HIGHER INTELLECTUAL FUNCTIONS

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INTRODUCTION

- Higher intellectual functions are very essential to make up the human mind.
- These functions are also called **higher brain functions** or **higher cortical functions.**
- The extensive outer layer of gray matter in cerebral cortex is responsible for higher intellectual functions.
- Conditioned reflex forms the basis of all higher intellectual functions.

LEARNING

DEFINITION

- Learning is defined as the process by which new information is acquired.
- It alters the behavior of a person on the basis of past experience.

CLASSIFICATION OF LEARNING

- Learning is classified into two types:

1. **NON-ASSOCIATIVE LEARNING**
2. **ASSOCIATIVE LEARNING**

1. NON-ASSOCIATIVE LEARNING

- Non-associative learning involves response of a person to only one type of stimulus.
- It is based on two factors:

I. Habituation
II. Sensitization.

I. HABITUATION

- Habituation means getting used to something, to which a person is constantly exposed. When a person is exposed to a stimulus repeatedly, he starts ignoring the stimulus slowly.
- During first experience, the event (stimulus) is novel and evokes a response.
- However, it evokes less response when it is repeated.
- Finally, the person is habituated to the event (stimulus) and ignores it.

II. SENSITIZATION

- Sensitization is a process by which the body is made to become more sensitive to a stimulus. It is called **amplification of response.**
- When a stimulus is applied repeatedly, habituation occurs. But, if the same stimulus is combined with another type of stimulus, which may be pleasant or unpleasant, the person becomes more sensitive to original stimulus.
- For example, a woman is sensitized to crying sound of her baby. She gets habituated to different sounds around her and sleep is not disturbed by these sounds.
- However, she suddenly wakes up when her baby cries because of sensitization to crying sound of the baby.
- Thus, sensitization increases the response to an innocuous stimulus when that stimulus is applied after another type of stimulus.

2. ASSOCIATIVE LEARNING

- Associative learning is a complex process. It involves learning about relations between two or more stimuli at a time.
- Classic example of associative learning is the conditioned reflex.

CONDITIONED REFLEXES

- Conditioned reflex is the acquired reflex that requires learning, memory and recall of previous experience.
- It is acquired after birth and it forms the basis of learning.
- Conditioned reflex is different from unconditioned reflex.
- Unconditioned reflex is the inborn reflex, which does not need previous experience.

Conditioned reflex	Unconditioned reflex
Acquired after birth	Inborn reflex
Needs previous experience	Does not need previous experience
Involves learning and memory	Does not involve learning and memory
Elicited by conditioned stimulus	Elicited by unconditioned stimulus

TABLE : CONDITIONED REFLEX VS UNCONDITIONED REFLEX

CLASSIFICATION OF CONDITIONED REFLEXES

- Conditioned reflexes are classified into two types:

A. **Classical conditioned reflexes**

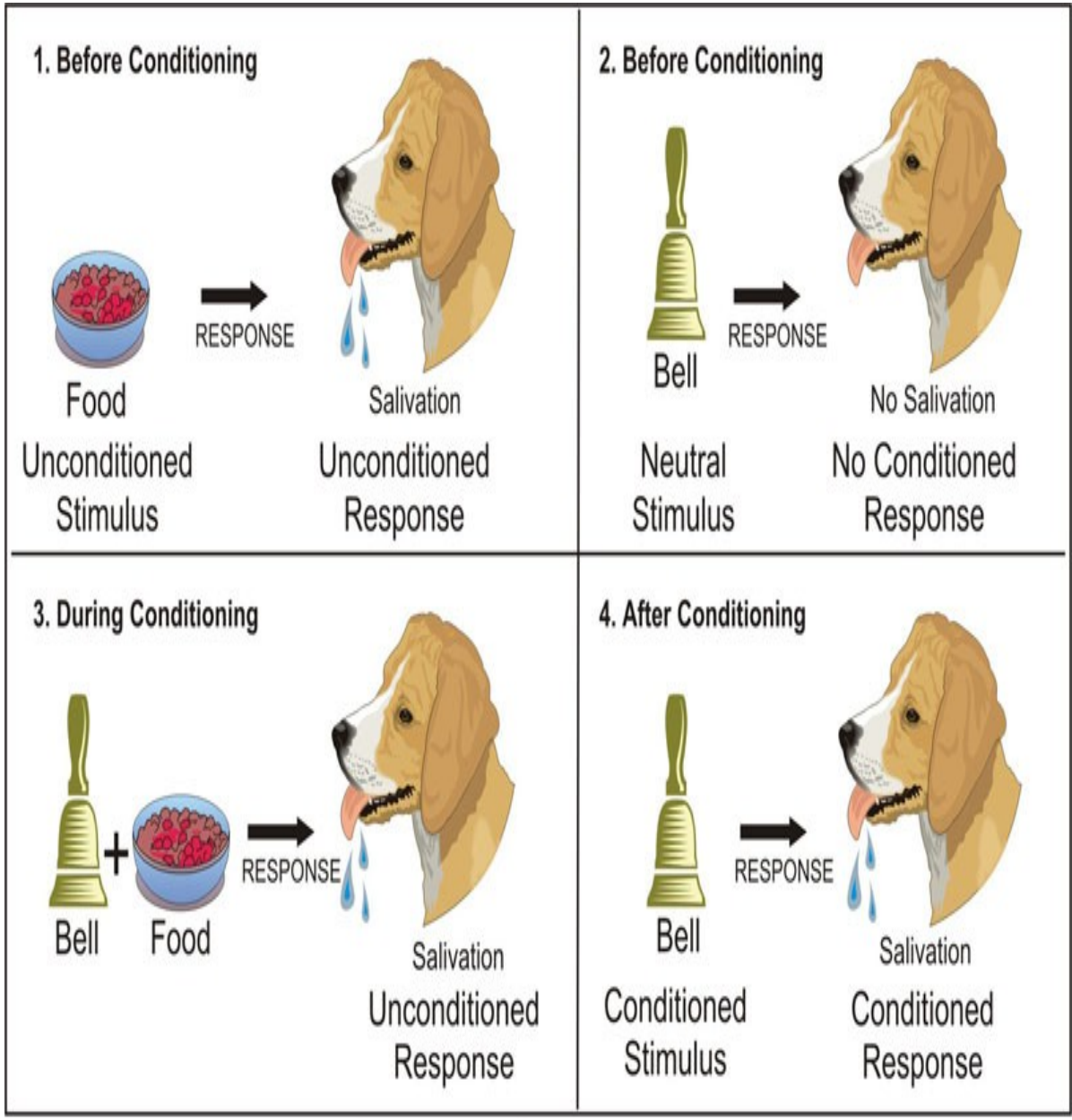
B. **Instrumental conditioned reflexes**

