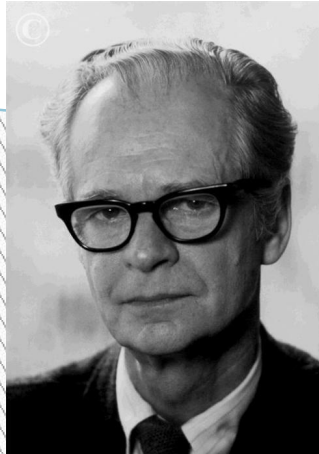
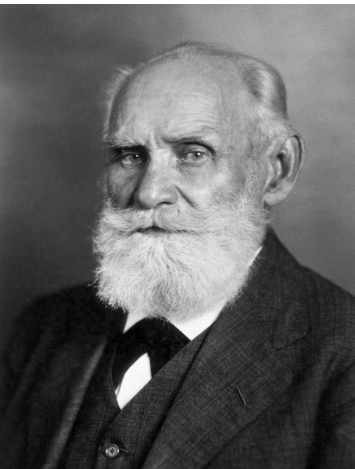


PHYSIOLOGY OF LEARNING & MEMORY



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Competency :

PY.10.9-Physiological basis of memory, learning

SLO:

- ❑ Define learning and memory
- ❑ Classify learning and memory
- ❑ Conditioned reflex
- ❑ Mechanism of learning and memory
- ❑ Brain areas involved

Introduction

- ❖ Human being have the ability to alter the behavior as the result of experience.
- ❖ Learning is acquisition of the information that makes this possible.
- ❖ Memory is retention and storage of this information.
- ❖ Learning and memory are closely associated higher functions of human brain.
- ❖ Learning utilizes memory and memory utilizes learning.

Learning-Two categories

1. Non-associative learning

2. Associative learning

Non-associative learning

- ❑ There is no predictive relationship between stimuli and response or what is learned
- ❑ Organism learns about single stimulus

Two types :

1. Habituation
2. Sensitization

Habituation

The simplest of all behavioral learning forms.

A decline in the tendency to respond to familiar stimuli(neutral stimulus).

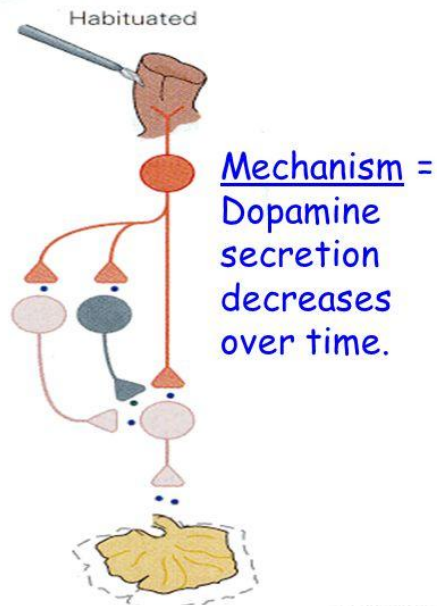
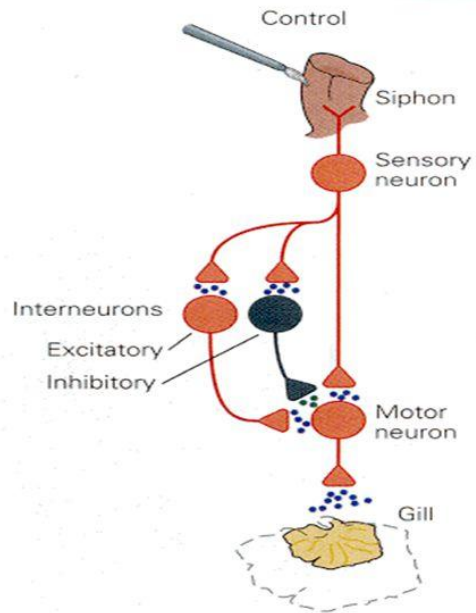
In habituation, one learns a familiar event but doesn't learn to associate it with anything

Sensitization

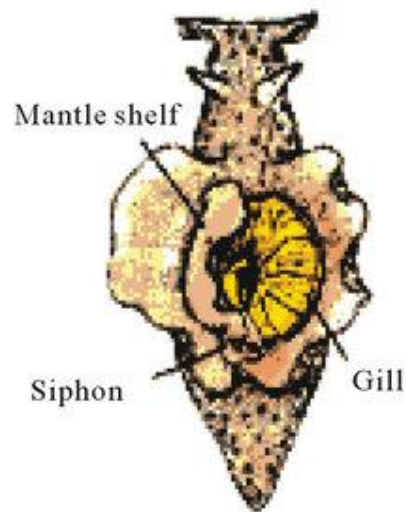
If a neutral stimulus is given along with a noxious stimulus ,the response to the neutral stimulus will be exaggerated.

Eg : mother who can sleeps through many kinds of noise wakes up to cry of her baby promptly

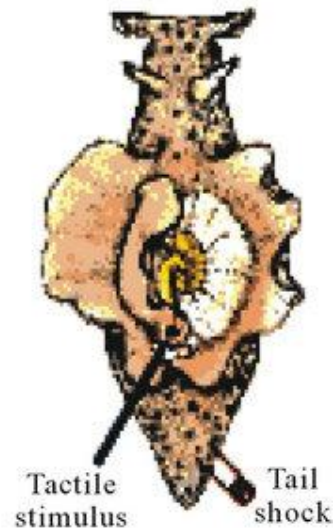
Learned behaviour
habituation in *Aplysia californica*, the sea slug



Gill Withdrawal Reflex



Sensitization



Associative learning

Associative learning occurs when the learning process involves relationship between stimuli.

