DR. RAMENDRA KUMAR SINGH

Assistant Professor
P.G .Deptt. Of Psychology
Maharaja College, Arrah

Memory and its Neurophysiological Basis

Paper- CC-6 (Neuropsychology)

P.G. Semester- II

What is memory

- Memory is an umbrella concept, and it is impossible to say categorically that someone has an overall good or bad memory. It is simply not a single system.
- Psychology text books typically describe memory as having three main divisions:

Sensory memory: is fleeting, lasting only milliseconds, but its capacity is essentially unlimited in what may be taken in.

Short term memory: is of limited capacity and degrades quickly over a matter of seconds if information is not held via a means such as rehearsal, or transferred to long term memory.

- **Long term memory:** theoretically, is of unlimited capacity and relatively permanents except for models that suggest that loss of information through forgetting is possible.
- Neuropsychologists are most concerned with long term memory and its disorders because these are the problems most evidenced by patients. Neuropsychological conceptualization of memory generally does not consider sensory memory, rather, it is thought of as a component of sensory processing. Neuropsychology concerns itself with understanding how memory systems work in correspondence with known brain functioning.

- Here we discuss memory and its neurophysiological basis into two broad systems:

1) Long Term Memory

2) Short Term Memory

Long term memory

- Neuropsychologist are referring it as a ability to register information(encode), organize the information in a meaningful way (storage) and recall or recognize the information when needed (retrieval). It is also called as Remote memory.
- *It is further divided into: Declarative Memory and Non Declarative memory*

Declarative memory:

- It is explicit and accessible to conscious awareness. The term declarative comes from declare, which means "to proclaim; to announce".
- It is memory of events and facts that we think and talk about
- further divided the declarative memory into episodic and semantic memory:-
- ***Episodic memory:*** which refers to individual episodes , usually autobiographical , that have specific spatial and temporal tags in memory. Episodic memories are specific to a particular time and place.
- ***Semantic memory****:* It refers to memory for information and facts that have no specific time tag reference. Semantic memory is less specific than episodic memories. Semantic memories can be acquired gradually, over time. Episodic memories, in contrast, must be learned all at once.

Non Declarative memory/procedural memory:

- It is usually implicit and a person demonstrates it via performance. It includes instances of perceptual, stimulus response and motor learning that we are not necessarily conscious of. It appears to operate automatically.
- Researchers have variously referred to the opposite of limbic circuitry based memory as "Habit memory" (Mishkin et al,1984), "Procedural Memory"(Cohen,1984) and 'Implicit memory"(Graf and Schacter,1985).

Neuroanatomical basis of Declarative Memory:

- Research has implicated three major constellations of brain structures in declarative memory:

Medial Temporal Lobe

Diencephalon

Basal Forebrain

- These three areas interconnected and play a role in consolidating information into LTM.

The Medial Temporal Lobe:

- The *Hippocampal formation* and the *limbic cortex* of the medial temporal lobe appear to be involved in the consolidation and retrieval of declarative memories, both episodic and semantic. But the semantic memories themselves appear to be stored in the *neocortex*, particularly in the neocortex of the anterolateral temporal lobe. The Hippocampal formation consists of the dentate gyrus, the CA fields(CA1,CA2,CA3,CA4) of the hippocampus itself, and the subiculum(its subregions). Neuropsychologists also believe the perirhinal and Parahippocampal cortex (regions of the limbic cortex) adjacent to the hippocampal formation have a role in memory.