A. CLASSICAL CONDITIONED REFLEXES

- Classical conditioned reflexes are those reflexes, which are established by a **conditioned stimulus,** followed by an **unconditioned stimulus.**

METHOD OF STUDY - PAVLOV'S BELL-DOG EXPERIMENTS

- Various types of classical conditioned reflexes and their properties are demonstrated by the classical belldog experiments done by **Ivan Pavlov** and his associates.



TYPES AND PROPERTIES OF CLASSICAL CONDITIONED REFLEXES

- Classical conditioned reflexes are classified into two groups according to the properties of reflexes, namely excitation or inhibition:

I. **Positive or excitatory conditioned reflexes**
II. **Negative conditioned reflexes.**

I. POSITIVE CONDITIONED REFLEXES (EXCITATION OF CONDITIONED REFLEXES)

- Types of positive conditioned reflexes:

A. PRIMARY CONDITIONED REFLEX

- Primary conditioned reflex is the reflex developed with one unconditioned stimulus and one conditioned stimulus.

B. SECONDARY CONDITIONED REFLEX

- Secondary conditioned reflex is the reflex developed with one unconditioned stimulus and two conditioned stimuli.

C. TERTIARY CONDITIONED REFLEX

- In this reflex, a **third conditioned stimulus** is added and the reflex is established. But, the reflex with more than three conditioned stimuli is not possible.

II. NEGATIVE CONDITIONED REFLEXES (INHIBITION OF CONDITIONED REFLEXES)

- The established conditioned reflexes can be inhibited by some factors.
- The inhibition is of two types:

1. **External or indirect inhibition**
2. **Internal or direct inhibition**

A. EXTERNAL OR INDIRECT INHIBITION

- Established conditioned reflex is inhibited by some form of stimulus, which is quite different from the conditioned stimulus.
- For example, some disturbing factors like sudden entrance of a stranger or a strong smell can abolish the conditioned reflex and inhibit salivary secretion.

B. INTERNAL OR DIRECT INHIBITION

- There are four ways in which the established conditioned reflex is abolished by direct or internal factors, which are related to the conditioned stimulus.

i. **Extinction of conditioned reflex**
ii. **Conditioned inhibition**
iii. **Inhibition by delay or delayed conditioned reflex**
iv. **Differential inhibition**

