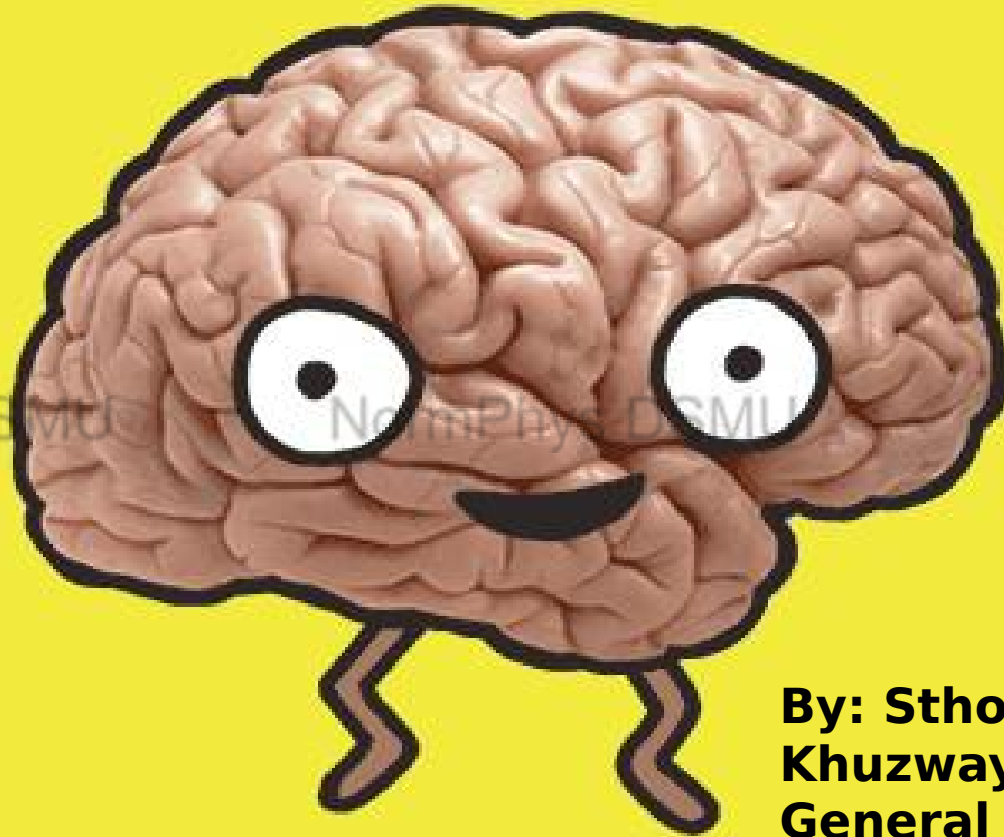# MEMORY

By: Sthokozile Khuzwayo, 4th year, General medicine 14.11.2020

SHORT-TERM/ LONG-TERM

INTRODUCTION, Memory

Memory (Kandel 2000): [is a higher nervous activity] the process of which knowledge and our experiences in this world are encoded, stored and retrieved for our later use.

The development of this specific function of HNA has allowed for the development of languages, relationships and even personal identity as human beings