Papez circuit

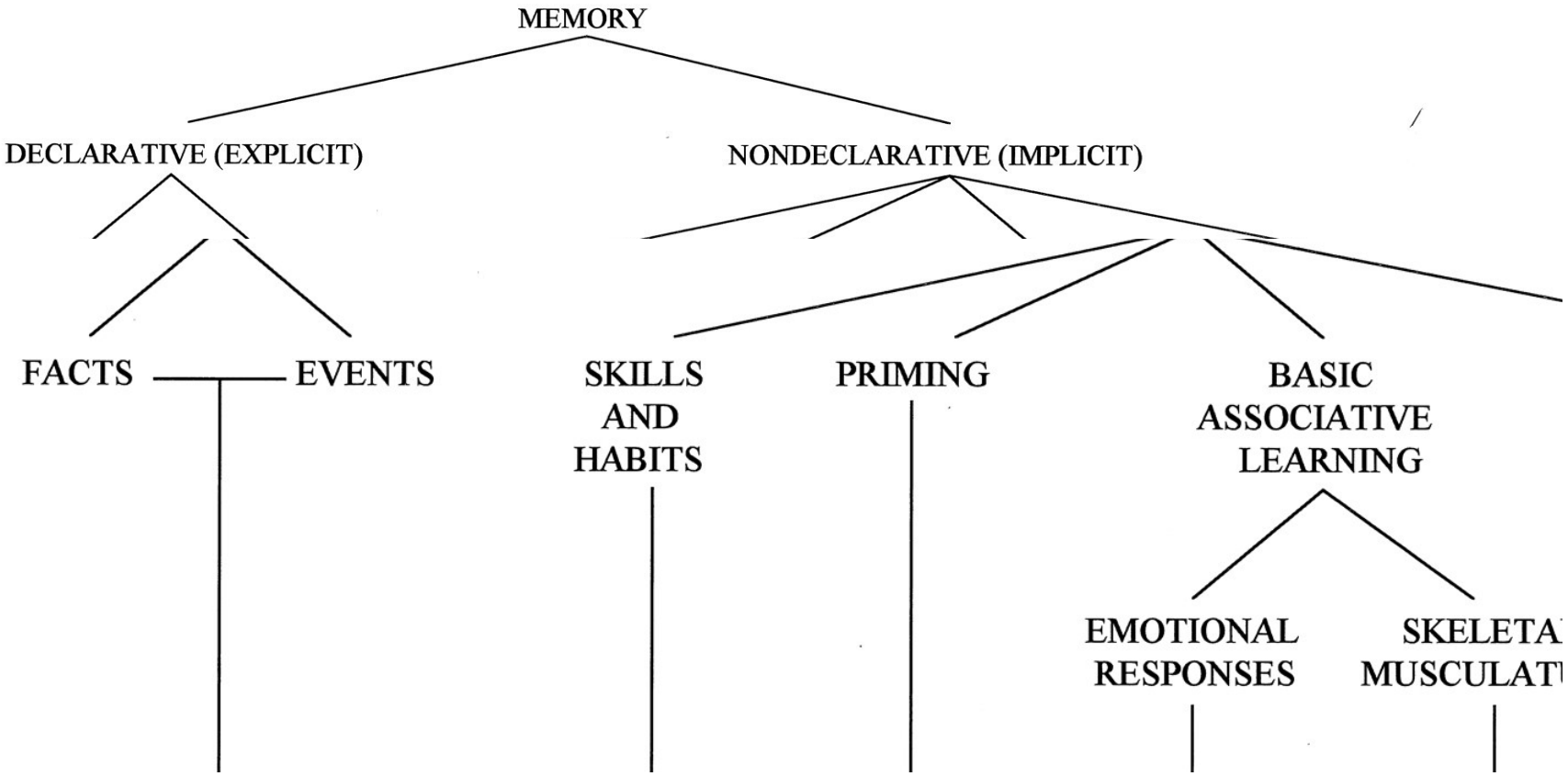
- Today, researchers know this loop has more to do with consolidating information in memory than as a primary emotional processor. Information from the cortex and higher cortical association areas enters the circuit through the cingulated gyrus, moves to the parahippocampal gyrus, and then into the hippocampus through the hippocampal formation. The major output system of the hippocampal formation is the fornix.
- Researchers concluded that the hippocampus is involved in memory, specifically normal recognition memory as well as spatial memory. Another job of the hippocampus is to project information to cortical regions that give memories meaning and connect them with other connected memories.

- **<u>Diencephalon:</u>** The structures of the diencephalon involved in memory center around *specific nuclei of thalamus* and the *mammillary bodies of the hypothalamus*. The Thalamus consists of several nuclei, with the dorsal medial nucleus of the thalamus most often implicated in memory disorders.
- **<u>Basal Forebrain:</u>** The basal forebrain structures implicated in memory include the *nucleus basalis of Meynert*, the *medial septal nucleus*, the nucleus of the *diagonal band of Broca, and the substantia innominata*

Neuroanatomical Basis of Non declarative memory:

