target word, such as the first letter, words that sound similar, or words that have a similar meaning. Sometimes a hint can help them remember: another example of cued memory.

Check your progress -1

- Note: a. Write your answer in the space given below
 b. Compare your answer with those given at the end of the unit

1. What is forgetting?

.....What
SQ3R method

.....

.....

11.5 METACOGNITIVE KNOWLEDGE

Metacognition refers to higher order thinking which involves active control over the cognitive processes engaged in learning. Activities such as planning how to approach a given learning task, monitoring comprehension, and evaluating progress toward the completion of a task are metacognitive in nature. "Metacognition" is often simply defined as "thinking about thinking." In actuality, defining metacognition is not that simple. The term "metacognition" is most often associated with John Flavell, (1979). According to Flavell (1979, 1987), metacognition consists of both metacognitive knowledge and metacognitive experiences or regulation. Metacognitive knowledge refers to acquired knowledge about cognitive processes, knowledge that can be used to control cognitive processes. Flavell further divides metacognitive knowledge into three categories: knowledge of person variables, task variables and strategy variables.

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11.5.1 Concept of Metacognition

The basis of metacognition is the notion of thinking about s own thoughts. How can the thoughts be looked at in three different dimensions, viz., knowledge, skill and experience? Since it includes what one knows about that, internal ' representation, how it works, and how one feels about it., metacognition sometimes has been defined as thinking about thinking, cognition of cognition, or in Flavell's (1979) 'words, "knowledge and cognition about cognitive phenomena".

Definitions:

Metacognition is characterized by

- 1 Awareness that one has options in one's learning
2. Self-regulation of one's learning
3. Conscious control of one's learning
4. Conscious awareness of one's learning
5. Choosing options and strategies to learn effectively
6. Assessing one's own learning ,
7. Explaining one's choices in learning

11.5.2 Features of Metacognition

According to Flavell, a person's ability to control "a wide `variety of cognitive enterprises occurs through the actions and interactions among four classes of phenomena: (a) metacognitive knowledge, (h) metaecognitive experiences, (c) goals (or tasks) and (d) actions (or strategies)". It consists of one's stored world knowledge ;that "has to do with people as cognitive creatures and with their divertive cognitive tasks, goals, actions and experiences". It consists of one's knowledge or beliefs about three general factors: his or her own nature or the nature of another as a - cognitive processor; a task, its demands, and how those demands can be met under varying conditions; and strategies for accomplishing the task (i.e.. cognitive strategies that are invoked to make progress toward goals, and metacognitive strategies that are invoked to monitor the progress of cognitive strategies).

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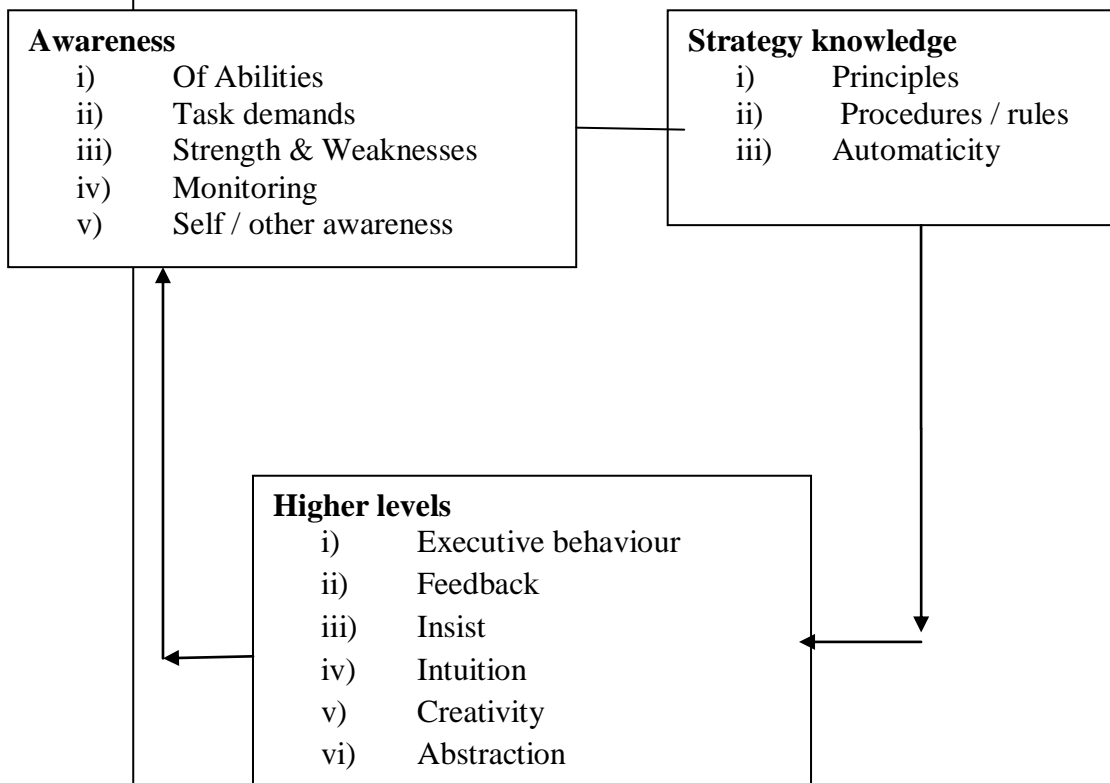
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11.5.3 Determinants Of Meta Cognition

The process of self-awareness leads one towards learning. It involves multiple factors interlinked and one may not exactly say where it begins. But anyway, if we look into these factors in a broader perspective, we may say, 'social influences' stand as the base for one's learning. Take for example, the associations between verbal perceptual ability, and other factors which affect learning. Verbal ability may be the result of the value placed on it by a society or family. It may also be the result of the verbal processing capacity of working memory. Both will likely affect preferences in learning patterns, those weaker in verbal abilities will prefer to learn through a visual mode.

11.5.4 Let us see the interlinkage of factors that determine 'metacognition' through a flowchart given below:



11.5.5 Structure of Metacognition

Metacognition refers to one's knowledge concerning one's own-cognitive processes and products or anything related to them, e.g. the learning relevant properties of information or data. For example, I am engaging in metacognition (metamemory, meta learning, meta attention, metalanguage or whatever) if I notice that I am having more trouble in learning A than B; if it is, it strikes me that I should double-check C before accepting it as a fact; if it occurs to me that I had better scrutinize each and every alternative in any multiple - choice type task situation before deciding which is the best one; if I sense that I had better make a note of D because I 'may forget it; Metacognition refers among other things, to the active monitoring and consequent regulation and orchestration of these processes in relation to the cognitive objects or data on which they bear, usually in the service of some concrete goal or objective".

If we dismantle the above definition we may get the inter linkage of the components in different forms, as:

Thinking about knowing, Learning about thinking, Control of learning

Knowing about knowing, Thinking about thinking

This complexity in the learning process can be structured in structure of metacognition. The concept of metacognition is used in the sense of steering one's cognitive process. Although knowledge and 'steering' are closely related, there is a slight difference between them. Paris and Winograd (1988) state that metacognition involves: knowledge and control of self - knowledge and control of process.

Finally, knowledge about strategy variables include knowledge about both cognitive and metacognitive strategies, as well as conditional knowledge about when and where it is appropriate to use such strategies.

Metacognitive Regulation

Metacognitive experiences involve the use of metacognitive strategies or metacognitive regulation (Brown, 1987). Metacognitive strategies are sequential processes that one uses to control cognitive activities, and to ensure that a cognitive goal (e.g., understanding a text) has been met. These processes help to regulate and oversee learning, and consist of planning and monitoring cognitive activities, as well as checking the outcomes of those activities .

For example, after reading a paragraph in a text a learner may question herself about the concepts discussed in the paragraph. Her cognitive goal is to understand the text. Self-questioning is a common metacognitive comprehension monitoring strategy. If she finds that she cannot answer her own questions, or that she does not understand the material discussed, she must then determine what needs to be done to ensure that she meets the cognitive goal of understanding the text. She may decide to go back and re-read the paragraph with the goal of being able to answer the questions she had generated. If, after re-reading through the text she can now answer the questions, she may determine that she understands the material. Thus, the metacognitive strategy of self-questioning is used to ensure that the cognitive goal of comprehension is met.

Metacognitive and cognitive strategies may overlap in that the same

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strategy, such as questioning, could be regarded as either a cognitive or a metacognitive strategy depending on what the purpose for using that strategy may be. For example, you may use a self-questioning strategy while reading as a means of obtaining knowledge (cognitive), or as a way of monitoring what you have read (metacognitive). Because cognitive and metacognitive strategies are closely intertwined and dependent upon each other, any attempt to examine one without acknowledging the other would not provide an adequate picture.

Knowledge is considered to be metacognitive if it is actively used in a strategic manner to ensure that a goal is met. For example, a student may use knowledge in planning how to approach a math exam: "I know that I (person variable) have difficulty with word problems (task variable), so I will answer the computational problems first and save the word problems for last (strategy variable)." Simply possessing knowledge about one's cognitive strengths or weaknesses and the nature of the task without actively utilizing this information to oversee learning is not metacognitive.

Metacognition and Intelligence

Metacognition, or the ability to control one's cognitive processes (self-regulation) has been linked to intelligence (Borkowski et al., 1987; Brown, 1987; Sternberg, 1984, 1986a, 1986b). Sternberg refers to these executive processes as "metacomponents" in his triarchic theory of intelligence (Sternberg, 1984, 1986a, 1986b). Metacomponents are executive processes that control other cognitive components as well as receive feedback from these components. According to Sternberg, metacomponents are responsible for "figuring out how to do a particular task or set of tasks, and then making sure that the task or set of tasks are done correctly" (Sternberg, 1986b, p. 24). These executive processes involve planning, evaluating and monitoring problem-solving activities. Sternberg maintains that the ability to appropriately allocate cognitive resources, such as deciding how and when a given task should be accomplished, is central to intelligence.

Cognitive Strategy Instruction (CSI) is an instructional approach which emphasizes the development of thinking skills and processes as a means to enhance learning. The objective of CSI is to enable all students to become more strategic, self-reliant, flexible, and productive in their learning endeavors (Scheid, 1993). CSI is based on the assumption that there are identifiable cognitive strategies, previously believed to be utilized by only the best and the brightest students, which can be taught to most students (Halpern, 1996). Use of these strategies have been associated with successful learning .

Implications

Metacognition enables students to benefit from instruction (Carr, Kurtz, Schneider, Turner & Borkowski, 1989; Van Zile-Tamsen, 1996) and influences the use and maintenance of cognitive strategies. While there are several approaches to metacognitive instruction, the most effective involve providing the learner with both knowledge of cognitive processes and strategies (to be used as metacognitive knowledge), and experience or practice in using both cognitive and metacognitive strategies and evaluating the outcomes of their efforts (develops metacognitive

regulation). Simply providing knowledge without experience or vice versa does not seem to be sufficient for the development of metacognitive control.

Retrieval

11.6 SUMMARY

In this unit you have studied in details about the theories of forgetting theories and Metacognition

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11.7 UNIT –END ACTIVITY

Write in detail about the Memory and metacognitive activities and this implications

Discuss the importance of memory ,Retrieval and forgetting

4. Describe the Retrieval process.
5. Explain any two forgetting theories.
6. Write a short note on metacognition and its implications.

11.8 ANSWERS IN CHECK YOUR PROGRESS

1. Forgetting refers inability to remember
2. SQ3R method help students study textbook material efficiently by inducing them to survey, question, read, recite and review.
3.
 - i. Self redulation of one's learning
 - ii. explaining ones's choices in learning
 - iii. Conscious control of one's learning

11.9SUGGESTED READING

1. Borkwski J Carr M & Pressely .M. (1987) Spontaneous strategy use Perspectives from metacognitve theory Intelligence
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UNIT 12 – NEUROPSYCHOLOGY

Neuropsychology

NOTES

12.1 INTRODUCTION

Man's interest in the relationship between the brain and behaviour extends back at least 2500 years. The study of brain-behaviour relationship evolved with the development of a science of human behaviour based on the function of human brain, known as neuropsychology. Clinical neuropsychology in the 20th century showed a steady accumulation of clinical reports and research investigations that have gradually refined the theoretical positions. However, assessment relies heavily on the use of specific tests to investigate brain-behaviour relationships. There has been several specific standardized tests as well as test batteries developed across the globe. Current article has focused on different neuropsychological test batteries to evaluate individuals suspected of having brain dysfunction or damage.

Neuropsychology is the study of brain-behaviour relationship with the development of a science of human behaviour based on the function of human brain behaviour relationships to clinical problems and neurological assessment, which is sensitive to the condition of the brain. Man's interest in this area extends back at least 2500 years, when Pythagoras argued that the brain was the site of human reasoning. Approximately 100 years later, Hippocrates claimed that the brain was the organ of the intellect and recognized that a depressed skull fracture on the right side of the head could produce motor paralysis on the (contra lateral) left side of the body. Galen, in approximately 170 a.d., was able to map out many of the major brain structures and argued that the frontal lobes were the seat of our mental abilities. Galen's hypothesis however, was later discarded in favour of the belief that reasoning and intelligence was a product of the ventricles of the brain.

Neuropsychology can be divided into two branches. The first, clinical neuropsychology includes behavioural neurology and deals with patients with cerebral lesions. The second branch is experimental neuropsychology, which studies normal subjects in the laboratory by a range of techniques including specialized physiological techniques (Sbordone, Saul, & Purisch, 2007).

12.2 OBJECTIVES

- To explain the process and function of Neuropsychology
- Student should be able to know the meaning and historical background of Anatomy.