- As an informational functioning system, it can be related to the neuron. And is therefore created by changes in sensitivity of synaptic transmissions between neurons as a result of previous neural activity. These changes create new pathways (or facilitated paths) for the development of signal transmission through neural circuits in the brain . these new paths are called MEMORY TRACES (ENGRAMS).
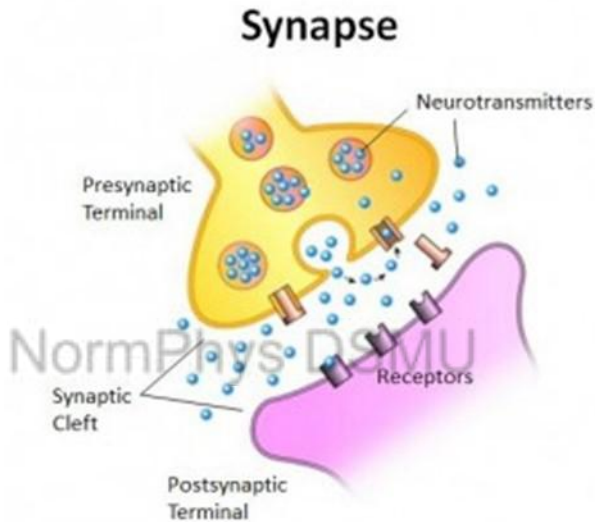
- Memory trace = a newly developed pathway or signal transmission resulting from facilitation of new synapses 🡪 creation of new neural circuits in the brain
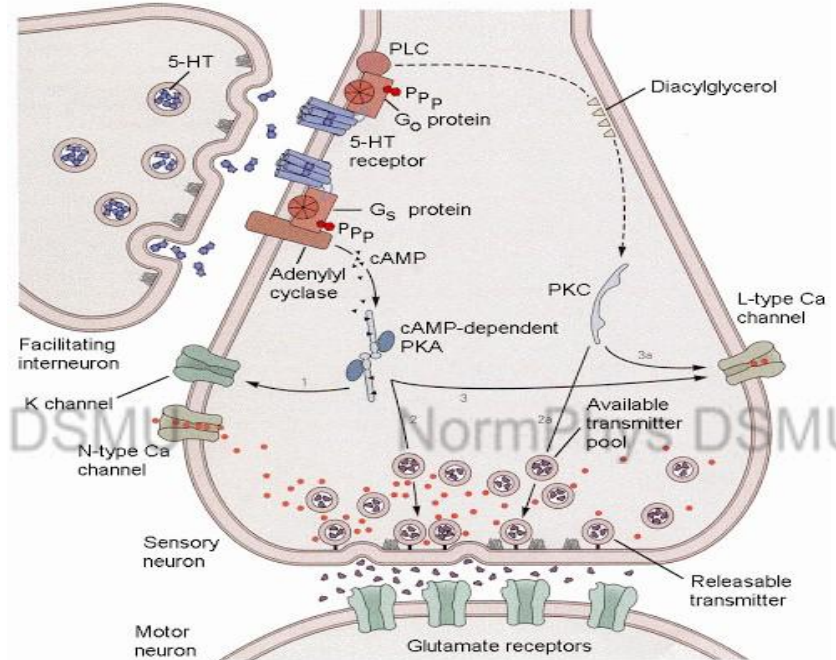
INTRODUCTION, contiued.

- The brains memory storage capacity, according to an article in the *Scientific American Mind Journal*, is something close to 2.5 petabytes (or a million gigabytes). This is accomplished due to the interconnectedness between neurons, meaning that each helps with many memories at a time.