Eg: conditioned responses

The conditioned responses have two components that are associated with emotional response and motor responses

Types :

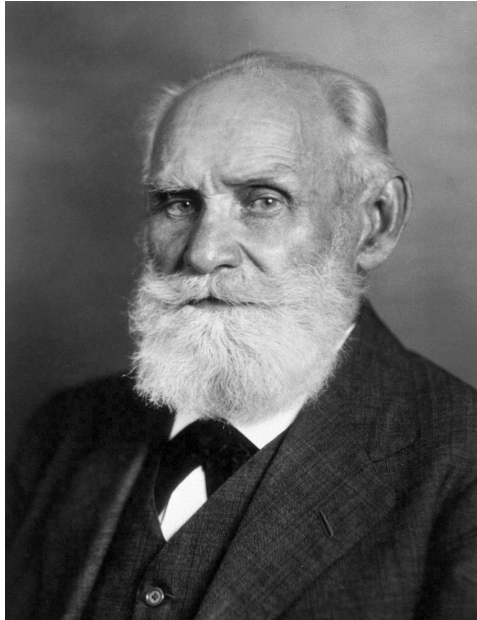
1. Classical Conditioning
2. Operant conditioning

Classical conditioning

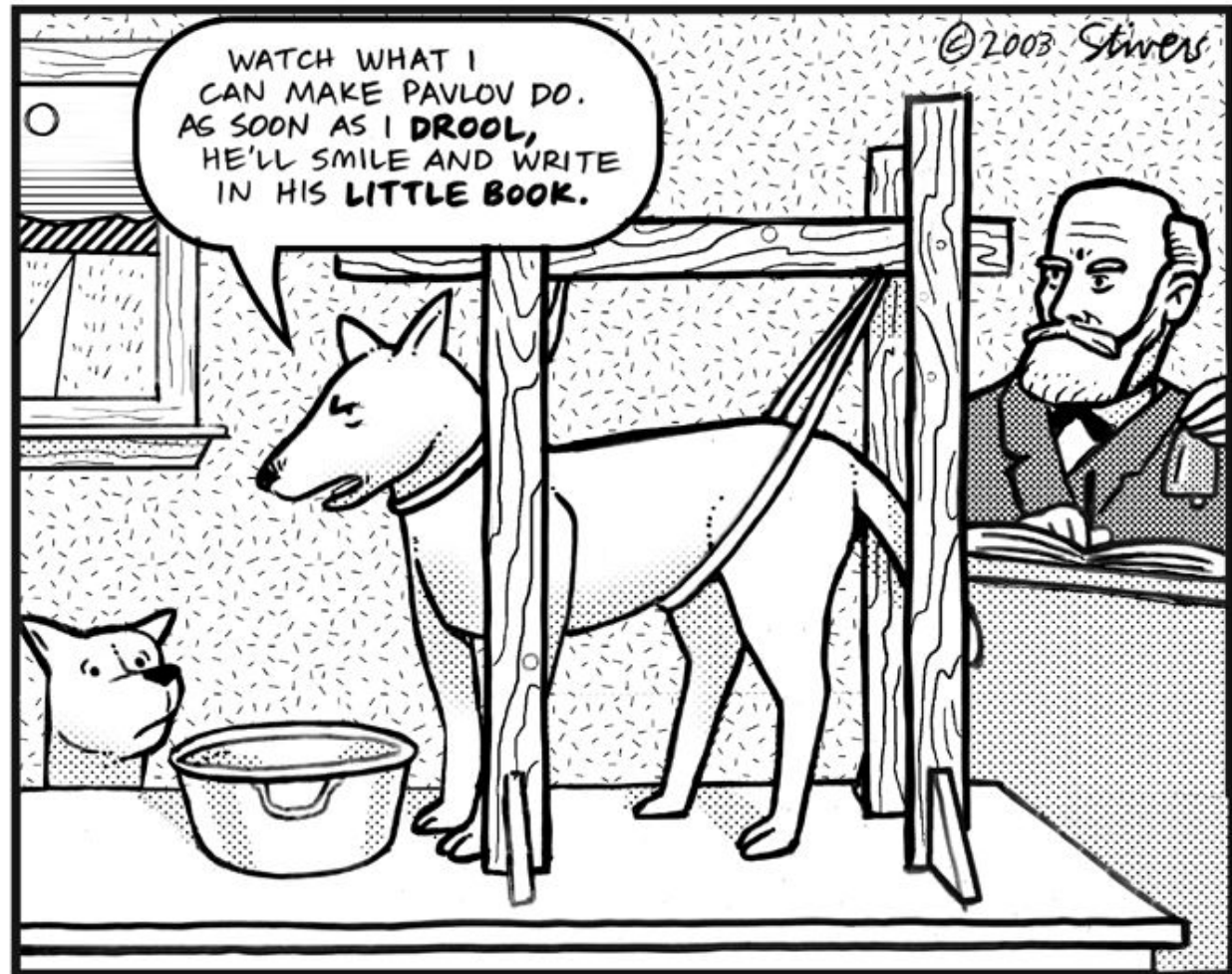
Classical conditioning was accidentally discovered around the beginning of the 20th century by Russian physiologist ***Ivan Pavlov***.