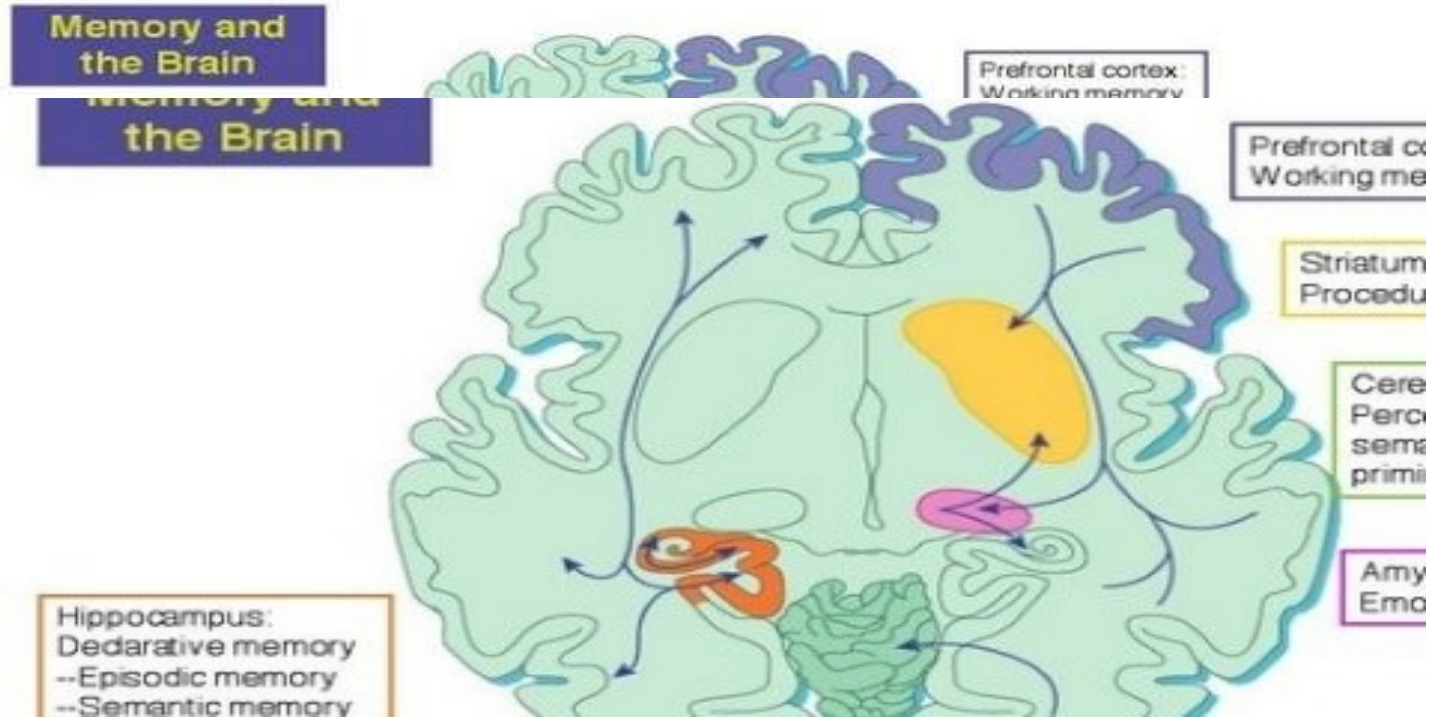
- Scientists can describe some aspects of non-declarative memory with respect to brain structures, particularly **subcortical basal gangalia areas.** Whether the same brain circuitry governs all aspects of non declarative memory is not clear. However evidence suggests that structures supporting non declarative memory are probably evolutionary and ontologically older and more primitive. Many brain structures involved in motor learning like cerebellum, basal gangalia, motor stripe. Cerebellum helps in sequential motor learning. The cerebellum plays a role in the learning of procedural memory, and motor learning, such as skills requiring co-ordination and fine motor control.

Summary of the different regions involved in different memory



Summary of the different regions involved in different memory

Different regions of brain involved in specific memory



Lobes and memory:

- *Temporal Lobes* in this cortex are more closely associated with memory and in particular autobiographical memory and also concerned with recognition memory.
- *Parietal lobe* also assists with verbal short term memory and damage to the supramarginal gyrus cause short term memory loss

Role of Neurotransmitter in memory:

- Epinephrine, dopamine, serotonin, glutamate, and acetylcholine played major role in memory (Myhrer, 2003). It is also believed that strong emotions trigger the formation of strong memories, and weaker emotional experiences form weaker memories; this is called arousal theory (Christianson, 1992). It is due to activation of neurotransmitter. A very important role in the establishment of STM is played by the balance between Ca+2,CaMKII9 calmodium dependent protein Kinase II and protein Phosphate 1.