   - <u>to give context</u>: 2.5 petabytes would be enough to hold 3 million hours of TV shows, meaning you would have to leave a TV running continuously for more than 300 years to use up all that space
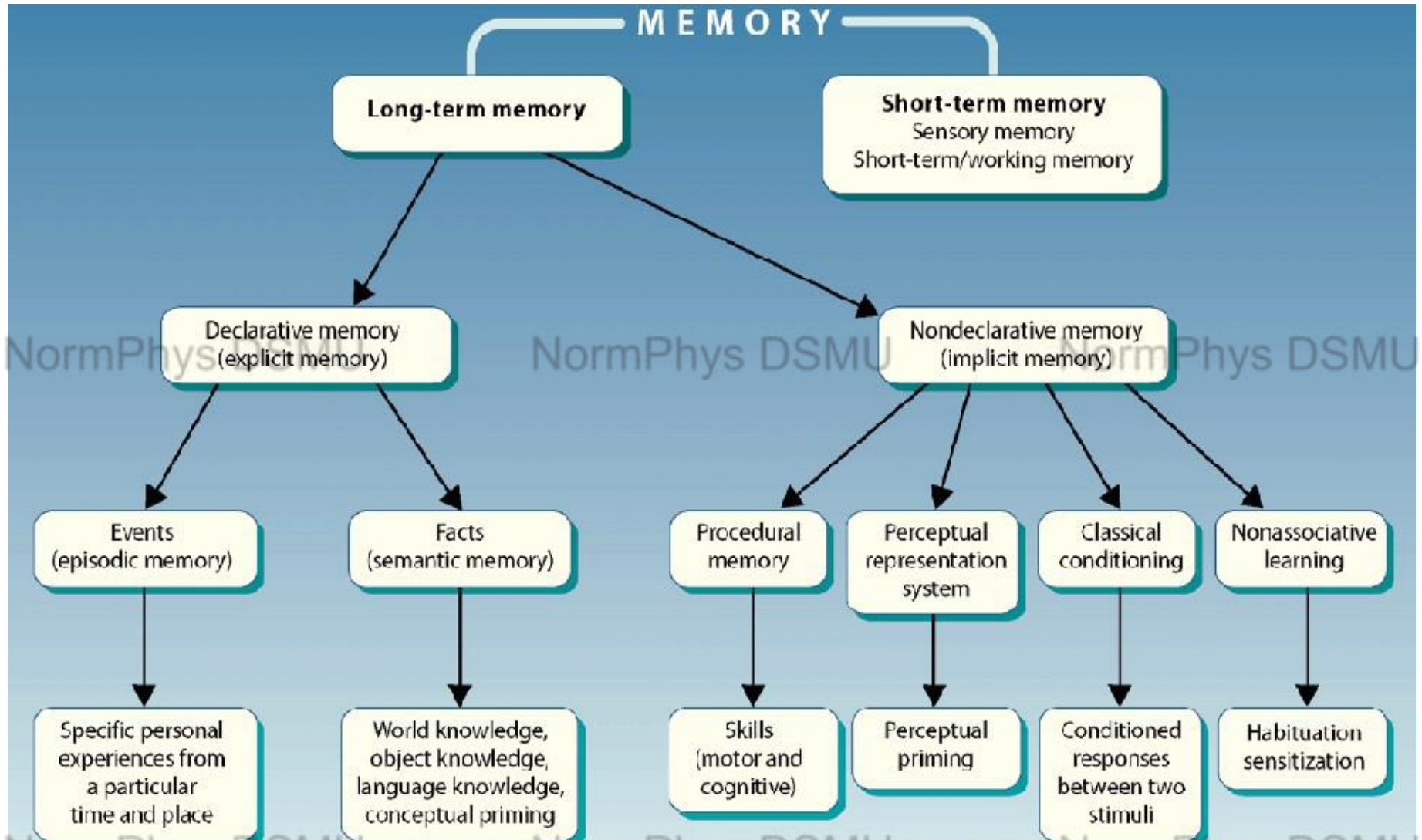
ANATOMICAL BASIS, of a memory synapse

Synapse

Neurotransmitters

Presynaptic Terminal

Synaptic Cleft

Receptors

Postsynaptic Terminal

VS

PLC
5-HT
PP_P
G_o protein
5-HT receptor
Diacylglycerol
G_S protein
PP_P
cAMP
Adenylyl cyclase
PKC
L-type Ca channel
cAMP-dependent PKA
Facilitating interneuron
K channel
Available transmitter pool
N-type Ca channel
Sensory neuron
Releasable transmitter
Motor neuron
Glutamate receptors
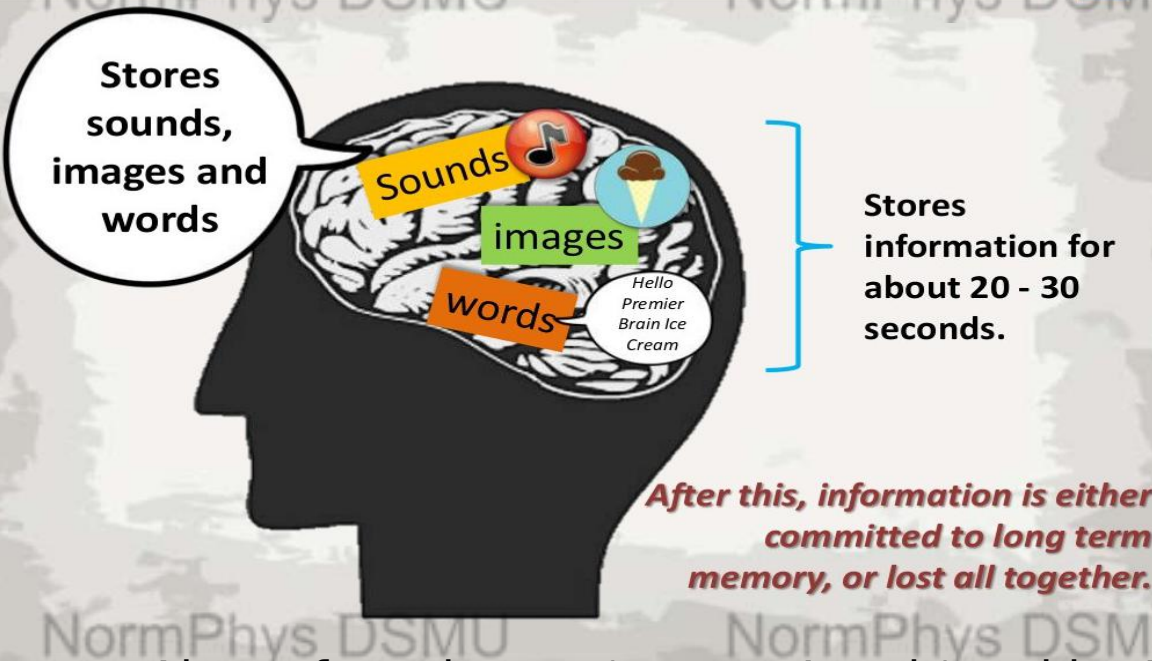
- Consists of 2 separate presynaptic terminals:
  1) Primary presynaptic terminal (called **sensory terminal**), ends at conventional postsynaptic neuron
  2) Facilitator terminal, ends on sensory terminal itself.