Pavlov was studying digestive process in dogs when he discovered that the dogs salivated before they received their food.

IVAN PAVLOV
(1849- 1936)



Pavlov's Dog



Classical Conditioning

PAVLOV'S DOG

- ❑ To experiment on classical conditioning, Pavlov utilized a bell and meat .
- ❑ He ring the bell and followed the sound with the meat .
- ❑ Pavlov presented the sound (bell) with the meat at the exact same time increments.
- ❑ In the beginning, the dog salivated only to the meat , but after this was repeated, salivated at the sound of the bell.
- ❑ Even when Pavlov took away the meat , the dog continued to salivate at the sound of the ringing bell.

Principles of Classical Conditioning

In classical conditioning, an organism learns to associate one stimulus with another.

The organism learns that the first stimulus is a cue for the second stimulus.

In Pavlov's experiment above, the bell cued the dogs that food might be coming.

In technical terms,

The food -**unconditioned stimulus** (UCS)

The salivation -**unconditioned response** (UCR).

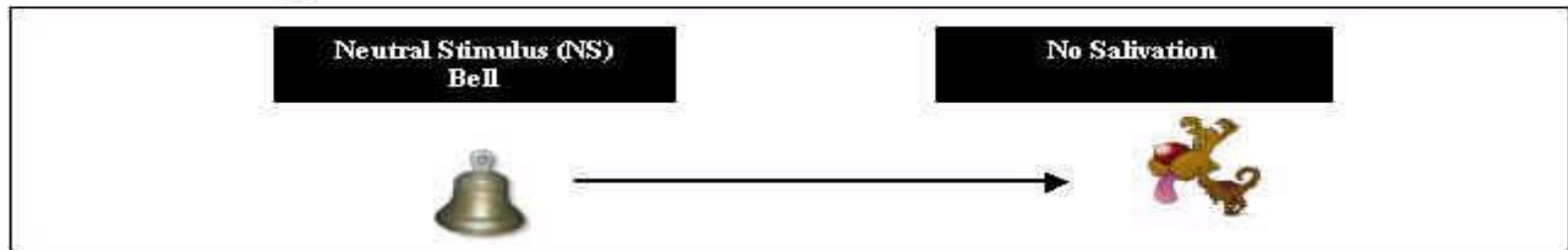
The bell is a neutral stimulus until the dog learns to associate the bell with food.

Then

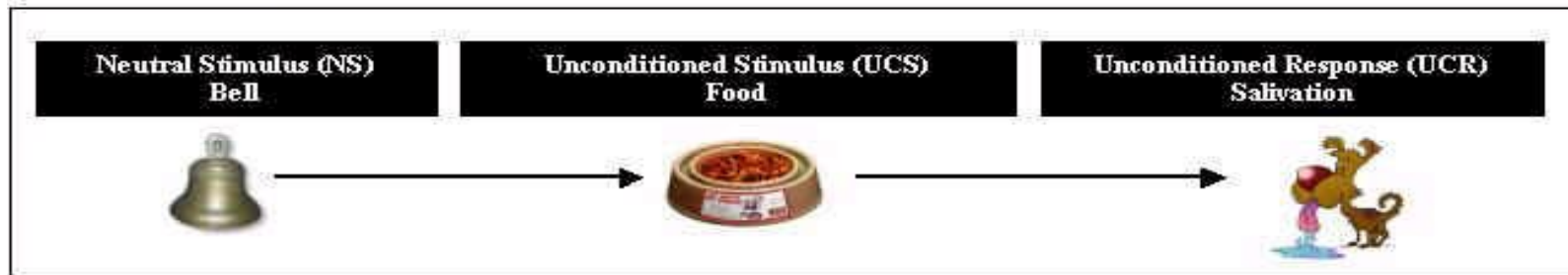
The bell becomes a **conditioned stimulus** (CS) which produces the **conditioned response** (CR) of salivation after repeated pairings between the bell and food.