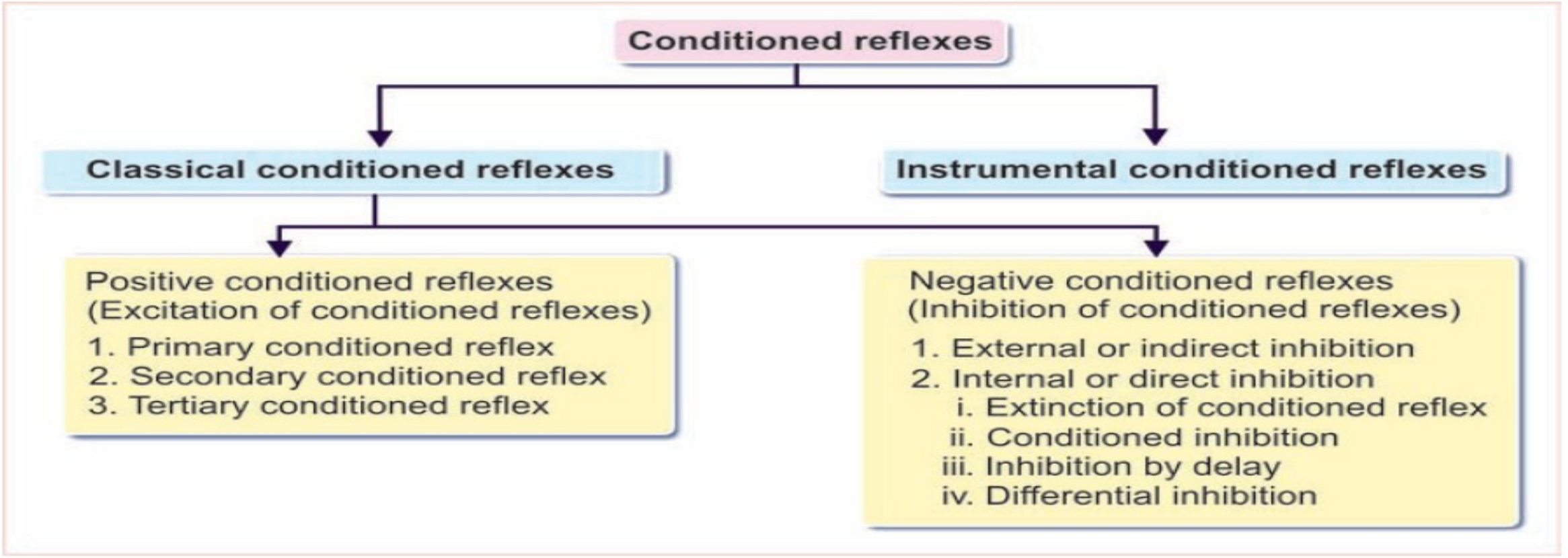
Type of inhibition		Cause
External inhibition		Disturbing factors like a stranger, noise or strong smell
Internal inhibition	Extinction of conditioned reflex	Failure to reinforce the conditioned reflex by unconditioned stimulus
	Conditioned inhibition	Introduction of unknown (new) conditioned stimulus
	Inhibition by delay	Delay in applying unconditioned stimulus
	Differential inhibition	Alteration of conditioned stimulus

B. INSTRUMENTAL OR OPERANT CONDITIONED REFLEXES

- Instrumental conditioned reflexes are those reflexes in which the behavior of the person is instrumental.
- This type of reflexes is developed by the conditioned stimulus, followed by a reward or a punishment.
- The instrumental conditioned reflexes are also called **operant conditioned reflexes** or **Skinner conditioning.**

- During the development of this type of reflexes, the animal is taught to perform some task, in order to obtain a reward or to avoid a punishment. Accordingly, the instrumental conditioned reflexes are of several types, such as:

1. Conditioned avoidance reflex
2. Food avoidance reflex
3. Conditioned reward reflex.

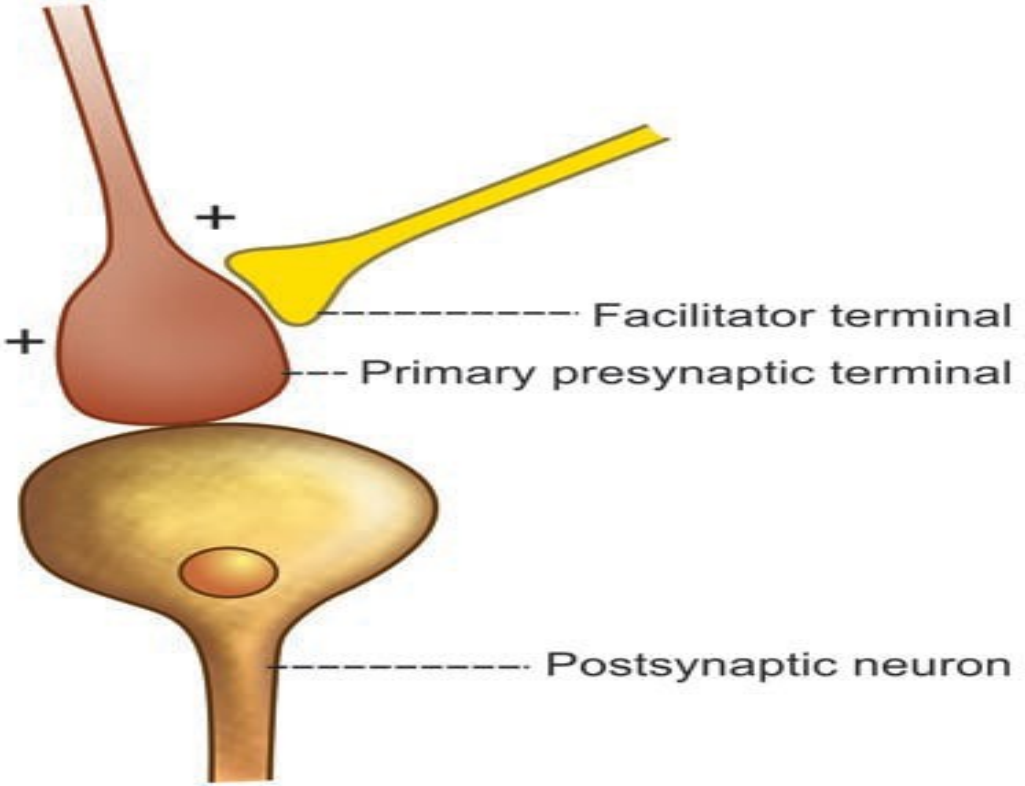


MEMORY

- Memory is defined as the ability to recall past experience or information.
- It is also defined as retention of learned materials.
- Some memories remain only for few seconds, while others last for hours, days, months or even years together.