- When sensory terminal is stimulated alone = leads to habituation
- If both terminals are stimulated = Facilitation occurs and signal remains strong fro long periods.

CLASSIFICATION, Memory

Stores sounds, images and words

Sounds

images

words

Hello Premier Brain Ice Cream

Stores information for about 20 - 30 seconds.

*After this, information is either committed to long term memory, or lost all together.*

Examples:
- ❖ Where you parked your car this morning
- ❖ What you had for lunch yesterday
- ❖ Trying to remember a telephone number
- ❖ Remembering details from a book you read a few days ago

- Also referred to as 'nearest' and 'working' memory.
- STM enables the brain to remember a small amount of information for a short period of time.
- **Duration**: (< 20 seconds if not rehearsed) Allows for recalling of events/info from a period of several seconds to minutes to hours without rehearsal of that information.
- **Capacity**: 7+/- 2 items (Miller). Modern estimates = decreased but it has been shown that chunking helps the capacity.
- **Entry** into storage: Acoustic code is used i.e. verbalization
- **Access** to storage: rapid
- **Mechanism**: made by the formation of temporary memory traces, which occur due to long term potentiation and changes in physical

- STM = Stored in Prefontal and parietal cortex

- Interestingly enough: 'working' memory, some theorists argue is distinct from STM. They state that WM allows for the manipulation of stored information, whereas, STM ONLY refers to short-term storage of information.
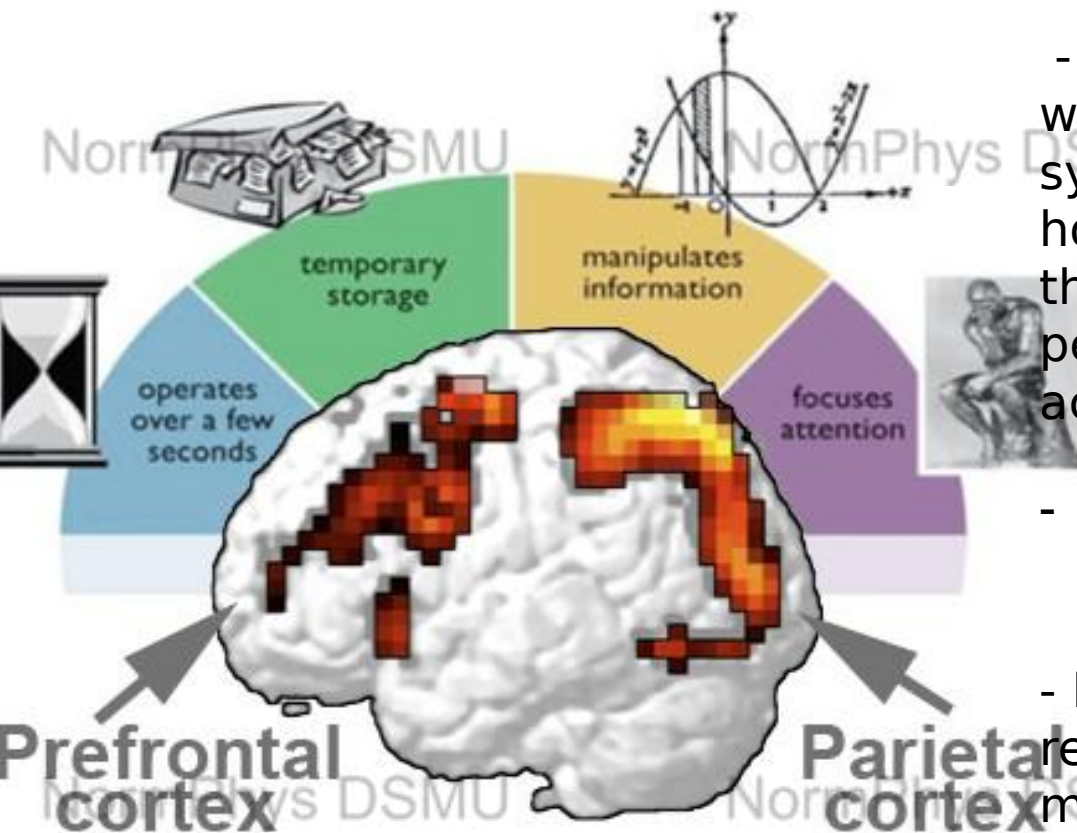