Classical Conditioning

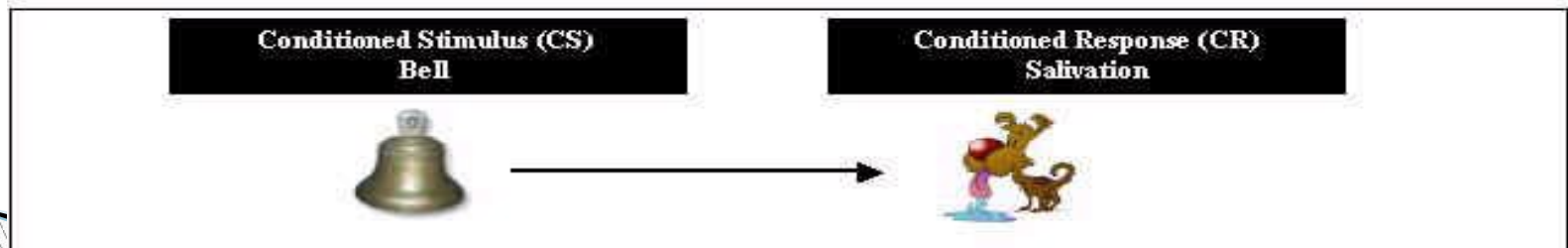
Before Conditioning



During Conditioning

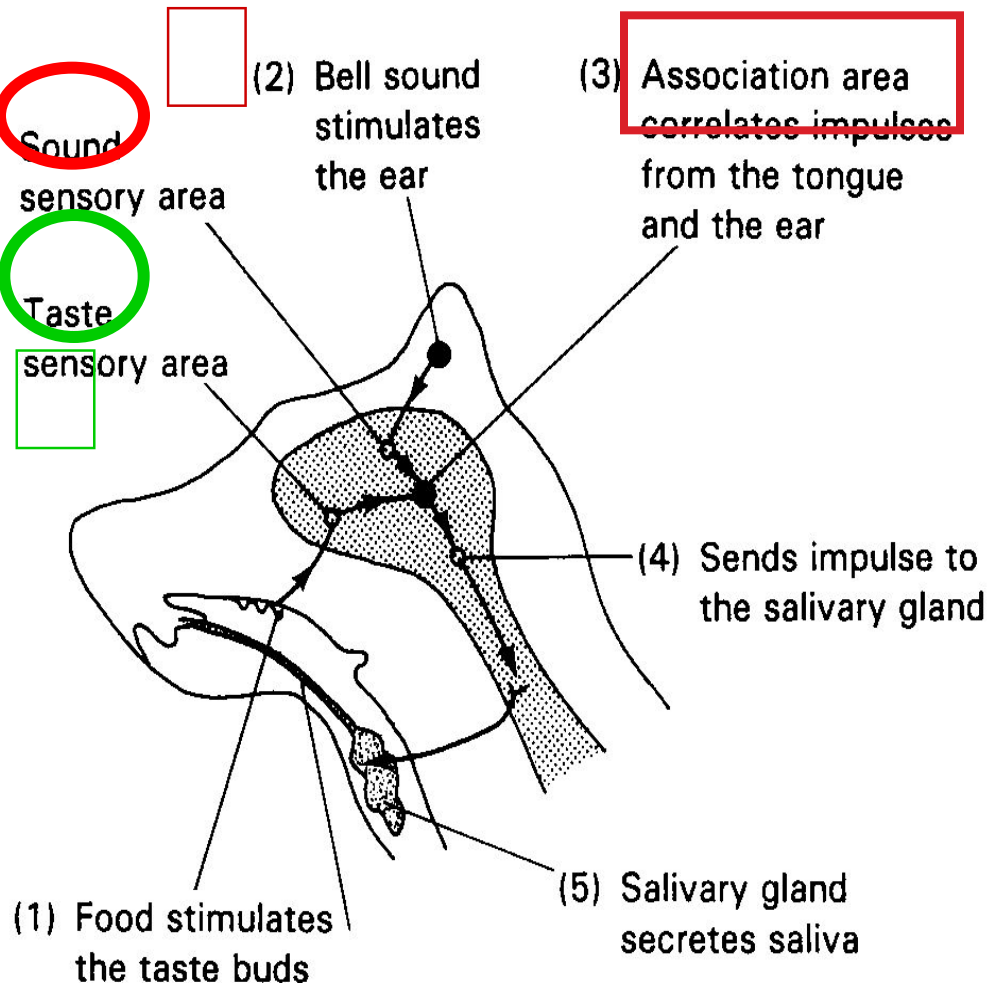


After Conditioning

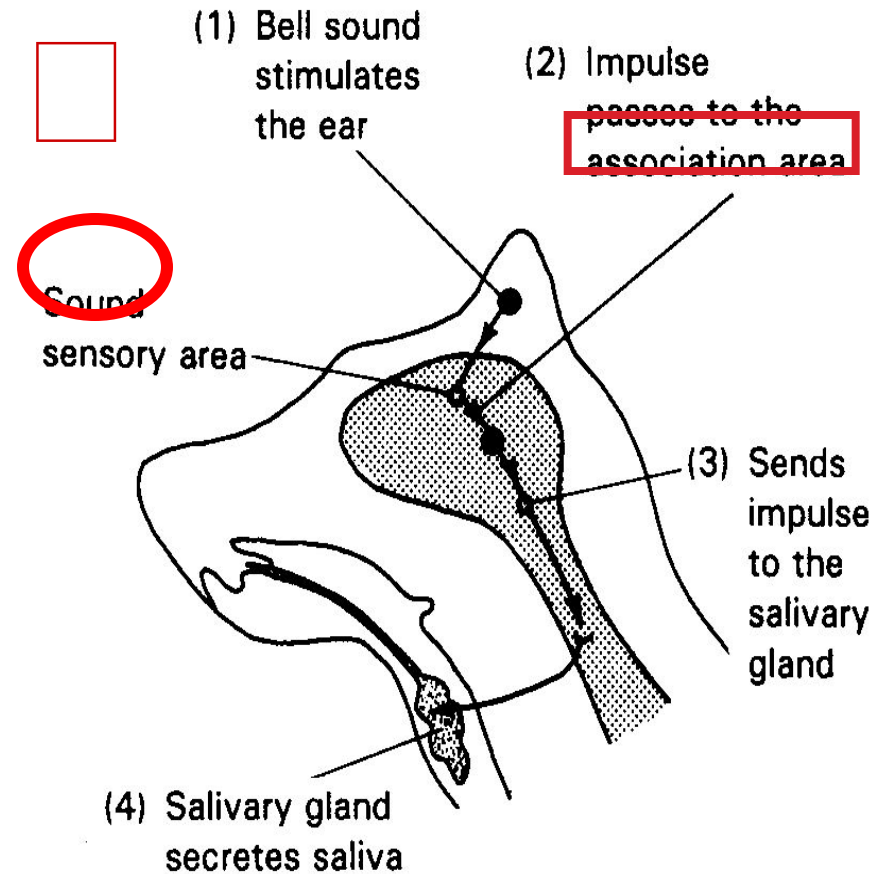


Conditioned Reflex in Dog

SIMPLE REFLEX ACTION



CONDITIONED REFLEX ACTION



Conditioned reflex

1. Acquired (not inherited) through training or learning.
2. Replace a normal stimulus by a unrelated stimulus to give same response.
3. Initial skills by voluntary; then become unconscious (conditional reflex)
4. Enable animal to modify behavior to adapt the environment (i.e. avoid danger)

Properties of Conditioned reflex

The CS precedes the US

Extinction

The dog's response to the bell can be extinguished by repeatedly presenting the bell (CS) without the food (UCS).

External inhibition – if the animal is disturbed by the external stimulus immediately after the CS is applied , conditioned response may not occur.

Reinforcement_

Positive Reinforcement