ANATOMICAL BASIS OF MEMORY

- Anatomical basis of memory is the **synapse** in brain.
- Synapse for memory coding is slightly different from other synapses.
- Two separate presynaptic terminals are present here.
- One of the terminals is **primary presynaptic Terminal.**
- Other presynaptic terminal ends on the sensory terminal itself. This terminal is called **facilitator terminal.**



- When, sensory terminal is stimulated alone without facilitator terminal, the firing from sensory terminal leads to habituation, i.e. the firing decreases slowly.
- On the other hand, if both the terminals are stimulated, facilitation occurs and the signals remain strong for long period, i.e. for few months to few years.

PHYSIOLOGICAL BASIS OF MEMORY

- Memory is stored in brain by the alteration of synaptic transmission between the neurons involved in memory.
- Storage of memory may be facilitated or habituated depending upon many factors, such as neurotransmitter, synaptic transmission, functional status of brain, etc.

I. FACILITATION

- Facilitation is the process by which memory storage is enhanced.
- Often, facilitation is referred as positive memory.

II. HABITUATION

- Habituation is the process by which memory storage is **attenuated** (decrease in strength, effect or value).

III. BASIS FOR SHORT-TERM MEMORY

- Basic mechanism of memory is the development of new neuronal circuits by the formation of new synapses and facilitation of synaptic transmission. This forms the basis of short-term memory.

IV. BASIS FOR LONG-TERM MEMORY

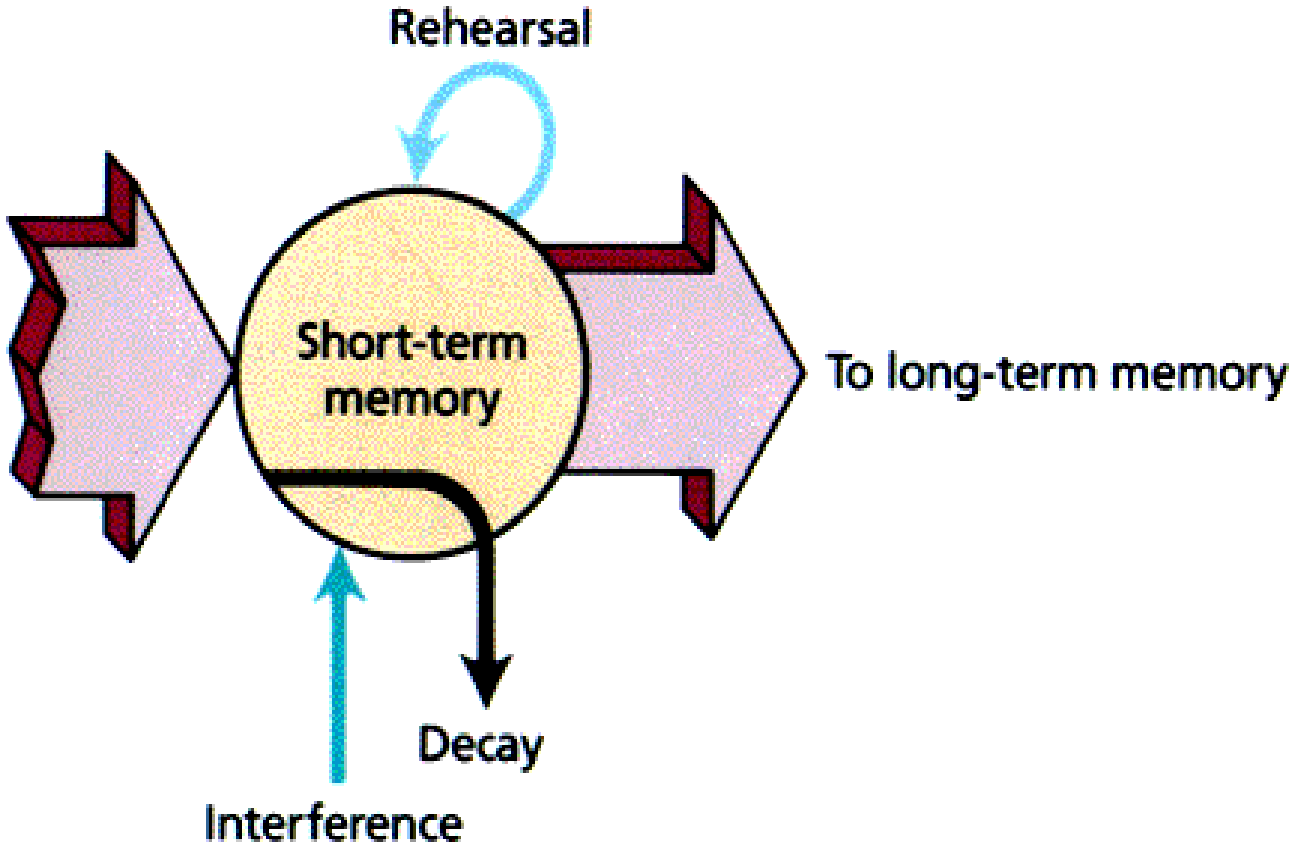
- When neuronal circuit is reinforced by constant activity, memory is consolidated and encoded into different areas of the brain. This encoding makes memory a permanent or a long-term memory.

CONSOLIDATION OF MEMORY

- The process by which a short-term memory is crystallized into a long-term memory is called memory consolidation.
- Consolidation causes permanent facilitation of synapses.
- It is possible by rehearsal mechanism, i.e. rehearsal of same information again and again accelerates and potentiates the degree of transfer of short-term memory into long-term memory.
- This is what happens in memorizing a poem or a phrase.