- Therefore the definition given to working memory is: a cognitive system with limited capacity that hold information temporarily, on the basis of which an action is performed. Also, 'memory-in-action'.

- Is important for reasoning, learning and comprehension

- Examples: recalling steps to recipe while cooking favourite meal. Writing an essay.

- **Synaptic plasticity** is also a very important mechanism by which formation of memories in general finds its basis.
  - Refers to the <u>changes that occur at synaptic levels in response to how active or inactive the synapses are</u> (their synaptic strength)

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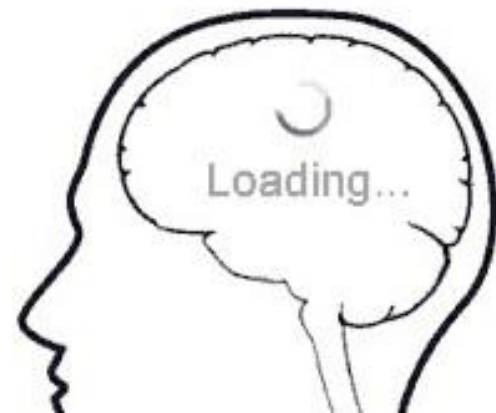
Long-Term Memory

Declarative Memory (Explicit)

Non-Declarative Memory (Implicit)

Facts (semantic)

Events (episodic)

Procedural memory: skills & habits (basal ganglia)

Classical conditioning

Priming (neocortex)

Skeletal musculature (cerebellum)

Emotional Responses (amygdala)

Emotional responses (Amygdala)

LONG TERM MEMORY

- LTM can store greater quantities (unlimited capacity) of information for potentially unlimited durations: hours to years
- **Entry** into storage: through practise/ repetition &/or punishment and reward
- **Access** to storage: slow
- **Mechanism**: is formed by long-term memory traces (Memory engrams) which are formed by structural changes in pre-synpatic terminals i.e. Long-term potentiation

LONG-TERM POTENTIATION
(best mech.)

- 1. The <u>binding of glutamate to its NMDA receptors</u> and simultaneous depolarization of the postsynaptic membrane causes <u>the NMDA receptor channels to open</u>.
- 2. This opening of the NMDA receptor channels <u>allows Ca2+ to enter</u>.
- 3. The entry of Ca2+ into the postsynaptic neuron causes <u>long-term potentiation in that neuron</u>.
- 4. The entry of Ca2+ into the postsynaptic neuron also activates nitric oxide synthase, <u>causing nitric oxide production</u>.
- 5. The nitric oxide then acts as a <u>retrograde messenger</u>, diffusing into the presynaptic neuron and somehow <u>causing</u> it to <u>release more neurotransmitter (serotonin</u>).