12.3 ASSUMPTIONS AND METHODS

Firstly, let's be clear what "assumption" means here. It does not mean there are some things which cognitive neuropsychologists assert to be true of people. It means something quite different. Here are some things which need to be true of people, Atleast to a good approximation, for cognitive

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neuropsychology to be able to succeed in its aims. There are four major assumptions, as follows:

Assumption I: Functional Modularity

Since a fundamental aim of cognitive neuropsychology is to discover functional architectures of cognitive systems, and since a functional architecture is a configuration of modules, cognitive neuropsychology will get nowhere except when cognitive systems actually are configurations of modules. Fodor (1983) is interesting again here. In that book, he offers an account of the mind as consisting of two systems. There's the system of input modules and there's the central system. The input modules are responsible for encoding and recognizing perceptual inputs. The central system is responsible for such "higher-level" cognitive processes as the fixation of belief. The input module system is, of course, modular, but the central system is non-modular. What follows from that, according to Fodor, is that, because cognition which involves the central system is non-modular, it is not amenable to scientific study: Indeed, he offered this as Fodor's First law of Non-existence of Cognitive Science. If he is correct that some forms of cognition depend upon cognitive systems that are not functionally modular, then these forms of cognition cannot be successfully studied by cognitive neuropsychology. It remains to be seen whether this is the case.

Assumptions 2 Anatomical Modularity

Even if cognitive systems are actually configurations of modules, it does not follow that any of these modules is realized in some specific and relatively small region of the brain. It could be that the neural tissue for each individual functional module is very widely spread throughout the brain. In other words, it is possible for there to be functional modularity but no anatomical modularity. If so, almost any form of brain damage must affect very many-even all-modules. In that case, cognitive neuropsychology would get nowhere because the functional modularity of cognition would not manifest itself in the performance of brain-damaged patients-for example, even if the face recognition system and spoken-word recognition system were two quite distinct functional modules, one would never see a patient who could recognize faces but not spoken words, nor a patient who could recognize spoken words but not faces.

Assumption 3: Uniformity of Functional Architecture Across people

Even, if cognitive systems are actually configurations of modules(i.e., there is functional modularity,) and even if individual functional modules generally are realized in restricted brain regions(i.e., there is anatomical modularity), Cognitive neuropsychology would still not get anywhere if different individuals had different functional architectures for the same cognitive domain. That's because it would not be possible to make inferences about the functional architecture of the cognitive systems of people in general from the data of a single patient, however, well-justified the inference was from that patient's data to claims about that particular patient's functional architecture. Of course, this assumption is not peculiar

to cognitive neuropsychology: it is widespread throughout the whole of cognitive psychology. Thus if this assumption is false, that's not just bad news for cognitive neuropsychology: it is bad news for all of cognitive psychology.

Assumption 4:Subtractivity

Cognitive neuropsychology treats the functional architecture of an impaired cognitive system as the functional architecture of the intact cognitive system with one or more of its components damaged or deleted. The assumption here is that brain damage can impair or delete existing boxes or arrows in the system, but cannot introduce new ones: that is, it can subtract from the system, but cannot add to it. If this were not so, studying impaired systems could not tell us about normal systems. This is not at all to say that brain –damaged patients do not adopt new strategies to cope with their impairments, strategies that intact individuals do not use. Such compensatory strategies could consist of using the normal functional architecture in an abnormal way.

If one or more of these four assumptions is untrue, what are the implications for cognitive neuropsychology? Suppose for example that Assumptions 1,2, and 4 are true but Assumption 3 is false. This will mean that patients A and B will, before their brain damage, have possessed functionally modular cognitive architectures which were also anatomically modular, and that their brain damage has subtracted from, but not added anything to, these architectures: but the architectures of each patient were, and so still are, very different. This will be immediately apparent: Patient A's data will strongly suggest a certain cognitive architecture, so will patient B's, but the two architectures thus suggested will be different ones. Thus, the cognitive neuropsychologist will not be happily oblivious here: It will be obvious that something is deeply wrong if different patients yield quite different ideas about what the functional architecture is.

What if Assumption 1 is false, or Assumption 2? In both cases, the consequence will be that we simply won't see patients with highly selective cognitive disorders, patients such as AC (whose semantic impairment was just for visual information). If just Assumption 1 is false, then we won't see such cases because the brain does not have the degree of anatomical modularity that would allow brain damage to produce such disorders.

Finally, Assumption 4: was fail If the other Assumptions were all correct but this one were false, that would soon be evident, because the functional architectures inferred from studies of brain-damaged patients could not be successfully applied to the explanation of results obtained by cognitive psychologists studying people without brain damage.

To Sum of, then, if any of these four assumptions were false, that would have soon become apparent, because cognitive-neuropsychological research would soon have run into severe difficulties: thus, there is a kind of fail-safe mechanism here. From this follows an even more important point: If one considers that cognitive neuropsychological research over the

past 30 years or so has yielded much coherent evidence about cognition that has led to proposals about cognitive architectures which are also useful in explaining data from studies of people with intact cognitive systems, that conclusion constitutes evidence that all four of these quite fundamental assumptions about mind and brain are in fact correct.

Check your progress – 1

Note: a. Write your answer in the space given below
b. Compare your answer with those given at the end of the unit

1. What are the various Assumption

.....
.....
.....

MODULARITY

Modularity is the principle of separating tasks so that different parts of a program (modules) perform these separate tasks. Modules should interact with each other only if one module requires another module to complete a task. The benefits of modularity include that code can be easily reused for other tasks, or new code can easily be added to increase functionality. It's a good technique to use, particularly if you are developing in a group, so that each partner can work on a different part of the code.

Functional modularity

The theory of modularity suggests that there are functionally specialized regions in the brain that are domain specific for different cognitive processes. Jerry Fodor expanded the initial notion of phrenology by creating his Modularity of the Mind theory. The Modularity of the Mind theory indicates that distinct neurological regions called modulus are defined by their functional roles in cognition. He also rooted many of his concepts on modularity back to philosophers like Descartes, who wrote about the mind being composed of "organs" or "psychological faculties". An example of Fodor's concept of modules is seen in cognitive processes such as vision, which have many separate mechanisms for colour, shape and spatial perception

One of the fundamental beliefs of domain specificity and the theory of modularity suggests that it is a consequence of natural selection and is a feature of our cognitive architecture. Researchers Hirschfeld and Gelman propose that because the human mind has evolved by natural selection, it implies that enhanced functionality would develop if it produced an increase in "fit" behaviour. Research on this evolutionary perspective suggests that domain specificity is involved in the development of cognition because it allows one to pinpoint adaptive problems.

Neuropsychology

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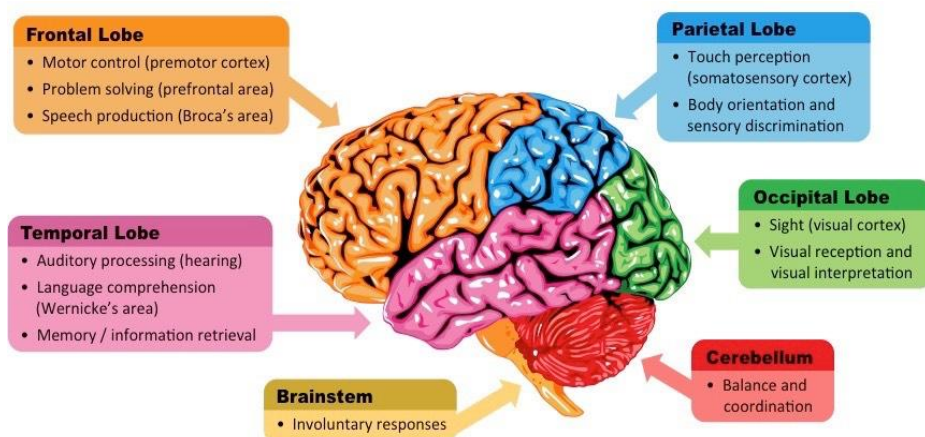
An issue for the modular theory of cognitive neuroscience is that there are cortical anatomical differences from person to person. Although many studies of modularity are undertaken from very specific lesion case studies, the idea is to create a neurological function map that applies to people in general. To extrapolate from lesion studies and other case studies this requires adherence to the *universality assumption*, that there is no difference, in a qualitative sense, between subjects who are intact neurologically. For example, two subjects would fundamentally be the same neurologically before their lesions, and after have distinctly different cognitive deficits. Subject 1 with a lesion in the "A" region of the brain may show impaired functioning in cognitive ability "X" but not "Y", while subject 2 with a lesion in area "B" demonstrates reduced "Y" ability but "X" is unaffected; results like these allow inferences to be made about brain specialization and localization, also known as using a double dissociation.

NOTES

Future developments for modular theories of neuropsychology may lie in "modular psychiatry". The concept is that a modular understanding of the brain and advanced neuro-imaging techniques will allow for a more empirical diagnosis of mental and emotional disorders. There has been some work done towards this extension of the modularity theory with regards to the physical neurological differences in subjects with depression and schizophrenia, for example. Zielasek and Gaebel have set out a list of requirements in the field of neuropsychology in order to move towards neuropsychiatry:

1. To assemble a complete overview of putative modules of the human mind
2. To establish module-specific diagnostic tests (specificity, sensitivity, reliability)
3. To assess how far individual modules, sets of modules or their connections are affected in certain psychopathological situations
4. To probe novel module-specific therapies like the facial affect recognition training or to retrain access to context information in the case of delusions and hallucinations, in which "hyper-modularity" may play a role.

BRAIN DIAGRAM



Neuropsychology

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MAJOR BRAIN AREAS

The brain is comprised of a number of different regions, each with specialized functions. Here is another view of the brain's structure and function, also with roughly three separate parts. The brain's central core, which includes the brain stem and the midbrain, is quite different than the cerebral cortex that envelops it. The central core is relatively simple, older and its activity is largely unconscious. In contrast, the cortex is highly developed and capable of the deliberation and associations necessary for complex thinking and problem solving. In humans, its size and function has increased rapidly. While the older portions of the brain remain relatively static.

THE BRAIN STEM

The brain stem seems to be inherited almost "as is" from the reptilian brain. It consists of structures such as the medulla (controlling breathing, heart rate, and digestion) and the cerebellum (which coordinates sensory input with muscle movement).

THE MIDBRAIN

The Midbrain includes features that appear intimately connected to human emotion and to the formation of long-term memory via neural connections to the lobes of the neocortex. The structures contained here also link the lower brain stem to the thalamus — for information relay from the senses, to the brain, and back out to muscles — and to the limbic system. The limbic system, essentially alike in all mammals, lies above the brain stem and under the cortex. It consists of a number of interrelated structures. Researchers have linked the limbic system to hormones, drives, temperature control, and emotion. One part is dedicated to memory formation, thus explaining the strong link between emotion and longterm memory. The limbic system includes these parts:

- The hypothalamus is instrumental in regulating drives and actions. Neurons affecting heart rate and respiration are concentrated here. These direct most of the physical changes that accompany strong emotions, such as the "flight or fight" response.
- The amygdala appears connected to aggressive behavior.
- The hippocampus plays a crucial role in processing various forms of information to form long-term memories. Damage to the hippocampus will produce global retrograde amnesia. One very important feature of the

Self-Instructional Material

midbrain and limbic system is the reticular activating system (RAS). It is this area that keeps us awake and aware of the world. The RAS acts as a master switch that alerts the brain to incoming data — and to the urgency of the message.

THE FOREBRAIN OR NEOCORTEX

The forebrain, which appears as a mere bump in the brain of a frog, balloons out into the cerebrum of higher life forms and covers the brain stem like the head of a mushroom. This, the newest part of the human brain, is also called the neocortex, or cerebral cortex. The Neocortex The structure of the neocortex is very complicated. Here most of the higher level functions associated with human thought are enabled.

BRAIN HEMISPHERE

In humans, the neocortex has evolved further than in other mammals, into the two cerebral hemispheres. The wrinkled surface of the hemispheres is about two millimeters thick and has a total surface area the size of a desktop (about 1.5 square meters). For more information about the two hemispheres and how they work together, refer to the next lesson called Left Brain/Right Brain. Remember that there is symmetry between hemispheres. However, not every specialized region is found on both sides. For example, highly specialized language centers exist only in the left hemisphere. The brain coordinates information between the two hemispheres, and does so with startling speed and skill. Here is a brief description of the four lobes that make up the cerebral hemispheres, or neocortex.

FRONTAL LOBES

The frontal lobes occupy the front part of the brain and are associated with making decisions, planning, and voluntary muscle movement. Speech, smell, and emotions are processed here as well. The frontal lobes control our responses and reactions to input from the rest of the system. The saying “Get your brain in gear” refers to activity in the frontal lobes. Parietal Lobes The parietal lobes are most closely associated with our sense of touch. They contain a detailed map of the whole body’s surface. More neurons are dedicated to some regions of surface area than others. For example, the fingers have many more nerve endings than the toes, and therefore they have more associated areas in the brain for processing. The parietal lobe of the right hemisphere appears to be especially important for perceiving spatial relationships. The recognition of relationships between objects in space is important to activities such as drawing, finding your way, construction, and mechanical or civil engineering.

TEMPORAL LOBES

The temporal lobes are concerned with emotions, and also contain the primary auditory cortex, which processes sound. Doesn’t this provoke wonder at the profound connection between music and strong emotion? Occipital Lobes The occipital lobes are the primary visual cortex. This area at the back of the brain, just above the cerebellum, processes stimuli from our eyes, via the optic nerve, and associates that information with other sensory input and memories. Recall that areas crucial to long-term memory

also reside at the back of the brain. These association areas interpret sensory data by relating it to existing knowledge, and are essential to memory formation. More information on memory is included in later sections of the text.