CLASSIFICATION OF MEMORY

- Memory is classified by different methods, on the basis of various factors.



A. SHORT-TERM MEMORIES AND LONG-TERM MEMORIES

- Generally, memory is classified as short-term memory and long-term memory.

1. SHORT-TERM MEMORY

- Short-term memory is the recalling events that happened very recently, i.e. within hours or days.
- It is also known as recent memory.
- For example, telephone number that is known today may be remembered till tomorrow. But if it is not recalled repeatedly, it may be forgotten on the third day.
- Short-term memory may be interrupted by many factors such as stress, trauma, drug abuse etc.

2. LONG-TERM MEMORY

- Long-term memory is the recalling of events of weeks, months, years or sometimes lifetime.
- It is otherwise called the **remote memory.**
- Examples are, recalling first day of schooling, birthday celebration of previous year, picnic enjoyed last week, etc. Long-term memory is more resistant and is not disrupted easily.

B. EXPLICIT AND IMPLICIT MEMORIES

- Physiologically, memory is classified into two types, namely explicit memory and implicit memory.

1. EXPLICIT MEMORY

- Explicit memory is defined as the memory that involves conscious recollection of past experience.

- It consists of memories regarding events, which occurred in the external world around us. The information stored may be about a particular event that happened at a particular time and place.
- Examples of explicit memory are recollection of a birthday party celebrated three days ago, events taken place while taking breakfast, etc.

2. IMPLICIT MEMORY

- Implicit memory is defined as the memory in which past experience is utilized without conscious awareness.
- It helps to perform various skilled activities properly.
- Examples of implicit memory are cycling, driving, playing tennis, dancing, typing, etc.

APPLIED PHYSIOLOGY – ABNORMALITIES OF MEMORY

1. AMNESIA

- Loss of memory is known as amnesia.
- Amnesia is classified into two types:

i. **Anterograde amnesia:** Failure to establish new long-term memories. It occurs because of lesion in hippocampus.

ii. **Retrograde amnesia:** Failure to recall past remote long-term memory. It occurs in temporal lobe syndrome.

2. DEMENTIA

- Dementia is the progressive deterioration of intellect, emotional control, social behavior and motivation associated with loss of memory.
- It is an age-related disorder. Usually, it occurs above the age of 65 years.

CAUSES

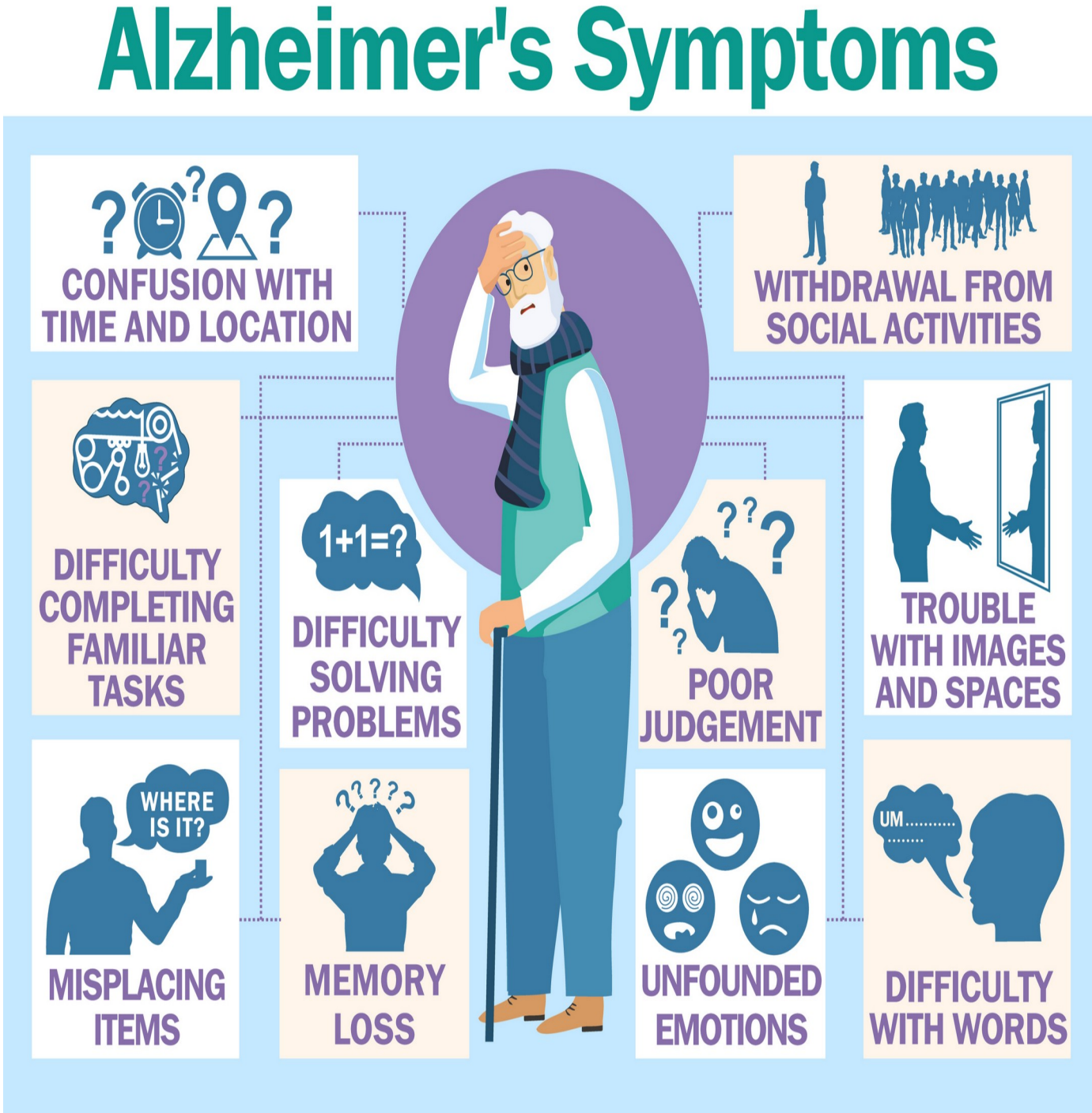
- Dementia occurs due to many reasons. Most common cause of dementia is Alzheimer disease.
- Other common causes of dementia are hydrocephalus, Parkinson disease, viral encephalitis, HIV infection, hypothyroidism, alcoholic intoxication, poisoning by high dose of barbiturate, carbon monoxide, heavy metals, etc.