PHASES OF MEMORY
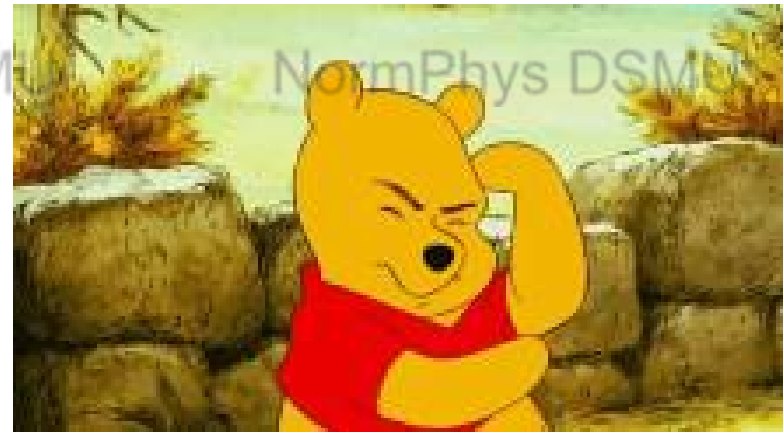
1. **Encoding** - Information for each memory is assembled from the different sensory systems and translated into whatever form necessary to be remembered. 3 main ways for encoding information: acoustic, visual, semantic (meaning/factual)

- **Consolidation** -converting the encoded information into a form that can be permanently stored. Process where recently learned experiences are transformed into long term memory (by strengthening of synaptic connections between neurons) .The *hippocampus, ant. & lat. Temporal lobe, medial temporal lobe, amygdala* and surrounding areas apparently accomplish this.