SENSORY CORTEX AND MOTOR CORTEX

Regions called the sensory cortex and the motor cortex are sandwiched between the frontal and parietal lobes, right at the top of the head. These areas specialize in the control of movement and in receiving information from the body's primary sensory systems (vision, smell, taste, touch, and sound).

AWARENESS OF TIME

According to some researchers, the lobes to the front and the back of the brain seem to be aware of the passage of time. Thus the frontal lobe of the neocortex appears to be responsible for planning, decision-making, and risk-taking while the back of the brain stores memories.

The middle section is focused on experiencing the present moment, since it houses the primary sensory and motor cortex. It is busily processing information from our five senses and sending control signals back out to our muscles.

Check your progress

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. Write the parts of the Neuron

.....

2. Short notes on Cranial nerves

.....

.....

The Nervous System

Basic Cells of the Nervous System

Neuron

- Basic functional cell of nervous system
- Transmits impulses (up to 250 mph)

Parts of a Neuron

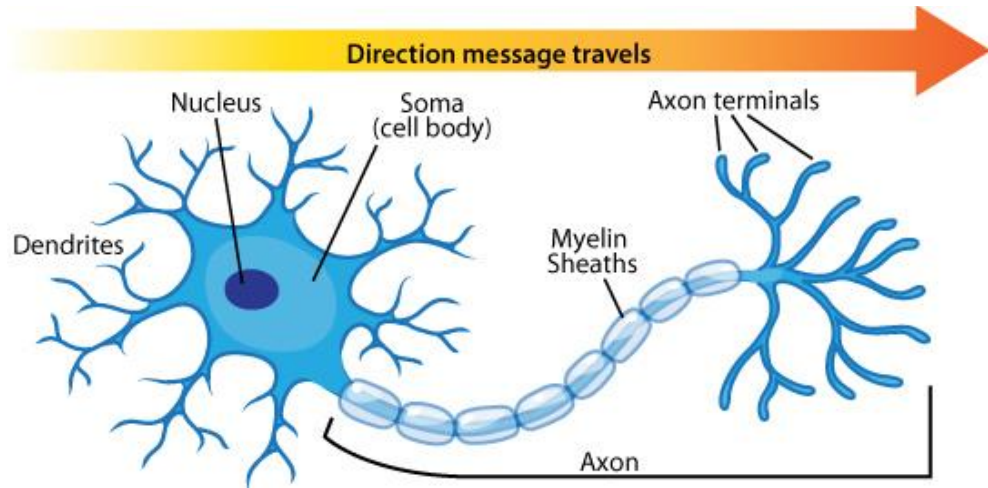
- **Dendrite** – receive stimulus and carries it impulses toward the cell body
- **Cell Body with nucleus** – nucleus & most of cytoplasm
- **Axon** – fiber which carries impulses away from cell body
- **Schwann Cells**- cells which produce myelin or fat layer in the

Peripheral Nervous System

- **Myelin sheath** – dense lipid layer which insulates the axon – makes the

axon look gray

- **Node of Ranvier** – gaps or nodes in the myelin sheath
- Impulses travel **from dendrite to cell body to axon.**



Functions of the Nervous System

1. Gathers information from both inside and outside the body - Sensory Function
2. Transmits information to the processing areas of the brain and spine
3. Processes the information in the brain and spine – Integration Function
4. Sends information to the muscles, glands, and organs so they can respond appropriately –

Motor Function

It controls and coordinates all essential functions of the body including all other body systems allowing the body to maintain homeostasis or its delicate balance.

The Nervous System is divided into Two Main Divisions: **Central Nervous System (CNS) and the Peripheral Nervous System (PNS)**

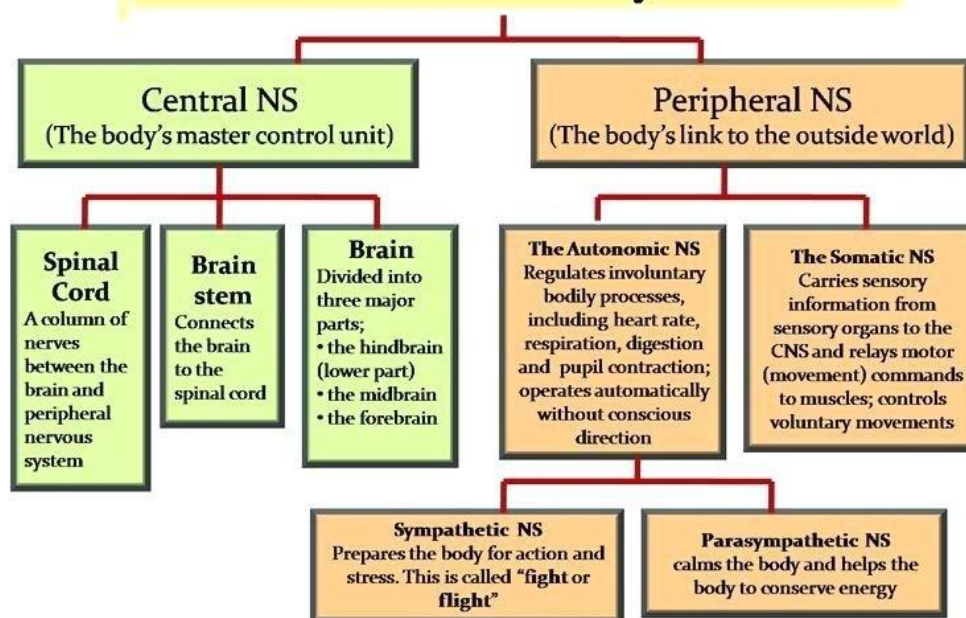
Divisions of the Nervous System

The central nervous system consists of the brain and spinal cord. It is referred to as "central" because it combines information from the entire body and coordinates activity across the whole organism.

Fast facts on the central nervous system

- The CNS consists of the brain and spinal cord.
- The brain is the most complex organ in the body and uses 20 percent of the total oxygen we breathe in.
- The brain consists of an estimated 100 billion neurons, with each connected to thousands more.
- The brain can be divided into four main lobes: temporal, parietal, occipital and frontal.

The Nervous System



Neuropsychology

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CNS consists of the brain and spinal cord.

The brain is protected by the skull (the cranial cavity) and the spinal cord travels from the back of the brain, down the center of the spine, stopping in the lumbar region of the lower back.

The brain and spinal cord are both housed within a protective triple-layered membrane called the meninges.

The central nervous system has been thoroughly studied by anatomists and physiologists, but it still holds many secrets; it controls our thoughts, movements, emotions, and desires. It also controls our breathing, heart rate, the release of some hormones, body temperature, and much more.

The retina, optic nerve, olfactory nerves, and olfactory epithelium are sometimes considered to be part of the CNS alongside the brain and spinal cord. This is because they connect directly with brain tissue without intermediate nerve fibers.

The brain

The brain is the most complex organ in the human body; the cerebral cortex (the outermost part of the brain and the largest part by volume) contains an estimated 15–33 billion neurons, each of which is connected to thousands of other neurons.

In total, around 100 billion neurons and 1,000 billion glial (support) cells make up the human brain. Our brain uses around 20 percent of our body's total energy.

Self-Instructional Material

The brain is the central control module of the body and coordinates activity. From physical motion to the secretion of hormones, the creation of memories, and the sensation of emotion.

To carry out these functions, some sections of the brain have dedicated roles. However, many higher functions — reasoning, problem-solving, creativity — involve different areas working together in networks.

The brain is roughly split into four lobes:

Temporal lobe (green): important for processing sensory input and assigning it emotional meaning.

It is also involved in laying down long-term memories. Some aspects of language perception are also housed here.

Occipital lobe (purple): visual processing region of the brain, housing the visual cortex.

Parietal lobe (yellow): the parietal lobe integrates sensory information including touch, spatial awareness, and navigation.

Touch stimulation from the skin is ultimately sent to the parietal lobe. It also plays a part in language processing.

Frontal lobe (pink): positioned at the front of the brain, the frontal lobe contains the majority of dopamine-sensitive neurons and is involved in attention, reward, short-term memory, motivation, and planning.

Brain regions

Next, we will look at some specific brain regions in a little more detail:

Basal ganglia: involved in the control of voluntary motor movements, procedural learning, and decisions about which motor activities to carry out. Diseases that affect this area include Parkinson's disease and Huntington's disease.

Cerebellum: mostly involved in precise motor control, but also in language and attention. If the cerebellum is damaged, the primary symptom is disrupted motor control, known as ataxia.

Broca's area: this small area on the left side of the brain (sometimes on the right in left-handed individuals) is important in language processing. When damaged, an individual finds it difficult to speak but can still understand speech. Stuttering is sometimes associated with an underactive Broca's area.

Corpus callosum: a broad band of nerve fibers that join the left and right hemispheres. It is the largest white matter structure in the brain and allows the two hemispheres to communicate. Dyslexic children have smaller corpus callosums; left-handed people, ambidextrous people, and musicians typically have larger ones.

Medulla oblongata: extending below the skull, it is involved in involuntary functions, such as vomiting, breathing, sneezing, and maintaining the correct blood pressure.

Hypothalamus: sitting just above the brain stem and roughly the size of an almond, the hypothalamus secretes a number of neurohormones and influences body temperature control, thirst, and hunger.

Thalamus: positioned in the center of the brain, the thalamus receives sensory and motor input and relays it to the rest of the cerebral cortex. It is involved in the regulation of consciousness, sleep, awareness, and alertness.

Amygdala: two almond-shaped nuclei deep within the temporal lobe. They are involved in decision-making, memory, and emotional responses; particularly negative emotions.

The spinal cord, running almost the full length of the back, carries information between the brain and body, but also carries out other tasks.

From the brainstem, where the spinal cord meets the brain, 31 spinal nerves enter the cord.

Along its length, it connects with the nerves of the peripheral nervous system (PNS) that run in from the skin, muscles, and joints.

Motor commands from the brain travel from the spine to the muscles and sensory information travels from the sensory tissues — such as the skin — toward the spinal cord and finally up to the brain.

The spinal cord contains circuits that control certain reflexive responses, such as the involuntary movement your arm might make if your finger was to touch a flame.

The circuits within the spine can also generate more complex movements such as walking. Even without input from the brain, the spinal nerves can coordinate all of the muscles necessary to walk. For instance, if the brain of a cat is separated from its spine so that its brain has no contact with its body, it will start spontaneously walking when placed on a treadmill. The brain is only required to stop and start the process, or make changes if, for instance, an object appears in your path.

White and gray matter

The CNS can be roughly divided into white and gray matter. As a very general rule, the brain consists of an outer cortex of gray matter and an inner area housing tracts of white matter.

Both types of tissue contain glial cells, which protect and support neurons. White matter mostly consists of axons (nerve projections) and oligodendrocytes — a type of glial cell — whereas gray matter consists predominantly of neurons.

Central glial cells

Also called neuroglia, glial cells are often called support cells for neurons. In the brain, they outnumber nerve cells 10 to 1.

Without glial cells, developing nerves often lose their way and struggle to form functioning synapses.

Glial cells are found in both the CNS and PNS but each system has different types. The following are brief descriptions of the CNS glial cell types:

Astrocytes: these cells have numerous projections and anchor neurons to their blood supply. They also regulate the local environment by removing excess ions and recycling neurotransmitters.

Oligodendrocytes: responsible for creating the myelin sheath — this thin layer coats nerve cells, allowing them to send signals quickly and efficiently.

Ependymal cells: lining the spinal cord and the brain's ventricles (fluid-filled spaces), these create and secrete cerebrospinal fluid (CSF) and keep it circulating using their whip-like cilia.

Radial glia: act as scaffolding for new nerve cells during the creation of the embryo's nervous system.

Cranial nerves

The cranial nerves are 12 pairs of nerves that arise directly from the brain and pass through holes in the skull rather than traveling along the spinal cord. These nerves collect and send information between the brain and parts of the body – mostly the neck and head.

Of these 12 pairs, the olfactory and optic nerves arise from the forebrain and are considered part of the central nervous system:

Olfactory nerves (cranial nerve I): transmit information about odors from the upper section of the nasal cavity to the olfactory bulbs on the base of the brain.

Optic nerves (cranial nerve II): carry visual information from the retina to the primary visual nuclei of the brain. Each optic nerve consists of around 1.7 million nerve fibers.

Central nervous system diseases

Below are the major causes of disorders that affect the CNS:

Trauma: depending on the site of the injury, symptoms can vary widely from paralysis to mood disorders.

Infections: some micro-organisms and viruses can invade the CNS; these include fungi, such as cryptococcal meningitis; protozoa, including malaria; bacteria, as is the case with leprosy, or viruses.

Degeneration: in some cases, the spinal cord or brain can degenerate. One example is Parkinson's disease which involves the gradual degeneration of dopamine-producing cells in the basal ganglia.

Structural defects: the most common examples are birth defects; including anencephaly, where parts of the skull, brain, and scalp are missing at birth.

Tumors: both cancerous and noncancerous tumors can impact parts of the central nervous system. Both types can cause damage and yield an array of symptoms depending on where they develop.

Autoimmune disorders: in some cases, an individual's immune system can mount an attack on healthy cells. For instance, acute disseminated encephalomyelitis is characterized by an immune response against the brain and spinal cord, attacking myelin (the nerves' insulation) and, therefore, destroying white matter.

Stroke: a stroke is an interruption of blood supply to the brain; the resulting lack of oxygen causes tissue to die in the affected area.

THE PERIPHERAL NERVOUS SYSTEM

The peripheral nervous system refers to parts of the nervous system outside the brain and spinal cord. It includes the cranial nerves, spinal nerves and their roots and branches, peripheral nerves, and neuromuscular junctions. The anterior horn cells, although technically part of the central nervous system (CNS), are sometimes discussed with the peripheral nervous system because they are part of the motor unit.

