2e. Memory - Brain Regions

Brain regions involved in the storage of LTM:

Overview of brain structures:

- **Cerebral cortex** – short-term memories and declarative memories
- **Hippocampus** – consolidating long term memories and transfer of memories to cerebral cortex for storage
- **Amygdala** – the addition of emotional content to memories
- **Cerebellum** - storage of conditioned motor responses involving simple reflexes

1. **Cerebral cortex: the thin outer, wrinkly looking layer of neural tissue that covers the largest part of the brain (the cerebrum).**

- Long-term explicit semantic and episodic memories are widely distributed throughout the cortex.
- Formation of memories: needed to allow sensory information involved in explicit memories to come in.
- Permanent storage tends to be in the areas where the relevant information was first processed.
- When required, the separate parts are gathered together and reconstructed as a single, integrated memory for retrieval into our conscious awareness

- Through continual use of memory networks when recalling an episodic memory, the groups of neurons involved in storing the different bits of information will repeatedly fire together, strengthening their connections as they become tied together as a single memory. **This is known as LTP (long term potentiation).**

Research shows that:

- Episodic memories tend to also be stored throughout the cortex but especially in the right frontal lobe and the right temporal lobe.
- Frontal and temporal lobes as being more significantly involved in explicit memory processes than the other lobes

2. Hippocampus:

- Located in the median (middle) temporal lobe
- Two = one in each hemisphere
- During memory formation, hippocampus enables us to remember aspects like where the event happened, when and who it happened with. These details are explicit memories. Formation of emotional memories.

3. Amygdala: small structure (1.5cm long) located next to and interconnected to the hippocampus

- Role in emotional reactions (like fear and aggression) and attaching emotion to memory (e.g. memory of emotion shown on faces).
- Important for learning and memory of fear responses involving implicit memory (**conditioned fear responses**)
- Role in activating the hippocampus for declarative memories with emotional content and enhancing consolidation of these memories.

How does Hippocampus and Amygdala work together?

- Through its interaction with the amygdala, the hippocampus plays a role in the formation of emotional memories, particularly the explicit memory component of an emotional event.
- When emotionally aroused, we form semantic and episodic memories about the situations in which these occur and the hippocampus enables neural representations of this information as explicit memories.

For example, when you have an emotionally traumatic experience and you retrieve the memory from the cerebral cortex at some time in the future:

Hippocampus:

Activity of the hippocampus during memory formation will enable you to remember such aspects as where the event happened, when it happened, and whom you were with at the time when you retrieve the memory. These details are explicit memories.

Amygdala:

Your amygdala is also activated during the retrieval process, you will also remember the emotional arousal

content, and sympathetic nervous system reactions that have been linked to the memory may be initiated; for example, your muscles may tighten, your heart may beat faster, and so on. These details are implicit memories

4. **Cerebellum: the cauliflower shaped structure located at the base of the brain and at the rear.**

- Important roles in everyday voluntary, purposeful movements, such like talking, reaching, walking, brushing teeth or throwing a ball, so that your body parts can make one continuous movement.
    - Damage to the cerebellum makes it difficult to time and coordinate muscle control for everyday activities.

The role of the Cerebellum in LTM:

- Encoding and storage of implicit procedural memories for motor skills
- Long term storage of implicit procedural memories is between the connections of the basal ganglia and cerebellum (VCAA 2017 MCQ)
- The cerebellum does form and store implicit memories of simple reflexes acquired through classical conditioning, such as associating a sound with an impending puff of air and consequently blinking in anticipation of the puff.

- Other brain regions and structures such as the basal ganglia and motor areas of the cerebral cortex also play crucial roles in the learning and memory of simple and complex motor skills.