The dog has not completely forgotten the association between the bell and the food. If the condition reflex is repeated time to time by pairing CS and US , the dog may retain the conditioned response indefinite time and salivate again to the bell.

Negative Reinforcement

If the UCS is associated with an unpleasant affect, negative reinforcement occurs

Generalization

Occurs when there is a small difference in the presented stimulus and the original conditioned stimulus. If Pavlov's dog heard a bell of a similar tone, the dog would still salivate.

Discrimination

The opposite of generalization, discrimination happens when a conditioned response does not occur when there is a difference between the presented stimulus and the original conditioned stimulus. If Pavlov's dog heard a bell with a different tone and was not awarded the unconditioned stimulus (food), the dog would learn not to salivate to the second tone.

Biofeedback

Conditioning of visceral response

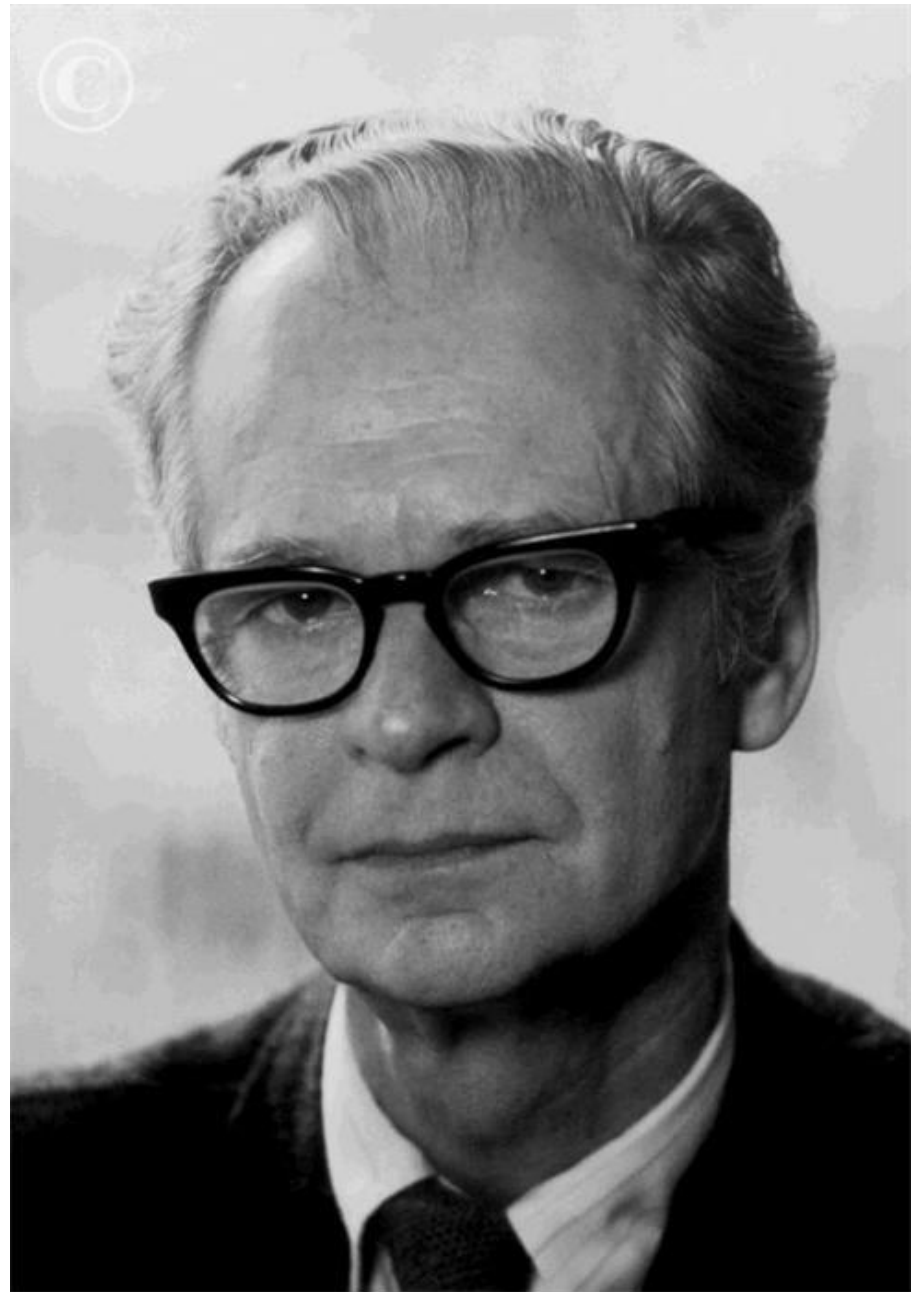
Alteration in heart rate and BP –successfully
tried for treatment of hypertension