In the peripheral nervous system, bundles of nerve fibers or axons conduct information to and from the central nervous system. The autonomic nervous system is the part of the nervous system concerned with the innervations of involuntary structures, such as the heart, smooth muscle, and glands within the body

Difference between the CNS and peripheral nervous system

The term peripheral nervous system (PNS) refers to any part of the nervous system that lies outside of the brain and spinal cord. The CNS is separate from the peripheral nervous system, although the two systems are interconnected.

There are a number of differences between the CNS and PNS; one difference is the size of the cells. The nerve axons of the CNS — the slender projections of nerve cells that carry impulses — are much shorter. PNS nerve axons can be up to 1 meter long (for instance, the nerve that activates the big toe) whereas, within the CNS, they are rarely longer than a few millimeters.

Another major difference between the CNS and PNS involves regeneration (regrowth of cells). Much of the PNS has the ability to regenerate; if a nerve in your finger is severed, it can regrow. The CNS, however, does not have this ability.

SUBTRACTIVITY

- The assumption that if something is damaged in a brain, this cannot *add* functionality to the brain
- If patients developed new modules to compensate for the damaged ones, then this would make it hard to infer anything from the behaviour of brain-damaged patients
- Assumption most likely to be correct when brain damage happens in adulthood and the evaluation is done soon after the damage has occurred
 - Brain *plasticity* allows areas to learn new skills to compensate for damaged areas .

Check your progress- 3

Note: a. Write your answer in the space given below
b. Compare your answer with those given at the end of the unit

1. Define tumors

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.....

12.6 SUMMARY

In this unit you have studied in detailed about Assumptions and methods of functional modularity ,anatomical functional architecture and Substarctivity.

12.7 UNIT END ACTIVITY

1. Explain Functional modularity and anatomical modularity
 2. Explain any two methods of investigation.
 3. What is the nervous system and explain types.
 4. Explain the parts of the brain.
-

12.8 ANSWERS IN CHECK YOURS PROGRESS

1. 1. i.Functional Modularity ii. Anatomical Modularity
iii.Uniformity of functional Architecture across people iv. Subtractivity
 2. Dendrite, Cell body with nucleus, Axon Schwann cells , Myelin sheath, Node of Ranvier
 3. The cranial nerves are 12 pairs of nervous that arise directly from the brain and pass through holes in the skull rather than traveling along the spinal cord.
 4. Both cancerous and noncancerous tumors cam impacts of the central nervous system.
-

12.9 SUGGESTED READINGS

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UNIT 13 – METHODS OF INVESTIGATION

Methods of Investigation

NOTES

13.1 INTRODUCTION

Man's interest in the relationship between the brain and behaviour extends back at least 2500 years. The study of brain-behaviour relationship evolved with the development of a science of human behaviour based on the function of human brain, known as neuropsychology. Clinical neuropsychology in the 20th century showed a steady accumulation of clinical reports and research investigations that have gradually refined the theoretical positions. However, assessment relies heavily on the use of specific tests to investigate brain-behaviour relationships. There has been several specific standardized tests as well as test batteries developed across the globe. Current article has focused on different neuropsychological test batteries to evaluate individuals suspected of having brain dysfunction or damage.

Neuropsychology is the study of brain-behaviour relationship with the development of a science of human behaviour based on the function of human brain behaviour relationships to clinical problems and neurological assessment, which is sensitive to the condition of the brain. Man's interest in this area extends back at least 2500 years, when Pythagoras argued that the brain was the site of human reasoning. Approximately 100 years later, Hippocrates claimed that the brain was the organ of the intellect and recognized that a depressed skull fracture on the right side of the head could produce motor paralysis on the (contra lateral) left side of the body. Galen, in approximately 170 a.d., was able to map out many of the major brain structures and argued that the frontal lobes were the seat of our mental abilities. Galen's hypothesis however, was later discarded in favour of the belief that reasoning and intelligence was a product of the ventricles of the brain.

Neuropsychology can be divided into two branches. The first, clinical neuropsychology includes behavioural neurology and deals with patients with cerebral lesions. The second branch is experimental neuropsychology, which studies normal subjects in the laboratory by a range of techniques including specialized physiological techniques (Sbordone, Saul, & Purisch, 2007).

13.2 OBJECTIVES

- To explain the process and function of Neuropsychology
- To understand the methods of investigation in Neuro Psychology
- To provide the knowledge about Neuro generative disorders.

Self-Instructional Material

13.3 METHODS OF INVESTIGATION

Methods of Investigation

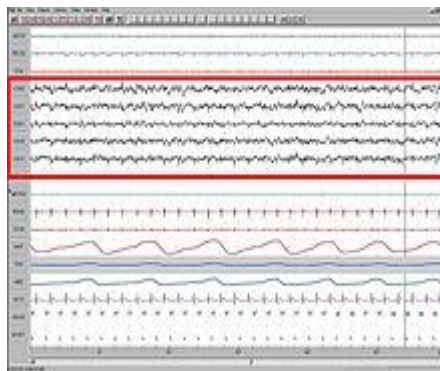
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The methods we have mentioned up to now examine the metabolic activity of the brain. But, there are also other cases in which one wants to measure electrical activity of the brain or the magnetic fields produced by the electrical activity. The methods we discussed so far do a great job of identifying where activity is occurring in the brain. A disadvantage of these methods is that they do not measure brain activity on a millisecond-by-millisecond basis. This measuring can be done by electromagnetic recording methods, for example by single-cell recording or the Electroencephalography (EEG). These methods measure the brain activity really fast and over a longer period of time so that they can give a really good temporal resolution.

13.3.1 Single cell method

Single cell studies are not very helpful for studying the human brain, since it is too invasive to be a common method. Hence, this method is most often used in animals. There are just a few cases in which the single-cell recording is also applied in humans. People with epilepsy sometimes get removed the epileptic tissue. A week before surgery electrodes are implanted into the brain or get placed on the surface of the brain during the surgery to better isolate the source of seizure activity. So, using this method one can decrease the possibility that useful tissues will be removed. Due to the limitations of this method in humans, there are other methods which measure electrical activity. Those we are going to discuss next.

13.3.2 Electroencephalography -EEG



EEG record during sleep

One of the most famous techniques to study brain activity is probably the Electroencephalography (EEG). Most people might know it as a technique which is used clinically to detect aberrant activity such as epilepsy and disorders.

Self-Instructional Material

In an experimental way, this technique is used to show the brain activity in certain psychological states, such as alertness or drowsiness. To measure the brain activity, mental electrodes are placed on the scalp. Each electrode, also known as lead, makes a recording of its own. Next, a

reference is needed which provides a baseline, to compare this value with each of the recording electrodes. This electrode must not cover muscles because its contractions are induced by electrical signals. Usually it is placed at the “mastoid bone” which is located behind the ear.

During the EEG, electrodes are placed like this: Over the right hemisphere electrodes are labelled with even numbers. Odd numbers are used for those on the left hemisphere. Those on the midline are labelled with a z. The capital letters stand for the location of the electrode (C=central, F=frontal, Fop= frontal pole, O= occipital, P= parietal and T= temporal).

After placing each electrode at the right position, the electrical potential can be measured. This electrical potential has a particular voltage and furthermore a particular frequency. Accordingly, to a person's state the frequency and form of the EEG signal can differ. If a person is awake, beta activity can be recognized, which means that the frequency is relatively fast. Just before someone falls asleep one can observe alpha activity, which has a slower frequency. The slowest frequencies are called delta activity, which occur during sleep. Patients who suffer epilepsy show an increase of the amplitude of firing that can be observed on the EEG record. In addition, EEG can also be used to help answering experimental questions. One can see that there is a greater alpha suppression over the right frontal areas than over the left ones, in case of depression. One can conclude from this, that depression is accompanied by greater activation of right frontal regions than of left frontal regions.

The disadvantage of EEG is that the electric conductivity, and therefore the measured electrical potentials vary widely from person to person and, also during time. This is because all tissues (brain matter, blood, bones etc.) have other conductivities for electrical signals. That is why it is sometimes not clear from which exact brain-region the electrical signal comes from.

13.3.3 Event-Related Potentials - ERP

Whereas EEG recordings provide a continuous measure of brain activity, event-related potentials (ERPs) are recordings which are linked to the occurrence of an event. A presentation of a stimulus for example would be such an event. When a stimulus is presented, the electrodes, which are placed on a person's scalp, record changes in the brain generated by the thousands of neurons under the electrodes. By measuring the brain's response to an event we can learn how different types of information are processed. Representing the word eats or bake for example causes a positive potential at about 200msec. From this one can conclude, that our brain processes these words 200 ms after presenting it. This positive potential is followed by a negative one at about 400ms.

This one is also called N400 (whereas N stands for negative and 400 for the time). So, in general one can say that there is a letter P or N to denote whether the deflection of the electrical signal is positive or negative. And a number, which represents, on average, how many hundreds of milliseconds

NOTES

after stimulus presentation the component appears. The event-related-potential shows special interest for researchers, because different components of the response indicate different aspects of cognitive processing. For example, presenting the sentences “The cats won’t eat” and “The cat won bake”, the N400 response for the word “eat” is smaller than for the word “bake”.

From this, one can draw the conclusion that our brain needs 400 ms to register information about a word’s meaning. Furthermore, one can figure out where this activity occurs in the brain, namely if one looks at the position on the scalp of the electrodes that pick up the largest response.

13.3.4 CAT – Computerized Axial Tomography

CAT scanning was invented in 1972 by the British engineer Godfrey N. Hounsfield and the South African (later American) physicist Alan Cromack.

CAT (Computed Axial Tomography) is an x-ray procedure which combines many x-ray images with the aid of a computer to generate cross-sectional views, and when needed 3D images of the internal organs and structures of the human body. A large donut-shaped x-ray machine takes x-ray image at many different angles around the body. Those images are processed by a computer to produce cross-sectional picture of the body. In each of these pictures the body is seen as an x-ray ‘slice’ of the body, which is recorded on a film. This recorded image is called tomogram.



X-ray picture.

CAT scans are performed to analyze, for example, the head, where traumatic injuries (such as blood clots or skull fractures), tumors, and infections can be identified. In the spine the bony structure of the vertebrae can be accurately defined, as can the anatomy of the spinal cord. ATC scans are also extremely helpful in defining body organ anatomy, including visualizing the liver, gallbladder, pancreas, spleen, aorta, kidneys, uterus, and ovaries. The amount of radiation a person receives during CAT scan is minimal. In men and non-pregnant women it has not been shown to produce any adverse effects. However, doing a CAT test hides some risks. If the subject or the patient is pregnant it maybe recommended to do another type of exam to reduce the possible risk of exposing her fetus to radiation. In cases of asthma or allergies it is also recommended to avoid

this type of scanning. Since the CAT scan requires a contrast medium, there's a slight risk of an allergic reaction to the contrast medium. Having certain medical conditions such as Diabetes, asthma, heart disease, kidney problems or thyroid conditions also increases the risk of a reaction to contrast medium.

13.3.5 MRI – Magnetic Resonance Imaging

Although CAT scanning was a breakthrough, in many cases it was substituted by Magnetic resonance imaging (also known as MRI) since magnetic resonance imaging is a method of looking inside the body without using x-rays, harmful dyes or surgery. Instead, radio waves and a strong magnetic field are used in order to provide remarkably clear and detailed pictures of internal organs and tissues.



MRI head side

MRI is based on a physics phenomenon, called nuclear magnetic resonance (NMR), which was discovered in the 1930s by Felix Bloch (working at Stanford university) and Edward Purcell (from Harvard University). In this resonance, magnetic field and radio waves cause atoms to give off tiny radio signals. In the year 1970, Raymond Damadian, a medical doctor and research scientist, discovered the basis for using magnetic resonance imaging as a tool for medical diagnosis. Four years later a patent was granted, which was the worlds first patent issued in the field of MRI. In 1977, Dr. Damadian completed the construction of the first “whole-body” MRI scanner, which he called the “Indomitable”. The medical use of magnetic resonance imaging has developed rapidly. The first MRI equipment in health was available at the beginning of the 1980s. In 2002, approximately 22000 MRI scanners were in use worldwide, and more than 60 million MRI examinations were performed.



A full size MRI-Scanner.

Because of its detailed and clear pictures, MRI is widely used to diagnose sports-related injuries, especially those affecting the knee, elbow, shoulder, hip and wrist. Furthermore, MRI of the heart, aorta and blood vessels is a fast, non-invasive tool for diagnosing artery disease and heart problems. The doctors can even examine the size of the heart-chambers and determine the extent of damage caused by a heart disease or a heart attack. Organs like lungs, liver or spleen can also be examined in high detail with MRI. Because no radiation exposure is involved, MRI is often the preferred diagnostic tool for examination of the male and female reproductive systems, pelvis and hips and the bladder.

An undetected metal implant may be affected by the strong magnetic field. MRI is generally avoided in the first 12 weeks of pregnancy. Scientists usually use other methods of imaging, such as ultrasound, on pregnant women unless there is a strong medical reason to use MRI.

13.3.6 PET – Positron Emission Tomography

Positron emission tomography, also called PET imaging or a PET scan, is a diagnostic examination that involves the acquisition of physiologic images based on the detection of radiation from the emission of positrons.

