

TSM Lectures 108-109: Memory, the temporal lobe and cognitive function

Aims:

1. Describe the basic synaptic mechanism underlying learning and memory: LTP.
2. Describe the anatomical relationship between the systems for memory formation and the limbic system
3. Describe the structure of the temporal lobe and its role in cognitive function
4. Describe the characteristics of temporal lobe epilepsy
5. Describe the functional anatomy of language and speech production and relate this to aphasias

Learning and Memory

- Learning and memory are linked.
- Memory is stored as a neural trace.
- Recall is reactivation of the trace.
- Long-term potentiation (LTP):
 - Increase in efficiency and strength of a particular synapse, which results from an increase in activity at that synapse
- Studied in the animal hippocampus.

Basic neural circuitry of the hippocampus.

- **LTP** induced at CA3→ CA1 synapse, using *tetanus* (burst of high-frequency stimulation) to CA3
 - Input-specific
 - potentiates response to subsequent stimulus from same, but not different, input to same cell
 - Early LTP
 - Lasts for hours (short-term memory)
 - Late LTP
 - may last for weeks (long-term memory)
 - perhaps a lifetime, for lifelong memories
- **Basic anatomy and functional components of the temporal lobe**
 - **Auditory cortex**: lining lateral fissure, in Heschl's gyri (areas 41 & 42)
 - **Auditory association area** in superior temporal gyrus (area 22)
 - **Limbic areas** on medial surface, including parahippocampal gyrus & hippocampus
 - **Declarative memory** formation system: parahippocampal gyrus, entorhinal cortex & hippocampus
 - **Wernicke's speech** area (posterior part of area 22)

The Limbic system (MacLean 1952)

- Interconnected brain areas that regulate and express

- Emotions (vital feelings evoked by stimuli)
- Motivations (states of need or desire, which prompt actions)
- Includes
 - Hypothalamus (paternal genes)
 - Heart of the limbic system
 - Posterior hypothalamus: sham rage
 - Lateral hypothalamus: the pleasure center
 - Neocortex (maternal genes)

Temporal Lobe Epilepsy

- Neurons in limbic system have low threshold for epilepsy: "deranged synchronisation".
- Temporal lobe epilepsy (TLE) is characterised by aura, mood change, absence, motoric fit, and subsequent amnesia for fit.
- TLE also associated with an 'interictal behavioural syndrome':
 - Altered emotions
 - Distinctive intellectual interests – hyperreligiosity, hypergraphia
 - Personal dispositions – preoccupation with details, circumstantiality

Language

- In most people, a lateralised function, with left-sided dominance.
 - The *Wada* test for cerebral dominance

Aphasias

- **Broca's aphasia** (defined 1860s):
 - Understand written & spoken language
 - Cannot repeat spoken phrases or sentences on command
 - Difficulty speaking spontaneously; agrammatical
 - Dysarthric voice
 - Lesion in left frontal lobe
- **Wernicke's aphasia** (defined 1870s):
 - Difficulty understanding written & spoken language
 - Difficulty repeating on command
 - Fluent in speaking spontaneously
 - Lack of content & meaning in speech
 - Specific, causative lesion found in left superior temporal gyrus
- **Conduction aphasia**:
 - Cannot repeat on command
 - Fluent speech, with lots of 'filler' words
 - Full comprehension
 - Damage to arcuate fasciculus

The Wernicke-Geschwind model of language – The superior-longitudinal fasciculus (arcuate fasciculus) interconnects Broca's (language production) and Wernicke's (language comprehension) areas.