CLINICAL FEATURES

- Common features are loss of recent memory, lack of thinking and judgment and personality changes. As the disease progresses, psychiatric features begin to appear.
- Finally, the patient has to lead a vegetative life without any thinking power.
- The person is speechless and is unable to understand anything.

3. ALZHEIMER DISEASE

- Alzheimer disease is a progressive neurodegenerative disease.
- It is due to degeneration, loss of function and death of neurons in many parts of brain, particularly
- cerebral hemispheres, hippocampus and pons.
- There is reduction in the synthesis of most of the neurotransmitters, especially acetylcholine.
- Dementia is the common feature of this disease.



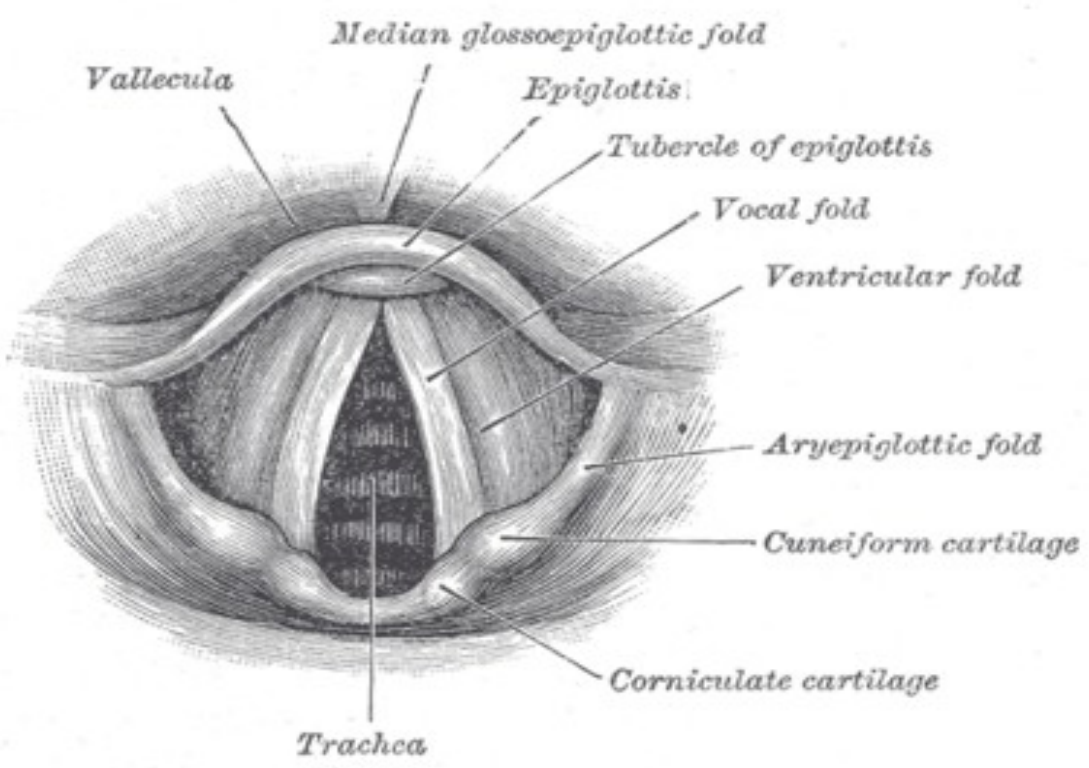
SPEECH

INTRODUCTION

- Speech is defined as the expression of thoughts by production of articulate sound, bearing a definite meaning.
- It is one of the highest functions of brain.
- When a sound is produced verbally, it is called the speech.
- If it is expressed by visual symbols, it is known as writing.
- If visual symbols or written words are expressed verbally, that becomes reading.

MECHANISM OF SPEECH

- Speech depends upon coordinated activities of central speech apparatus and peripheral speech apparatus.
- **Central speech apparatus** consists of higher centers, i.e. the cortical and subcortical centers.