It is currently the most effective way to check for cancer recurrences. Positrons are tiny particles emitted from a radioactive substance administered to the patient. This radiopharmaceutical is injected to the patient and its emissions are measured by a PET scanner. A PET scanner consists of an array of detectors that surround the patient. Using the gamma ray signals given off by the injected radionuclide, PET measures the amount of metabolic activity at a site in the body and a computer reassembles the signals into images. PET's ability to measure metabolism is very useful in diagnosing Alzheimer's disease, Parkinson's disease, epilepsy and other neurological conditions, because it can precisely illustrate areas where brain activity differs from the norm. It is also one of the most accurate methods available to localize areas of the brain causing epileptic seizures and to determine if surgery is a treatment option. PET is often used in conjunction with an MRI or CT scan through "fusion" to give a full three-dimensional view of an organ.

13.3.7 fMRI – Functional Magnetic Resonance Imaging

The fMRI (Functional Magnetic Resonance) Imaging is based on the Nuclear magnetic resonance (NMR). The way this method works is as follows All atomic nuclei with an odd number of protons have a nuclear spin. A strong magnetic field is put around the tested object which aligns all spins parallel or antiparallel to it. There is a resonance to an oscillating magnetic field at a specific frequency, which can be computed in dependence on the atom type (the nuclei's usual spin is disturbed, which induces a voltage $s(t)$, afterwards they return to the equilibrium state). At this level different tissues can be identified, but there is no information about their location. Consequently the magnetic field's strength is gradually changed, thereby there is a correspondence between frequency and location and with the help of Fourier analysis we can get one-dimensional location information. Combining several such methods as the Fourier analysis, it is possible to get a 3D image.

fMRI has moderately good spatial resolution and bad temporal resolution since one fMRI frame is about 2 seconds long. However, the temporal response of the blood supply, which is the basis of fMRI, is poor relative to the electrical signals that define neuronal communication. Therefore, some research groups are working around this issue by combining fMRI with data collection techniques such as electroencephalography (EEG) or magneto encephalography (MEG), which has much higher temporal resolution but rather poorer spatial resolution.

Check your progress -1

Note: a. Write your answer in the space given below
b. Compare your answer with those given at the end of the unit

1. List out the two branches in Neuro Psychology

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13.4 NEUROPSYCHOLOGICAL TEST BATTERIES

There are number of standardized neuropsychol-ogical batteries to evaluate individuals suspected of having brain dysfunction or damage. Some of the important neuropsychological test batteries are discussed below:

13.4.1 Luria-Nebraska Neuropsychological Bttery (LNNB)

It is a comprehensive battery that integrates the neuropsychological assessment procedures of the late Professor Alexander Romanovich Luria and the American psychometric tradition through the work of its authors (Golden et al., 1978). This battery contains a total of 269 test items that make up 11 clinical scales, which are motor functions, rhythm and pitch,

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tactile and kinaesthetic functions, visual functions, receptive language, expressive language, reading, writing, arithmetic, memory, and intellectual processes. Later on Form II was developed, which is “largely a parallel form”. This contains a 12th scale, intermediate memory, which assesses delayed recall of some of the previously administered short-term memory items.

Performance on each item is evaluated on a 3-point scale where, 0 indicates no impairment and 2 indicates severe impairment. The summed scores for each of these scales produce 11 of the above scoring indices.

In addition to these scales, 3 additional scales have been developed (based on the 269 test items) that are sensitive to brain impairment and recovery following brain injury. These are known as the Pathognomonic, which consists of items that best discriminated patients with brain impairment from healthy controls and sensitive to the acuteness of an injury, Profile elevation, and Impairment scales together register the level of present functioning and degree of overall impairment. LNNB also contains 2 lateralization scales, i.e., left-hemisphere and right-hemisphere scale, which are composed of all the tactile and motor function items.

In addition, 8 scales (four for each side of the brain) have been developed to localize brain damage to the frontal, sensorimotor, parietal-occipital, and temporal regions. Also attempts to integrate the qualitative tradition of Luria by listing 66 different qualitative indices that aid the examiner in evaluating the nature of failure and not merely its fact. The entire test battery can usually be administered in 2½ to 3 hours.

13.4.2 Halstead–Reitan Neuropsychological Test Battery

This is perhaps the best known and most widely used battery, developed by Ward Halstead and Ralph M. Reitan (Horton & Wedding, 1984). The tests were initially used by Halstead to investigate the cognitive abilities that were compromised by brain injury. It consists of adult, intermediate child (9 to 14 years) and young child (5 to 8 years) versions. Each battery is designed to include a minimum of 14 neuropsychological tests capable of assessing as many as 26 different brain-behavior relationships. The Halstead-Reitan Battery includes Aphasia Screening Test (Halstead & Wepman, 1959), Halstead Category Test (Reitan & Wolfson, 1993), Finger Tapping Test (Halstead, 1947; Reitan and Wolfson, 1993), Grip Strength (Hand Dynamometer) Test, several perceptual examinations, tactile and tactual perceptual examinations. This battery also includes Minnesota Multiphasic Personality Inventory (MMPI) (Hathaway & McKinley, 1940), and Wechsler Adult Intelligence Scale (WAIS) (Wechsler, 1955). The indices include Halstead Impairment Index, Average Impairment Index, and General Neuropsychological Deficits Scale.

13.4.3 Neuropsychological assessment battery (NAB)

This was designed by Stern and White (2003) to assess the major five cognitive areas (called “modules”) of functioning, i.e., Attention, Language, Memory, Spatial, and Executive functions. A sixth module called the screening module is composed of two or more of the same or

abbreviated tests in the other five modules so chosen as to test both high and low ability levels. The battery was developed for flexible use. Each module (including the screening module) can stand alone and norms are provided for individual tests as well.

13.4.4 San diego neuropsychological test battery

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It was developed as part of a Multicentre National Traumatic Coma Data Bank Program to provide a complete mental status examination by Baser and Ruff (1987). The goal was not necessarily to develop new tests, but rather to use tests that had psychometric properties. The time for test administration was limited to an average of 3½ hours to avoid excessive fatigue or the need to split testing over two sessions. The underlying theoretical basis of this test is Luria's three primary functional units (arousal, analyzing and coding, and planning). This battery consists of 21 procedures that together yield a total of 38 scores. The test data is initially interpreted quantitatively in terms of whether a patient's performance falls in the normal, borderline or impaired range on each of the 38 test scores. These test scores are then qualitatively evaluated based on Luria's model of cortical organization.

13.4.5 Micro cognitive assessment of cognitive functioning computerized battery

It is a computer-administered and scored test that was intended to serve as a screening device or diagnostic tool as part of a general neuropsychological examination or examination of cognitive functioning (Powell et al., 1993). The standard form consists of 18 subtests and the short form contains 12 subtests. Nine index scores are derived from the subtest scores and are conceptually formed to represent functioning in five neuro-cognitive domains, i.e., attention/mental control, memory, reasoning/calculation, spatial processing, and reaction time.

Interpretation of the patient's test data is generally based on level of performance in comparison to an appropriate normative group. The Microcog automatically computes a number of pair-wise comparisons between index scores and subtest scores. These comparisons were selected on the basis that significant differences between them would most likely be clinically meaningful. In general, the larger the discrepancy and the less frequently it occurs, the less likely it can be explained as a normal variation.

Check your progress - 2

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. Abbreviation CAT and PET

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13.5 NEURODEGENERATIVE DISORDERS

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Neurodegenerative disease is an umbrella term for a range of conditions which primarily affect the neurons in the human brain.

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Neurons are the building blocks of the nervous system which includes the brain and spinal cord. Neurons normally don't reproduce or replace themselves, so when they become damaged or die they cannot be replaced by the body. Examples of neurodegenerative diseases include Parkinson's, Alzheimer's, and Huntington's disease.



Neurodegenerative diseases are incurable and debilitating conditions that result in progressive degeneration and / or death of nerve cells. This causes problems with movement (called ataxias), or mental functioning (called dementias).

Dementias are responsible for the greatest burden of disease with Alzheimer's representing approximately 60-70% of cases.

The neurodegenerative diseases that JPND focuses on are:

- Huntington's Disease (HD)
- Parkinson's disease (PD) and PD-related disorders
- Alzheimer's disease (AD) and other dementias
- Autistic Spectrum Disorders (ASD)
- Prion disease

13.5.1 Huntington's disease

Huntington's disease is a devastating autosomal dominant neurodegenerative disease that results from a CAG trinucleotide repeat expansion within the disease-causing huntingtin / IT15 gene. This gene encodes an extended polyglutamine tract in the huntingtin protein (The Huntington's Disease Collaborative Research Group, 1993). The clinical symptoms of HD are progressive involuntary choreatic movements, bradykinesia, cognitive decline and psychiatric syndromes (reviewed in Walker, 2007). Impaired olfactory function was noticed in patients and presymptomatic gene carriers (Mochel et al., 2007).

Aggregation of the mutant huntingtin results in neuronal damage in the medium spiny neurons of the neostriatum and other neurons such as in the

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cortex (reviewed in Li & Li, 2004). Among several mechanisms, a recently suspected toxic mechanism is due to the presence of toxic oligomers (Sathasivam et al., 2010).

13.5.2 Parkinson's disease

Loss of DAergic neurons in the substantia nigra of the midbrain and loss of other neurotransmitter phenotype neurons in other brain regions are characteristic neuro pathological hallmarks (reviewed in Goedert, 2001). Prominent clinical features of PD are motor symptoms (bradykinesia, tremor, rigidity and postural instability) and non-motor related PD symptoms (olfactory deficits, autonomic dysfunction, depression, cognitive deficits and sleep disorders). Non-DA brain regions that are affected in PD have recently attracted increasing interest because the onsets of the non-motor symptoms linked to these neuro pathological alterations are observed early in the course of the disease.

/ OB system. Interestingly, several monogenetic forms of PD show a decreased gray matter volume in the hippocampal region (Reetz et al., 2010).

13.5.3 Alzheimer's Disease:

The most frequent discriminative issues surround Alzheimer's disease, which, neuropsychologically is characterized by a progressive deterioration in certain features of intellectual, particularly reasoning inferential skills and conceptual and abstract thinking (assessed, for eg, by the similarities, comprehension, picture arrangement, block design, object assembly and Arithmetic series of revised Wechsler adult intelligence scale and by the Raven's progressive matrices.)

13.5.4 Autistic Spectrum Disorders (ASD)

Autism (or "classical autism") is a neurodevelopmental disorder characterized by deficiencies in social interactions and communication skills, as well as repetitive and stereotyped patterns of behavior. It is one of the group of developmental disorders known as autism spectrum disorders (ASDs). Biochemical, anatomical and neuroradiographical studies suggest a disturbance of brain energy metabolism in autistic patients, although its cause is still unknown.

Autism is characterised by three distinctive types of behaviour – difficulties with social interaction, problems with verbal and nonverbal communication, and repetitive behaviour or narrow, obsessive interests. The impact of these can range from mild to disabling.

The hallmark feature of autism is impaired social interaction. Parents are usually the first to notice symptoms of autism in children. Even in infancy, a baby with autism may be unresponsive to people, or focus intently on one item to the exclusion of others for long periods. A child with autism may appear to develop normally and then withdraw and

become indifferent to social contact. Many children with autism have a reduced sensitivity to pain, but are abnormally sensitive to sensations such as sound, touch, or other sensory stimulation. These unusual sensitivities may contribute to behavioural symptoms such as a resistance to being cuddled or hugged (US National Institute of Mental Health)..

There is no cure for ASDs. For many children, their symptoms improve with treatment and with age. Some children with autism grow up to lead normal or near-normal lives. Therapies and behavioural interventions can target specific symptoms and bring about substantial improvement. In contrast to 20 years ago, when many autistic individuals were institutionalised, there are now many flexible solutions. Usually, only the most severely affected individuals live in institutions.

13.5.5 Prion Diseases

Prion diseases are a group of neurodegenerative diseases caused by **prions**, which are “proteinaceous infectious particles.” For some background, first see this introduction to prions. Prion diseases are caused by misfolded forms of the prion protein, also known as PrP. These diseases affect a lot of different mammals in addition to humans – for instance, there is scrapie in sheep, mad cow disease in cows, and chronic wasting disease in deer.

The human forms of prion disease are most often the names **Creutzfeldt-Jakob disease (CJD)**, **fatal familial insomnia (FFI)**, **Gertsmann-Straussler-Scheinker syndrome (GSS)**, **kuru** and **variably protease-sensitive prionopathy (VPSPr)**. All of these diseases are caused by just slightly different versions of the same protein, so we refer to them all as prion diseases.

Even though prion diseases do come in slightly different forms, they have a whole lot in common. In each disease, the prion protein (PrP) folds up the wrong way, becoming a Prion and then causes other PrP molecules to do the same. Prions can then spread “silently” across a person’s brain for years without causing any symptoms. Eventually prions start to kill neurons, and once symptoms strike, the person has a very rapid cognitive decline. Most prion diseases are fatal within a few months, though some can last a few years .Prion diseases in humans are fairly rare – about 1 in 1 million people dies of a prion disease each year. Prion diseases can come about in one of three ways: acquired, genetic or sporadic.

Acquired means the person gets exposed to prions and becomes infected. Even though prions are scary, they’re very hard to catch, and so infection is the least common way of getting a prion disease. There was a famous epidemic of **kuru**, a prion disease which was passed from person to person by cannibalism, in Papua New Guinea, but this has now mostly subsided. Then there is **mad cow** disease or **bovine spongiform encephalopathy**. This disease passed from cows to humans through contaminated food. The human form of the disease is called **variant Creutzfeldt-Jakob Disease (vCJD)** and has killed about 200 people in the U.K. since 1994. Today there are only a few people are dying of this disease each year. There have

also been cases where prion disease has been transmitted via contaminated surgical instruments, human growth hormone supplements, or transplants of dura mater (a tissue surrounding the brain). These medical infections are called “**iatrogenic**” infections.