Operant Conditioning

A type of conditioning in which desired voluntary behavior leads to reward or prevents a punishment.

Consequences determine the behavior that results in learning.

B.F. SKINNER **(1904 – 1990)**

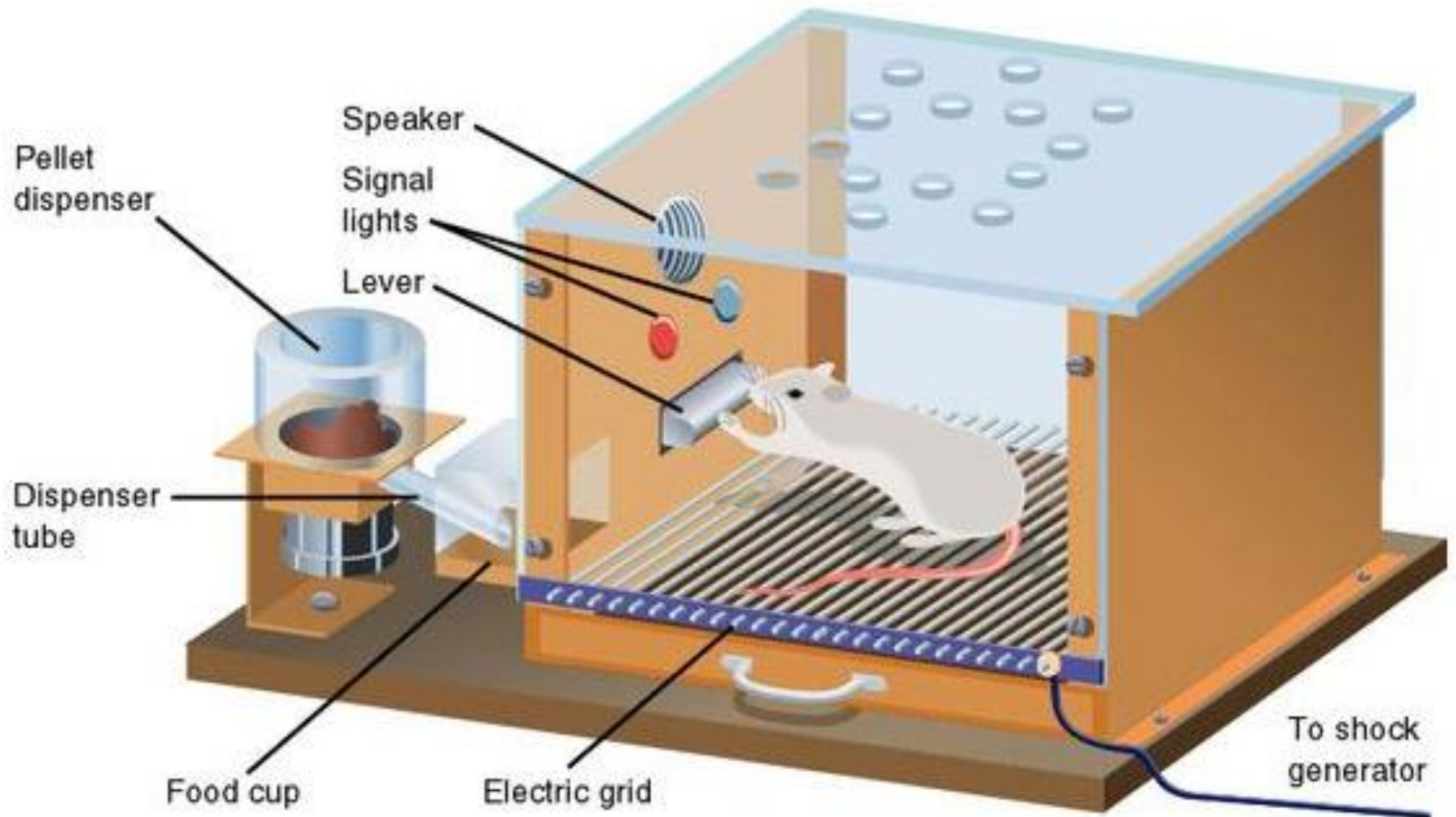


AJ482A [RM] © www.visualphotos.com

SKINNER'S OPERANT CONDITIONING

- ❑ Beginning in the 1930's, Skinner started his experimentation on the behavior of animals.
- ❑ Skinner's quest was to observe the relationship between observable stimuli and response.
- ❑ Skinner controlled his experiments by using **“Skinner boxes.”**
- ❑ The Skinner box was a contraption that would automatically dispense food pellets and electric shocks

Operant Conditioning



<https://www.youtube.com/watch?v=MOgowRy2WC0>

SKINNER'S OPERANT CONDITIONING

- ❑ Skinner believed that the learning he observed in his Skinner boxes could apply to human behavior.
- ❑ He called this learning operant conditioning.
- ❑ Operant conditioning can be described as behavior adjustments as a result of greater or lesser, negative or positive reinforcement and punishment.
- ❑ Skinner hypothesized that human behaviors were controlled by rewards and punishment

Positive Reinforcement

Making a behavior stronger by following the behavior with a pleasant stimulus. For example, a rat presses a lever and receives food.