- **Peripheral speech apparatus** includes larynx or sound box, pharynx, mouth, nasal cavities, tongue and lips.
- All the structures of peripheral speech apparatus function in coordination with respiratory system, with the influences of motor impulses from respective motor areas of the cerebral cortex.

DEVELOPMENT OF SPEECH

FIRST STAGE

- First stage in the development of speech is the association of certain words with visual, tactile, auditory and other sensations, aroused by objects in the external world.
- Association of words with other sensations is stored as memory.

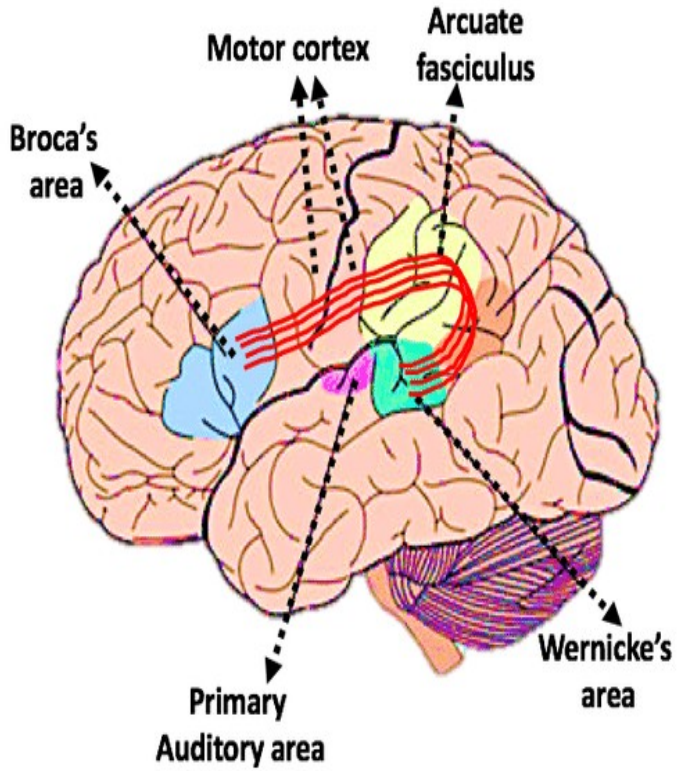
SECOND STAGE

- New neuronal circuits are established during the development of speech.
- When a definite meaning has been attached to certain words, pathway between the auditory area (Heschl area; area 41) and motor area for the muscles of articulation, which helps in speech (Broca area 44) is established.
- The child attempts to formulate and pronounce the learnt words.

ROLE OF CORTICAL AREAS IN THE DEVELOPMENT OF SPEECH

- Development of speech involves integration of three important areas of cerebral cortex:

1. WERNICKE AREA
2. BROCA AREA
3. MOTOR AREA



Broca's area: involved in production of speech sound

Wernicke's area: involved in Understanding of speech

Motor cortex: controls the Movements of muscles

Arcuate fasciculus: connects Wernicke's area to Broca's area.

ROLE OF WERNICKE AREA – SPEECH UNDERSTANDING

- Understanding of speech begins in Wernicke area that is situated in upper part of temporal lobe.
- It sends fibers to Broca area through a tract called arcuate fasciculus.
- Wernicke area is responsible for understanding the visual and auditory information required for the production of words.
- After understanding the words, itsends the information to Broca area.

ROLE OF BROCA AREA – SPEECH SYNTHESIS

- Speech is synthesized in the Broca area.
- It is situa ted adjacent to the motor area, responsible for the movements of tongue, lips and larynx, which are necessary for speech.
- By receiving information required for production of words from Wernicke area, the Broca area develops the pattern of motor activities required to verbalize the words.
- The pattern of motor activities is sent to motor area.

ROLE OF MOTOR AREA – ACTIVATION OF PERIPHERAL SPEECH APPARATUS

- By receiving the pattern of activities from Broca area, motor area activates the peripheral speech apparatus.
- It results in initiation of movements of tongue, lips and larynx required for speech.

- Later, when the child is taught to read, auditory speech is associated with visual symbols (area 18).
- Then, there is an association of the auditory and visual areas with the motor area for the muscles of hand.
- Now, the child is able to express auditory and visual impressions in the form of written words.

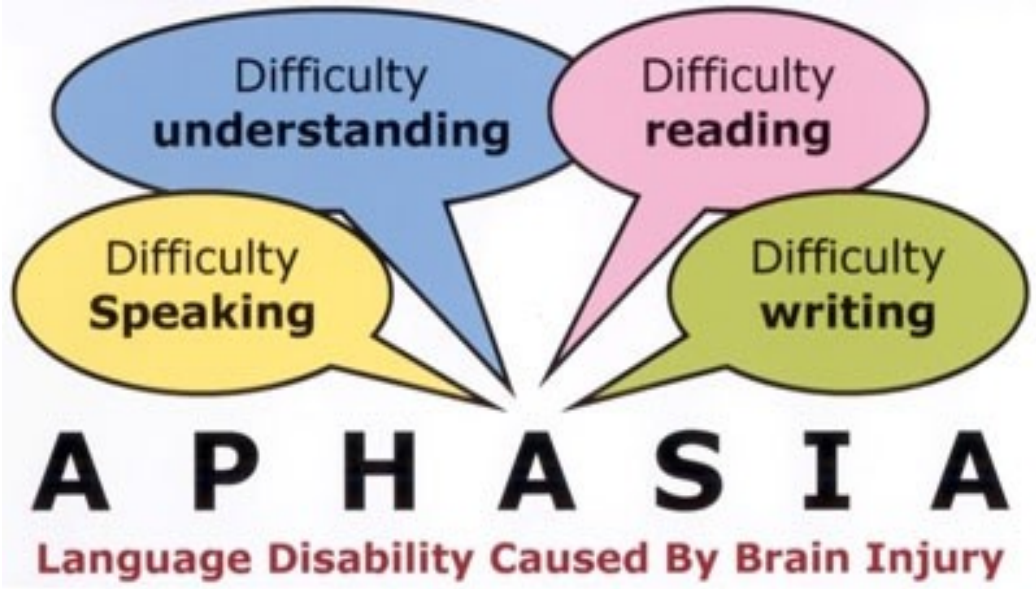
APPLIED PHYSIOLOGY – DISORDERS OF SPEECH