Prion diseases can also be **genetic**. First, let’s recall some biology basics. DNA contains instructions which get re-written in RNA, and then the instructions in RNA get translated into protein. So changes in a person’s DNA can cause changes in the proteins their cells produce. Everyone has a gene called *PRNP* which codes for the protein called PrP, and most of the time this protein is perfectly healthy and fine. Some people have mutations in the DNA of their *PRNP* gene, which cause it to produce mutant forms of PrP. These mutant forms don’t form prions instantly, and most people with *PRNP* mutations live perfectly healthy for decades. But as people get older, the mutant forms of PrP are more and more likely to fold up the wrong way and form prions. Once they do, the person has a rapid neurodegenerative disease.

Some people refer to genetic prion diseases as “**inherited**” or “**familial**” prion diseases. We prefer not to use these terms: just because a disease is genetic doesn’t mean it’s inherited or familial. Every DNA mutation has to start somewhere, so some people with genetic prion disease are the first in their family – they didn’t inherit the mutation, and it’s not familial. According to one estimate, 60% of genetic prion disease patients have no family history of the disease

Finally, prion diseases can simply be **sporadic**, meaning we don’t know why they happen. Some people think that sporadic prion diseases happen when one prion protein just misfolds by chance, and then spreads from there. Others think that the disease may start with one cell that has a spontaneous DNA mutation and starts producing mutant PrP. We don’t know what the real answer is. Either way, the effect is that people with no previous exposure to prions and no mutations in (most of) their DNA end up getting a prion disease out of nowhere

13.6 SUMMARY

In this unit you have studied in detailed about Assumptions and methods of functional modularity ,anatomical functional architecture and substarctivity and methods of investigation, nero psychological batteries and neuro generative disorders. This will make the people aware of the methods of investigation and neuro generative disorders.

13.7 UNIT –END ACTIVITY

Write a detail assignment about assumption and methods of modularity

Discuss in details about ASD and other types of disorders

1. Explain Functional modularity and anatomical modularity
2. Explain any two methods of investigation

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3. Write in detail notes on Functional Magnetic Resonance Imaging

4. Write in detail note on Autistic Spectrum Disorders

13.8 ANSWERS IN CHECK YOUR PROGRESS

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1. Clinical Neuro Psychology and Experimental Neuro Psychology
 2. Computerized axial tomography , Positron Emission Tomography
 3. Autism is a neuro developmental disorder characterized by deficiencies in social interactions and communication skills as well as repetitive and stereotyped patterns of behavior.
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13.9 SUGGESTED READINGS

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2. **Hardiman**, Orla, **Doherty**, Colin P. (Eds.) (2016) e book., Neuro degenerative Disorders,A Clinical Guide.
3. Mohan S (2000) Information Processing Approach course material for M.Phil Distance Education, Alagappa University
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UNIT 14 NEUROPSYCHOLOGICAL PLASTICITY AND RESTORATION OF BRAIN

14.1 INTRODUCTION

For many years, scientists knew that the cells that line the intestine are replaced every two weeks. The dead cells on the surface of our skin slough off, and new cells move up to take their place every few months. The liver is capable of natural regeneration of lost tissue; 25% of a liver can regenerate into a whole liver. Conversely, as recently as 15 years ago, scientists believed that people were born with all of the brain cells they would ever have.

The belief was that, unlike the intestine, skin and liver, the brain and nerves could not regenerate to take the place of damaged cells. Observations of stroke patients and individuals with brain trauma and disease suggested that brain damage from accidents or disease was permanent. Nerves and areas of the brain that controlled the movement of specific limbs were not expected to regain function following injury or disease. If improvements were seen in individuals that had experienced trauma, the assumption was that the injury was "incomplete" and that recovery was due to nerves and tissues that had escaped severe injury.

14.2 OBJECTIVES

- To know the historical antecedents and approaches
- To know the types of brain injury methods
- To understand the function mind and brain relationship

14.3 HISTORICAL ANTECEDENTS AND APPROACHES

One line of investigation that began to suggest the existence of plasticity in the brain and nervous system was in the area of brain cell regeneration. The first evidence that brain cells could divide to form "newly born" brain cells in an adult animal came nearly 50 years ago.

One of the first observations was the migration of stem cells to the olfactory bulb, where they became the type of brain cell that mediates the sense of smell. In 1998, NIH-supported researchers teamed up with Swedish scientists to demonstrate that new neurons were produced in the hippocampus of humans.

14.3.1 Observations in Patients

In parallel, over approximately the same period, neurologists, anatomists and physical therapists were working with patients with brain injuries and

performing experiments in animal models to determine whether the brain could be re-trained following injury. These researchers were instrumental in "mapping" which part of the brain controlled specific functions.

14.3.2 Finding Plasticity in the Nervous System

A key early observation by the scientists looking for brain stem cells in animals was that new brain cells appeared to regenerate more rapidly in response to changes experienced by the animal, such as training—e.g. physical exertion of a specific limb—injury, or infection.

A similar observation was made by neurologists in experiments in animals where physical therapy appeared to cause the brain to "re-map." That is, their experiments showed that the brain appeared to have "adaptive plasticity," meaning that it could be trained to use a different brain region to "take over" control of a specific limb or function in place of a damaged brain region that previously controlled the function.

Based on experiments in animals and humans over the past 20 years, researchers established that the cortex, which is the dominant feature of the human brain, has significant plasticity—the ability to reconfigure its functional organization as the result of experience, such as training.

This is supported in animal experiments where a number of physiological changes are observed in response to behavioral training. These include changes in the size and shape of brain regions, speeding up and/or slowing down of neuron signaling, increases in the molecules that help transmit signals through the brain, and the growth of new neurons.

14.3.3 Studying, Harnessing & Enhancing Healing

With the discovery of the body's plastic regenerative responses to injury, researchers and therapists are using this information to optimize therapies that induce plasticity and repair for a number of diseases, disorders and injuries.

Different types of interventions are used and include specific types of training activities, pharmacological interventions, and cognitive therapies, among others. The following are examples of approaches. They include those that are currently in practice and those being tested in animal models, as well as potential future therapies based on the increasing understanding of the cellular and molecular pathways that induce plasticity.

In spinal cord injury, plasticity resulting in improved function can be induced by interventions such as intense repetitive training, which involves various types of exercise that provide certain benefits depending on the specifics of the rehabilitative training regimen. For example, NICHD-funded researchers determined that *passive* exercise can be used to maintain or improve neuromuscular function and involves, for example, cycling on a motorized device that does not require effort by the patient. *Active* exercise requires subjects to perform assisted or unassisted movements that require effort by the patient and provides the benefits of

passive exercise but also promotes the additional benefit of functional activation of muscles. In each case, the movement training induces plasticity, i.e. physiological and functional changes in nerve, muscle, and the connections between them.

Traumatic brain injury (TBI) affects nearly 2 million Americans annually, and 100,000 of those injuries result in long-term behavioral disturbances that adversely affect quality of life. NICHD-funded researchers have found that, following injury, the brain is receptive to neuroplasticity, repair, and recovery, and the success of these processes can be enhanced by specific rehabilitation strategies.

One successful rehabilitation strategy is known as *environmental enrichment*. Environmental enrichment consists of an enhanced living environment with increased social interaction and novel stimuli that together promote physical and cognitive stimulation. Remarkably, the enhanced environment results in numerous neuroplastic changes in the brain, such as increased neuron size, increased density and branching of neurons, and increased size of the brain cortex (measured in animal experiments). While environmental enrichment is being used to improve function in TBI patients, researchers in the laboratory are working to understand the physiological, cellular, and molecular mechanisms that mediate these effects in an effort to continue to improve rehabilitation strategies.

One notable discovery is the identification of brain-derived growth factor (BDGF) as a possible key player in the neuroplastic response to an enhanced environment. Experiments show that exposure to complex environments in normal animals can increase levels of BDNF in multiple brain regions. Early studies in animals with experimental TBI show increased levels of BDNF in response to an enriched environment. Similarly, changes in levels of neurotransmitters (molecules involved in neuron signals) in response to TBI are under study with the goal of using the understanding of the molecular pathways involved in the neuroplastic process to design more successful rehabilitation regimens.

Imaging techniques such as magnetic resonance imaging (MRI) can also detect neuroplastic events. Used to study stroke patients, MRI revealed a cellular and molecular reorganization around the stroke site. In work performed by NIH researchers, including those funded by the NICHD, two major regenerative events were observed: Neurons sprout new connections that extend into the area surrounding the site, and newly born neurons appear and migrate into the area of the stroke. Also, to accelerate the healing process, molecules that normally inhibit the growth of new neurons are turned off.

Researchers are working to determine the molecules that cause these healing changes so that they might eventually be used in conjunction with physical therapies to develop improved interventions following a stroke that enhance the naturally occurring healing processes that promote

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neuronal regeneration and remodeling.

14.3.4 From Research to Rehabilitation

To harness the plasticity demonstrated experimentally and attempt to apply it clinically, the National Center for Medical Rehabilitation and Research within the NICHD supports major clinical trials in rehabilitation, often funded in collaboration with other institutes at NIH.

The EXCITE trial (Extremity Constraint Induced Extremity Evaluation) built on early experimental approaches in stroke patients and in animal models of stroke that involved repetitive training of a paralyzed upper extremity on task-oriented activities. The study tested a training technique known as constraint induced movement therapy (CIMT), where the functional limbs are constrained to force use of the injured limb. Participants were assigned to receive either CIMT (wearing a restraining mitt on the less-affected hand while engaging in repetitive task practice and behavioral shaping with the paralyzed hand) or usual and customary care.

The results of this randomized controlled trial indicated that among patients that had a stroke within the previous 3 to 9 months, CIMT produced significant and clinically relevant improvements in arm motor function that persisted for at least one year. A subsequent trial demonstrated that individuals that received the identical intervention 15 to 21 months after stroke achieved approximately the same benefit as the 3 to 9 month group and that the improvement remained at 24 months post-treatment for both groups.

In addition to renewing its connections in the brain, forcing use of the affected hand is thought to help overcome "learned nonuse," a maladaptive plastic response where the brain remaps to shut down connections with the nonfunctioning limb. Studying such maladaptive plasticity is also extremely important as researchers seek to identify the molecules and pathways responsible for this phenomenon, with the ultimate goal of blocking maladaptive responses as part of enhanced treatment.

14.3.5 A Path to Independence

Brain-computer interfaces (BCIs) are artificial systems that control external devices or body muscles with signals generated by neural activity, and are one of the most dramatic examples of the current and future potential for a revolution in rehabilitation based on neuro plasticity.

The Future

The examples on the preceding pages give a glimpse of what can be accomplished when advanced knowledge of the body's innate plastic and adaptive healing mechanisms guide new rehabilitation approaches.

Stem cells

The discovery of stem cells, which offer the promise to create and replace damaged cells to cure degenerative disease and injuries, is clearly an area of intense research. For example, diabetes is a disease long thought to be amenable to stem cell therapy because the disease is caused by the loss of the single type of cell that produces insulin and, therefore, might be cured

by providing insulin-producing cells made in the laboratory.

NICHD-supported researchers took advantage of the fact that the uterus contains numerous stem cells needed to make the new cells that replenish the uterine lining every month. Researchers took this rich source of stem cells and added various nutrients and growth factors that caused the cells to "differentiate" into insulin-producing cells. These cells were injected into a diabetic mouse model, where they secreted insulin and stabilized blood glucose levels. This impressive example of stem cell-based therapy suggests that women could successfully be treated for diabetes or other disorders using cells from the lining of the uterus. Such research is an excellent example of the potential of stem cell therapy to effectively address major, chronic disorders.

14.3.6 Mechanisms of plasticity

Regarding rehabilitation following traumatic injury and assistive technologies for those with disabilities that limit function, scientists are now working to expand their understanding of plasticity in its broadest sense, including the mechanisms that underlie adaptive as well as maladaptive change at the molecular, cellular, organ, and system levels.

14.3.7 Plasticity and adaptation

Based on years of research and observations, we now know that the basic processes that allow us to recover from illness and injury are plasticity and adaptation. Plasticity is the change in the body's structure and physiology in reaction to injury and it occurs in virtually all tissues of the body, from the central nervous system to bone. Adaptation refers to the changes in strategies that individuals use to accomplish tasks in new ways to overcome their disabilities.

Learning how to enhance and improve the body's natural mechanisms of plasticity is central to developing more effective regeneration and rehabilitation interventions. With the remarkable progress that has already been made, it may not be such a leap to envision a time when one might see a tetraplegic individual parallel parking their solar-powered car, given they have the essentials: their driver's license, their car keys, and their thoughts.

Check your progress – 1

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. Define stem cells

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14.4 BRAIN INJURY

"The brain is without doubt our most fascinating organ. Parents, educators, and society as a whole have a tremendous power to shape the wrinkly universe inside each child's head, and, with it, the kind of person he or she will turn out to be. We owe it to our children to help them grow the best brains possible." - **Lise Eliot**

14.4.1 Brain Injury Definitions

Traumatic Brain Injury (TBI)

TBI is defined as an alteration in brain function, or other evidence of brain pathology, caused by an external force.



Adopted by the Brain Injury Association Board of Directors in 2011. This definition is not intended as an exclusive statement of the population served by the Brain Injury Association of America.

Acquired Brain Injury

An acquired brain injury is an injury to the brain, which is not hereditary, congenital, degenerative, or induced by birth trauma. An acquired brain injury is an injury to the brain that has occurred after birth.