Negative Reinforcement

Making a behavior stronger by taking away a negative stimulus. For example, a rat presses a lever and turns off the electric shock (conditioned avoidance reflex)

Food aversion conditioning

Survival value

MEMORY

MEMORY

- A trace left behind of the past experience (learning) that can be recalled in future
- ***Memory has four stages:***
- **Registration of memory**- includes proper perception and attention
- **Integration and retention**-learned experiences are processed and integrated by various structures in CNS, then retained in appropriate place
- **Recognition and recall**-at appropriate time and place, memory is recalled for proper use.
- **Reutilization**- memory is utilized for improvement of further learning.

MEMORY

Types of memory:

1. Reflexive/Implicit or non-declarative memory
2. Explicit or declarative memory

1. Reflexive/Implicit or non-declarative memory

a. Priming

- Priming is the facilitation of recognition of words or objects by prior exposure to them.

Eg, improved recall of words when presented with first few letters.

b. Procedural memory

- **Repetitive motor activities** with absent/minimal conscious effort to execute them, e.g.,

- Talking while chewing

- Encoded in BG & cerebellum

2.Explicit or declarative memory

- ❑ Past experiences recalled 'with effort' (unlike 'reflex recall')
 - Memory of events-episodic memory
 - Memory of facts- semantic memory
- ❑ Types: **Recent & long-term**

Recent (primary) memory: few sec-few hours

- Thalamo cortical somato sensory signals entering cortical reverberating circuits ❑ memory ***trace***
- Consolidation dependent on arrival/interference by newer signals

Long-term (secondary) memory: years together

- Prolonged & intense sensory experience activates synapses:
 - ❖ Reverberation & changes in structure, biochemical & behavioral
 - ❖ Permanent memory

Mechanism of learning and memory

- Cellular mechanism
- Neural mechanism
- Biochemical mechanism

Learning and memory are initiated and established by several Neuro-chemical secretion, formation of intracellular second messengers, protein synthesis and gene expression

❖ **Habituation**

- Decreased neurotransmitter release
- Decreased Ca^{++} content

❖ **Sensitization**

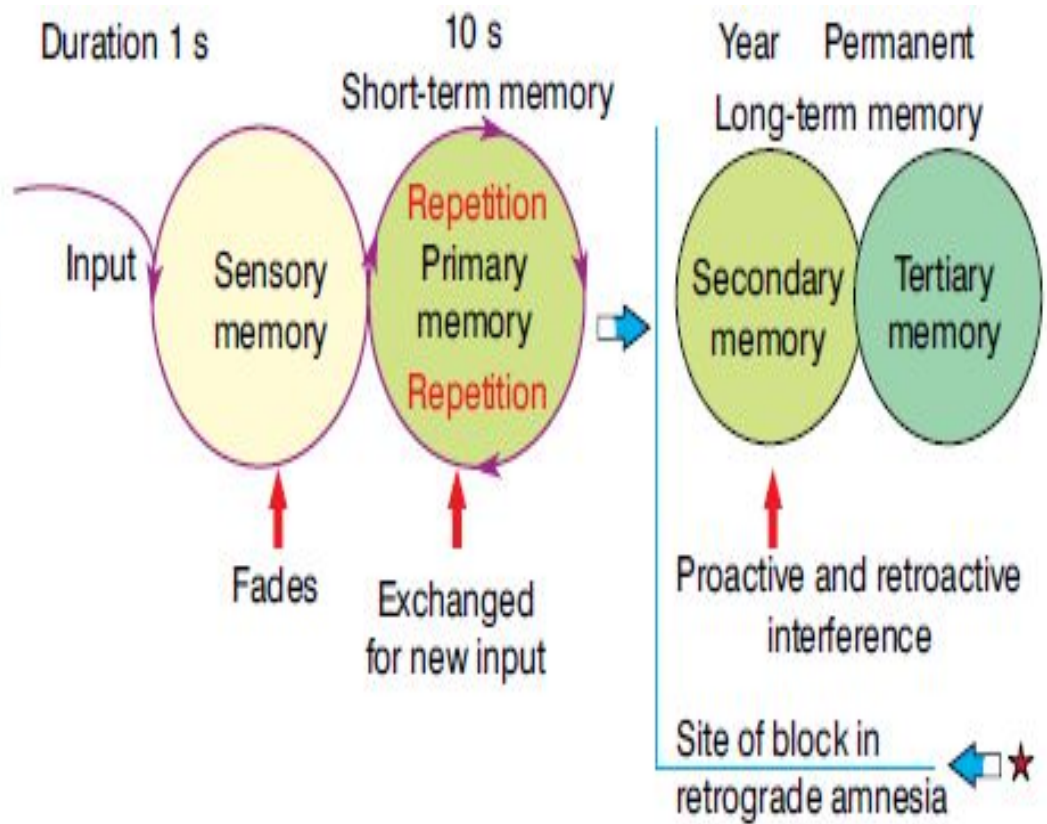
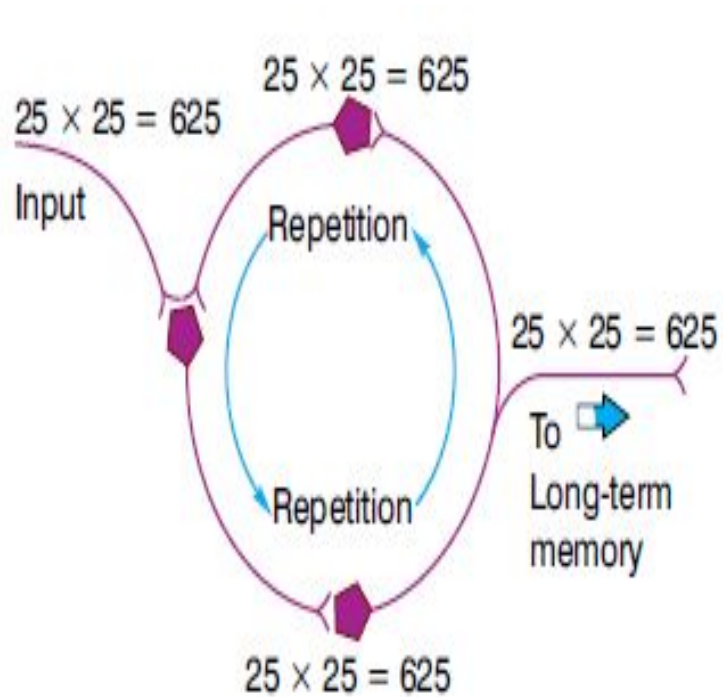
- Increased neurotransmitter release from modular neuron
- Presynaptic facilitation