Neocortex

Prefrontal
cortex

Basal
ganglia

Cerebellum

Hippocampus

Amygdala

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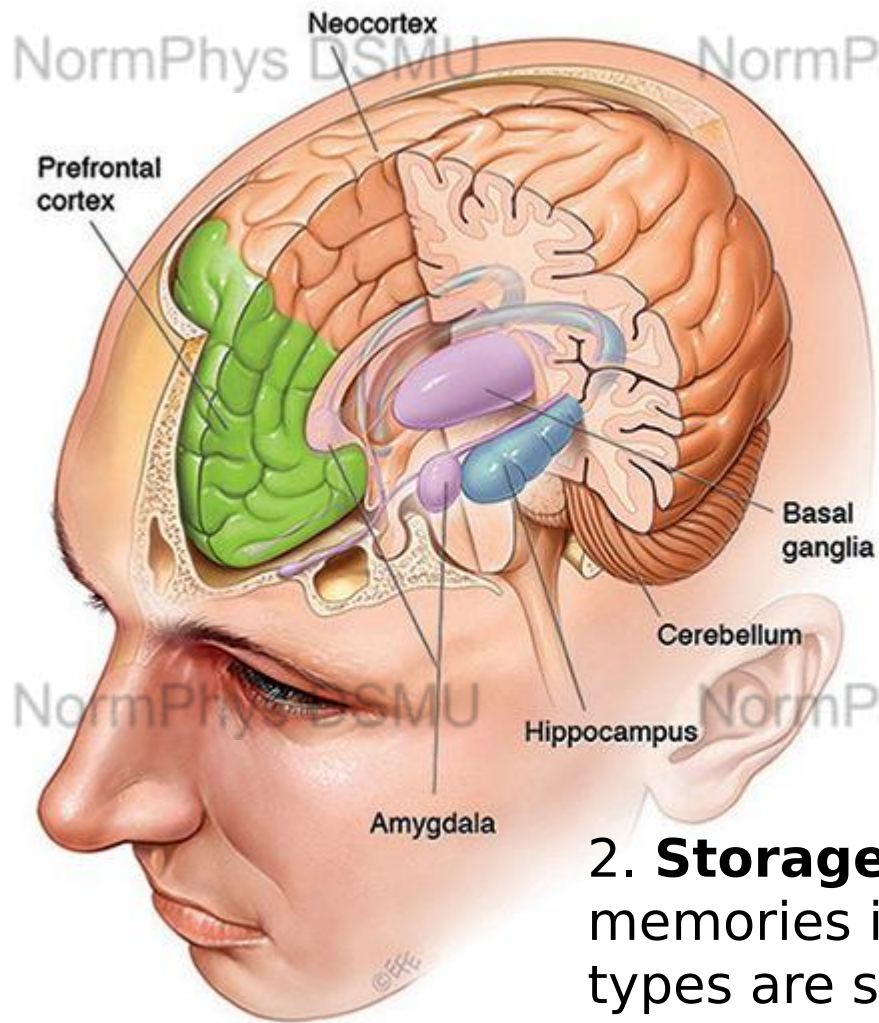
2. **Storage** -the actual deposition of the memories into the final resting places – different types are stored across different interconnected brain regions.
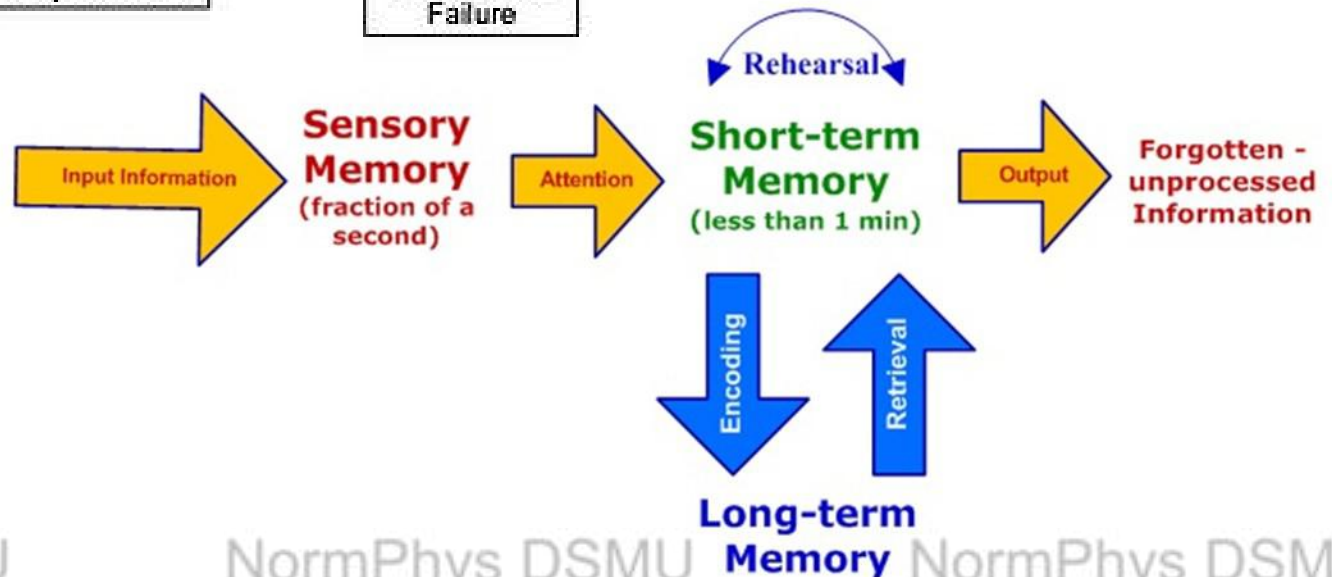
– short-term memories: prefrontal cortex
– Explicit memories: hippocampus, neocortex and amygdala
– Implicit memories: basal ganglia and cerebellum