There is sometimes confusion about what is considered an acquired brain injury. By definition, any traumatic brain injury (eg, from a motor vehicle accident, or assault) could be considered an acquired brain injury. In the field of brain injury, acquired brain injuries are typically considered any injury that is non traumatic. Examples of acquired brain injury include stroke, near drowning, hypoxic or anoxic brain injury, tumor, neurotoxins, electric shock or lightning strike.

14.4.2 Types of Brain Injury

1. Diffuse Axonal Injury (TBI)
2. Concussion (TBI)
3. Contusion (TBI)
4. Coup-centre coup injury (TBI)
5. Second Impact Syndrome (TBI)
6. Open and Closed Head Injuries
7. Penetrating Injury (TBI)
8. Shaken Baby Syndrome (TBI)
9. Locked in Syndrome (TBI)
10. Anoxic brain injury (ABI)
11. Hypoxic brain injury (ABI)



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Diffuse Axonal Injury

- ❖ A Diffuse Axonal Injury can be caused by shaking or strong rotation of the head, as with Shaken Baby Syndrome, or by rotational forces, such as with a car accident.
- ❖ Injury occurs because the unmoving brain lags behind the movement of the skull, causing brain structures to tear.
- ❖ There is extensive tearing of nerve tissue throughout the brain. This can cause brain chemicals to be released, causing additional injury.
- ❖ The tearing of the nerve tissue disrupts the brain's regular communication and chemical processes.
- ❖ This disturbance in the brain can produce temporary or permanent widespread brain damage, coma, or death.
- ❖ A person with a diffuse axonal injury could present a variety of functional impairments depending on where the shearing (tears) occurred in the brain.

Concussion

- A concussion can be caused by direct blows to the head, gunshot wounds, violent shaking of the head, or force from a whiplash type injury.

Self-Instructional Material

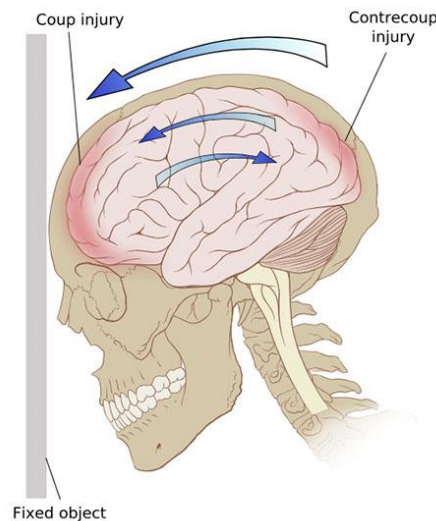
- Both closed and open head injuries can produce a concussion. A concussion is the most common type of traumatic brain injury.
- A concussion is caused when the brain receives trauma from an impact or a sudden momentum or movement change. The blood vessels in the brain may stretch and cranial nerves may be damaged.
- A person may or may not experience a brief loss of consciousness (not exceeding 20 minutes). A person may remain conscious, but feel “dazed” or “punch drunk”.
- A concussion may or may not show up on a diagnostic imaging test, such as a CAT Scan.
- Skull fracture, brain bleeding, or swelling may or may not be present. Therefore, concussion is sometimes defined by exclusion and is considered a complex neurobehavioral syndrome.
- A concussion can cause diffuse axonal type injury resulting in permanent or temporary damage.
- It may take a few months to a few years for a concussion to heal.

Contusion

A contusion is the bruising of brain tissue.

The area that is bruised and the seriousness of the brain injury depend on where the head was hit and how hard it was hit. Common places for contusions are the frontal and temporal lobes. The underside of the frontal lobes and the tips of the temporal lobes have the biggest risk of contusions because they can be dragged across the very bumpy and sharp inner surface of the skull.

Bruising to the brain can cause bleeding and swelling of the brain. This can be very serious.



Coup-Contrecoup Injury

- Coup-Contrecoup Injury describes contusions that are both at the site of the impact and on the complete opposite side of the brain.
- This occurs when the force impacting the head is not only great enough to cause a contusion at the site of impact, but also is able to move the brain and cause it to slam into the opposite side of the skull, which causes the additional contusion.

Second Impact Syndrome "Recurrent Traumatic Brain Injury"

- Second Impact Syndrome, also termed "recurrent traumatic brain injury," can occur when a person sustains a second traumatic brain injury before the symptoms of the first traumatic brain injury have healed. The second injury may occur from days to weeks following the first. Loss of consciousness is not required. The second impact is more likely to cause brain swelling and widespread damage.
- Because death can occur rapidly, emergency medical treatment is needed as soon as possible.
- The long-term effects of recurrent brain injury can be muscle spasms, increased muscle tone, rapidly changing emotions, hallucinations, and difficulty thinking and learning.

Penetrating Injury

- Penetrating injury to the brain occurs from the impact of a bullet, knife or other sharp object that forces hair, skin, bone and fragments from the object into the brain.
- Objects traveling at a low rate of speed through the skull and brain can ricochet within the skull, which widens the area of damage.
- A "through-and-through" injury occurs if an object enters the skull, goes through the brain, and exits the skull. Through-and-through traumatic brain injuries include the effects of penetration injuries, plus additional shearing, stretching and rupture of brain tissue.
- The devastating traumatic brain injuries caused by bullet wounds result in a 91% firearm-related death rate overall.
- Firearms are the single largest cause of death from traumatic brain injury.

Shaken Baby Syndrome

- Shaken Baby Syndrome is a violent criminal act that causes traumatic brain injury. Shaken Baby Syndrome occurs when the perpetrator aggressively shakes a baby or young child. The forceful whiplash-like motion causes the brain to be injured.
- Blood vessels between the brain and skull rupture and bleed.
- The accumulation of blood causes the brain tissue to compress while the injury causes the brain to swell. This damages the brain cells.
- Shaken Baby Syndrome can cause seizures, lifelong disability, coma, and death.

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- Irritability, changes in eating patterns, tiredness, difficulty breathing, dilated pupils, seizures, and vomiting are signs of Shaken Baby Syndrome. A baby experiencing such symptoms needs immediate emergency medical attention.

Locked in Syndrome

- Locked in Syndrome is a rare neurological condition in which a person cannot physically move any part of the body except the eyes.
- The person is conscious and able to think.
- Vertical eye movements and eye blinking can be used to communicate with others and operate environmental controls.

Anoxic Brain Injury

- Anoxic Brain Injury occurs when the brain does not receive oxygen. Cells in the brain need oxygen to survive and function.
Types of Anoxic Brain Injury:
 - Anoxic Anoxia - Brain injury from no oxygen supplied to the brain
 - Anemic Anoxia - Brain injury from blood that does not carry enough oxygen
 - Toxic Anoxia - Brain injury from toxins or metabolites that block oxygen in the blood from being used

Hypoxic Brain Injury

- Hypoxic Brain Injury results when the brain receives some, but not enough, oxygen. A Hypoxic Ischemic Brain Injury, also called Stagnant Hypoxia or Ischemic Insult, occurs because of a critical reduction in blood flow or low blood pressure leading to a lack of blood flow to the brain.

Open Head Injury

The following are terms used to describe types of skull fractures that can occur with open head injuries:

- Depressed Skull Fracture - The broken piece of skull bone moves in towards the brain.
- Compound Skull Fracture - The scalp is cut and the skull is fractured.
- Basilar Skull Fracture:
 - The skull fracture is located at the base of the skull (neck area) and may include the opening at the base of the skull.

- Can cause damage to the nerves and blood vessels that pass through the opening at the base of the skull.
- Battle's Sign
 - The skull fracture is located at the ear's petrous bone.
 - This produces large "black and blue mark" looking areas below the ear, on the jaw and neck.
 - It may include damage to the nerve for hearing.
 - Blood or cerebral spinal fluid may leak out of the ear. This is termed "CSF Otorrhea."
- Raccoon Eyes
 - The skull fracture is located in the anterior cranial fossa.
 - This produces "black and blue" mark looking areas around the eyes.
 - Cerebral spinal fluid may leak into the sinuses. This is termed "CSF Rhinorrhea."
 - Nerve damage for the sense of smell or eye functions may occur.
- Diastatic Skull Fracture
 - The skull of infants and children are not completely solid until they grow older.
 - The skull is composed of jigsaw-like segments (cranial fissures) which are connected together by cranial sutures.
 - Skull fractures that separate the cranial sutures in children prior to the closing of the cranial fissures are termed "diastatic skull fractures."
- Cribriform Plate Fracture
 - The cribriform plate is a thin structure located behind the nose area.
 - If the cribriform plate is fractured, cerebral spinal fluid can leak from the brain area out the nose

Closed Head Injury

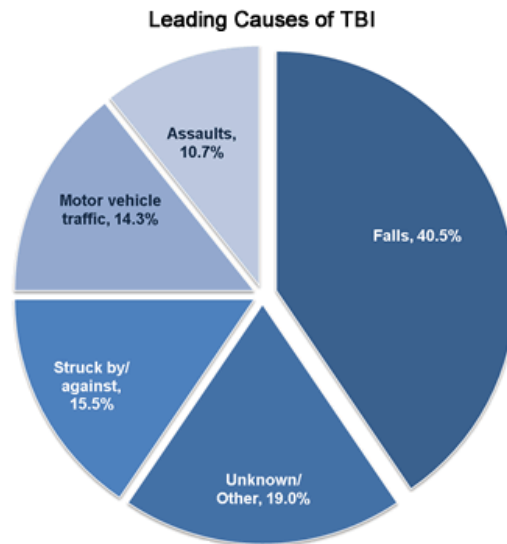
When a person receives an impact to the head from an outside force, but the skull does not fracture or displace this condition is termed a "closed head injury". Again, separate terminology is added to describe the brain injury. For example, a person may have a closed head injury with a severe traumatic brain injury.

- With a closed head injury, when the brain swells, the brain has no place to expand. This can cause an increase in intracranial pressure, which is the pressure within the skull.
- If the brain swells and has no place to expand, this can cause brain tissues to compress, causing further injury.
- As the brain swells, it may expand through any available opening in the skull, including the eye sockets. When the brain expands through the eye sockets, it can compress and impair the functions of the eye nerves. For instance, if an eye nerve, Cranial Nerve III, is compressed, a person's pupil (the dark center part of the eye) will

appear dilated (big). This is one reason why medical personal may monitor a person's pupil size and intracranial pressure.

Causes

According to the Centers for Disease and Control Injury Prevention Center, the leading causes of traumatic brain injury are:



Falls: 40.5%

Unknown/Other: 19%

Motor Vehicle: 14.3%

Struck by/against: 15.5%

Assault: 10.7%

Outcomes after Brain Injury

Brain injury can result in a range of outcomes:

- 52,000 die;
- 280,000 are hospitalized; and
- 2.2 million are treated and released from an emergency department.

Among children ages 0 to 14 years, TBI results in an estimated

- 2,685 deaths;
- 37,000 hospitalizations; and
- 435,000 emergency department visits.

The number of people with TBI who are not seen in an emergency department or who receive no care is unknown

Severity of Brain Injury

Emergency personnel typically determine the severity of a brain injury by using an assessment called the Glasgow Coma Scale (GCS). The terms Mild Brain Injury, Moderate Brain Injury, and Severe Brain Injury are used to describe the level of initial injury in relation to the neurological severity caused to the brain. **There may be no correlation between the initial Glasgow Coma Scale score and the initial level of brain injury and a person's short or long term recovery, or functional abilities.** Keep in mind that there is nothing "Mild" about a brain injury—the term "Mild" Brain injury is used to describe a level of neurological injury. Any injury to

the brain is a real and serious medical condition. There is additional information about mild brain injury on our mild brain injury page.

Glasgow Coma Scale (GCS)

Glasgow Coma Score		
Eye Opening (E)	Verbal Response (V)	Motor Response (M)
4=Spontaneous	5=Normal conversation	6=Normal
3=To voice	4=Disoriented conversation	5=Localizes to pain
2=To pain	3=Words, but not coherent	4=Withdraws to pain
1=None	2=No words.....only sounds	3=Decorticate posture
	1=None	2=Decerebrate
		1=None
Total = E+V+M		

The scale comprises three tests: eye, verbal and motor responses. The three values separately as well as their sum are considered. The lowest possible GCS (the sum) is 3 (deep coma or death), while the highest is 15 (fully awake person). A GCS score of 13-15 is considered a "mild" injury; a score of 9-12 is considered a moderate injury; and 8 or below is considered a severe brain injury.

Mild Traumatic Brain Injury (GCS of 13-15)

Some symptoms of mild TBI include:

- Headache
- Fatigue
- Sleep disturbance
- Irritability
- Sensitivity to noise or light
- Balance problems
- Decreased concentration and attention span
- Decreased speed of thinking
- Memory problems
- Nausea
- Depression and anxiety
- Emotional mood swings

This information is not intended to be a substitute for medical advice or examination. A person with a suspected brain injury should contact a physician immediately, go to the emergency room, or call 911 in the case of an emergency. Symptoms of mild TBI can be temporary. The majority of people with mild TBI recover, though the timetable for recovery can vary significantly from person to person.

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Moderate Brain Injury (GCS of 8-12)

A moderate TBI occurs when there is a loss of consciousness that lasts from a few minutes to a few hours, when confusion lasts from days to weeks, or when physical, cognitive, and/or behavioral impairments last for months or are permanent. Persons with moderate TBI generally can make a good recovery with treatment and successfully learn to compensate for their deficits.