❖ **Post-tetanic potentiation**

- Enhanced post synaptic potential
- Ca^{++} accumulation

❖ **Long-term potentiation**

- Addition of receptor-proteins along with G-proteins



Brain regions involved

- The brain regions that are thoroughly studied in experimental animals to understand learning and memory are –
- Prefrontal cortex
- Inferio temporal cortex
- Hippocampus

Prefrontal cortex

- ❑ Removal of prefrontal cortex-delayed responses
- ❑ Spatial short memory- dorsolateral frontal areas

Inferotemporal cortex

- ❑ Lesion leads interferes with visual discrimination (others unaffected)
- ❑ Integrity of prefrontal and inferotemporal cortices is required for relatively difficult tasks

Hippocampus

- ❑ Part of Papez Circuit with hypothalamus, thalamus, amygdale, septum
- ❑ With prefrontal cortex- working memory
- ❑ Reward centre
- ❑ bilateral destruction –deficit in short term memory

Brain areas for integration of Various forms of memory

Explicit memory-medial temporal lobe

Short term- hippocampus

Working – prefrontal cortex

Long term-neocortex

Implicit memory

Priming-neocortex

Procedural(skills & habits)-striatum

Associative learning(conditioned responses)

Emotional –amygdala

Skeletal –cerebellum

Non associative -reflex pathways

LEARNING & MEMORY: APPLIED PHYSIOLOGY

- Possibility to improve memory
 - Development of synaptic plasticity □ altered synaptic excitability □ memory trace
- Chemical agents influencing memory consolidation
 - *Caffeine*: Stimulates RF & cortical centers via adenosine, dopamine etc.
 - *Nicotine*: Stimulates cholinergic receptors
 - *Amphetamine*: CNS stimulant
 - *Physostigmine*: Anticholinesterase activity
 - *Convulsants* (e.g., picrotoxin, strychnine, pentylenetetrazol)
 - *Pemoline* (cylert): Stimulates RNA synthesis

Amnesia- *impairment of memory*

- **Types:**

Retrograde amnesia: *Loss of primary & retention of secondary memory*

- Influencing factors of the process:
 - ❖ Disturbances 'erase'
 - ❖ Brain-stimulants hasten (e.g., caffeine, nicotine or amphetamine)
 - ❖ Commonly in head injury patient

Anterograde amnesia: *inability to recall or form new memory after the event.*

Follows head injury

Dementia- *syndrome of several intellectual inabilities*

Eg: Senile dementia ,Alzheimer's disease, Drug induced , alcoholic

Alzheimer's disease

- The most common cause of Dementia
 - Progressive Memory Loss
 - Plus loss in one other area of cognition:
 - Perception
 - Attention
 - Language/Symbols
 - Judgment
 - Reasoning
 - Problem Solving
- Interferes with Activities of Daily Living
- Other causes (stroke) and mimics (depression) ruled out

Causes of Alzheimer's Disease

- The cause or causes of Alzheimer's disease are not yet known
- Experts believe that Alzheimer's develops as a result of multiple factors, rather than a single cause
- These factors include a variety of changes in the brain
 - Accumulation of the protein-amyloid outside neurons
 - Accumulation of the protein tau inside neurons
- Genetic mutation is a known cause of Alzheimer's disease

THANK YOU