Biological Basis of Memory

Chap 12
374-382
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Post-Traumatic Amnesia

- Head trauma (like a concussion or worse) may disrupt normal brain functioning. May temporarily disrupt memory functions, or may produce more lasting effects if trauma is severe.

- Most common type: Retrograde amnesia for events just before the trauma. Memories for those events were in the process of being stored when the trauma happened. (More severe trauma increases the amount of RA).

Retrograde Amnesia by ECS or Other Traumas

- Recent memories most susceptible to disruption
- Rats given ECS 10 secs to 10 mins after learning showed decreased memory for task. ECS 1-3 hrs after learning had no effect.
- More recent memories may continue to be somewhat more susceptible than older memories:
- Humans receiving ECT show decreased recall of TV shows from last 1-3 years, no impairment of memory of shows from 4-17 years ago.

- Studying patients with amnesia has helped researchers understand the memory system.
• In instances of sudden stops or the extremes of movement in an accident situation, the brain can be injured by banging against the interior of the skull even if the skull is not fractured ("closed head injury").

Closed Head Injuries to Brain

• Prefrontal region & front tips of temporal lobes are particularly at risk (like the front bumper or headlights on your car, the front parts are likely to collide with skull).

Floor of Skull

Contusions of Closed Head Injury

• Pattern of frontal and temporal lobe bruising often seen.

The Sad Case of H. M.

• Patient H.M. was knocked down by a bike as a kid and lost consciousness for 5 minutes. This apparently damaged the tips of both of his temporal lobes.

• Three years later he developed post-traumatic focal epilepsy in both temporal lobes which could not be controlled by medication.

• Unilateral temporal lobe surgeries had successfully reduced seizures in previous patients with an epileptic focus in that area.

• Bilateral surgeries had been done in animals without serious disruptions of behavior, so……

• HM had bilateral medial temporal lobectomy
H. M.

- His epilepsy greatly improved but memory severely impaired
- Retrograde amnesia - most severe for the 2-3 years before surgery, some retrieval problems for memories as long as 9 years before surgery, but older memories and IQ intact.
- STM fairly normal but once HM is distracted, those memories are lost – consolidation of new memories not occurring
- Severe anterograde amnesia

Another Type of Post-Traumatic Amnesia

- Anterograde amnesia - impaired storing of new memories of events after the trauma (more severe damage increases anterograde amnesia)

Retrograde vs. Anterograde Loss

Different Aspects of Long Term Memory

- Terms to refer to types of LTM:
  - Declarative memories – memories we can state in words:
    - information ("semantic" memories)
    - life experiences ("episodic" memories)
  - Nondeclarative memories – memories resulting from motor skill learning and classical conditioning

- HM’s anterograde amnesia was an inability to store new declarative memories.
H.M. Also Shows All Memories Not Stored in Same Way

- H.M. has shown evidence of the formation of new procedural & implicit memories
- Finger maze, mirror tracing & reading, rotary pursuit, playing Tetris, classical conditioning

Clive W.

- Suffered damage to hippocampus and frontal cortex during a bout of encephalitis
- Extreme anterograde amnesia similar to H.M.’s; old LTM’s are fine – some additional dyscontrol of emotion because of frontal lobe damage.
- http://www.youtube.com/watch?v=CnBkmxI1vLks&list=PLjDIfEq66T_BnU79vD99GyDzMaGooy
- go to 1:58

New View of STM

- Now think that “STM” may be the current memory files we have “open” or are still working on – things that we are keeping in mind.
- Now call it “working memory”. Depends on prefrontal cortex. Many working memories will never be added to LTM because they concern temporary information.
- This kind of memory has not yet developed in infants & gradually develops into early adulthood.

Delayed Response Task to Test Working Memory

One task used to study working memory and the ability to keep something in mind is the “delayed response task”.

Prefrontal Cortex & Working Memory

- Animals or people with prefrontal damage are impaired on delayed response tasks
- Monitoring brain activity reveals that the prefrontal area is active during the delay
Memory Role of Other Areas

- Amygdala - emotional significance
- Cerebellum & Striatum/Basal Ganglia - nondeclarative motor and conditioning memories
- Long-term memories - diffusely stored in the secondary & association cortex areas involved in the original stimulus perception/processing

Nondeclarative Memory Region

- Richard Thompson (1986) found a nucleus in the cerebellum (LIP – lateral interpositus) essential for the conditioned eyelid response of rabbits
- Neurons active in this area during this learning
- Inactivating these neurons disrupts conditioning
- These neurons also appear to be active in humans during eyelid conditioning

http://www.learner.org/series/discoveringpsychology/09/off/expand.html go to 19:30

Alzheimer’s Disease

Most common dementia - a terminal progressive degenerative disease
Affects ~5.2 million in US.

PET Scan of Decreased Brain Activity in Severe AD

Alzheimer’s Disease

Widespread degeneration in cortex (especially association areas), hippocampus, amygdala, as well as a critical source of ACh - nucleus basalis. Cortical & hippocampal changes can be seen on MRI as disease advances.

- Runs in families; genes on at least 4 different chromosomes have been linked to early AD and others are linked (but less strongly) to the more common late-occurring variety
- Several pathological changes in brain
  - Production of abnormal amyloid protein which damages neurons, causing distinctive plaques of neural debris.
  - Production of abnormal tau protein which produces abnormal neurofibrillary tangles within neurons. Interfere with neuron function & may cause toxic levels of glutamate to be released, causing cell death.
Special PET Scan Tracer Which Binds to Amyloid Plaques

• Currently: drugs to boost ACh by preventing its breakdown (Aricept, Cognex, Exelon, Reminyl) provide some improvement in the early stages.
• One new med to try to block toxic effects of glutamate (Namenda)
• Researchers investigating potential genetic, stem cell, and insulin related treatments as well as a possible amyloid 42 vaccine.
• http://www.medicalnewstoday.com/articles/287837.php

Amnesia Due to Thalamus/Hypothalamus Damage

• Korsakoff’s Syndrome - serious anterograde AND increasing retrograde amnesia. Tendency to confabulate as their episodic memories deteriorate.
• Like HM, implicit memories are better preserved.
• Due to thiamine deficiency, most often in alcoholics, which impairs the supply of energy (glucose) to the brain
• Widespread loss of neurons; most concentrated damage in DM thalamus & mammillary bodies of hypothalamus, and cortex

How About Other Limbic Areas?

Other Diencephalic Cases

• N.A. & his fencing foil
• mild retrograde + more serious anterograde amnesia
• 1970 CAT scan revealed left DM thalamus lesion
• More recent MRI scan showed additional damage to mammillary bodies.