- Speech disorder is a communication disorder characterized by disrupted speech.
- It is of four types:

I. Aphasia
II. Anarthria or dysarthria
III. Dysphonia
IV. Stammering.

APHASIA

- Aphasia is defined as the loss or impairment of speech due to brain damage (in Greek, aphasia = without speech).
- It is an acquired disorder and it is distinct from developmental disorders of speech or other speech disorders like dysarthria.
- Aphasia is not due to paralysis of muscles of articulation. It is due to damage of speech centers.



- Damage of speech centers impairs the expression and understanding of spoken words. It also affects reading and writing.
- Speech function is localized to left hemisphere in most of the people.
- Aphasia may be associated with other speech disorders, which also occur due to brain damage.

TABLE : ROLE OF CORTICAL AREAS IN CONTROL OF SPEECH

Cortical areas		Function
Motor areas	Broca area: Areas 44 and 45	Controls movement of structures involved in speech
	Upper frontal motor area	Controls movements involved in writing
Sensory areas	Secondary auditory area: Area 22	Concerned with interpretation of auditory sensation Concerned with storage of memories of spoken words
	Secondary visual area: Area 18	Concerned with interpretation of visual sensation Concerned with storage of memories of visual symbols
Wernicke area		Concerned with interpretation of auditory sensation Concerned with understanding auditory information and sending it to Broca area

CAUSES FOR APHASIA

- Usually aphasia occurs due to damage of one or more speech centers, which are situated in cerebral cortex.
- Damage of speech centers occurs due to:

1. Stroke
2. Head injury
3. Severe blow to head
4. Cerebral tumors
5. Brain infections
6. Degenerative diseases

- Usually, in conditions like head injury, aphasia occurs suddenly and in conditions like infections or cerebral tumors, it develops slowly.
- In children, traumatic aphasia can develop by exposure to a horrifying event, without any brain damage. It may be cured with psychological treatment.

TABLE : FEATURES AND CAUSES OF DIFFERENT TYPES OF APHASIA

Type of aphasia	Features	Cause
Broca aphasia	Non-fluent speech problem	Lesion in left frontal lobe
Wernicke aphasia	Speech without any meaning	Lesion in left temporal lobe
Global aphasia	Combined features of Broca aphasia and Wernicke aphasia	Widespread lesion in speech areas of left cerebral hemisphere
Nominal aphasia	Inability to name the familiar objects	Lesion in posterior temporal and inferior parietal gyri
Motor aphasia	Difficulty in uttering individual words	Defect in pathway between left speech center and precentral cortex
Auditory aphasia	Inability to understand spoken words	Lesion in secondary auditory area
Visual aphasia	Inability to understand written symbols	Lesion in secondary visual area
Agraphia	Inability to write	Defect in pathway between cortical areas concerned with writing

DYSARTHRIA OR ANARTHRIA

- The term dysarthria refers to disturbed articulation. Anarthria means inability to speak.
- Dysarthria or anarthria is defined as the difficulty or inability to speak because of paralysis or ataxia of muscles involved in articulation.
- Psychic aspect of speech is not affected. The spoken and written words are understood.

CAUSES OF DYSARTHRIA

- Dysarthria is caused by damage of brain or the nerves that control the muscles involved in speech.
- It occurs in conditions like stroke, brain injury, degenerative disease like Parkinson disease and Huntington disease.

DYSPHONIA

- Dysphonia is a voice disorder. Often, it is characterized by hoarseness and a sore or a dry throat.
- Hoarseness means the difficulty in producing sound while trying to speak or a change in the pitch or loudness of voice.
- The voice may be weak, breathy, scratchy or husky.

CAUSES OF DYSPHONIA

1. Trauma of vocal cords
2. Paralysis of vocal cords
3. Lumps (nodules) on vocal cords
4. Inflammation of larynx
5. Hypothyroidism
6. Stress (psychological dysphonia).

STAMMERING

- Stammering or **shuttering** is a speech disorder characterized by hesitations and involuntary repetitions of certain syllables or words.
- It is also described as a speech disorder in which normal flow of speech is disturbed by repetitions, prolongations or abnormal block or stoppage of sound and syllables.
- It is due to the neurological incoordination of speech and it is common in children.
- Stammering is associated with some unusual facial and body movements.
- Exact cause for stammering is not known. It is thought that stammering may be due to genetic factors, brain damage, neurological disorders or anxiety.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