3. **Retrieval**
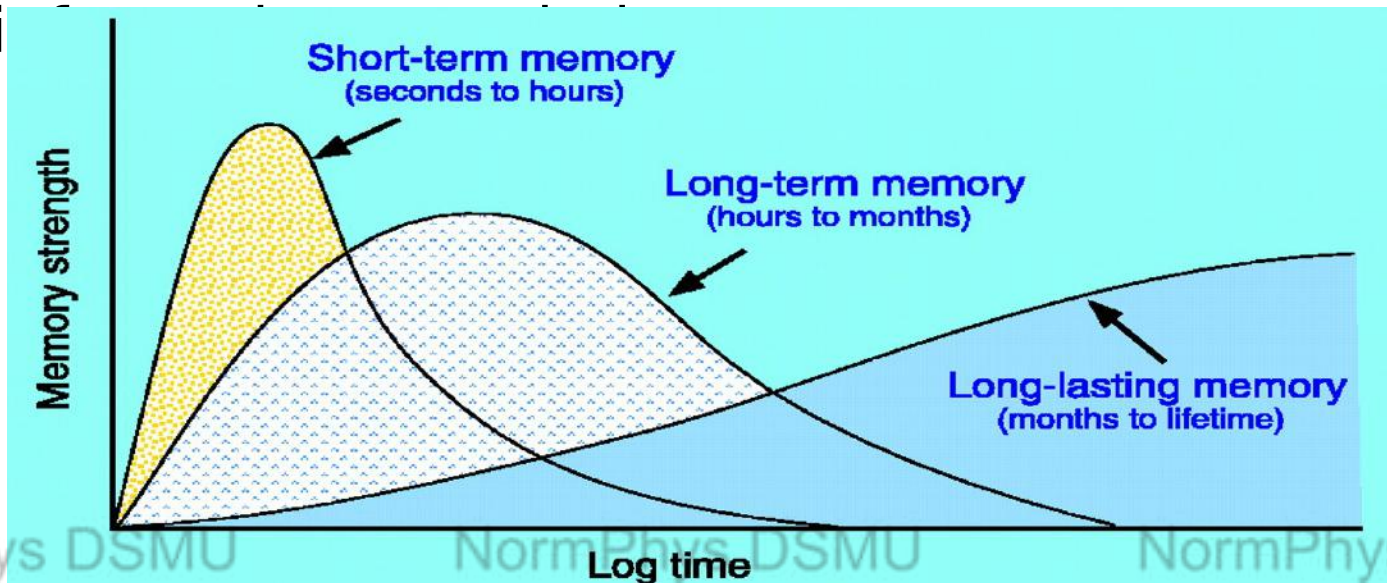
Multi Store Model - Atkinson & Shiffrin
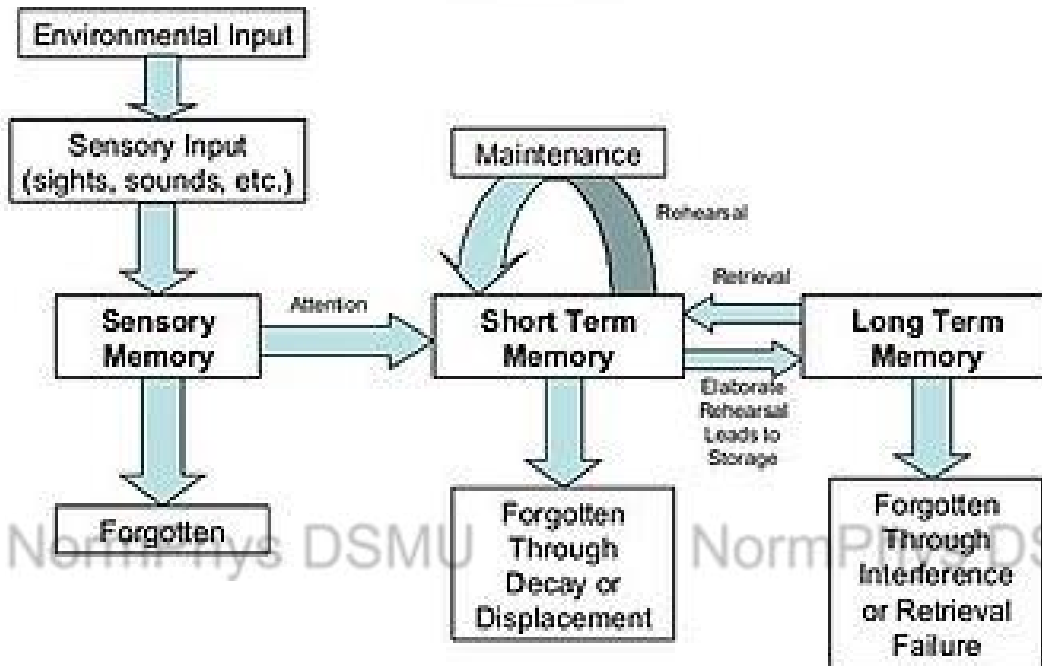
Although too simplistic, the model allows for a basic overall understanding of the structure and process of STM.

FINAL THOUGHTS AND COMMENTS

- Memory isn't perfect and can easily be affected by many factors.
  - The way in which it is encoded, stored and retrieved can be corrupted, due to trauma, degenerative dieases, none rehearsal of the information etc.
  - Amnesia, Senile dementia and Alzheimer disease
  - The amount of attention given affects amount of i...

THANK YOU FOR YOUR ATTENTION