Severe Brain Injury (GCS Below 8)

Severe brain injury occurs when a prolonged unconscious state or coma lasts days, weeks, or months. Severe brain injury is further categorized into subgroups with separate features:

- Coma
- Vegetative State
- Persistent Vegetative State
- Minimally Responsive State
- Akinetic Mutism
- Locked-in Syndrome

Tips to Aid Recovery

- Get lots of rest. Don't rush back to daily activities such as work or school.
- Avoid doing anything that could cause another blow or jolt to the head.
- Ask your doctor when it's safe to drive a car, ride a bike, or use heavy equipment, because your ability to react may be slower after a brain injury.
- Take only the medications your doctor has approved, and don't drink alcohol until your doctor says it's OK.
- Write things down if you have a hard time remembering.
- You may need help to re-learn skills that were lost. Contact the Brain Injury Association in your state to learn more about the programs, supports and services available to people with brain injury and their families

Check your progress - 2

- Note: a. Write your answer in the space given below
b. Compare your answer with those given at the end of the unit
1. Any five type of Brain injuries

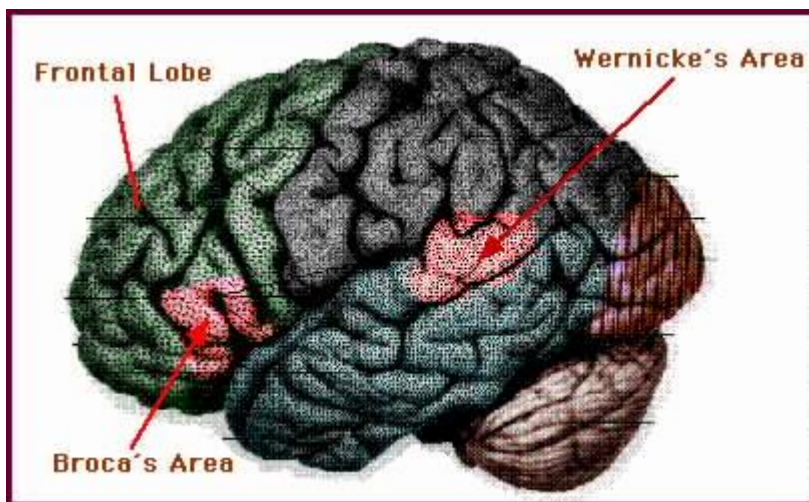
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14.5 LOCALIZATION AND BRAIN FUNCTIONS

Historically, there have been two major views on the localization of

higher cognitive functions. One view, in its extreme form, is phrenology, which postulated that all cognitive abilities and personality traits had specific areas of the brain that controlled each one separately. This view was discarded in the first decades of this century, mainly because most of the proponents of phrenology did not follow rigorous scientific methods. The second view, hence derived from opposition to the phrenologists, postulated that higher cognitive functions and traits could only be localized in the cerebral cortex, but that the cortex functioned as a whole, with any part of it could substitute for the functions of another. It also postulated that the effects on cognitive functions due to cortical lesions was due to the extent of damaged tissue, but not on the localization of it. This holistic view gained much acceptance, and nearly neutralized all of the phrenologists postulates.

From early on, some clinical observations contradicted the holistic view, particularly the consistent observation that aphasias (language distinctions) occurred when either of two specific brain regions were lesioned. These areas are the Broca and Wernicke areas of the cortex. These areas are localized only in the left hemisphere of the brain in over 80% of the population, and can be anatomically localized. Broca's area is localized just beneath the motor cortex that controls face movement, and is specialized in the expression of language.



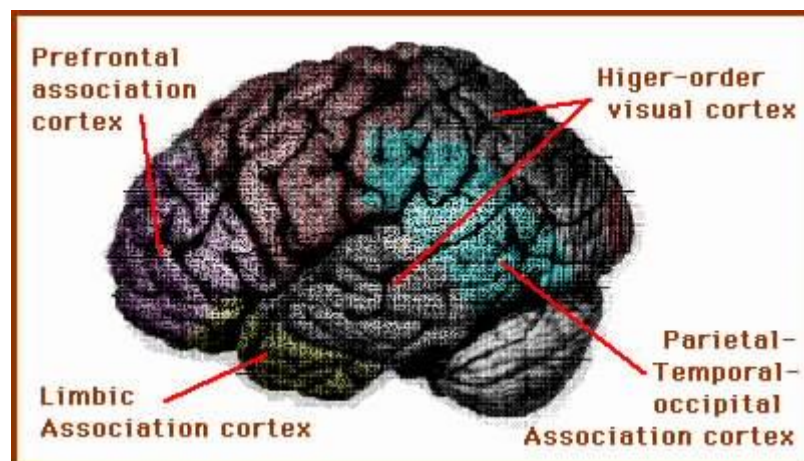
Patients with lesion of this area can understand language and conversation, even complex abstract concepts, but cannot talk coherently. They can pronounce words with perfect intonation, so the motor aspects of word utterance are intact, but the words seem to be randomly emitted. Typical speech could go like: "... house ran duck ink ink, resolve..." In the case of Wernicke's area, which is above the left temporal auditory cortex, lesions seem to alter understanding, but not hearing, since these patients can understand simple requests and attend only when called by their names, but cannot understand a simple conversation. In opposition to lesions to the Broca area where talk is incoherent, Wernicke area lesions produce incongruent talk. Patients can form complete understandable phrases, but will emit them out of any context. An answer to the question "how did you

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wake up this morning?" could be "cold water that runs from the spring".

Today, most scientist accept a midway version between holism and phrenology, especially with the discovery of association cortices. Even in the holistic views, it was accepted that some specific cortical areas were necessary for sensory input, but the high order processing was carried out by the cortex as a whole.

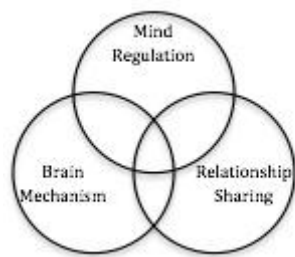
The study of sensory systems, particularly vision, led to the discovery that a lot of processing was carried out by the system itself, still dependent of cortical localization in what is known as higher-order sensory cortices such as detection of direction, intensity, contrast, speed, and several other combined attributes of visual stimuli. Furthermore, some areas were described as responding to exclusively a combination of two sensory inputs, these were called association cortices. The great discrepancy between the modern view and phrenology is that in the former the localization is not of functions, but of systems, and it is the interconnections and interactions between systems that give rise to specific cognitive functions. In this context, cortical systems can be classified on the basis of the functions they participate in. As a first level, we can find the primary sensory cortices, where the information first arrives at the cortical level. Second, there are the higher order sensory cortices mentioned earlier. Third, there are association cortices.



The cortical association areas are supposedly the anatomical basis for thought and perception, since stimulation of these areas produce little if not no overt behavioral changes, but receive sensory input from high-order sensory systems and project to motor cortex. There are three identified association areas of the cortex. One is the parieto-temporal-occipital cortex. This cortex has regions that receive somatosensory, auditory and visual projections, and also receives the high-order input from their respective cortices, and is therefore thought to integrate information from these sensory modalities and is necessary for language. The second cortex that is identified, is the prefrontal association area, which is believed to control several cognitive behaviors such as propositive behavior, and also to control motor planning

14.6 BRAIN – MIND CONNECTION

For many years the scientific community has struggled to make the mind-brain connection. Not surprisingly, there is not a clear definition of the mind because of the mystery which surrounds it. From a religious perspective, mind is synonymous with soul, spirit and divine principle. Scientists have so far been unable or unwilling to define the mind. Daniel Siegel has probably provided the most comprehensive definition of the mind, which is gaining widespread acceptance amongst scientists. He defined the mind as follows: “a core aspect of the mind is an embodied and relational process that regulates the flow of energy and information”. Siegel’s conceptualization of the mind, encapsulating the mind, brain and relationship elements, is illustrated in the diagram below.



In this conception of the mind, the brain is seen as an organ having a variety of parts designed to perform some specific functions by themselves in combination with other parts. The mind is conceptualized as the flow of energy and information. This assumes that the mind regulates the energy. By regulating, Siegel meant monitoring what is happening with the energy and exerting an influence to alter the way things are happening. The information component represents the symbolization of what is happening. The relationship element of the model suggests a mind-body connection, rather than a limited perspective of mind-brain connection. According to Siegel, the mind regulates energy and information flow not only throughout the whole body of an individual, but also between and among people. The relationship function is for sharing of energy and information flow (Campbell, 2008). This brain-mind conception proposes the brain as a flexible, modifiable, malleable organ that can be altered with new experiences and thoughts. As mentioned earlier, the mind is the flow of energy and information. Therefore the dynamics of brain plasticity can be explained as the effects of the mind over the brain. New experiences and thoughts generate a flow of energy and information (mind), which acts on the neurons to trigger the development of new neurons and new neural connections.

14.7 NEUROPSYCHOLOGICAL REHABILITATION

"Neuropsychological rehabilitation involves diagnostic and therapeutic approach aimed at reduction of cognitive and emotional disorders resulting

from, brain injury, recovery of cognitive functions of attention, memory, executive functions, spatial orientation, oculo-spatial skills and vision loss.

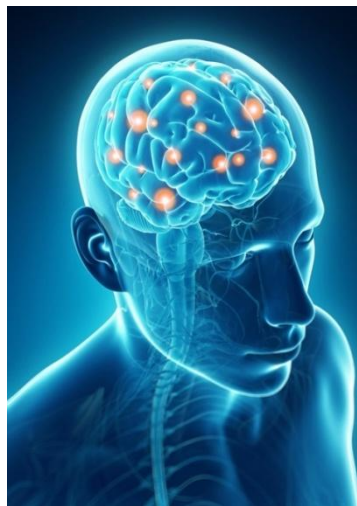
The Vienna Test System and CogniPlus trainings

The computer-assisted diagnostic and training system of cognitive functions, attention, memory, executive functions, spatial orientation, visual-spatial skills and vision impairment.

The Vienna Test System is a world standard of computer-assisted psychological assessment. Vienna Test System tests and Cogni-Plus training procedures are mutually coordinated.

Each training program is intended for particular deficits, and associated only with those functions that are trainable.

CogniPlus is an intelligent, interactive system that is never too easy or too difficult for a patient. The system identifies individual abilities and adapts automatically. That allows meeting one of the conditions of an efficient training: motivation of a trainee.



The Vienna Test System is regarded the leading European system of computer-assisted rehabilitation of patients with cognitive function disorders.

It is a set of training programs for children and adults suffering from cognitive dysfunctions caused by a focal or generalised brain damage, e.g. post a stroke or cerebral haemorrhage, with disorders of verbal and non-verbal memory, attention and concentration deficits, logical reasoning, perception and association disorders, problems with memory and face recognition, reaction time, coordination disorders and planning dysfunctions."

Check your progress- 3

Note: a. Write your answer in the space given below

b. Compare your answer with those given at the end of the unit

1. Write a future of severe brain injury

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14.8 SUMMARY

In this chapter you have studied about the historical antecedents ,types aof brain injuries and localization and cognitive functions in the brain, mind and brain relationship and neuropsychological rehabilitation and training. This will make the awareness about brain injuries and cognitive functions in the brain.

Neuropsychological
Plasticity and Restoration
of Brain

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14.9 UNIT –END ACTIVITY

Write a detail assignment about types of brain injuries with images.
Discuss in detail about Neuro psychological rehabilitation and training.

1. Write a short note on history of neuroplasticity.
2. What are the types of brain injuries.
3. Describe relationship of mind and brain.
4. Explain computer assisted neuropsychological rehabilitation and training.

14.10 ANSWERS IN CHECK YOUR PROGRESS

1. Stem cells which offer the promise to create and replace damaged cells
2. Concussion , Contusion, Penetrating injury, Shaken baby syndrome, Open and closed head injuries
3. Coma, Vegetative state, minimally Responsive state, locked – in syndrome

14.11 SUGGESTED READINGS

1. Brumback R. Oklahoma Notes: Neurology and Clinical Neuroscience. (2nd ed.). New York: Springer; 2006. and Center for Disease Control and Injury Prevention.
2. Glisky EL, Schacter DL, Tulving E.(1986) Learning and retention of computer-related vocabulary in memory-impaired patients: method of vanishing cues. J Clin Exp Neuropsychol.
3. Smity, E.E.&Kosslyn,S (2007).Cognitive Psychology: Mind and Brain, New Delhi:Prentice Hall.
4. Zasler, N. Brain Injury Source, Volume 3, Issue 3, Ask the Doctor.

Self-Instructional Material

**DISTANCE EDUCATION- CBSC-(2019-20 Academic Year
Onwards)**

Question Paper Pattern

Neuropsychological
Plasticity and Restoration
of Brain

Time: 3 Hours

Maximum: 75 Marks

Part- A

(10 x 2 = 20 Marks)

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Answer all questions

1. Draw the diagram of the brain with its parts
2. What is the difference between EEG & MEG.
3. Write down different types of Reasoning
4. What is Artificial Intelligence
5. What are the factors influencing memory
6. Define : Weber's law
7. Difference between Metacognition and Intelligence
8. Write short notes about NAB
9. What is MRI and its uses
10. Write short notes about stem cells

Part – B

(5 x 5 = 25 Marks)

Answer all questions choosing either (a) or (b)

11. a. Write down the nervous system and types of Nerve cells (or)
b. Given account of both top down and bottom up processing with example
12. a. List out the types of memory and Explain (or)
b. Write down the Problem solving methods
13. a. Describe Morr's Perception method (or)
b. Given Evidence to support Grogory's theory
14. a. Explain Information Processing model with neat diagram (or)
b. Write short notes on major brain areas
15. a. Different types of Brain injuries (or)
b. Write short notes about Neurodegenerative Disorders

Part – C

(3 x 10 = 30 Marks)

Answer any 3 out of 5 questions

16. Analyze the various research method in Cognitive Psychology
17. Describe Signal Detection theory
18. Explain the theories of Attention
19. Explain Top- Down Indirect Perception theories
20. Given Details about forgetting and forgetting theories types.